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The Natural History of Enewetak Atoll

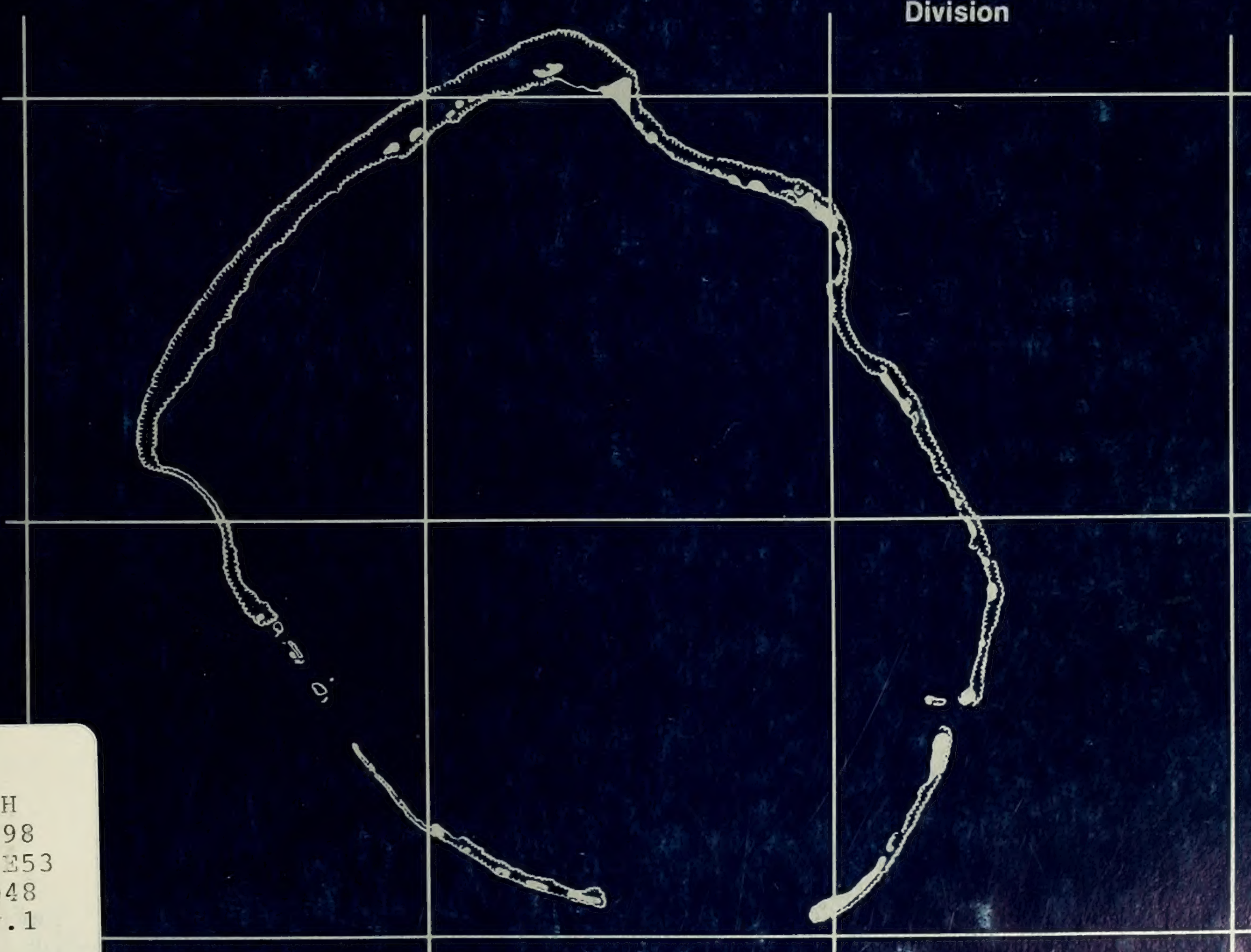
Volume II Biogeography and Systematics

United States
Department of Energy

Office of
Energy Research

Office of Health and
Environmental Research

Ecological Research
Division



Volume II

Biogeography and Systematics

Top: Aerial view of Enewetak Atoll from an altitude of 10,000 ft looking north. The wide south passage to the lagoon is at the bottom of the picture. The three islands to the right of the passage are Enewetak, Medren, and Japtan. The deep east pass is seen between Medren and Japtan. The five southwest islands are seen to the left of the wide south passage. Ikuren is the first one. North of these islands is the shallow southwest pass. The Atoll is elliptical in shape measuring about 41 km from north to south and 33 km from east to west. [Photography by P. L. Colin.]

Bottom: Aerial view of the northern end of Enewetak Island showing the cluster of buildings of the Mid-Pacific Research Laboratory. The quarry is visible on the reef flat. The small island immediately to the north is Bokandretak. [Photography by E. S. Reese.]

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The Natural History of Enewetak Atoll

Volume II Biogeography and Systematics

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[Photograph by Annabelle Lyman.]

Bok in, kōn menninmour ko im menin eddōk ko ion Enewetak, ej kein kememej im kautiej ri Enewetak.

This volume on the natural history of Enewetak Atoll is dedicated to the people of Enewetak.

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Foreword

As activity and funding at the Mid-Pacific Research Laboratory began to diminish in the early 1980s, it seemed fitting that a synthesis be prepared of the three decades of research that had been conducted at this Laboratory on Enewetak Atoll. For 30 years the Atoll served as a convenient, accessible location for studies of Mid-Pacific island ecosystems, and several hundred scientists utilized the facility. Primary funding was provided by the Office of Health and Environmental Research, Ecological Research Division, U. S. Department of Energy (formerly the Atomic Energy Commission and the Energy Research and Development Administration).

This is an attempt to synthesize in two volumes the results of the Mid-Pacific Research Laboratory studies that have been published in hundreds of widely dispersed publications. It is hoped that present and future scientists involved in studies of Mid-Pacific islands will find this synthesis a convenient resource for their research.

Considerable time and effort were expended by many contributors to make this synthesis possible. Thanks are extended to all these authors for their manuscripts. Special appreciation is expressed for Dr. Dennis Devaney's dedication in filling gaps in the taxonomic descriptions of several invertebrate groups. This publication would not have been possible, however, without the determination and persistence of Dr. Ernst Reese in organizing and collecting the material. Deepest gratitude is acknowledged for his conscientious efforts.

Helen M. McCammon, *Director*
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United States Department of Energy

Acknowledgments

Many people have contributed in many ways to the production of these two volumes. Regardless of the nature of the contribution, everyone listed below has given thought and time, that most precious commodity of thinking individuals, to bring *The Natural History of Enewetak Atoll* into publication. Authors of the chapters are not listed separately, even though, in most cases, they critically read other chapters. No doubt we have overlooked many who have contributed in important ways, and for these oversights we apologize. To all of you we wish to extend our deepest thanks.

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Preface

The two volumes of *The Natural History of Enewetak Atoll* summarize research done at the Mid-Pacific Research Laboratory from 1954 to 1984 under the auspices of the Department of Energy. The history of the laboratory and the reasons for its support by the United States Department of Energy are described in Chapter 1 of Volume 1.

Over a thousand persons—established scientists, their assistants, and graduate students—conducted research at the laboratory during the 30-year period. Their efforts resulted in 223 publications. These have been collected in four volumes of reprints entitled *Mid-Pacific Marine Laboratory Contributions, 1955–1979*, U. S. Department of Energy, Publication NVO 628-1. The laboratory has continued operation on a limited scale to the present. A collection of papers recently appeared in the *Bulletin of Marine Science*, Volume 38, 1986.

Much of the research conducted at the laboratory was on the marine environment. The reason was that the majority of scientists applying to work at Enewetak were marine biologists. For many, this was the first opportunity to study the biota of a coral atoll. Fewer studies were conducted in the terrestrial environment and its biota. Nevertheless, as these volumes attest, the coverage is amazingly complete and thorough, and there are few, if any, studies of an equivalent ecosystem that equal the total research effort reported in these volumes.

Volume I provides a synthesis of the research carried out under the subject headings of the respective chapters. Certain of the chapters, e.g., those on geology, subtidal and intertidal environments and ecology, and those on reef processes and trophic relationships, summarize a great diversity of research carried out by many scientists for many years. In contrast, the chapters on meteorology and oceanography summarize research carried out under one integrated program involving fewer scientists working over a shorter period.

Volume II of *The Natural History of Enewetak Atoll* provides information on the taxonomy of animals and plants known to occur at Enewetak Atoll. This taxonomy represents a fulfillment of one of the first assignments to the laboratory—to determine the scientific names of the biota of the atoll. The collections on which the checklists in each chapter are based are housed at the Bernice P. Bishop Museum in Honolulu and the U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C.

In addition to the species checklists, each chapter in Volume II provides a succinct summary of the biota with respect to endemism, range extensions, and other features that set the Enewetak biota apart from those one might expect to find on equivalent Indo-Pacific islands. This compendium of taxonomic information for an atoll should prove of immense value to scientists interested in biogeography and evolutionary biology of island ecosystems for years to come.

One of the problems of editing these volumes has been the correct use of place names. In some cases authors used the military code names for islands while others used the native names. Even the native names have changed from early phonetic spellings to the spellings currently in use and preferred by the Enewetak people. For example, the name of the atoll has changed from Eniwetok to Enewetak, and, although the correct current spelling is used throughout, the old spelling occurs in older references and maps which appear in these volumes. Maps giving the military code names and the native names preferred by the Enewetak people are located in Chapter 1 of Volume I. Surprisingly, it is difficult to determine the exact number of islands. Due to the effects of storms, small islands are ephemeral, and two islands and part of a third were obliterated by nuclear explosions. Currently there are 39 recognizable islands, and these are shown on the map used throughout the book.

These volumes do not report on the extensive radiological surveys and studies which have been conducted by the Lawrence Livermore Laboratory, University of California, and the Radiation Laboratory, University of Washington, also under the auspices of the U. S. Department of Energy.

Dennis M. Devaney, senior editor of this volume, disappeared while collecting specimens off the Island of Hawaii on August 13, 1983. Dennis was doing what he loved best, collecting marine invertebrates, at the time of his death. He collected extensively at Enewetak, and he undertook the task of organizing the systematic chapters of Volume II. Beatrice L. Burch, Devaney's assistant at the

Bishop Museum, completed the task, and she has written the introduction to Volume II.

It is fitting that the two volumes of this book are dedicated to the people of Enewetak Atoll. They, like so many other human beings, were caught up by forces beyond their control and understanding in an immense cataclysm of human history. In a small way, this book stands as something good that has resulted from those years.

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Introduction

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The organization and coordination of the taxonomic section of this volume was initiated by Dr. Dennis M. Devaney of the Bernice P. Bishop Museum and was completed by Beatrice L. Burch after Dr. Devaney died in a tragic scuba-diving accident on August 13, 1983, as he was investigating shrimp offshore from the Big Island of Hawaii. His great interest in all invertebrates in the tropics was increased when the opportunity arose for him to work at the Mid-Pacific Research Laboratory at Enewetak Atoll. Devaney made his first collecting trip to the atoll in the early 1960s while he was still in graduate school. As the collection grew and taxonomy of the organisms became better known, it was soon apparent that the reference collection at Enewetak was becoming increasingly valuable. Devaney was pleased to participate in the Coral Reef Workshop held at the atoll in 1976, because he believed that the scleractinian coral collection was the key for the study of other organisms. The workshop brought together international coral specialists to establish species limits on this important and variable group. After the workshop was held, reference material from Enewetak was deposited in European and American museums for ready reference by a wider audience of scientists. Each year after the Coral Reef Workshop, Devaney went to Enewetak to curate the reference collection and to conduct his own research on echinoderms. At the same time, he encouraged the work of specialists to compile taxonomic and other research from Enewetak for this publication.

The diversity of the organisms at Enewetak made it difficult to find specialists to study all groups, so Devaney prepared several chapters himself. Unfortunately, most groups were collected in the course of other work such as physiology, toxicity, etc., and were not extensively collected by specialists for a particular taxonomic group.

The number of families, genera, and species reported in this volume either from the literature or from new records determined by the authors of this volume are presented in Table 1.

References in this volume show that some or much work was done on a particular taxon. Many groups remain

TABLE 1

Taxonomic Groups at Enewetak Atoll

Taxon	No. of species	No. of genera	No. of families
Algae	238	106	40
Fungi	112	58	18
Vascular plants	123	97	48
Forams and nonplanktonic protozoa	279	144	58
Porifera	40	33	26
Actiniaria	27	21	14
Octocorallia	31	17	12
Scleractinia	169	53	12
Brachiopoda	4	4	4
Bryozoa	84	61	39
Sipuncula	11	77	3
Echiura	2	2	2
Platyhelminthes	31	11	10
Nemertea	1	1	1
Nematoda	1	1	1
Polychaeta	132	110	34
Mollusca (fossil, recent)	1240	453	151
Insects and related arthropods	190	157	93
Pycnogonida	5	4	4
Stomatopoda	12	4	4
Cirripedia	10	7	6
Lagoon plankton	285	177	82
Ostracoda	10	10	5
Natantia	145	56	14
Reptantia	4	3	3
Anomura	76	29	10
Brachyura	293	114	16
Holothuroidea	20	11	5
Echinodermata other than Holothuroidea	97	65	32
Fishes of the Marshall Islands	815	338	92
Reptilia	9	9	5
Aves	41	27	12
Mammalia	9	7	6
Miscellaneous	124	87	40
Totals	4671	2284	902

to be worked on more thoroughly by specialists in particular fields, such as Porifera or Tunicata, which, at the present time, seem to be represented so lightly at Enewetak Atoll. By having a named reference collection, the researchers there were able to identify organisms used in their studies on biochemistry, ecology, productivity, animal or plant associations, physiology, immunology, radiobiology, growth rates, and reproduction. They were also able to make broad interpretations of reef chronology, geochemistry, stratigraphy, and biogeographic distribution.

The checklist contained in each chapter has a coded entry symbol placed before the generic designation to indicate (1) if the organism represents a newly recorded species for Enewetak or for the Marshall Islands, (2) if it is a fossil record, or (3) if it has some other reason to be so marked. The explanations for these codes follow each species checklist.

Chapter 1

Marine Benthic Algae of Enewetak Atoll

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Our present knowledge of the floristics and ecology of the marine benthic algae on Pacific atolls is based primarily on studies conducted on Enewetak Atoll. There are more species of marine benthic algae known from this atoll than are known from any other Indo-Pacific atoll.

The first published account of the marine benthic algae of Enewetak appeared in Taylor's (1950b) treatise of the plants of Bikini, which was part of a comprehensive study of the flora and fauna of Bikini Atoll and other adjacent atolls conducted in 1946 prior to the atomic bomb tests of "Operation Crossroads." The phycological study was not only the first for these atolls but also represented the pioneering study in the Marshall Islands. Descriptive and illustrative records of 57 species were included from Enewetak. Three new species of the green algal genus *Halimeda* were described based on Enewetak specimens as holotypes (*H. fragilis* Taylor, *H. gigas* Taylor, and *H. lacunalis* Taylor).

Dawson (1957) made extensive collections of marine algae on Enewetak during the summer of 1955 under the auspices of the Eniwetok Marine Biological Laboratory (now called the Mid-Pacific Marine Laboratory). His objective was to provide the laboratory with an algal reference collection. The extensive collections made by Ralph F. Palumbo of the Applied Fisheries Laboratory, University of Washington, in relation to his radiobiological survey in the Marshalls were also incorporated in the floristic account of the 211 species reported by Dawson (1957). A few of these species were mentioned in technical reports of the U. S. Atomic Energy Commission by Palumbo (1950, 1955, 1959) and a later paper (Lowman and Palumbo, 1962). Based on the Enewetak specimens as holotypes, five new red algal species were described: *Antithamnion percurrens* Dawson, *Callithamnion marshallensis* Dawson, *Ceramium marshallense* Dawson, *C. sympodiale* Dawson, and *C. vagabunde* Dawson.

The first ecological study on deep water algae in an atoll lagoon was conducted on Enewetak by Gilmartin (1960). During 1955 and 1956, he ran a transect across the lagoon in waters ranging from 20 to 65 m deep and recorded, as well as collected, algae he observed at the various depths. A total of 87 species was reported: 16 species represented new records not previously reported by Taylor (1950b) or Dawson (1957).

Further algal studies which mention specimens from Enewetak were mainly monographic treatments of specific algae. Records of blue-green algae from Enewetak can be found in monographs by Drouet and Daily (1956) and Drouet (1968, 1973), who drastically revised the classification scheme. Drouet's classification scheme is followed in this presentation, and it is coincidental that he identified all the blue-green algae reported by Taylor (1950b), Dawson (1957), and Gilmartin (1960).

Other algal genera studied include records of *Halimeda* (Hillis, 1959), *Turbinaria* (Taylor, 1964), *Tydemania* (Gilmartin, 1966), *Dawsoniella* (Hollenberg, 1967), *Polysiphonia* (Hollenberg, 1968a, 1968b), *Herposiphonia* (Hollenberg, 1968c), *Lophosiphonia* (Hollenberg, 1968d), *Fosliella* on sea urchin spines (Lawrence and Dawes, 1969), and *Caulerpa* (Calvert et al., 1976). *Polysiphonia pentamera* Hollenberg (1968b) was described as a new species from Enewetak Atoll. A recent study on the distribution of *Halimeda* and *Tydemania* on Enewetak by Hillis-Colinvaux (1977) added two more species records of *Halimeda* to the flora. In the last chapter of the exhaustive review of *Halimeda* by Hillis-Colinvaux (1980), the habitats occupied by *Halimeda* at Enewetak are described in detail. In a paper presented at the 63rd Annual Meeting of the Western Society of Naturalists held at the California State University of Long Beach, Hillis-Colinvaux (1982) described the large populations of *Halimeda* down to 100 m and growth to over 140 m on the windward and leeward outer slopes of Enewetak. The submersible "*Makali'i*" was used for observations.

Aside from the above papers, several ecological studies mention algal species. Marsh (1970) carried out studies on the primary productivity of crustose coralline algae and later conducted studies on the productivity of the reef community as a whole (Smith and Marsh, 1973). Other studies which mention algae are those of Odum and Odum (1955), Bakus (1967), Johannes et al. (1972), and Gerber and Marshall (1974). *Calothrix crustacea* Schousboe and Thuret and *Hormothamnion enteromorphoides* B. and Fl.

were heterocystous blue-greens studied by Wiebe et al. (1975), Webb and Wiebe (1975), Webb et al. (1975), and Wiebe (1976) in their studies on the nitrogen cycle.

On the basis of the papers cited above, 238 species (106 genera) of marine benthic algae are known from Enewetak Atoll: Cyanophyta (16 species), Chlorophyta (89 species), Phaeophyta (24 species), and Rhodophyta (109 species). Nine of the species (preceded by a dagger in Table 1) were described as new with the Enewetak specimens serving as holotypes. It is interesting to note that 40

TABLE 1

Checklist of Marine Benthic Algae of Enewetak

Division CYANOPHYTA (blue-green algae)
Class CYANOPHYCEAE
Order CHROOCOCCALES
Family CHAMAESIPHONACEAE
Entophysalis conferta (Kütz.) Dr. and Daily: Dawson, 1957.
Entophysalis deusta (Menegh.) Dr. and Daily: Drouet and Daily, 1956; Dawson, 1957.
Family CHROOCOCCACEAE
Anacystis dimidiata (Kütz.) Dr. and Daily: Dawson, 1957.
Coccochloris stagnina Sprengel: Dawson, 1957.
Gomphosphaeria aponina Kütz.: Taylor, 1950b; Drouet and Daily, 1956; Dawson, 1957.
Order OSCILLATORIALES
Family NOSTOCACEAE
Calothrix crustacea Schousboe and Thuret: Dawson, 1957; Bakus, 1967; Drouet, 1973; Webb et al., 1975; Webb and Wiebe, 1975; Wiebe et al., 1975; Wiebe, 1976.
Rivularia atra Roth: Dawson, 1957.
Rivularia polyotis (J. Ag.) B. and Fl.: Dawson, 1957.
Hormothamnion enteromorphoides B. and Fl.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960; Webb et al., 1975; Wiebe et al., 1975.
Scytonema hofmanii Ag.
Scytonema myocyrous (Dillw.) C. Ag.: Dawson, 1957.
Scytonema polycystum B. and Fl.: Dawson, 1957; Gilmartin, 1960.
Family OSCILLATORIACEAE
Microcoleus lyngbyaceus (Kütz.) Crouan.
Hydrocoleum cantharidosmum (Mont.) Gomont: Taylor, 1950b.
Hydrocoleum coccineum Gomont: Dawson, 1957.
Hydrocoleum comoides (Harv.) Gomont: Dawson, 1957; Gilmartin, 1960.
Hydrocoleum glutinosum (C. Ag.) Gomont: Dawson, 1957; Gilmartin, 1960.
Hydrocoleum lyngbyaceum Kütz.: Dawson, 1957.
Lyngbya aestuarii (Mert.) Lyngb.: Dawson, 1957.
Lyngbya confervoides C. Ag.: Taylor, 1950b; Dawson, 1957.
Lyngbya majuscula (Dillw.) Harv.: Dawson, 1957; Gilmartin, 1960.
Lyngbya meneghiniana (Kütz.) Gomont: Taylor, 1950b; Dawson, 1957.
Lyngbya semiplena (Ag.) J. Ag.: Dawson, 1957.
Oscillatoria submembranacea Ard. and Straff: Drouet, 1968.
Phormidium penicillatum Gomont: Dawson, 1957.
Porphyrosiphon notarisii (Menegh.) Kütz.
Oscillatoria nigro-viridis Thw.: Dawson, 1957.
Schizothrix arenaria (Berkeley) Gomont.
Symploca laete-viridis Gomont: Dawson, 1957; Gilmartin, 1960.
Schizothrix calcicola (C. Ag.) Gomont: Bakus, 1967; Drouet, 1968; Johannes et al., 1972; Webb and Wiebe, 1975.
Phormidium crosbyanum Tilden: Taylor, 1950b; Dawson, 1957.
Plectonema nostocorum Bornet: Taylor, 1950b; Dawson, 1957.
Plectonema terebrans B. and Fl.: Dawson, 1957.
Schizothrix lacustris A. Br.: Dawson, 1957.
Schizothrix mexicana Gomont: Drouet, 1968.
Lyngbya gracilis (Menegh.) Rabenh.: Taylor, 1950b; Dawson, 1957.
Lyngbya sordida (Zanard.) Gomont: Dawson, 1957; Gilmartin, 1960.
Symploca hydnoides (Harv.) Kütz: Dawson, 1957; Gilmartin, 1960.
Schizothrix tenerrima (Gomont) Dr.: Drouet, 1968.
Microcoleus tenerrimus Gomont: Dawson, 1957.
Spirulina subsalsa Oersted: Dawson, 1957.
Spirulina major Kütz.: Dawson, 1957.
Spirulina tenerrima Kütz.: Dawson, 1957.

(This table continued on next page.)

TABLE 1 (cont'd)

Division CHLOROPHYTA (green algae)
  Class CHLOROPHYCEAE
    Order CHAETOPHORALES
      Family CHAETOPHORACEAE
        •*Entocladia viridis* Reinke: Dawson, 1957.
    Order ULVALES
      Family ULVACEAE
        •*Enteromorpha acanthophora* Kütz.: Dawson, 1957.
        Enteromorpha clathrata (Roth) J. Ag.: Dawson, 1957.
        Enteromorpha intestinalis (L.) Link: Dawson, 1957.
        Enteromorpha kylinii Bliding: Dawson, 1957.
        Enteromorpha lingulata J. Ag.: Taylor, 1950b.
        Enteromorpha ralfsii Harvey: Dawson, 1957.
        •*Enteromorpha tubulosa* (Kütz.) Kütz.: Dawson, 1957.
    Order CAULERPALES
      Family BRYOPSIDACEAE
        Bryopsis hypnoides Lamx.: Dawson, 1957.
        Bryopsis indica A. and E. S. Gepp: Taylor, 1950b; Dawson, 1957.
        Bryopsis pennata Lamx.: Dawson, 1957; Gilmartin, 1960.
      Family CAULERPACEAE
        Caulerpa ambigua Okamura
          Caulerpa vickersiae Boerg.: Dawson, 1957; Gilmartin, 1960.
        Caulerpa antoensis Yamada: Dawson, 1957.
        Caulerpa bikinensis Taylor: Dawson, 1957.
        Caulerpa brachypus Harv.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
        Caulerpa elongata W. v. Bosse: Odum and Odum, 1955; Dawson, 1957; Calvert et al., 1976.
        Caulerpa filicoides Yamada: Dawson, 1957.
          Caulerpa acuta (Yamada) Yamada: Gilmartin, 1960.
        Caulerpa peltata Lamx.: Gilmartin, 1960.
        Caulerpa racemosa (Forsk.) J. Ag.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
        Caulerpa serrulata (Forsk.) J. Ag.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960; Calvert et al., 1976.
        Caulerpa sertularioides (Gmel.) Howe: Gilmartin, 1960.
        Caulerpa taxifolia (Vahl) C. Ag.: Dawson, 1957.
        Caulerpa urvilliana Montagne: Taylor, 1950b; Dawson, 1957; Calvert et al., 1976.
        Caulerpa verticillata J. Ag.: Gilmartin, 1960.
        Caulerpa webbiana Montagne: Dawson, 1957; Gilmartin, 1960; Calvert et al., 1976.
      Family CODIACEAE
        Avrainvillea lacerata Harv.: Taylor, 1950b; Dawson, 1957.
        Avrainvillea nigricans Decaisne: Gilmartin, 1960.
        Codium arabicum Kütz.: Dawson, 1957.
        Codium edule Silva: Dawson, 1957.
        Codium geppii O. C. Schmidt: Dawson, 1957; Gilmartin, 1960.
        •*Codium saccatum* Okamura: Dawson, 1957.
        Codium tenue Kütz.: Taylor, 1950b; Dawson, 1957.
        Halimeda copiosa Goreau and Graham: Hillis-Colinvaux, 1977.
          Halimeda opuntia f. *hederacea* Barton: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
        Halimeda cylindracea Decaisne: Hillis-Colinvaux, 1977.
          Halimeda monile (Solander) Lamx.: Dawson, 1957; Gilmartin, 1960, 1966.
        Halimeda discoidea Decaisne: Gilmartin, 1960.
        Halimeda distorta (Yamada) Colinvaux: Hillis-Colinvaux, 1977.
        Halimeda fragilis Taylor: Taylor, 1950b; Hillis, 1959; Gilmartin, 1960, 1966; Hillis-Colvinaux, 1977.†
        †*Halimeda gigas* Taylor: Taylor, 1950b; Dawson, 1957; Hillis, 1959; Hillis-Colinvaux, 1977.
        Halimeda gracilis Harv.: Gilmartin, 1960; Hillis-Colinvaux, 1977.
        Halimeda incrassata (Ellis) Lamx.: Hillis-Colinvaux, 1977.
          Halimeda tridens (E. and S.) Lamx.: Gilmartin, 1960.
          Halimeda tridens f. *lamourouxii* (J. Ag.) W.v. Bosse: Taylor, 1950b; Dawson, 1957.
          Halimeda tridens f. *tripartita* (Barton) Collins: Taylor, 1950b.
          Halimeda tridens f. *typica* (Barton) Collins: Taylor, 1950b.

•Only specimen recorded from Micronesia.
†New species; holotype based on Enewetak specimens.

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TABLE 1 (cont'd)

Family CODIACEAE (cont'd)
†*Halimeda lacunalis* Taylor: Taylor, 1950b; Dawson, 1957; Hillis, 1959; Gilmartin, 1960; Hillis-Colinvaux, 1977.
Halimeda macrophysa Askenasy: Dawson, 1957; Hillis-Colinvaux, 1977.
Halimeda micronesica Yamada: Hillis-Colinvaux, 1977.
Halimeda minima (Taylor) Colinvaux: Hillis-Colinvaux, 1977.
Halimeda opuntia f. *minima* Taylor: Dawson, 1957; Gilmartin, 1960.
Halimeda opuntia (L.) Lamx.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960; Hillis-Colinvaux, 1977.
Halimeda stuposa Taylor: Taylor, 1950b; Dawson, 1957; Hillis-Colinvaux, 1977.
Halimeda taenicola Taylor: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960; Hillis-Colinvaux, 1977.
Pseudochlorodesmis furcellata (Zanard.) Boerg.: Dawson, 1957; Gilmartin, 1960.
Rhipilia diaphana Taylor: Taylor, 1950b; Dawson, 1957.
Rhipilia geppii Taylor: Taylor, 1950b; Dawson, 1957.
Rhipilia orientalis A. and E. S. Gepp: Dawson, 1957.
Tydemania expeditionis W. v. Bosse: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960, 1966; Hillis-Colinvaux, 1977.
Udotea indica A. and E. S. Gepp: Taylor, 1950b; Gilmartin, 1960.
Udotea javensis (Mont.) A. and E. S. Gepp: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
Udotea orientalis A. and E. S. Gepp: Gilmartin, 1960.
Udotea palmetta Decaisne: Dawson, 1957.
Family DERBESIACEAE
Derbesia attenuata Dawson: Dawson, 1957.
Derbesia marina (Lyngb.) Solier: Dawson, 1957.
**Derbesia neglecta* Reinbold: Gilmartin, 1960.
Derbesia ryukiuensis Yamada and Tanaka: Dawson, 1957.
Family PHYLLOSIPHONACEAE
Ostreobium reineckii Bornet: Dawson, 1957.
Order SIPHONOCLADALES
Family BOODLEACEAE
Boodlea composita (Harv.) Brand: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
Boodlea siamensis Reinbold: Taylor, 1950b; Dawson, 1957.
Struvea anastomosans (Harv.) Piccone: Dawson, 1957.
Family SIPHONOCLADACEAE
Cladophoropsis gracillima Dawson: Dawson, 1957; Gilmartin, 1960.
Cladophoropsis sundanensis Reinbold: Dawson, 1957; Gilmartin, 1960.
Siphonocladus rigidus Howe: Dawson, 1957.
Family VALONIACEAE
Boergesenia forbesii (Harv.) Feldmann: Dawson, 1957.
Dictyosphaeria cavernosa (Forsk.) Boerg.: Taylor, 1950b; Dawson, 1957; Webb et al., 1975.
Dictyosphaeria intermedia W. v. Bosse: Taylor, 1950b; Odum and Odum, 1955; Dawson, 1957.
Dictyosphaeria versluysii W. v. Bosse: Dawson, 1957.
Valonia aegagropila C. Ag.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
Valonia fastigiata Harv.: Dawson, 1957.
Valonia utricularis (Roth) C. Ag.: Dawson, 1957; Gilmartin, 1960.
Valonia ventricosa J. Ag.: Dawson, 1957; Gilmartin, 1960.
Valoniopsis pachynema (Martens) Boerg.: Taylor, 1950b; Dawson, 1957.
Order DASYCLADALES
Family DASYCLADACEAE
Acetabularia moebii Solms-Laubach: Dawson, 1957; Gilmartin, 1960.
Neomeris bilimbata Koster: Dawson, 1957.
Order CLADOPHORALES
Family ANADYOMENACEAE
Anadyomene wrightii Gray: Dawson, 1957.
Microdictyon japonicum Setch.: Dawson, 1957.
Microdictyon okamurai Setch.: Taylor, 1950b; Dawson, 1957.
Rhipidiphyllon reticulatum Askenasy: Taylor, 1950b; Dawson, 1957.
Family CLADOPHORACEAE
Chaetomorpha indica Kütz.: Dawson, 1957.
**Cladophora albida* (Hudson) Kütz.: Gilmartin, 1960.
Cladophora crystallina (Roth) Kütz.: Dawson, 1957.
**Cladophora gracilis* (Griffiths) Kütz.: Gilmartin, 1960.

*Only specimen recorded from Micronesia.
†New species; holotype based on Enewetak specimens.

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TABLE 1 (cont'd)

Family CLADOPHORACEAE (cont'd)
Cladophora inserta Dickie: Dawson, 1957.[*]
Cladophora socialis Kütz.: Dawson, 1957; Gilmartin, 1960.
Rhizoclonium implexum (Dillwyn) Kütz.: Dawson, 1957.[*]
Division PHAEOPHYTA (brown algae)
Class PHAEOPHYCEAE
Order ECTOCARPALES
Family ECTOCARPACEAE
Ectocarpus breviarticulatus J. Ag.: Dawson, 1957.
Ectocarpus mitchellae Harv.: Taylor, 1950b; Dawson, 1957.
Feldmannia indica (Sonder) Womersley and Bailey.
Ectocarpus indicus Sonder: Taylor, 1950b; Dawson, 1957.
Feldmannia irregularis (Kütz.) Hamel.
Ectocarpus irregularis Kütz.: Dawson, 1957.
Order SPHACELARIALES
Family SPHACELARIACEAE
Sphacelaria furcigera Kütz.: Dawson, 1957; Gilmartin, 1960.
Sphacelaria novaehollandiae Sonder: Taylor, 1950b; Dawson, 1957.
Sphacelaria tribuloides Menegh.: Dawson, 1957.
Order DICTYOTALES
Family DICTYOTACEAE
Dictyopteris repens (Okam.) Boerg.: Dawson, 1957; Gilmartin, 1960, 1966.
Dictyota cervicornis Kütz.: Gilmartin, 1960.
Dictyota dichotoma Lamx.: Gilmartin, 1960.
Dictyota divaricata Lamx.: Dawson, 1957; Gilmartin, 1960; Lowman and Palumbo, 1962; Gilmartin, 1966.
Dictyota patens J. Ag.: Dawson, 1957.
Dictyota pinnatifida Kütz.: Taylor, 1950b; Dawson, 1957.
Lobophora papenfussii (Taylor) Womersley.
Pocockiella papenfussii Taylor: Taylor, 1950b; Dawson, 1957.
Lobophora variegata (Lamx.) Womersley: Smith and Marsh, 1973.
Pocockiella variegata (Lamx.) Papenfuss: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
Zonaria variegata (Lamx.) Mertens: Odum and Odum, 1955.
Padina australis Hauck: Dawson, 1957.
Padina tenuis Bory.
Padina commersonii Bory: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960, 1966.
Spatoglossum schroederi (Mert.) J. Ag.: Gilmartin, 1960.[*]
Order SCYTOSIPHONALES
Family SCYTOSIPHONACEAE
Hydroclathrus clathratus (Bory) Howe: Taylor, 1950b; Dawson, 1957.
Rosenvingea fastigiata (Zanard.) Boerg.: Taylor, 1950b; Dawson, 1957.[*]
Rosenvingea intricata (J. Ag.) Boerg.: Taylor, 1950b; Dawson, 1957.
Rosenvingea orientalis (J. Ag.) Boerg.: Gilmartin, 1960.[*]
Order DICTYOSIPHONALES
Family CHNOOSPORACEAE
Chnoospora implexa (Hering) J. Ag.: Dawson, 1957.
Order FUCALES
Family SARGASSACEAE
Turbinaria ornata (Turn.) J. Ag.: Taylor, 1950b; Dawson, 1957, 1964.
Division RHODOPHYTA (red algae)
Class BANGIOPHYCEAE
Order BANGIALES
Family ERYTHROPELTIDACEAE
Erythrotrichia carnea (Dillwyn) J. Ag.: Taylor, 1950b; Dawson, 1957.
Erythrotrichia parietalis Tanaka: Dawson, 1957.
Order PORPHYRIDIALES
Family GONIOTRICHACEAE
Asterocystis ornata (C. Ag.) Hamel: Taylor, 1950b; Dawson, 1957.
Goniotrichum alsidii (Zanard.) Howe: Taylor, 1950b.
Goniotrichum elegans (Chauvin) Zanard.: Dawson, 1957.

[*]Only specimen recorded from Micronesia.

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TABLE 1 (cont'd)

Class FLORIDEOPHYCEAE
- Order NEMALIALES
  - Family ACROCHAETIACEAE
    - *Acrochaetium gracile* Boerg.: Dawson, 1957.
    - *Acrochaetium robustum* Boerg.: Dawson, 1957; Gilmartin, 1960.
    - **Kylinia crassipes* (Boerg.) Kylin: Dawson, 1957.
    - **Kylinia secunda* (Lyngb.) Papenfuss: Dawson, 1957.
  - Family BONNEMAISONIACEAE
    - *Asparagopsis taxiformis* (Delile) Collins and Hervey: Dawson, 1957; Gilmartin, 1960; Gerber and Marshall, 1974.
    - *Falkenbergia hillebrandii* (Bornet) Falkenberg: Dawson, 1959; Gilmartin, 1960.
  - Family CHAETANGIACEAE
    - *Galaxaura fastigiata* Decaisne: Dawson, 1957.
    - *Galaxaura filamentosa* Chou: Dawson, 1957.
  - Family GELIDIACEAE
    - **Gelidiella bornetii* (W. v. Bosse) Feldmann and Hamel: Dawson, 1957.
    - *Gelidiella tenuissima* Feldmann and Hamel: Dawson, 1957.
    - **Gelidium crinale* (Turn.) Lamx.: Dawson, 1957.*
    - *Gelidium pusillum* (Stackh.) LeJolis: Dawson, 1957.
    - *Wurdemannia miniata* (Lmk. and D. C.) Feldmann and Hamel: Dawson, 1957.
  - Family HELMINTHOCLADIACEAE
    - *Liagora farinosa* Lamx.: Dawson, 1957.
    - **Liagora hawaiiana* Butters: Dawson, 1957.
    - **Liagora orientalis* J. Ag.: Dawson, 1957.
    - *Liagora pinnata* Harv.: Dawson, 1957.
    - **Liagora robusta* Yamada: Dawson, 1957.
- Order CRYPTONEMIALES
  - Family CORALLINACEAE
    - *Fosliella farinosa* (Lamx.) Howe: Dawson, 1957; Lawrence and Dawes, 1969.
    - *Heteroderma minutula* Foslie: Dawson, 1957.
    - *Heteroderma subtilissima* Foslie: Dawson, 1957.
    - *Jania capillacea* Harv.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960; Smith and Marsh, 1973.
    - *Jania decussato-dichotoma* (Yendo) Yendo: Dawson, 1957; Gilmartin, 1960.
    - *Jania micranthrodia* Lamx.: Dawson, 1957.
    - *Jania tenella* Kütz.: Dawson, 1957.
    - *Porolithon craspedium* (Foslie) Foslie: Taylor, 1950b; Dawson, 1957.
    - *Porolithon gardineri* (Foslie) Foslie: Taylor, 1950b; Dawson, 1957.
    - *Porolithon onkodes* (Heyd.) Foslie: Taylor, 1950b; Marsh 1970; Smith and Marsh, 1973.
    - *Lithothamnion* sp.: Taylor, 1950b.
  - Family CRYPTONEMIACEAE
    - *Grateloupia filicina* (Wulfen) C. Ag.: Dawson, 1957.
  - Family PEYSSONELIACEAE
    - *Cruoriella dubyi* (Crouan and Crouan) Schmidt: Dawson, 1957.
    - *Peyssonelia rubra* (Crev.) J. Ag.: Dawson, 1957.
- Order GIGARTINALES
  - Family DICRANEMACEAE
    - **Dicranema rosaliae* Setch. and Gard.: Dawson, 1957.
  - Family HYPNEACEAE
    - *Hypnea esperi* Bory: Dawson, 1957; Gilmartin, 1960.
    - *Hypnea nidulans* Setch.: Dawson, 1957.
    - *Hypnea pannosa* J. Ag.: Dawson, 1957.
    - *Hypnea spinella* (C. Ag.) Kütz.: Taylor, 1950b.
- Order RHODYMENIALES
  - Family CHAMPIACEAE
    - *Champia parvula* (Ag.) J. Ag.: Dawson, 1957; Gilmartin, 1960.
    - *Champia vieilardii* Kütz.: Dawson, 1957.
    - *Lomentaria hakodatensis* Yendo: Dawson, 1957.
  - Family RHODYMENIACEAE
    - *Botryocladia skottsbergii* (Boerg.) Levring: Dawson, 1957; Gilmartin, 1960.
    - *Coelothrix irregularis* (Harv.) Boerg.: Dawson, 1957.
    - *Rhodymenia anastomosans* W. v. Bosse: Dawson, 1957; Gilmartin, 1960.

*Only specimen recorded from Micronesia.

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TABLE 1 (cont'd)

Order CERAMIALES
  Family CERAMIACEAE
    Antithamnion lherminieri (Crouan and Crouan) Nasr: Dawson, 1957; Gilmartin, 1960.
    •†*Antithamnion percurrens* Dawson: Dawson, 1957.
    Antithamnionella breviramosa (Dawson) Wollaston.
      Antithamnion breviramous Dawson: Dawson, 1957.
    •†*Callithamnion marshallensis* Dawson: Dawson, 1957.
    Centroceras apiculatum Yamada: Dawson, 1957.
    Centroceras clavulatum (C. Ag.) Mont.: Dawson, 1957; Gilmartin, 1960.
    Centroceras minimum Yamada: Dawson, 1957.
    Ceramium clarionense Setch. and Gardn.: Dawson, 1957.
    Ceramium gracillimum Griff. and Harv.: Dawson, 1957; Gilmartin, 1960.
    •†*Ceramium marshallense* Dawson: Dawson, 1957.
    Ceramium mazatlanense Dawson: Dawson, 1957; Gilmartin, 1960.
    Ceramium serpens Setch. and Gardn.: Dawson, 1957.
    †*Ceramium sympodiale* Dawson: Dawson, 1957.
    •*Ceramium taylori* Dawson: Dawson, 1957.
    †*Ceramium vagabunde* Dawson: Dawson, 1957.
    •*Corynospora pedicellata* (Smith) J. Ag.
      Neomonospora pedicellata v. *tenuis* Feldm.-Mazoyer: Dawson, 1957.
    Crouania attenuata (Bonnemaison) J. Ag.: Gilmartin, 1960.
    •*Griffithsia ovalis* Harvey: Dawson, 1957.
    Griffithsia tenuis C. Ag.: Dawson, 1957; Gilmartin, 1960.
    Haloplegma duperreyi Montagne: Gilmartin, 1960.
    •*Herposiphonia nuda* Hollenberg: Hollenberg, 1968c.
    Herposiphonia pacifica Hollenberg: Hollenberg, 1968c.
    Herposiphonia parca Setch.: Hollenberg, 1968c.
    Herposiphonia secunda (C. Ag.) Ambronn: Dawson, 1957.
    Herposiphonia tenella (C. Ag.) Naegeli: Dawson, 1957; Hollenberg, 1968c.
    Hetersiphonia wurdemanni (Bailey) Falkenberg: Dawson, 1957; Gilmartin, 1960.
    Lophosiphonia bermudensis Collins and Herv.: Dawson, 1957.
    •*Lophosiphonia cristata* Falkenberg: Hollenberg, 1968d.
    Lophosiphonia obscura (Ag.) Falkenberg: Dawson, 1957; Gilmartin, 1960.
    •*Lophosiphonia villum* (J. Ag.) Setch. and Gard.: Gilmartin, 1960.
    •*Mesothamnion caribaeum* Boerg.: Gilmartin, 1960.
    Polysiphonia coacta Tseng: Dawson, 1957.
    Polysiphonia exilis Harv.: Hollenberg, 1968b.
    Polysiphonia flaccidissima Hollenberg: Hollenberg, 1968a.
    †*Polysiphonia pentamera* Hollenberg: Hollenberg, 1968b.
    Polysiphonia poko Hollenberg: Hollenberg, 1968a.
    Polysiphonia setacea Hollenberg: Hollenberg, 1968a.
    Polysiphonia subtilissima Montagne: Dawson, 1957; Gilmartin, 1960.
    Polysiphonia tongatensis Harvey: Dawson, 1957; Gilmartin, 1960.
    Spermothamnion saccorhiza (Setch. and Gardn.) Feldmann-Mazoyer; Gilmartin, 1960.
    Spyridia filamentosa (Wulf.) Harv.: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
    •*Taenioma perpusillum* J. Ag.: Dawson, 1957.
    Tolypiocladia calodictyon (Harv.) Silva.
      Roschera calodictyon (Harv.) W. v. Bosse: Taylor, 1950b; Dawson, 1957; Gilmartin, 1960.
    Wrangelia anastomosans Yamada: Dawson, 1957.
    Wrangelia argus (Mont.) Montagne: Dawson, 1957.
    Wrangelia penicillata C. Ag.: Taylor, 1950b; Dawson, 1957.
  Family DASYACEAE
    Dasya adhaerens Yamada: Taylor, 1950b; Dawson, 1957.
    •*Dasya corymbifera* J. Ag.: Gilmartin, 1960.
    •*Dasya iyengarii* Boerg.: Dawson, 1957; Gilmartin, 1960.
    •*Dasya mollis* Harv.: Dawson, 1957; Gilmartin, 1960.
    •*Dasyopsis geppii* W. v. Bosse: Dawson, 1957.
    Dictyurus purpurascens Bory: Dawson, 1957.

•Only specimen recorded from Micronesia.
†New species; holotype based on Enewetak specimens.

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TABLE 1 (cont'd)

Family DELESSERIACEAE
Hypoglossum minimum Yamada: Dawson, 1957; Gilmartin, 1960.
Martensia fragilis Harv.
Hemitrema fragilis (Harv.) Dawson: Dawson, 1957.
Family RHODOMELACEAE
**Chondria baileyana* (Montagne) Harv.: Gilmartin, 1960.
**Chondria minutula* W. v. Bosse: Dawson, 1957.
**Chondria polyrhiza* Collins and Hervey: Dawson, 1957.
Chondria repens Boerg.: Dawson, 1957; Gilmartin, 1960.
**Dawsoniella bulborhiza* Hollenberg: Hollenberg, 1967.
Laurencia mariannensis Yamada: Taylor, 1950b; Dawson, 1957.
Laurencia nana Howe: Dawson, 1957.
Laurencia parvipapillata Tseng: Dawson, 1957.

*Only specimen recorded from Micronesia.
†Holotype based on Enewetak specimens.

species (nine Chlorophyta, three Phaeophyta, and 28 Rhodophyta) or 16% of the species reported from Enewetak represent the only collections known from the geographic region of Micronesia (preceded by an asterisk in Table 1). It is unlikely that these species are unique to Enewetak; further intensive collections from other areas in Micronesia will no doubt provide additional records. To date, there has been no record of a seagrass on Enewetak. *Thalassia hemprichii* (Ehrenb.) Aschers is the only species of seagrass reported from the Marshall Islands, and it has been found on Ujilang Atoll, Jaluit Atoll, and Ailinglapalap Atoll (Tsuda et al., 1977). Until further intensive collections are made from other islands in Micronesia, it is difficult to make a comparative analysis with the marine flora from other islands. Although it is hardly fair to compare the Enewetak marine flora with that of Guam, a high island located farther west, some inferences can be made. As can be seen in Table 2, there are slightly more genera known from Guam (118 genera) than Enewetak (106 genera), but there are more species reported from Enewetak. Taylor (1950a) described the dominant algae on the atoll and found it was difficult to compare the Marshall marine flora with those of other islands because of the paucity of collections from other islands. He did mention that *Sargassum* was noticeably absent on Enewetak. This genus has yet to be found on any of the atolls in the Marshall Islands (Doty, 1954; Tsuda, 1976). Clearly, the phycological studies conducted on Enewetak Atoll have provided much of the information on the marine benthic algae within Micronesia.

TABLE 2

Comparison of the Marine Benthic Flora of Enewetak and Guam

Division	Genera E*	Genera G†	Species E*	Species G†
Cyanophyta	12	10	16	13
Chlorophyta	29	30	89	69
Phaeophyta	12	15	24	27
Rhodophyta	53	63	109	11
Total	106	118	238	120

*Enewetak
†Guam

Locations of the early collection sites are available in the Departments of Botany and Invertebrate Zoology at the B. P. Bishop Museum.

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Chapter 2

Fungi of Enewetak Atoll

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INTRODUCTION

The microfungi of Enewetak Atoll are typical tropical forms and are not restricted to that atoll. Because of the extreme isolation of Enewetak, however, it seems likely that the fungi there are indigenous to the atoll and are not introductions by man. Whether the origin is terrestrial or from the beaches remains a question.

The first study of microfungi on Enewetak (Sparrow, 1948) isolated unicellular chytrids of three different families from soil samples (Table 1), but no filamentous chytrids or Oomycetes were isolated. An extensive study (Dunn, 1973) isolated 101 specimens from the beaches of Enewetak. An additional eight newly recorded taxa are listed in Table 1. The specimens were isolated by the Warcup plating method (Warcup, 1950), which established only that viable propagules were present. Whether the fungal propagules of the Enewetak beaches are dormant or active was not defined. Fungal propagules have been preserved for long periods when stored in distilled water (Campbell and Stewart, 1980). It can be assumed, therefore, that nutrient-poor seawater could provide a habitat in which those propagules that tolerate salinity could remain viable.

Reports from the atoll beaches (Dunn, 1973; Steele, 1967) are based on isolations from enrichment culture. Marine fungi have been defined as those observed growing on a substrate in a marine habitat (Kohlmeyer and

TABLE 1

Checklist of Enewetak Atoll Fungi

Kingdom MYCETEAE
- Class CHYTRIDIOMYCETINA
  - Order CHYTRIDIALES
    - Family OLPIDIACEAE
      - *Olpidium rhizophlyctidis* Sparrow: Sparrow, 1948.
    - Family PHLYCTIDIACEAE
      - *Rhizophydium marshallense* Sparrow: Sparrow, 1948.
    - Family RHIZIDIACEAE
      - *Rhizophlyctis rosea* (DeBary and Woronin) Fischer: Sparrow, 1948.
- Class ZYGOMYCOTINA
  - Order MUCORALES
    - Family PIPTOCEPHALIDACEAE
      - [*]*Syncephalastrun racemosum* Cohn ex Schroter, 1886.
    - Family THAMNIDIACEAE
      - [*]*Helicostylum glomeratum* (van Tieghem and Le Monnier) van Tieghem, 1876.
    - Family MUCORACEAE
      - *Absidia corymbifera* (Cohn) Saccardo and Trotter: Dunn, 1973.
      - *Mucor* sp.: Dunn, 1973.
      - *Rhizopus nigricans* Ehrenberg: Dunn, 1973.
  - Order ENTOMOPHTHORALES
    - Family ENTOMOPHTHORACEAE
      - *Conidiobolus* sp.: Dunn, 1973.

[*]New Enewetak Atoll record.

(This table continued on next page.)

TABLE 1 (cont'd)

Class ASCOMYCOTINA
  Order SPHAERIALES
    Family CHAETOMIACEAE
      Ascotricha guamensis Ames: Dunn, 1973.
      Chaetomium globosum Kunze ex Fries: Dunn, 1973.
    Family MELANOSPORACEAE
      **Melanospora* sp.
  Order PLEOSPORALES
    Family SPORORMIACEAE
      Sporormia sp.: Dunn, 1973.
  Order EUROTIALES
    Family GYMNOASCACEAE
      Emericellopsis minima Stolk: Dunn, 1973.
      Gymnoascus reesii Baranetsky: Dunn, 1973.
  Order MICROASCALES
    Family MICROASCACEAE
      Microascus cinereus (Emile-Weil and Gaudin) Curzi: Dunn, 1973.
      Microascus trigonosporus Emmons and Dodge: Dunn, 1973.
Class DEUTEROMYCOTINA
  Order SPHAEROPSIDALES
    Family SPHAERIOIDACEAE
      Lasiodiplodia theobromae (Pat.) Griff. and Maubl.: Dunn, 1973.
  Order MELANCONIALES
    Family MELANCONACEAE
      Pestalotia sp.: Dunn, 1973.
  Order MONILIALES
    Family MONILIACEAE
      Acremonium bacillisporum (Onions and Barron) W. Gams (Teleomorph: *Chaetomium* sp.): Dunn, 1973.
      **Acremonium charticola*: (Lindau) W. Gams, 1971.
      Acremonium pteridii W. Gams and Frankland: Dunn, 1973.
      Acremonium terricola (Miller et al.) W. Gams: Dunn, 1973.
      Aspergillus aculeatus Iizuka: Dunn, 1973.
      Aspergillus carneus (v. Tiegh) Blochwitz: Dunn, 1973.
      Aspergillus conjunctus Kwon and Fennell: Dunn, 1973.
      Aspergillus flavipes (Bain. and Sart.) Thom and Church: Dunn, 1973.
      Aspergillus flavus Link: Dunn, 1973.
      Aspergillus ochraceus Wilhelm; Dunn, 1973.
      Aspergillus oryzae (Ahlburg) Chon: Dunn, 1973.
      Aspergillus recurvatus Raper and Fennell: Dunn, 1973.
      Aspergillus terreus Thom: Dunn, 1973.
      Aspergillus terricola? Marchal: Dunn, 1973.
      Aspergillus tubingensis (Schober) Mosseray: Dunn, 1973.
      Aspergillus ustus (Bainier) Thom and Church: Dunn, 1973.
      Aspergillus variecolor (Berk. and Br.) Thom and Raper: Dunn, 1973.
      Aspergillus versicolor (Vuill.) Tiraboschi: Dunn, 1973.
      Aspergillus wentii group: Dunn, 1973.
      Emmonsia sp.: Dunn, 1973.
      Geotrichum sp.: Dunn, 1973.
      Hansfordia ovalispora Hughes: Dunn, 1973.
      Nodulisporium sp.: Dunn, 1973.
      Oidiodendron sp.: Dunn, 1973.
      Paecilomyces sp.: Dunn, 1973.
      Paecilomyces lilacinum (Thom) Samson: Dunn, 1973.
      Penicillium sp. (monoverticillate, with sclerotia): Dunn, 1973.
      Penicillium sp. (polyverticillate): Dunn, 1973.
      Penicillium canescens Sopp.: Dunn, 1973.
      Penicillium citreo-viride Biourge: Dunn, 1973.
      Penicillium corylophilum Dierckx: Dunn, 1973.
      Penicillium frequentans Westling: Dunn, 1973.

*New Enewetak Atoll record.

(This table continued on next page.)

TABLE 1 (cont'd)

Family MONILIACEAE (cont'd)
Penicillium funicolosum Thom: Dunn, 1973.
Penicillium janthinellum Biourge: Dunn, 1973.
Penicillium verruculosum Peyronel: Dunn, 1973.
Phialophora sp.: Dunn, 1973.
Sporothrix sp.: Dunn, 1973.
Sporotrichum sp.: Dunn, 1973.
**Trichoderma aureoviride* Rifai, 1969.
**Trichoderma harzianum* Rifai, 1969.
**Trichoderma pseudokongii* Rifai, 1969.
Tritirachium sp.: Dunn, 1973.
Verticillium lecanii (Zimm.) Viegas: Dunn, 1973.
Yeast: Dunn, 1973.

Family DEMATIACEAE
Acrophialophora fusispora (Saksena) M. B. Ellis: Dunn, 1973.
Aureobasidium pullulans (DeBary) Arnaud: Dunn, 1973.
Cercospora sp.: Dunn, 1973.
Cladosporium cladosporioides (Fresen.) de Vries: Dunn, 1973.
Cladosporium herbarum (Pers.) Link ex S. F. Gray: Dunn, 1973.
Cladosporium sphaerospermum Penz.: Dunn, 1973.
Curvularia sp.: Dunn, 1973.
Curvularia clavata Jain: Dunn, 1973.
Curvularia lunata (Wakker) Boedijn: Dunn, 1973.
Curvularia oryzae Bugnicourt: Dunn, 1973.
Curvularia senegalensis (Speg.) Subram.: Dunn, 1973.
Curvularia tuberculata Jain: Dunn, 1973.
Drechslera australiensis (Bugnicourt) Subram. and Jain Ex M. B. Ellis: Dunn, 1973.
Drechslera halodes (Drechsler) Subram. and Jain: Dunn, 1973.
Drechslera hawaiiensis (Bugnicourt) Subram. and Jain Ex M. B. Ellis: Dunn, 1973.
Drechslera papendorfii (van der Aa) M. B. Ellis: Dunn, 1973.
Gliomastix murorum (Corda) Hughes: Dunn, 1973.
Gliomastix murorum (Corda) Hughes var. *felina* (Marchal) Hughes: Dunn, 1973.
Gliomastix murorum (Corda) Hughes var. *polychroma* (van Beyma) Dickinson: Dunn, 1973.
Humicola fuscoatra Traaen: Dunn, 1973.
Humicola sp.: Dunn, 1973.
Leptographium sp.: Dunn, 1973.
Mammaria sp.: Dunn, 1973.
Memnoniella echinata (Riv.) Galloway: Dunn, 1973.
Nigrospora sphaerica (Sacc.) Mason: Dunn, 1973.
Nigrospora state of *Khuskia oryzae* Hudson: Dunn, 1973.
Rhinocladiella cellaris (Pers. ex S. F. Gray) M. B. Ellis: Dunn, 1973.
Scolecobasidium humicola Barron and Busch: Dunn, 1973.
Scolecobasidium variabile Barron and Busch: Dunn,1973.
Scopulariopsis baarnensis Morton and Smith: Dunn, 1973.
Scopulariopsis brumptii: Dunn, 1973.
Scopulariopsis brevicaulis (Sacc.) Bainier: Dunn, 1973.
Scopulariopsis chartarum (Smith) Morton and Smith: Dunn, 1973.
Scopulariopsis fimicola (Cost. and Matr.) Vuill.: Dunn, 1973.
Scopulariopsis sphaerospora Zach: Dunn, 1973.
Scopulariopsis sp.: Dunn, 1973.
Stachybotrys atra Corda: Dunn, 1973.
Stachybotrys state of *Melanopsamma pomiformis* (Pers. ex Fr.) Sacc.: Dunn, 1973.
Stemphylium vesicarium (Wallr.) Simmons: Dunn, 1973.
Trichocladium canadense Hughes: Dunn, 1973.
**Ulocladium chartarum* (Preuss) Simmons, 1967.

Family STILBACEAE
Graphium putredinis (Corda) Hughes: Dunn, 1973.
Isaria sp.: Dunn, 1973.

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*New Enewetak Atoll record.

(This table continued on next page.)

TABLE 1 (cont'd)

Family TUBERCULARIACEAE
Cylindrocarpon sp.: Dunn, 1973.
Fusarium episphaeria (Tode) Fr.: Dunn, 1973.
Fusarium solani (Mart.) Sacc.: Dunn, 1973.
Fusarium sp.: Dunn, 1973.
Metarrhizium anisopliae (Metschn.) Sorok.: Dunn, 1973.
Myrothecium roridum Tode ex Steudel: Dunn, 1973.
Myrothecium striatisporum Preston: Dunn, 1973.
Class BASIDIOMYCOTINA
Unidentified air isolate.

*New Enewetak Atoll record.

Kohlmeyer, 1979). None of the fungi isolated from Enewetak, therefore, fits the definition of a marine fungus. Inhibitors in seawater (Kirk, 1980) and in soil (Lockwood, 1977) may prevent fungal spores from germinating until changes occur in the endogenous or exogenous nutrient status or until the exogenous spore inhibitors are removed. The exogenous inhibitors of nonmarine fungi can be partly removed or deactivated by autoclaving seawater; most marine fungi can germinate in raw seawater. Addition of glucose can also counteract the inhibition (Kirk, 1980).

Few studies have been done on decomposition of subtidal substrate. In a study of seagrass, *Thalassia testudinum* Konig, Newell and Fell (1980) showed that although nonmarine fungi were present, they played only a minor role in decomposition of *T. testudinum* leaves until the leaves were deposited in the intertidal. The terrestrial fungi are active in the intertidal zone, but their significance in relation to marine fungi is unknown (Newell and Fell, 1980, 1982). On the basis of the present discussion, it can be suggested that the fungal propagules in Enewetak Atoll beaches are also dormant until they come in contact with a proper substrate.

Fungi from the beaches of Enewetak Atoll have been compared with those from other locations. When the specimens isolated by Dunn (1973) were compared with fungi plated from sediment of a coastal estuary of North Carolina with salinities from 0 to $36°/_{oo}$ (Borut and Johnson, 1962), a Dice similarity quotient of 17% was found, indicating a distinct biota for these two very different marine habitats.

In a comparison of the fungi isolated by Warcup plating from beaches at Enewetak Island and the Hawaiian Islands, a Dice similarity quotient of 43% was found (Dunn, 1973). The beaches in the Hawaiian Islands are both volcanic and carbonate, whereas the beaches at Enewetak Island are carbonate. Similarity is greater between the mycobiota of the carbonate beaches in Enewetak and Hawaii (48%) than between the carbonate and volcanic beaches in Hawaii (41%). The principal difference between the mycobiota of the carbonate beaches sampled in Enewetak and those in Hawaii was the abundance of species present in both beaches relative to the total isolates. Typical of the pattern are *Gymnoascus reesii* Baranetsky and two species in the genus *Microascus*, which were common at Enewetak Island beach but were infrequently isolated from Kahala Beach, Oahu, Hawaii.

CHYTRIDIOMYCOTINA

The isolates of this class were all unicellular. *Rhizophyctis rosea* (DeBary and Woronin) Fischer was the most common isolate, and it is the most widespread of all chytrids (Sparrow, 1960). Unicellular chytrids were found in the beach areas by Dunn (1973) but were not identified. Sparrow (1948) consistently found only the same three species of this class on Enewetak and on three other Marshall Island atolls. The filamentous species of the class were conspicuously absent.

OOMYCOTINA

Although many species in this class are common plant pathogens and would be expected to be associated with the vegetation, none has been reported from this atoll. They may be too sensitive to salinity to do well in beach habitats (TeStrake, 1959; Lee and Baker, 1972), although some have been isolated from other beach areas.

ZYGOMYCOTINA

Conidiobolus sp. was isolated from subtidal areas on Enewetak. Species in this genus are normally associated with dung of insect-eating animals or decaying vegetation. This species was isolated only from seawater sources and seems to require salinity. It does not resemble any described species and does not last many generations in culture. Members of the order Mucorales are common isolates from beaches at Enewetak but have salinity optima more appropriate for terrestrial species (Dunn, 1973).

ASCOMYCOTINA

Many ascomycetes are known to produce two types of spores: the teleomorph, or sexual state, and the anamorphs, or asexual states. The teleomorph may be associated with one or more anamorphs. The teleomorph genus regularly associated with the isolated *Scopulariopsis* anamorph, for example, is well documented but was not isolated in the studies. *Ascotricha guamensis* Ames previously was isolated from Guam, New Guinea, India, and more recently, from soil at Enewetak. *Microascus cinereus* (Emele-Weil and Gaudin) Gurzi, the teleomorph, and its associated anamorph were among the most frequently isolated fungi in the beach study. These were rarely isolated from carbonate beaches in Hawaii. *Gymnoascus reesii* is typical of the saline habitats all through the Pacific basin (Baker and Meeker, 1972).

DEUTEROMYCOTINA

At Enewetak Atoll, the majority of the Deuteromycotina genera isolated from beaches was comprised of members of the order Moniliales (94 taxa), with the majority of species evenly divided between the families Dematiaceae and Moniliaceae. *Acremonium bacillisporum* (Onions and Barron) W. Gams was a prominent member of the carbonate sand community at both Enewetak and Kahala Beach, Oahu, Hawaii (Dunn, 1973). The aspergilli were common and the penicillia were rare in beaches at both localities (Dunn, 1973). These patterns coincide with other data indicating that the aspergilli are more common in the subtropics, and the penicillia are more common in temperate climates. *Graphium putredinis* (Corda) Hughes was found commonly in the anaerobic zone in deeper sediments off Enewetak Atoll. *Fusarium solani* (Mart.) Sacc. was common in beaches at Enewetak but mostly was found near the land zone. The moniliaceous genus *Dreschlera* is represented on Enewetak Atoll by four species (Table 1). All are known from the tropics and southernmost Africa. Two of the species of *Cladosporium*, *C. cladosporioides*, and *C. sphaerospermum* are found in tropical and subtropical climates in saline habitats. A third species, *C. herbarum*, was not found frequently at Enewetak and is cosmopolitan in distribution.

BASIDIOMYCOTINA

The most common isolate from air at Enewetak Atoll is a basidiomycete identifiable by large clamp connections on the hyphae (Dunn, 1973). It did not sporulate in culture. Other basidiomycetes in the Marshall Islands, mostly associated with decaying wood, were collected by Rogers (1947) and Taylor (1950). They did not collect fungi on Enewetak Atoll, and fungi from decaying wood have not been studied on Enewetak.

CONCLUSION

The mycological data from Enewetak Atoll reflect two principles of fungal biogeography: similar regions have similar biotas, and distributional data are often due to bias collection activity of mycologists (Baker and Meeker, 1972). For example, the genus *Myrothecium* was initially reported in the Pacific from New Zealand. This genus was then reported from Moorea, Society Island (Peterson, 1960).

As data from other Pacific islands became available, the distribution was enlarged to include Tonga, Hawaii, New Caledonia (Baker and Meeker, 1972), and Enewetak (Baker and Meeker, 1972; Dunn, 1973). A similar expansion through the tropical Pacific may be expected for most of the species reported here.

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Chapter 3

Natural History of Terrestrial Vascular Plants of Enewetak Atoll

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INTRODUCTION

Enewetak Atoll has evolved over geological time from a raised limestone island environment supporting mangrove swamps and an upland mixed forest to a low coral sand island habitat with typical strand vegetation. The 128 species of plants recorded from the atoll include many introduced weeds and ornamental or food plants, although 43% of the flora is considered to be indigenous to Micronesia.

The dry, windy season from November through April causes many of the plants to drop some or all of their leaves or to die back completely. Summer—June through September—is the season of maximum plant growth and more flower and seed production.

The effects of World War II and post-war military activity, the nuclear test program from 1948 to 1958, and the radiological cleanup and rehabilitation for the return of the people of Enewetak have been significant with regard to the vegetation. Many species were accidentally or intentionally introduced to the atoll, and some species have disappeared. The vegetation was greatly altered because of destruction of habitat with removal of soil and nutrients and exposure of the plants to salt spray and drying winds. Several collections and studies of the flora have been reported.

This chapter describes stages in the succession of the vegetation following disturbance. The vegetation of the islands during the period 1975 to 1977 is also described in some detail.

ENVIRONMENT AND BIOGEOGRAPHY

The islands and shallow reefs of Enewetak Atoll are the top of a limestone cap approximately 1 km thick, resting on the basalt remains of an extinct volcano which was active during the pre-Tertiary geological period. Core samples from drilling on the island of Medren and on the former island of Elugelab include basalt encountered at depths of 1271 and 1405 m, respectively. The samples also show that during the reef's geological history it was exposed and submerged several times as a result of fluctuations in sea level (Emery, Tracey, and Ladd, 1954; Tracy and Ladd, 1974).

Analysis of pollen grains in the cores (Leopold, 1969) showed that during Miocene times Enewetak was a raised limestone island supporting an intertidal mangrove swamp, mangrove depressions on beach ridges, an upland forest of salt-intolerant plants, and a typical strand vegetation (Fosberg, 1960) similar to that presently found at Enewetak. Leopold (1969) listed 17 angiosperm genera among 54 species of plants found as fossil remains in the cores, including *Pandanus, Pisonia, Terminalia, Tournefortia, Cordia, Morinda,* and *Guettarda*.

The islands of Enewetak Atoll have apparently reached their present form within the Holocene. The reef around the atoll grew to keep pace with the rising sea level, then was eroded by wave action during a more recent drop in sea level within the past 2000 to 4000 years (Buddemeier, Smith, and Kinzie, 1975). The terrestrial plants that occur now at Enewetak have been introduced by chance or intentionally as seeds and cuttings brought to the atoll by ocean currents, wind, birds, and people.

In comparison with other atolls in the Marshalls, Enewetak has fewer species of plants, and to those familiar with the dense undergrowth and luxuriant ferns of the southern atolls, Enewetak may seem somewhat barren. Only 79 out of 155 species of plants, including those cultivated in gardens, listed by Fosberg (1955) in the northern Marshall Islands have been reported from Enewetak. Species indigenous to Micronesia comprise 43% of the total flora (55 species). (See Tables 1 through 4.) Specimens of all species in Table 1, except *Cocos nucifera* and others noted in Table 4 were deposited in the reference collection at the Mid-Pacific Laboratory at Enewetak. Additional specimens from Enewetak, including the new species listed, are deposited at the Bishop Museum (BPBM) and at the U. S. National Museum of Natural History (USNM). The taxonomic nomenclature for the Dicotyledonae and

TABLE 1

Checklist of Terrestrial Vascular Plants of Enewetak Atoll*

Division TRACHEOPHYTA
- Class PSILOPSIDA
  - Order PSILOTALES
    - Family PSILOTACEAE
      - †*Psilotum nudum* (L.) Beauvais: Lamberson, 1982; Fosberg et al., 1982.
- Class PTEROPSIDA
  - Order FILICALES
    - Family POLYPODIACEAE
      - †*Polypodium scolopendria* Burmann f.
        - *Phymatodes scolopendria* (Burmann f.) Ching: St. John, 1960.
        - *Polypodium phymatodes* Linn: Bryan, 1944.
- Class ANGIOSPERMAE
  - Subclass MONOCOTYLEDONEAE
    - Family PANDANACEAE
      - ‡*Pandanus* sp.: Bryan, 1944; Taylor, 1950; Woodbury, 1962; Fall et al., 1971; Koranda et al., 1973; Lamberson, 1982.
      - †*Pandanus tectorius* Park: Fosberg, 1955; Welander et al., 1966.
      - †*Pandunus brachypodus* Kanehira: Kanehira, 1935; St. John, 1960.
      - †*Pandanus enchabiensis* Kanehira: Kanehira, 1935; St. John, 1960.
      - †*Pandanus korrorensis* Kanehira: St. John, 1960.
      - †*Pandanus odoratissimus* L. f. var. *novocaledonicus* (Martelli) St. John: St. John, 1960.
      - †*Pandanus odoratissimus* L. f. var. *novoguineensis* (Martelli) St. John: St. John, 1960.
      - †*Pandanus pulposus* (Warb.) Martelli: St. John, 1960.
      - †*Pandanus rectanulatus* Kanehira: Kanehira, 1935; St. John, 1960.
      - †*Pandanus rhombocarpus* Kanehira: Kanehira, 1935; St. John, 1960.
      - †*Pandanus utiyamai* Kanehira: St. John, 1960.
    - Family GRAMINAE
      - *Cenchrus brownii* Roemer and Schultes: Taylor, 1950; St. John, 1960.
      - *Cenchrus echinatus* L.: Bryan, 1944; St. John, 1950; Taylor, 1950; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Lamberson, 1982.
        - *Cenchrus* sp.: Fall et al., 1971.
      - *Chloris inflata* Link: St. John, 1950; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Lamberson, 1982.
      - *Cynodon dactylon* (L.) Persoon: Bryan, 1944; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Koranda et al., 1973; Lamberson, 1982.
      - *Dactyloctenium aegypticum* (L.) Willdenow: St. John, 1960; Welander et al., 1966; Lamberson, 1982.
      - †*Digitaria setigera* Roemer and Schultes: St. John, 1960; Lamberson, 1982.
        - *Digitaria pruriens* (Trinius) Buese: Taylor, 1950.
        - *Digitara microbachne* (Presl) Henrard: Fosberg, 1955.
      - *Eleusine indica* (L.) Gaertner: Bryan, 1944; Taylor, 1950; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Lamberson, 1982.
      - *Eragrostis scabrifolia* Swallen: Lamberson, 1982.
      - *Eragrostis tenella* (L.) Roemer and Schultes: Lamberson, 1982.
        - *Eragrostis ambilis* (L.) Wight and Arnott: Taylor, 1950, Fosberg, 1955; St. John, 1960; Welander et al., 1966.
      - *Eragrostis* sp.: Lane, 1960.
      - *Lepturopetium marshallense* Fosberg and Sachet, 1982.
      - *Lepturus repens* (Forster f.) R. Brown var. *occidentalis:* St. John, 1960.
        - *Lepturus repens* (Forst. f.) R. Brown: Bryan, 1944; Taylor, 1950; Fosberg, 1955; Palumbo, 1962; Woodbury, 1962; Welander et al., 1966; Fall et al., 1971; Koranda et al., 1973; Lamberson, 1982.
      - *Lepturus* sp.: Lane, 1960; Carpenter et al., 1968.
      - ¶*Lepturus repens* (Forster f.) R. Brown var. *subulatus* Fosberg.
      - *Brachiaria mutica* (Forsskål) Stapf.: Lamberson, 1982.
      - *Setaria verticillata* (L.) Beauvais: Bryan, 1944; Taylor, 1950; Fosberg, 1955; St. John, 1960.
      - †*Thuarea involuta* (Forster f.) Roemer and Schultes: Taylor, 1950; Fosberg, 1955; St. John, 1960; Lamberson, 1982.
      - *Tricachne insularis* (L.) Neẹs: Fosberg, 1955; St. John, 1960; Welander et al., 1966; Lamberson, 1982.
      - *Tricholaena rosea* Nees
        - *Tricholaena repens* (Willdenow) Hitchcock: Taylor, 1950; Lane, 1960; St. John, 1960.

*Excludes plant species reported only from gardens, which are considered to be transient components of the flora.

†Species considered indigenous to Micronesia.

‡The taxonomy of the genus *Pandanus* is disputed. Some taxonomists would consider most of the species listed here as forms of the species *Pandanus tectorius*.

¶New Enewetak record; see Table 4.

(This table continued on next page.)

TABLE 1 (cont'd)

Family CYPERACEAE
Cyperus compressus L.: Lamberson, 1982.
†*Cyperus javanicus* Houttuyn: St. John, 1960.
Cyperus ferax L. C. Richard
Cyperus odoratus L.: St. John, 1960.
Cyperus rotundus L.: Lamberson, 1982.
†Fimbristylus cymosa R. Brown ssp. *spathacea* (Roth) Koyama, 1964.
Fimbristylus annua Roemer and Schultes forma *diphyllia* (Retz) Kukenth: Bryan, 1944.
Fimbristylus cymosa R. Brown: Taylor, 1950.
Fimbristylus atollensis St. John: Lane, 1960; St. John, 1960; Welander et al., 1966; Fall et al., 1971; Koranda et al., 1973; Koranda et al., 1978; Lamberson, 1982.
Fimbristylus sp.: Woodbury, 1962.
Family PALMAE
Cocos nucifera L.: Bryan, 1944; St. John, 1950; Taylor, 1950; Fosberg, 1955; St. John, 1960; Palumbo, 1962; Woodbury, 1962; Welander et al., 1966; Carpenter et al., 1968; Fall et al., 1971; Koranda et al., 1973; Lamberson, 1982.
Family AMARYLLIDACEAE
†*Crinum asiaticum* L.: Bryan, 1944; St. John, 1960; Lamberson, 1982.
Pancratium littorale Jacquin: Lamberson, 1982.
Family TACCACEAE
†*Tacca leontopetaloides* (L.) O. Kuntze: Taylor, 1950; Fosberg, 1955; St. John, 1960; Welander, et al., 1966; Koranda et al., 1973; Lamberson, 1982.
Tacca pinnatifida Forster: Bryan, 1944.
Subclass DICOTYLEDONEAE
Family MORACEAE
Artocarpus altilis (Parkinson) Fosberg: Fosberg et al., 1979.
Artocarpus incisus (Thunberg) L. f.: St. John, 1960.
†*Artocarpus mariannensis* Trecul: Fosberg et al., 1979.
Family URTICACEAE
†*Laportea ruderalis* (Forster f.) W. L. Chew: Fosberg et al., 1979; Lamberson, 1982.
Fleurya ruderalis (Forster f.) Gaudichaud: St. John, 1950; Taylor, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Welander et al., 1966.
Family OLACACEAE
†*Ximenia americana* L.: Taylor, 1950; Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Family POLYGANACEAE
Coccoloba uvifera (L.) L.: Lamberson, 1982.
Family AMARANTHACEAE
†*Achyranthes aspera* L.: Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
†*Achyranthes canescens* R. Brown: St. John, 1960.
†*Amaranthus dubius* Martell: Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Amaranthus viridis L.: Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Family NYCTAGINACEAE
†*Boerhavia albiflora* var. *powelliae* Fosberg: Fosberg et al., 1979.
†*Boerhavia repens* L.
Boerhavia diffusa L. var. *eudiffusa*: St. John, 1950.
Boerhavia diffusa L.: Taylor, 1950; Fosberg, 1955; Lane, 1960; Welander et al., 1966; Fall et al., 1971.
Boerhavia diffusa L. var. *diffusa*: St. John, 1960.
†*Boerhavia tetrandra* Forster: Taylor, 1950; Fosberg, 1955; Palumbo, 1962; Woodbury, 1962; Welander et al., 1966.
Boerhavia diffusa var. *tetrandra* (Forster f.) Heimerl: Bryan, 1944; St. John, 1960.
Boerhavia spp.: Lamberson, 1982.
†*Pisonia grandis* R. Brown: Bryan, 1944; Taylor, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Welander et al., 1966; Carpenter et al., 1960; Fall et al., 1971; Koranda et al., 1973; Koranda et al., 1978; Fosberg et al., 1979; Lamberson, 1982.
Pisonia sp.: Woodbury, 1962; Lee and Lee, 1978.
Family PORTULACACEAE
†*Portulaca australis* Endl.: Fosberg et al., 1979.
Portulaca quadrifida L.: Bryan, 1944; Taylor, 1950; Welander et al., 1966.
Portulaca samoensis v. Poelln.: Fosberg, 1955: Lane, 1960; St. John, 1960; Lamberson, 1982.
†*Portulaca lutea* Solander ex Forster f.: Taylor, 1950; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Fosberg et al.. 1979; Lamberson, 1982.

†Species considered indigenous to Micronesia.

(This table continued on next page.)

TABLE 1 (cont'd)

Family PORTULACACEAE (cont'd)

Portulaca oleracea L.: Bryan, 1944; St. John, 1950; Biddulph and Cory, 1952; Fosberg, 1955; Lane, 1960; St. John, 1960; Palumbo, 1962; Welander et al., 1966; Fosberg et al., 1979; Lamberson, 1982.

Family LAURACEAE

Cassytha filiformis L.: Bryan, 1944; Taylor, 1950; Fosberg, 1955; St. John, 1960; Woodbury, 1962; Welander et al., 1966; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.

†*Cythya filiformis*: Koranda et al., 1978.

Family FABACEAE

†*Canavalia cathartica* Thouars: Fosberg et al., 1979; Lamberson, 1982.

Canavalia microcarpa (DeCandolle) Piper: Fosberg, 1955; St. John, 1960; Welander et al., 1966.

Desmodium incanum DeCandolle.

Desmodium adscendens (Sw.) DeCandolle: Lamberson, 1982.

Leucaena leucocephala (Lamarck) DeWit: Lamberson, 1982.

†*Vigna marina* (Burmann) Merrill: Bryan, 1944; St. John, 1960.

Family ZYGOPHYLLACEAE

Tribulus cistoides L.: Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.

Family RUTACEAE

¶*Citrus aurantifolia* (Christm.) Swingle.

Family SURIANACEAE

Suriana maritima L.: Taylor, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Woodbury, 1962; Welander et al., 1966; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.

Family SIMAROUBACEAE

†*Soulamea amara* Lamarck: Welander et al., 1966.

Family EUPHORBIACEAE

†*Euphorbia chamissonis* (Klotsch and Garcke) Boissier: Fosberg, 1955; St. John, 1960; Fosberg et al., 1979; Lamberson, 1982.

Euphorbia atoto Forster: Welander et al., 1966.

Euphorbia hirta L.: Fosberg, 1955; St. John, 1960; Welander et al., 1966; Fosberg et al., 1979; Lamberson, 1982.

Euphorbia thymifolia L.: St. John, 1960; Welander et al., 1966; Lamberson, 1982.

Phyllanthus amarus Schum. and Thonn.: St. John, 1960; Fosberg et al., 1979; Lamberson, 1982.

Ricinus communis L.: Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.

Family TILIACEAE

†*Triumfetta procumbens* Forster: Bryan, 1944; Taylor, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Palumbo, 1962; Woodbury, 1962; Welander et al., 1966; Carpenter et al., 1968; Fall et al., 1971; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.

Family MALVACEAE

†*Hibiscus tiliaceus* L.: Lamberson, 1982.

Malvastrum coromandelianum (L.) Garcke: St. John, 1960.

†*Sida fallax* Walpers: Bryan, 1944; Taylor, 1950; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.

Family STERCULIACEAE

Waltheria indica L.: Lamberson, 1982.

Family LYTHRACEAE

†*Pemphis acidula* Forster: Taylor, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Welander et al., 1966; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.

Pemphis sp.: Carpenter et al., 1968.

Family COMBRETACEAE

†*Terminalia samoensis* Rechinger: Fosberg, 1955; St. John, 1960; Welander et al., 1966; Fall et al., 1971; Fosberg et al., 1979.

Terminalia litoralis Seeman: Taylor, 1950; Lane, 1960; Lamberson, 1982.

Terminalia sp.: Woodbury, 1962.

Family LOGANIACEAE

Polypremum procumbens L.: Lamberson, 1982.

Family APOCYANACEAE

†*Neisosperma oppositifolia* (Lamarck) Fosberg and Sachet: Fosberg et al., 1979; Lamberson, 1982.

Ochrosia parviflora (Forster) Henslow: Bryan, 1944; Taylor, 1950.

Ochrosia oppositifolia (Lamarck) K. Schumann: Fosberg, 1955; Lane, 1960; St. John, 1960; Welander et al., 1966; Fall et al., 1971; Koranda et al., 1973.

Ochrosia sp.: Woodbury, 1962.

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†Species considered indigenous to Micronesia.

¶New Enewetak record; see Table 4.

(This table continued on next page.)

TABLE 1 (cont'd)

Family APOCYANACEAE (cont'd)
¶*Plumeria obtusa* L., 1753.
¶*Plumeria rubra* L., 1753.
Family CONVOLVULACEAE
†*Ipomoea macrantha* Roemer and Schultes: Fosberg et al., 1979; Lamberson, 1982.
Ipomoea grandiflora (Choisy) Hallier: Bryan, 1944.
Ipomoea tuba (Schlechtendahl) G. Don: St. John, 1950; Biddulph and Biddulph, 1953; Fosberg, 1955; Lane, 1960; St. John, 1960; Woodbury, 1962; Welander et al., 1966.
Ipomoea alba L.: Taylor, 1950.
†*Ipomoea pes-caprae* ssp. *brasiliensis* (L.) v. Ooststroom: St. John, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Welander et al., 1966; Koranda et al., 1973; Koranda et al., 1978; Fosberg et al., 1979.
Ipomoea brasiliensis (L.) Sweet: Lamberson, 1982.
Ipomoea sp.: Carpenter et al., 1968; Fall et al., 1971.
Family BORAGINACEAE
†*Cordia subcordata* Lamarck: Taylor, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Welander et al., 1966; Fall et al., 1971; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.
Cordia sp.: Woodbury, 1962; Carpenter et al., 1968.
†*Heliotropium procumbens* var. *depressum* (Chamisso) Fosberg and Sachet.
Heliotropium anomalum Hooker and Arnott: Welander et al., 1966; Lamberson, 1982.
Tournefortia argentea L. f.: Taylor, 1950: Carpenter et al., 1968; Fall et al., 1971; Fosberg et al., 1979.
Messerschmidia argentea (L.f.) Johnston: Bryan, 1944; St. John, 1950; Fosberg, 1955; Lane, 1960; St. John, 1960; Woodbury, 1962; Palumbo, 1962; Welander et al., 1966; Jackson and Carpenter, 1967; Koranda et al., 1973; Koranda et al., 1978; Lamberson, 1982.
Messerschmidia sp.: Lee and Lee, 1978.
Family VERBENACEAE
†*Clerodendrum inerme* var. *oceanicum* A. Gray: Fosberg et al., 1979.
Lippia nodiflora (L.) Rich: Lamberson, 1982.
†*Premna obtusifolia* R. Brown: Lamberson, 1982.
Stachytarpheta jamaicensis (L.) Vahl.
Stachytarpheta urticaefolia (Salisb.) Sims: Lamberson, 1982.
¶*Vitex trifolia* L.
Family SOLANACEAE
Nicotiana glauca Graham: St. John, 1960.
Physalis angulata L. var. *angulata* St. John, 1960; Welander et al., 1966; Lamberson, 1982.
Family ACANTHACEAE
Pseuderanthemum carruthersii (Seemann) Guillaumin var. *carruthersii:* Lamberson, 1982.
Pseuderanthemum carruthersii (Seemann) Guillaumin var. *atropurpureum* (Bull.) Fosberg; Lamberson, 1982.
Family RUBIACEAE
†*Guettarda speciosa* L.: Bryan, 1944; St. John, 1950; Taylor, 1950; Lane, 1960; St. John, 1960; Palumbo, 1962; Welander et al., 1966; Fall et al., 1971; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.
Guettarda sp.: Woodbury, 1962.
Morinda citrifolia L.: Bryan, 1944; St. John, 1950; Taylor, 1950; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Fall et al., 1971; Koranda et al., 1973; Fosberg et al., 1979; Lamberson, 1982.
Morinda sp.: Woodbury, 1962.
Family GOODENIACEAE
Scaevola taccada (Gaertner) Roxburgh: Lane, 1960; Jackson and Carpenter, 1967; Carpenter et al., 1968; Fall et al., 1971; Fosberg et al., 1979; Lamberson, 1982.
Scaevola frutescens (Miller) Krause: Bryan, 1944; St. John, 1950; Taylor, 1950; Fosberg, 1955; St. John, 1960; Woodbury, 1962; Welander et al., 1966; Koranda et al., 1973; Koranda et al., 1978.
Scaevola seriacea Vahl: Palumbo, 1962.
Scaevola sp.: Lee and Lee, 1978.
Family COMPOSITAE
Bidens pilosa L. var. *minor* (Bl.) Sherff: Lamberson, 1982.
Conyza bonariensis (L.) Cronquist: Fosberg et al., 1979; Lamberson, 1982.
Erigeron bonariensis L.: St. John, 1960.
Eclipta alba (L.) Hasskarl: Lamberson, 1982.
†*Pluchea indica* (L.) Lessing: St. John, 1960; Fosberg et al., 1979; Lamberson, 1982.

†Species considered indigenous to Micronesia.
¶New Enewetak record; see Table 4.

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TABLE 1 (cont'd)

Family COMPOSITAE (cont'd)
Pluchea symphytifolia (Miller) Gillis: Lamberson, 1982.
Pluchea odorata (L.) Cassini: Fosberg, 1955; St. John, 1960; Welander et al., 1966; Koranda et al., 1973; Koranda et al., 1978.
Tridax procumbens L.: Lamberson, 1982.
Veronia cinerea (L.) Lessing: Fosberg, 1955; St. John, 1960; Welander et al., 1966; Fosberg, 1979; Lamberson, 1982.
Wedelia trilobata (L.) Hitchcock: Fosberg et al., 1979; Lamberson, 1982.
†*Wollastonia biflora* (L.) DeCandolle.
Wedelia biflora (L.) DeCandolle: Bryan, 1944; Fosberg, 1955; St. John, 1960; Welander et al., 1966; Lamberson, 1982.

†Species considered indigenous to Micronesia.

TABLE 2

Garden Plants Reported from Enewetak Atoll, Considered to Be Transient Members of the Flora

Division TRACHEOPHYTA
Class ANGIOSPERMAE
Subclass MONOCOTYLEDONEAE
Family GRAMINAE
Sorghum bicolor (L.) Moench var. *technicum* (Koern.) Fiori and Paoli, "broom corn": Fosberg, 1955. *Sorghum vulgare* (L.) Persoon: Taylor, 1950.
Zea mays L., "corn": St. John, 1960.
Family AGAVACEAE
**Cordyline terminalis* (L.) Kunth, "ti."
Family LILIACEAE
Allium cepa L., "onion": Bryan, 1944; St. John, 1960.
Family MUSACEAE
**Musa sapientum* L., "banana."
Family ARACEAE
**Epipremnum pinnatum* (L.) Engler cv. "Aureum."
Subclass DICOTYLEDONEAE
Family NYCTAGINACEAE
Mirabilis jalapa L., "four-o'clock": Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Family CRUCIFERAE
Brassica oleracea L. *capitata*, "cabbage": Bryan, 1944; St. John, 1960.
Brassica pekinensis (Lour.) Rupr., "Chinese cabbage": Bryan, 1944; St. John, 1960.
Brassica sp.: Bryan, 1944; Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Raphanus sativus L., "radish": Bryan, 1944; St. John, 1960.
Family FABACEAE
Phaseolus sp., "beans": Bryan, 1944; St. John, 1960.
Family MALVACEAE
**Hibiscus* hybrid (*H. rosa-sinensis* x *schizopetalus*?), "hibiscus."
Family CARICACEAE
Carica papaya L., "papaya": St. John, 1960.
Family CONVOLVULACEAE
Ipomoea purpurea (L.) Roth: St. John, 1960.
Family SOLANACEAE
Solanum lycopersicum L., "tomato": Bryan, 1944; Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Family CUCURBITACEAE
Citrullus lanatus var. *caffrorum* (Alef.) Fosberg, "watermelon": Fosberg, et al., 1979.
Citrullus vulgaris Schrader, "watermelon": Bryan, 1944; Fosberg, 1955; St. John, 1960.
Cucumis melo L., "canteloupe": Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Cucurbita maxima Duchesne, "squash": Bryan, 1944; Fosberg, 1955; St. John, 1960; Fosberg et al., 1979.
Family COMPOSITAE
Lactuca sativa L., "lettuce": Bryan, 1944; St. John, 1960.

*New Enewetak record; see Table 4.

TABLE 3

Plants Reported from Enewetak Atoll but Found Only as Drift Seeds on Beaches

Division TRACHEOPHYTA
  Class ANGIOSPERMAE
    Subclass DICOTYLEDONEAE
      Family HERNANDIACEAE
        Hernandia sonora L.: St. John, 1960
      Family FABACEAE
        Caesalpina bonduc (L.) Roxbury: St. John, 1960.
        Dioclea reflexa Hook. f.: St. John, 1960
        Entada phaseoloides (L.) Merrill: St. John, 1960.
        Mucuna urens (L.) Medicus: St. John, 1960.
      Family EUPHORBIACEAE
        Aleurites moluccana (L.) Willdenow: St. John, 1960.
      Family SAPINDACEAE
        Sapindus saponaria L.: St. John, 1960.

TABLE 4

Collection Data of Newly Recorded Terrestrial Vascular Plants from Enewetak*

Family GRAMINAE
  Lepturus repens (Forst. f.) R. Brown var. *subulatus* Fosberg. Enewetak Islet: Mar. 1976; Enjebi Islet: s.n.s.d., coll. by R. Warner (MPRL).
Family MUSACEAE
  Musa sapientum L. Enjebi Islet: Planted in Lawrence Livermore Laboratory experimental garden. Japtan Islet: Planted near homes.
  Not collected.
Family ARACEAE
  Epipremnum pinnatum (L.) Engler cv. "Aureum" Enewetak Islet: Mar. 3 1975, under air conditioner (MPRL).
Family AGAVACEAE
  Cordyline terminalis (L.) Kunth. Enewetak Islet: Feb. 12, 1975, near buildings, coll. by E. H. Bryan, Jr. (BPBM).
Family RUTACEAE
  Citrus aurantifolia (Christm.) Swingle. Enjebi Islet: Planted in Lawrence Livermore Laboratory experimental garden.
  Not collected.
Family MALVACEAE
  Hibiscus sp. (hybrid, *H. rosa-sinensis* x *schizopetalus*?). Enewetak Islet: Mar. 1975, near chapel (MPRL).
Family APOCYANACEAE
  Plumeria obtusa L. Enewetak Islet: Feb. 1975, near buildings (MPRL).
  Plumeria rubra L. Enewetak Islet: Feb. 1975, near buildings, coll. by E. H. Bryan, Jr. (BPBM).
Family VERBENACEAE
  Vitex trifolia L. Enewetak Islet: Feb. 1975, near buildings at southwest end of runway; also collected Feb. 12, 1975 by E. H. Bryan, Jr. (MPRL, BPBM).

*Taxa are listed in the same order as in Tables 1 through 3. Specimens were collected by J. O. Lamberson, 1975 through 1977, except as noted, were determined by H. St. John and F. R. Fosberg, and are deposited in the U. S. National Museum Herbarium (USNM), the Bishop Museum Herbarium (BPBM), and the Mid-Pacific Research Laboratory Reference Collection (MPRL).

the Pteridophyta correlates with that given by Fosberg et al. (1979, 1982).

Thirty-six species (28.1% of the total) are introduced weeds, and 30 species (23.4%) are introduced ornamentals or food plants. Nineteen of these species occur only under cultivation and are considered transient members of the flora (Table 2). Seven species (5.5%) have been reported only as drift seeds found on beaches (Table 3). New records for the atoll reported in this chapter (Table 4) bring the total number of species recorded from the atoll to 128.

Enewetak Atoll averages 125 to 150 cm of rain annually and is much drier than atolls farther south, which are closer to the tropical convergence zone just north of the equator. Observations during the period 1975 to 1977 and meteorological records show that there is a definite seasonality on Enewetak: dry and windy from November through April, with more rain and less wind the other half of the year.

The plants of Enewetak reflect this seasonality, producing more flowers and fruit in summer and shedding some or most of their leaves in winter, depending on the species. *Pisonia* forests become open and light in the winter because *Pisonia* trees shed most of their leaves. This species flowered abundantly in January and February 1976, and the flowers were followed by the sticky fruits and new growth of leaves in March and April. *Terminalia* trees shed almost all of their leaves, which turn yellow and drop in the dry season. *Cordia, Tournefortia, Guettarda,* and *Scaevola* shed some of their leaves during the dry season and produce more flowers and fruit during the summer months. *Premna* and *Hibiscus tiliaceus* shed many of their leaves in winter, and new growth is produced in April or May. *Pemphis, Suriana, Cocos,* and *Morinda* produce flowers and fruit year round, though the plants may appear more wind-blown and dry in winter, and the seeds usually germinate in early summer.

Many of the ground plants and weedy species also reflect the seasonality. Annuals such as *Conyza, Physalis,* and some of the grasses are seen mostly in summer, as are *Laportea* and *Portulaca*. *Ipomoea* species are present year round but flower in summer. *Tacca* dies down in October or November and grows from the underground tubers in April or May, producing flowers in June and seeds in July. *Cyperus* species flower in summer, although *Fimbristylus* is in bloom year round. *Euphorbia* species are present year round, but *Phyllanthus* is much more abundant in summer. *Waltheria* also dies down in winter, and new growth is seen in April or May.

Tropical storms, though uncommon in the Marshall Islands, do occasionally occur in the vicinity of Enewetak, and storm waves sometimes wash over the islands. The dense shrub growth at the top of most of the island beaches affords some protection to plants farther inland, but storms may wash away parts of the islands or damage the larger trees, especially *Pisonia*, which is soft and easily broken. A typhoon approached the atoll in the summer of 1977, causing some damage to the *Pisonia* on the leeward islands and sending storm waves over the northeast end of Enewetak Island to a depth of more than 1 m.

HISTORY AND PREVIOUS OBSERVATIONS

During the late 1800s and early 1900s, the people of Enewetak Atoll cultivated *Tacca*, breadfruit, coconut, *Pandanus*, and other plants on the atoll and traded copra to the Germans. Some of the coconut trees planted in neat rows during German times still survive and produce coconuts. German soil used as ballast in ships was deposited on the island of Japtan to promote coconut growth. Plants and plant parts were utilized extensively in the Marshall Islands for food, drink, building materials (for houses and canoes), utensils, clothing, toys, medicine, and other uses (Anon., 1951; Bryan, 1972).

In 1914, Japan acquired Enewetak as a result of a World War I mandate, and a Japanese trader and his assistants resided on the atoll. The first known botanical collection from Enewetak was one of *Pandanus* made by Ohba in 1934 and published by Kanehira (1935). In the early 1940s, the Japanese cleared parts of some of the islands for construction of military fortifications, including an airfield on Enjebi.

In 1944, the atoll was attacked and captured by United States forces. The heavy shelling during the battle and subsequent clearing and grading resulted in large-scale destruction of the vegetation on Enjebi, Medren (then called Parry), and Enewetak Islands. Bryan (1944) described the atoll's vegetation at that time and noted that Medren resembled a plowed field with almost no plants at all. Bryan's report and 1954 Army Map Service maps based on aerial photographs taken in 1944 indicate, however, that some coconut trees were still present on several islands. In 1946, Fosberg visited the atoll and reported the results of his botanical survey and collection of Enewetak plants with those from other atolls in the Marshall Islands (Fosberg, 1955). Taylor (1950) described the marine and terrestrial vegetation and the plant species he encountered when he visited the atoll in 1946. At that time, *Pisonia* had been cut on Ikuren, Jedrol, and Alembel; military activity had also destroyed some of the vegetation on Lujor, Alembel, Runit, Japtan, and Jedrol; and the islands of Enewetak, Medren, and Enjebi had been reduced to "wastes of white sand" between buildings with a few weeds and scrubby coconuts. Runit, however, was completely occupied by a formal coconut grove, except for a military installation at the south end.

Aerial photographs taken in 1956 show that the flora of almost all the islands was affected by military activity during the nuclear test program conducted from 1948 to 1958. The islands of Louj through Boken (Irene) were almost bare, as were Runit, Boko, and Bokandretok. Enewetak, Medren, and Enjebi were covered with buildings, and only a few plants grew on these islands among the structures and roadways. Most of the other islands supported scrub vegetation or were partially cleared, and only the leeward islands from Ikuren through Biken were relatively undisturbed.

The effects of the nuclear test program on the biota and the environment at Enewetak and Bikini were extensively studied by the Applied Fisheries Laboratory of the University of Washington, later renamed the Laboratory of Radiation Biology. Their results were reported in UWFL series, in published papers, and in journalistic form in the book *Proving Ground* (Hines, 1962).

An article by St. John (1960) provides a comprehensive record of the land plants found on the atoll up to that time. It gives a systematic account of species recorded, with notes on islands, collectors, and dates. Also included are a key to species, index to genera, and other data helpful to an understanding of the flora of the atoll.

The long-term effects on the vegetation because of the nuclear test program were primarily those resulting from destruction of habitats and the removal of soil and vegetation from the islands (St. John, 1950; Biddulph and Cory, 1952; Palumbo, 1962). Some abnormalities, including tumors, calcium deficiency, growth irregularities, abnormal fruits and flowers, color abnormalities, and sterility, were found in plants near test sites (St. John, 1950; Biddulph, 1950; Biddulph and Cory, 1952; Biddulph and Biddulph, 1953). However, habitat disturbance and removal of the soil with loss of organic matter, inorganic nutrients, and water retention capability apparently had more lasting effects on the vegetation than the radioactivity. With the destruction of protective habitats, exposure to adverse environmental factors such as salt spray and drying winds was greater.

Following the conclusion of nuclear testing on Enewetak in 1958, the atoll was used for various other military and semi-military purposes during the 1960s and early 1970s. The Pacific Cratering Experiment (PACE) program bulldozed Aomon to the water table level and detonated nonnuclear explosives which left several small craters on the island.

The Enewetak Marine Biological Laboratory (EMBL) was established in 1954. An extensive reference collection of atoll biota, including marine and terrestrial plants, has been gradually gathered, and the laboratory has provided facilities for a large number of visiting scientists. Specimens for the reference collection were contributed by G. R. Baker, E. H. Bryan, P. Colinvaux, V. Frey, M. Gilmartin, J. Lamberson, P. Lamberson, I. E. Lane, M. A. Lee, H. St. John, and R. Warner. Some botanical studies have been made through the laboratory and are described in the laboratory annual reports (Bryan and Lee, 1975; Lee and Lee, 1978).

In 1957 to 1958, the University of Hawaii, the U. S. Weather Bureau, and the Joint Task Force Seven conducted microclimatic weather observations at Enewetak. During that study, Lane made botanical collections and notes and contributed a detailed section, which is included in that report, on the vegetation of some of the islands (Lane, 1960).

Woodbury (1962) gathered ecological data on the atoll for the University of Utah from February to May 1962. His report includes very general descriptions of the vegetation on the various islands at that time.

In 1964, the Laboratory of Radiation Biology of the University of Washington conducted a radiological resurvey of Bikini and Enewetak Atolls (Welander et al., 1966). This report includes many photographs and descriptions of the vegetation on various islands, including notes on vegetation recovery since the nuclear test days. Observations on vegetation have also been recorded in reports of studies on terrestrial radioisotope cycling (Jackson and Carpenter, 1967; Koranda et al., 1978), rats (Jackson, 1969; Fall et al., 1971), and birds (Carpenter et al., 1968).

The Atomic Energy Commission conducted another radiological survey of the biota and environment of Enewetak in 1972 and 1973. The three-volume report includes color aerial photographs of each of the islands, as well as radiological data on the water, sediments, soil, and biota. Terrestrial biota is reported by Koranda et al. (1973).

By 1975, the vegetation was gradually recovering on all of the islands and was growing over the remains of buildings and equipment left from the war and nuclear test days. Many of the plants which dominated the vegetation on the islands were introduced weeds, and a few ornamental and crop plants were growing in private gardens. A photographic field guide to plants observed on the atoll from 1975 to 1977 has been compiled (Lamberson, 1982).

In July 1975, a 12-acre plot of land was cleared on Enjebi for an experimental garden project to monitor the uptake of radionuclides from the soil into food plants. This long-term study is supported by the Department of Energy and is contracted to the Lawrence Livermore Laboratory (LLL) of Livermore, Calif. Radiologically "clean" soil from Jedrol was moved to Enjebi in 1975 for control studies. Breadfruit, pandanus, coconut, banana, sweet potato, lime, watermelon, and papaya were planted.

On September 16, 1976, legal control of Enewetak Atoll was formally transferred from the U. S. government back to the people of Enewetak, with the agreement that radioactive debris and soil and nonradioactive scrap would be removed from inhabitable islands. In late 1976, federal funds were approved for the cleanup, and in 1977 the project was well under way. Some of the people of Enewetak returned from Ujelang Atoll to live on Japtan in March 1977. The program of rehabilitation and resettlement of the people included building of houses on Enewetak, Medren, and Japtan and replanting of coconut, banana, breadfruit, pandanus, and other crop plants.

The effect of the cleanup on the vegetation of radiologically contaminated islands has been very significant. Radioactive soil and debris were removed from many of the northern islands and deposited in a crater on Runit, which will be a permanently radiologically quarantined island. Reconstruction of housing on Enewetak and Lojwa to support cleanup personnel resulted in fairly extensive clearing of the vegetation, and the rehabilitation program involved extensive clearing and replanting of crops and food trees on the southeast islands from Ananij to Enewetak. Homes were built for the returning people of Enewetak on the islands of Japtan, Medren, and Enewetak, and the people returned to the atoll between 1977 and 1979. The radiological cleanup and the rehabilitation programs were completed in 1980, but it will be years before the atoll again supports mature groves of coconut, breadfruit, and pandanus.

SUCCESSION AND OBSERVATION, 1975 TO 1977

After nuclear testing ceased at Enewetak Atoll in 1958, the vegetation was relatively undisturbed for almost 20 years, permitting the observation of plant distribution and succession under "natural," if unusual, conditions. The scrap and radiological cleanup operations beginning in 1977 and the rehabilitation and replanting for the return of the people of Enewetak have resulted in large-scale alterations to the vegetation. It seems appropriate, therefore, to report on the condition of the vegetation before the cleanup, 1975 to 1977.

Plant succession on the leeward islands, Ikuren through Biken, was followed through literature reports, aerial photographs, personal communication, and observation. For convenience, several stages of succession were defined.

Stage I, early pioneers, was seen on sand bars, spits, and small islands that were subject to storm damage and washover. Plants had to survive harsh conditions of intense sun, drying winds, and salt spray. They also had to overcome high salt concentration in the sand and the lack of water and nutrients. This stage was seen on narrow portions of Ikuren; on the small island between Elle and Bokenelab; on Bokinwotme; and on the small islands of Boko, Munjor, and Jinedrol. Plant genera present were *Tournefortia, Scaevola, Lepturus,* and *Triumfetta* and seedlings of *Guettarda, Morinda, Suriana,* and *Cocos* (Fig. 1).

As these plants become established, there is more protection from wind and sun, and organic matter accumulates in the soil to provide nutrients and to hold moisture.

In Stage II, a thick scrub growth of mixed genera occurs, impenetrable without a sharp machete and patience. This stage was seen on the eastern ends of Ikuren, the southeast end of Boken (Irwin), and on Bokandretok and formed the beach vegetation on many of the islands. It forms a protective barrier against salt spray and allows for development of vegetation inland on the larger islands. In addition to genera found in Stage I, vines such as *Ipomoea, Canavalia,* and *Cassytha* are present. *Terminalia, Cordia, Pemphis,* and *Pandanus* may also appear, and ground plants such as *Lepturus* and *Triumfetta* are confined to the margins (Fig. 2).

In Stage III, the soil is more fertile, the trees are larger, and birds nesting in the branches add to the soil nutrients with their droppings and an occasional regurgitated fish. An open grassland develops under the trees, and ground

Fig. 1 Stage I, early pioneer plants. Plants seen in this photograph are *Scaevola*, *Tournefortia*, *Suriana*, *Lepturus*, and *Triumfetta*.

Fig. 2 Stage II, scrub growth. Plants in this photograph are *Scaevola* and *Tournefortia*.

plants such as *Portulaca, Boerhavia, Laportea,* and *Sida* appear. *Pisonia* may become a component of the young mixed forest, and vines are abundant. *Cassytha* may help to open up the forest by killing some trees. Larger plants present include *Tournefortia, Scaevola, Cocos, Pandanus, Cordia, Terminalia, Morinda, Guettarda, Pisonia, Suriana,* and *Pemphis.* This stage was found on the middle section of Ikuren, on Mut, on Kidrenen, and on the ocean side of Biken. It was also seen on Ananij, Van, the central portion of Alembel, and Bokenelab (Fig. 3).

Fig. 3 Stage III, young mixed forest. Plants shown include *Scaevola, Tournefortia, Guettarda, Pemphis,* and *Lepturus*.

In Stage IV, *Pisonia* and *Cocos* dominate the older mixed forest, and *Scaevola* is nearly shaded out. *Morinda, Tournefortia, Guettarda,* and *Terminalia* reach for sun, and *Neisosperma* may appear. The whole forest is more open, and the undergrowth consists of small *Cocos* and *Pisonia* with ground plants of *Laportea, Boerhavia, Lepturus,* and *Portulaca*. *Sida* and *Scaevola* are restricted to open areas, *Suriana* and *Pemphis* occur mostly at the forest margins, and vines become fewer, usually growing only in the sun in clearings and at the outer margins. This stage predominated on the main portions of Ikuren and Ananij (Fig.4).

In Stage V, *Pisonia* takes over. *Cocos* trees become unproductive and gradually die out; other species of trees are confined to the edges of the forest. There is little

Fig. 4 Stage IV, older mixed forest. Plants illustrated are predominantly *Cocos* and *Pisonia*.

ground cover other than *Pisonia* seedlings and regenerated branches. Nesting noddy terns fill the branches of the *Pisonia* trees, and the forest is open and easy to walk through. Coconut crabs, which are often present in Stage III and common in Stage IV, become less abundant. Stage V was seen on Biken and Kidrenen (Fig. 5). Portions of Japtan were between Stages IV and V.

Fig. 5 Stage V, *Pisonia* forest. Only *Pisonia* is seen in this photograph.

THE ISLANDS, 1975 TO 1977

Between January 1975 and May 1977, the author visited most of the atoll islands to record vegetative data. An island-by-island summary of plant species collected or observed is presented in Table 5.

The northern islands from Bokoluo to Boken were extensively disturbed by the nuclear test program. These islands had an open vegetation of scattered *Scaevola* and *Tournefortia* to 6 m in height with some *Cordia*, *Guettarda*, *Cocos*, and *Pandanus* with vines; a ground cover of *Lepturus* and *Fimbristylis*; and some *Boerhavia*, *Cassytha*, *Triumfetta*, *Sida*, *Ipomoea*, and *Euphorbia* (Stages I through III).

Thirty-four plant species, other than those planted in the LLL garden project, were found on Enjebi. The general vegetation was open to dense scrub of *Tournefortia* and *Scaevola* to 6 m in height, with occasional *Pandanus*, *Pemphis*, *Morinda*, and *Cocos* (modified Stage II to III). *Cenchrus* (reported extinct on this island in 1964), *Lepturus*, *Fimbristylis*, *Cassytha*, *Euphorbia* spp., *Phyllanthus*, *Ipomoea* spp., *Pluchea* spp., *Stachytarpheta*, *Heliotropium*, and *Tridax* were common, especially in the LLL garden. This island was once planted with coconuts and was the home of the people of Enjebi, but the coconut plantation was destroyed by Japanese and American military activities. Ten nuclear tests were conducted on or near the island, and during the test days the vegetation consisted of only grass, vines, and low shrubs. By 1964, however, *Tournefortia* trees were up to 6 m in height, and *Scaevola* almost to 5 m (Welander et al., 1966). Some *Pisonia* was reported in 1946 (Fosberg, 1955) and 1964 (Welander et al., 1966) but was not seen in 1975 to 1977.

The islands of Mijikadrek through Lujor supported only a scrub vegetation, consisting predominately of *Scaevola* and *Tournefortia* (Stage II to III). Coconut trees were present on Bokenelab; a few sprouts had appeared on Lujor; and a grove of coconut trees with *Pisonia* occurred on Elle. *Pisonia* was also present on Mijikadrek, and its sticky fruits may eventually be transported by birds from there to other northern islands. *Lepturus*, *Cassytha*, *Fimbristylus*, *Triumfetta*, *Sida*, and *Ipomoea* were fairly common, and there was some *Guettarda*. Lujor had much *Morinda*, and Elle had a grove of *Terminalia* on the south end, ocean side. The island of Taiwel or Percy, between Kidrenen and Bokenelab, has been barren at least since 1944, and storm waves sometimes wash over it. It has a border of beachrock and may once have been vegetated, but the only evidence of plant life seen there from 1975 to 1977 was a sprouted coconut which had died.

The islands of Eleleron through Bijile were once joined by causeways, though Eleleron was divided by a nuclear test in 1956, and part of it is now separate, although part is still joined to Aomon by a causeway. Aomon was bulldozed and pockmarked with small craters during the PACE program. There was an airstrip on Bijile, which was joined by a bridge to Lojwa, the site of the northern camp during the 1977 and 1978 cleanup operations. All of these islands had a mixed scrub vegetation of *Tournefortia* and *Scaevola*, with some *Cocos*, *Pandanus*, *Pisonia* (on Bijile), *Suriana*, *Morinda*, and *Terminalia* (on Aomon), *Cordia*, and *Guettarda* (Stage II to III). *Pluchea* was common, as were *Lepturus*, *Fimbristylus*, *Euphorbia*, *Triumfetta*, *Ipomoea*, and *Heliotropium*. *Stachytarpheta*, *Lippia*, *Eragrostis*, *Portulaca*, *Cassytha*, and *Sida* were present but uncommon. Aomon was occupied by the Marshallese people during the war and postwar period, and in 1977 *Tacca* still grew on the ocean side, near stands of *Hibiscus tiliaceus* and *Wollastonia biflora*. In 1977, wedge-tailed shearwaters were found nesting in burrows near *Pisonia* trees on Bijile, and *Laportea* and *Tacca* were seen near the nesting area.

Alembel was relatively undisturbed and had a central mixed forest of *Pisonia*, *Cocos*, *Scaevola*, *Tournefortia*, *Premna*, *Morinda*, and *Guettarda* (Stage III). *Cordia* was present on the lagoon side, and two large *Pandanus* trees—one bearing fruit—were at the northernmost end. The outer margin was a thick scrub growth, primarily of *Tournefortia*, *Guettarda*, and *Scaevola*, with scrub *Pisonia* and *Pemphis* on the ocean side, and *Suriana* on the lagoon side (Stage II).

Runit, which was extensively disturbed during the nuclear test program and is now a depository for radioactive debris from other islands, had an open vegetation of scattered large *Tournefortia* and *Scaevola* bushes and a few coconut trees (modified Stage II). There was a ground cover of *Cassytha*, *Conyza*, *Heliotropium*, *Lepturus*, *Fimbristylis*, *Euphorbia*, *Triumfetta*, and *Ipomoea pescaprae*. A few individuals of *Suriana*, *Pemphis*, *Morinda*, *Guettarda*, and *Pluchea* were also seen. This island was bulldozed during the nuclear test days and was the site of 17 tests, including Lacrosse (1956) and Cactus (1958) which left fairly large craters at the north end.

The small islands of Boko, Munjor, and Inedrol supported a limited vegetation (Stage I). Inedrol had only *Lepturus* and *Tournefortia*, and the others had those species plus *Scaevola*. Inedral and Van had more species, including *Pisonia*, *Boerhavia*, *Ipomoea macrantha*, and *Guettarda*. Inedral also had *Suriana*, and Van had a young mixed forest (Stage III) of coconut, *Triumfetta*, *Cordia*, and *Canavalia*.

Ananij had a *Cocos–Pisonia* forest (Stage IV) in the middle of the wide portion of the island, with *Lepturus* and *Boerhavia* beneath the trees and *Scaevola* and *Tournefortia* around the edges of the old runway (Stage II). There were several *Terminalia* trees, plus a few *Cordia*, *Suriana*, and *Guettarda*. The consolidated rock bar extending oceanward perpendicular to the island was covered with *Pemphis*.

Jinimi is an unusual little island which was covered with a dense mat of *Boerhavia* with scattered scrub *Pisonia*, *Tournefortia*, and *Scaevola* bushes. *Portulaca* and *Fimbristylis* were also common. The island was sometimes the site of a large nesting colony of sooty terns, which were also found nesting on Aomon.

Japtan was partially cleared during the war and test days and in 1977 became the home of about 80

TABLE 5

Island-by-Island Summary of Plant Species Observed or Collected on Enewetak Atoll, 1975–1977, Excluding Garden Species

*Not visited	*Bidens pilosa*	*Boerhavia* spp.	*Brachiaria mutica*	*Canavalia cathartica*	*Cassytha filiformis*	*Cenchrus echinatus*	*Cenchrus brownii*	*Chloris inflata*	*Coccoloba uvifera*	*Cocos nucifera*	*Conyza bonariensis*	*Cordia subcordata*	*Crinum asiaticum*	*Cynodon dactylon*	*Cyperus compressus*	*Cyperus rotundus*	*Dactyloctenium aegypticum*	*Desmodium incanum*	*Digitaria setigera*	*Eclipta alba*	*Eleusine indica*	*Eragrostis scabrifolia*	*Eragrostis tenella*
Bokoluo		x			x					x		x											
Bokombako		x			x					x													
Kirunu										x													
Louj		x			x					x													
Bokinwotme										x													
Bokaidrikdrik												x											
Boken		x			x	x				x		x											
Enjebi		x			x	x	x			x	x	x							x		x	x	x
Mijikadrek		x																					
*Kidrinen																							
Bokenelab		x			x					x		x											
(unnamed islet)										x													
Elle					x					x		x											
*Aej																							
Lujor					x					x													
Eleleron										x													
Aomon		x			x					x													x
Bijile		x			x					x		x							x				
Lojwa										x													
Alembel										x		x							x				
Billae																							
Runit					x					x	x	x											
Boko																							
*Munjor																							
Inedral		x																					
(Van)		x		x						x		x											
Jinedrol																							
Ananij		x			x					x		x											
Jinimi		x																					
Japtan		x			x	x				x	x	x				x	x				x		x
Jedrol		x																					
Medren			x		x			x	x	x	x		x		x	x					x		x
Bokandretok																							
Enewetak	x		x		x	x		x	x	x	x		x	x		x	x	x		x	x	x	x
Ikuren		x		x	x					x		x											
Mut		x		x	x					x		x											
Boken		x			x					x		x											
Ribewon		x			x					x		x											
Kidrenen																							
Biken		x			x	x				x		x											

(Table continued on following page.)

TABLE 5 (cont'd)

•Not visited	*Euphorbia chamissonis*	*Euphorbia hirta*	*Euphorbia thymifolia*	*Fimbristylus cymosa*	*Guettarda speciosa*	*Heliotropium procumbens*	*Hibiscus tiliaceus*	*Ipomoea macranthra*	*Ipomoea pes-caprae*	*Laportea ruderalis*	*Lepturus repens*	*Leucaena leucocephala*	*Lippia nodiflora*	*Morinda citrifolia*	*Neisosperma oppositifolia*	*Pancratium litterale*	*Pandanus spp.*	*Pemphis acidula*	*Phyllanthus amarus*	*Physalis angulata*	*Pisonia grandis*	*Pluchea indica*	*Pluchea symphytifolia*
Bokoluo	x	x		x	x			x			x			x			x	x					
Bokombako					x						x						x						
Kirumu																							
Louj				x				x			x												
Bokinwotme					x						x												
Bokaidrikdrik																							
Boken		x		x	x			x			x							x					
Enjebi	x	x	x	x	x	x		x	x		x			x			x	x	x			x	x
Mijikadrek					x						x										x		
•Kidrinen																							
Bokenelab					x			x			x			x									
(unnamed islet)											x												
Elle					x			x			x			x							x		
•Aej																							
Lujor		x		x	x			x			x			x				x					
Eleleron											x						x						
Aomon		x	x	x		x	x	x	x		x			x			x						x
Bijile		x	x	x	x	x		x	x	x	x		x				x	x			x		x
Lojwa		x	x	x	x	x		x	x		x								x				x
Alembel					x			x			x			x			x				x		
Billae					x													x			x		
Runit		x	x	x		x		x	x		x			x			x	x				x	
Boko											x												
•Munjor																							
Inedral					x						x										x		
(Van)					x			x			x										x		
Jinedrol											x												
Ananij					x			x			x							x			x		
Jinimi											x										x		
Japtan	x	x	x	x	x	x		x	x		x			x	x		x	x	x	x	x		
Jedrol				x	x			x			x										x		
Medren	x	x	x	x		x		x	x		x	x	x	x			x		x	x		x	x
Bokandretok											x												
Enewetak	x	x	x	x	x	x	x	x	x		x		x			x	x	x	x	x		x	x
Ikuren					x			x		x	x			x	x			x			x		
Mut				x	x			x	x	x	x			x			x				x		
Boken					x			x		x	x			x				x			x		
Ribewon					x			x		x	x			x				x			x		
Kidrenen								x			x						x	x			x		
Biken					x			x	x	x	x			x			x				x		

(Table continued on following page.)

TABLE 5 (cont'd)

	Polypremum procumbens	Portulaca australis	Portulaca lutea	Portulaca oleracea	Premna obtusifolia	Pseuderanthemum carruthersii	Psilotum nudum	Scaevola taccada	Sida fallax	Stachytarpheta jamaicensis	Suriana maritima	Tacca leontopetaloides	Terminalia samoensis	Thuarea involuta	Tournefortia argentea	Tricachne insularis	Tridax procumbens	Triumfetta procumbens	Vernonia cinerea	Waltheria indica	Wedelia trilobata	Wollastonia biflora
Bokoluo				x				x	x				x		x			x				
Bokombako								x	x						x			x				
Kirumu								x					x		x							
Louj								x			x				x			x				
Bokinwotme								x							x			x				
Bokaidrikdrik								x							x							
Boken								x	x		x				x			x	x			
Enjebi				x				x	x	x					x		x	x	x			
Mijikadrek								x	x						x							
*Kidrinen																						
Bokenelab				x				x	x						x			x				
(unnamed islet)															x			x				
Elle								x					x		x			x				
*Aej																						
Lujor								x	x		x				x			x				
Eleleron								x							x							
Aomon								x	x	x	x	x	x		x			x				x
Bijile				x				x		x		x			x			x				
Lojwa								x		x					x			x				
Alembel					x			x							x			x				
Billae								x			x				x							
Runit								x		x	x				x		x	x				
Boko								x							x							
*Munjor																						
Inedral								x			x				x							
(Van)								x							x			x				
Jinedrol															x							
Ananij								x			x		x		x			x				
Jinimi				x				x							x							
Japtan		x		x				x		x		x		x	x	x	x	x				
Jedrol				x				x					x		x			x				
Medren			x	x				x	x	x					x		x	x	x	x		
Bokandretok								x							x			x				
Enewetak	x			x		x	x	x	x	x	x				x		x	x	x	x	x	
Ikuren								x			x		x		x			x				
Mut				x				x			x		x		x			x				
Boken				x				x			x		x		x			x				
Ribewon				x				x			x		x		x			x				
Kidrenen							x								x			x				
Biken				x				x	x				x		x			x				

*Not visited

Marshallese people. It had a productive coconut plantation (established during the time of the German occupation) which was somewhat overgrown and a field of *Tacca*. The ocean side of the island was overgrown with scrub *Scaevola* and *Tournefortia* (Stage II), and the cleared area had a ground cover of *Cenchrus* and other grasses, sedges, *Euphorbia* spp., *Physalis*, *Triumfetta*, *Portulaca*, *Phyllanthus*, *Conyza*, *Ipomoea*, *Stachytarpheta*, *Heliotropium*, and *Tridax*. *Pluchea* was notably absent. The residents cleared the underbrush from the area around the buildings and planted *Pandanus* and bananas. There was also a mixed forest on the southwest third of the island dominated by *Pisonia*, with *Neisosperma*, *Cocos*, *Morinda*, *Guettarda*, *Cordia*, and *Pandanus*, with *Boerhavia* near the margins (Stage IV to V).

Jedrol, a small island inside the deep pass, set back from the atoll rim, had a mature *Pisonia* forest with no *Cocos* but with *Scaevola*, *Tournefortia*, *Terminalia*, and *Guettarda* (Stage IV to V). *Fimbristylis*, *Lepturus*, and *Ipomoea macrantha* were common, and *Portulaca* and *Boerhavia* were present but less common. Some soil was removed from this island in 1975 for the Enjebi garden.

Medren and Enewetak were completely cleared during the war and nuclear test days for construction of housing and other buildings. Medren was abandoned in 1969, and the buildings and equipment left there became overgrown with plants (modified Stage II). Large shrubs and trees of *Tournefortia*, *Scaevola*, and *Cocos* were growing, and *Pluchea* spp. were abundant. There were remains of gardens containing *Coccoloba*, *Crinum*, and *Leucaena*. There was a ground cover of various grasses (not including *Cenchrus*), sedges, *Portulaca*, *Cassytha*, *Euphorbia* spp., *Phyllanthus*, *Triumfetta*, and *Ipomoea* and introduced species such as *Tridax*, *Lippia*, *Stachytarpheta*, *Conyza*, *Vernonia*, *Heliotropium*, and *Waltheria*. Enewetak was less overgrown because it had been continually occupied but had even more introduced species, including the weeds *Polypremum*, *Desmodium*, and *Bidens*. Ornamentals included *Crinum*, *Wedelia*, *Pseuderanthemum*, *Coccoloba*, *Plumeria*, and *Hibiscus*, and gardens contained many more transient species of food plants and flowers not recorded for this report.

Bokandretok is a small islet just north of Enewetak which may be reached from there on foot at low tide. It was barren and occupied by troops in the 1950s but in 1977 supported a dense cover of *Scaevola* and *Tournefortia*, with *Lepturus* and *Triumfetta* around the edges (Stage II).

The leeward islands, Ikuren through Ribewon, were little affected by the war and test days and were not involved in the cleanup and rehabilitation. There was a weather station on Kidrenen, and there were a few derelict barges and boats left along the shores, but the vegetation in 1977 was Stage III to IV mixed forest. Coconuts were abundant on Ikuren, Mut, and Kidrenen, but those on Mut were old and seemed to be dying out (Stage IV to V). *Pisonia* trees were present on all of the leeward islands, and there were some nearly pure stands of this species (Stage V) and of *Pemphis* on Ribewon and Boken. The successional stages described earlier were well illustrated on these islands.

Biken, isolated 20 km along the reef southwest of Bokoluo, in 1977 had a forest dominated by *Pisonia* with some old coconut trees and open underneath (Stage V). There was a scrub *Scaevola–Tournefortia* border along the south side, with a few *Guettarda* and *Morinda*. *Cenchrus*, *Sida*, and *Ipomoea* were present but uncommon on the lagoon side, and on the north side there were *Pandanus* and a group of *Terminalia* trees. A grove of old *Cordia* trees was found at the entrance to an overgrown road on the northwest side. The vegetation on this island was damaged by Oak test to the north in 1958. It was described in 1964 as thick and overgrown with *Ipomoea macrantha* making transit difficult (Welander et al., 1966), but in 1975 through 1977 it was open and easy to walk through. *Ipomoea* and *Cassytha* were still present but not abundant. The ground cover outside the *Pisonia* area included *Boerhavia*, *Lepturus*, and some *Portulaca* and *Triumfetta*. There were a number of small craters on the island and reef flat dating from World War II when the island was used as a target for bombing practice. Coconut crabs were abundant, and roosting immature frigate birds were often seen, as were many other species of birds.

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Chapter 4

*Recent Foraminifera and Nonplanktonic Protozoans**

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FORAMINIFERA

In 1946, during Operation Crossroads, 45 samples containing Recent Foraminifera were obtained in the Enewetak Lagoon from the shore to depths of 62 m (204 feet) and on the outer slopes at depths from 44 to 914 m (144 to 3000 feet) (Cushman et al., 1954). Of the 204 species of foraminifera recorded at Enewetak, approximately 60% were also collected from the reef flats, lagoons, and outer slopes of other Marshall Island atolls (Rongerik, Rongelap, Bikini) and Sylvania Guyot. Fourteen of the 18 new species and two new varieties described at that time from the Marshall Islands were found at Enewetak.

In the 1954 study, the Marshall Island foraminiferal fauna was composed of nearly 85% species characteristic of the tropical Pacific, 6% new to science, and the balance undetermined. No significant differences in the foraminiferal composition were evident between the four atolls sampled during the study. Compared with other unspecified Pacific islands, the absence of *Baculogypsina* spp., *Calcarina calcar*, and medium-to-large *Rotalia*, as well as the presence of a greater variety of miliolid species, was apparent (Cushman et al., 1954).

General features of specific biotopes (reef flat, lagoon, outer slope, and deep waters) with their dominant or restricted foraminiferal components were given, together with specific station localities (op. cit.).

Foraminifera from Enewetak were also recorded from borings at two drill sites on the atoll (Cole, 1957; Todd and Low, 1960). These sites include a large number of extant species. In fact, Cole (op. cit.) reported that samples from the surface to about 186 m (610 feet) contained only Recent species. The present list of Recent Enewetak Foraminifera recorded from these two papers includes 23 additional species that were listed among Recent Marshall Island species by Cushman et al. (1954).

Todd (1960) included Enewetak among localities discussed in the distribution of *Calcarina spengleri* and absence of members of the genus *Baculogypsina*.

Lacking a representative identified collection of Foraminifera and other protozoans at Enewetak, Mid-Pacific Research Laboratory (MPRL) contracted for such a collection to be made in 1956. Approximately 140 foraminiferal species were determined from the 142 samples obtained from shallow water throughout the atoll. The seaward reef and reef flat genera were compared with those found in beach sands and plankton tows (Hirshfield et al., 1968). This work also compared the foraminiferal genera of Enewetak with that from smaller samples taken in Hawaii, Kwajalein, and the Solomon and Caroline Islands. The species list (unpublished report to MPRL by Hirshfield, Helson, and Charmatz, 1957) included several additions to the Enewetak fauna, six of which were also found by Chave in 1981.

Subsequent work on Foraminifera at Enewetak included studies on the fine structure and morphology of *Carterina spiculotesta* (Lipps and Enrico, 1973; Deutsch and Lipps, 1976; Conger et al., 1977). Foraminiferan predation by fishes and the methods of feeding by foraminiferans were also investigated at Enewetak (Lipps and Delaca, 1980). The species, *Amphistegina lessonii* and *A. obifera*, reviewed by Halloch and Larsen (1979) included material from Enewetak. Showers and Atkinson (1979) worked at the atoll on the different forms of *Rosalina globularis*.

The checklist of Recent Foraminifera and nonplanktonic protozoans from Enewetak is presented in Table 1 and contains 280 species. The above-mentioned publications list 233 of these species. Forty-seven new Enewetak records have been added to this list by Chave (Table 2). Fourteen of these species were listed by Cushman et al. (1954) from other Marshall Island atolls; 33 species are new to Enewetak and the Marshall Islands.

*With the exception of planktonic foraminiferans, which are included in this chapter, other planktonic protozoans (dinoflagellates, radiolarians, and tintinnids) are presented in Chapter 20 (this volume).

TABLE 1

Checklist of Recent Foraminifera and Nonplanktonic Protozoans*

Phylum SARCODINA
  Class RETICULAREA
    Subclass GRANULORETICULOSIA
      Order FORAMINIFERIDA
        Family SACCAMMINIDAE
          Saccammina sp.
          Proteonina sp.: Cushman et al., 1954.
        Family HYPERAMMINIDAE
          Sagenina frondescens (Brady): Todd and Low, 1960.
        Family NOURIIDAE
          †*Nouria polymorphinoides* Heron-Allen and Earland: Cushman et al., 1954.
        Family LITUOLIDAE
          **Placopsilina bradyi* Cushman and McCullouch, 1939.
        Family TEXTULARIIDAE
          Bigenerina nodosaria d'Orbigny: Todd and Low, 1960.
          †*Bigenerina* sp.: Cushman et al., 1954.
          Clavulina angularis d'Orbigny: Todd and Low, 1960.
            Clavulina pacifica Cushman: Cushman et al., 1954.
          Textularia agglutinans d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
          Textularia candeiana d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
          Textularia conica d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
          Textularia foliacea Heron-Allen and Earland: Cushman et al., 1954.
          Textularia foliacea var. *oceanica* Cushman: Cushman et al., 1954; Todd and Low, 1960.
          Textularia kerimbaensis Said: Todd and Low, 1960.
          Textularia milletti Cushman: Cushman et al., 1954.
          **Textularia sagitula* var. *fistulosa* Brady, 1884.
          Textularia semialata Cushman: Cushman et al., 1954; Todd and Low, 1960.
          Valvulina davidiana Chapman: Cushman et al., 1954; Todd and Low, 1960.
        Family TROCHAMMINIDAE
          **Trochammina nitida* Brady, 1884.
          †*Trochammina* cf. *rotaliformia* Wright: Cushman et al., 1954.
        Family ATAXOPHRAGMIIDAE
          †*Gaudryina* cf. *pauperata* Earland: Cushman et al., 1954.
          Gaudryina triangularis angulata Cushman: Todd and Low, 1960.
            G. triangularis var. *angulata* Cushman: Cushman et al., 1954.
          Gaudryina trullissata Todd: Cushman et al., 1954.
          Gaudryina (Siphogaudryina) rugulosa Chapman: Cushman et al., 1954: Todd and Low, 1960.
          Gaudryina (Siphogaudryina) siphonifera Brady: Todd and Low, 1960.
          Karreriella bradyi (Cushman): Cushman et al., 1954.
        Family FISCHERINIDAE
          Cornuspira planorbis Schultze: Cushman et al., 1954; Todd and Low, 1960.
          Planispirinella exigua (Brady).
            Planispirinia exigua (Brady): Cushman et al., 1954.
        Family NUBECULARIIDAE
          Nebecularia lacunensis Chapman: Cushman et al., 1954.
          **Nubeculina divaricata* (Brady, 1879).
          **Ptychomiliola separans* Eimer and Fickert, 1921.
          †*Spiroloculina acescata* Cushman: Cushman et al., 1954.
          Spiroloculina angulata Cushman: Cushman et al., 1954; Todd and Low, 1960.
          Spiroloculina clara Cushman: Cushman et al., 1954; Todd and Low, 1960.
          Spiroloculina clara var. *lirata* Cushman: Cushman et al., 1954; Todd and Low, 1960.
          Spiroloculina communis Cushman and Todd: Cushman et al., 1954; Todd and Low, 1960.
          Spiroloculina corrugata Cushman and Todd: Cushman et al., 1954; Todd and Low, 1960.
          Spiroloculina folium Todd: Todd and Low, 1960.
            Spiroloculina sp. A: Cushman et al., 1954.
          **Spiroloculina grateloupi* d'Orbigny, 1839.
          Spiroloculina marshallana Todd: Cushman et al., 1954; Todd and Low, 1960.

*New Enewetak record.
†Not found in 1981 Enewetak collections.

(This table continued on next page.)

TABLE 1 (cont'd)

Family NUBECULARIIDAE (cont'd)
- *Spiroloculina mayori* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- **Spiroloculina* sp. B (of Cushman et al., 1954).
- *Vertebralina striata* d'Orbigny: Todd and Low, 1960.
- *Wiesnerella auriculata* (Egger): Cushman et al., 1954.

Family MILIOLIDAE
- †*Articulina elongata* Cushman: Cushman et al., 1954.
- *Articulina pacifica* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- **Articulina sagra* d'Orbigny, 1839.
- *Hauerina bradyi* Cushman: Cushman et al., 1954.
- *Hauerina diversa* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- *Hauerina involuta* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- *Hauerina milletti* Cushman: Cushman et al., 1954.
- †*Hauerina serrata* Cushman: Cushman et al., 1954.
- *Massilina planata* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- *Miliolinella australis* (Parr): Cushman et al., 1954; Todd and Low, 1960.
- *Parrina bradyi* (Millett): Cushman et al., 1954; Todd and Low, 1960.
- **Pseudomassalina australis* var. *reticulata* (Heron-Allen and Earland, 1915).
- *Pyrgo denticulata* (Brady): Cushman et al., 1954; Todd and Low, 1960.
- *Pyrgo denticulata* var. *striolata* (Brady): Cushman et al., 1954.
- **Pyrgo fornasini* Chapman and Parr, 1935.
- †*Pyrgo lucernula* (Schwager): Cushman et al., 1954.
- *Pyrgo millettii* (Cushman): Cushman et al., 1954.
- *Quinqueloculina anguina* var. *arenata* Said: Cushman et al., 1954.
- *Quinqueloculina bidentata* d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
- **Quinqueloculina bosciana* d'Orbigny, 1839.
- *Quinqueloculina sulcata* d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
- *Schlumbergerina alveoliniformis* (Brady): Cushman et al., 1954; Todd and Low, 1960.
- *Triloculina affinis* d'Orbigny, 1839.
  - *Triloculina trigonula* (Lamarck): Cushman et al., 1954; Todd and Low, 1960.
- *Triloculina* cf. *bassensis* Parr: Cushman et al., 1954.
- *Triloculina bikiniensis* Todd: Cushman et al., 1954.
- *Triloculina* cf. *bicarinata* d'Orbigny: Cushman et al., 1954.
- *Triloculina earlandi* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- *Triloculina involuta* Todd: Cushman et al., 1954.
- *Triloculina irregularis* (d'Orbigny): Cushman et al., 1954; Todd and Low, 1960.
- *Triloculina kerimbatica* (Heron-Allen and Earland): Cushman et al., 1954; Todd and Low, 1960.
- **Triloculina linneiana* d'Orbigny, 1839.
- *Triloculina marshallana* Todd: Cushman et al., 1954.
- *Triloculina oblonga* (Montagu): Todd and Low, 1960.
  - *Triloculina* cf. *oblonga* (Montagu): Cushman et al., 1954.
- *Triloculina* sp. A: Cushman et al., 1954.
- *Triloculina spinata* Cushman: Cushman et al., 1954.
- *Triloculina subplanciana* Cushman: Todd and Low, 1960.
- *Triloculina terquemiana* (Brady): Cushman et al., 1954.
- *Triloculina tricarinata* d'Orbigny: Cushman et al., 1954.
- *Triloculinella labiosa* (d'Orbigny): Cushman et al., 1954.
  - *Miliolinella laboisa* (d'Orbigny): Todd and Low, 1960.

Family SORITIDAE
- *Amphisorus hemptrichii* (Ehrenberg, 1840).
  - *Marginopora vertebralis* Blainville (in part): Cushman et al., 1954.
- *Marginopora vertebralis* Blainville: Cushman et al., 1954; Todd and Low, 1960.
- *Monalysidium politum* Chapman: Cushman et al., 1954; Todd and Low, 1960.
- *Sorites marginalis* (Lamarck): Cushman et al., 1954; Todd and Low, 1960.
- *Spirolina acicularis* (Batsch): Cushman et al., 1954.
- *Spirolina arietina* (Batsch): Cushman et al., 1954; Todd and Low, 1960.

Family ALVEOLINIDAE
- *Borelis pulchra* (d'Orbigny).
  - *Neoalveolina pulchra* (d'Orbigny): Cushman et al., 1954.
- *Borelis schlumbergeri* (Reichel): Cole, 1957.

*New Enewetak record.
†Not found in 1981 Enewetak collections.

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TABLE 1 (cont'd)

Family NODOSARIIDAE
- *Bolivinella folia* (Parker and Jones): Todd and Low, 1960.
- *Bolivinella folia* var. *ornata* Cushman: Cushman et al., 1954.
- **Dentalina filiformis* (d'Orbigny, 1826).
- †*Frondicularia* sp. A of Boomgaart: Cushman et al., 1954.
- *Lagena globosa* (Montagu): Cushman et al., 1954.
- †*Lagena spiralis* Brady: Cushman et al., 1954.
- †*Lagena striato-punctata* Parker and Jones: Cushman et al., 1954.
- †*Lagena williamsoni* (Alcock): Cushman et al., 1954.
- *Nodosaria pauciloculata* Cushman: Cushman et al., 1954.

Family VAGINULINIDAE
- **Astacolus pacifica* (Cushman and Hanazawa, 1936).
- **Astacolus planulata* Galloway and Whissler, 1927.
- *Robulus gibbus* (d'Orbigny): Cushman et al., 1954.
- *Robulus limbosus* (Reuss): Cushman et al., 1954.
- **Robulus orbicularis* (d'Orbigny, 1826).
- *Robulus* sp. A.: Cushman et al., 1954.

Family POLYMORPHINIDAE
- **Ramulina globulifera* Brady, 1879.

Family GLANDULINIDAE
- *Fissurina circularis* Todd: Cushman et al., 1954; Todd and Low, 1960.
- †*Fissurina formosa* (Schwager): Cushman et al., 1960; Todd and Low, 1960.
- †*Fissurina lacunata* (Burrows and Holland): Cushman et al., 1954; Todd and Low, 1960.
- *Fissurina marginato-perforata* (Seguenza): Todd and Low, 1960.
  - *Fissurina* sp. B: Cushman et al., 1954.
- *Fissurina milletti* Todd: Cushman et al., 1954.
- *Fissurina orbignyana flinti* (Cushman): Todd and Low, 1960.
  - *Fissurina* sp. C: Cushman et al., 1954.
- †*Fissurina* sp. A: Cushman et al., 1954.

Family SPIRILLINIDAE
- *Alanwoodia campanaeformis* (Brady, 1884).
  - *Conicospirillina semi-involuta* Cushman: Todd and Low, 1960.
- *Planispirillina denticulogranulata* (Chapman).
  - *Spirillina denticulo-granulata* Chapman: Todd and Low, 1960.
- *Planispirillina tuberculatolimbata* (Chapman).
  - *Spirillina tuberculato-limbata* Chapman: Cushman et al., 1954; Todd and Low, 1960.
- *Spirillina decorata* Brady: Todd and Low, 1960.
  - *Spirillina decorata* Brady var. of Sidebottom: Cushman et al., 1954.
- **Spirillina inaegualis* Brady, 1879.
- †*Spirillina spinigera* Chapman: Todd and Low, 1960.
- *Spirillina vivipara* var. *densepunctata* Cushman: Cushman et al., 1954; Todd and Low, 1960.
- *Spirillina vivipara* var. *revertens* Rhumbler: Cushman et al., 1954.

Family CERATOBULIMINIDAE
- **Ceratobulimina pacifica* Cushman and Harris, 1927.
- *Hoeglundina flinti* (Galloway and Whissler, 1927).
- *Hoeglundina elegans* d'Orbigny: Cushman et al., 1954.
- **Lamarckina scabra* (Brady, 1884).
- **Mississippina concentrica* (Parker and Jones, 1864).

Family ROBERTINIDAE
- **Alliatina excentrica* (di Napoli Alliata, 1952).

Family TURRILINIDAE
- †*Buliminella elegantissima* (d'Orbigny): Cushman et al., 1954.
- *Buliminella milletti* Cushman: Cushman et al., 1954.
- *Buliminoides williamsonianus* (Brady): Cushman et al., 1954.

Family SPHAEROIDINIDAE
- †*Sphaeroidina bullioides* d'Orbigny: Cushman et al., 1954.

Family BOLIVINITIDAE
- **Bolivina abbreviata* Heron-Allen and Earland, 1924.
- *Bolivina compacta* Sidebottom: Cushman et al., 1954; Todd and Low, 1960.

*New Enewetak record.
†Not found in 1981 Enewetak collections.

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TABLE 1 (cont'd)

Family BOLIVINITIDAE (cont'd)
Bolivina pseudopygmaea Cushman: Cushman et al., 1954; Todd and Low, 1960.
Bolivina rhomboidalis (Millett): Cushman et al., 1954; Todd and Low, 1960.
Bolivina robusta Brady: Cushman et al., 1954.
**Bolivina spinescens* Cushman, 1911.
Bolivina striatula Cushman: Cushman et al., 1954; Todd and Low, 1960.
Bolivina subexcavata Cushman and Wickenden: Cushman et al., 1954.
**Bolivina vadascens* Cushman, 1933.
Rectobolivina dimorpha var. *pacifica* (Cushman)
Siphogenerina dimorpha var. *pacifica* Cushman: Cushman et al., 1954.
Family ISLANDIELLIDAE
**Cassidulinoides* sp.
Family BULIMINIDAE
Bulimina fijiensis Cushman: Cushman et al., 1954.
Fijiella simplex (Cushman, 1929).
Reussella simplex (Cushman): Cushman et al., 1954, Todd and Low, 1960.
Fijiella spinulosa (Reuss, 1850).
Reussella sp. A: (Cushman): Cushman et al., 1954; Todd and Low, 1960.
Mimosina pacifica Cushman: Cushman et al., 1954.
Family UVIGERINIDAE
Siphogenerina raphana (Parker and Jones): Cushman et al., 1954; Todd and Low, 1960.
Trifarina albatrossi var. *ornata* (Cushman).
Angulogerina albatrossi var. *ornata* Cushman: Cushman et al., 1954.
Trifarina carinata (Cushman, 1927).
Trifarina bradyi Cushman: as figured by Cushman et al., 1954.
**Trifarina bradyi* Cushman, 1942.
**Trifarina scrobiculata* (Cushman, 1921).
Uvigerina porrecta Brady: Cushman et al., 1954.
†*Uvigerina proboscidea* Schwager: Cushman et al., 1954.
Uvigerina proboscidea var. *vadescens* Cushman: Cushman et al., 1954.
Family DISCORBIDAE
Discorbinella subbertheloti (Cushman).
Discorbis subbertheloti Cushman: Cushman et al., 1954.
Epistominella pulchra (Cushman): Cushman et al., 1954; Todd and Low, 1960.
Epistominella sp.: Cushman et al., 1954.
Neoconorbina crustata (Cushman).
Discorbis crustata Cushman: Cushman et al., 1954.
Neoconorbina tuberocapitata (Chapman).
Discorbis tuberocapitata (Chapman): Cushman et al., 1954.
**Patellinella carinata* Collins, 1958.
**Patellinella fijiana* Cushman, 1933.
†*Patellinella inconspicua* (Brady): Cushman et al., 1954.
Rosalina concinna (Brady).
Discorbis concinna (Brady): Cushman et al., 1954.
Rosalina floridana (Cushman, 1922).
Discorbis opima Cushman: Cushman et al., 1954.
**Rosalina globularis* d'Orbigny, 1826.
Rosalina micens (Cushman).
Discorbis micens Cushman: Cushman et al., 1954.
**Rosalina villardeboana* d'Orbigny, 1839.
**Rotorbinella lobatulus* Parr, 1950.
Rugidia corticata (Heron-Allen and Earland): Cushman et al., 1954.
Rugidia (?) *spinosa* Cushman: Cushman et al., 1954.
Tretomphalus bulloides (d'Orbigny), 1839.
Tretomphalus planus Cushman: Cushman et al., 1954.
**Tretomphalus millettii* Heron-Allen and Earland, 1915.
Valvulineria rugosa (d'Orbigny).
Discorbis rugosa (d'Orbigny): Cushman et al., 1954.
Rosalina rugosa d'Orbigny: Todd and Low, 1960.

*New Enewetak record.
†Not found in 1981 Enewetak collections.

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TABLE 1 (cont'd)

Family EPONIDAE
- *Eponides berthelotianus (d'Orbigny, 1839).
- *Eponides lateralis* (Terquem): Todd and Low, 1960.
- *Eponides repandus* (Fichtel and Moll, 1798).
  - *Poreponides cribrorepandus* Asano and Uicho: Todd and Low, 1960.

Family GLABRATELLIDAE
- *Glabratella patelliformis* (Brady).
  - *Discorbis patelliformis* (Brady): Cushman et al., 1954.
  - *Neoconorbina tabernacularis* (Brady): Todd and Low, 1960.
- *Heronallenia* sp.: Cushman et al., 1954.

Family PEGIDIIDAE
- *Pegidia dubia* (d'Orbigny): Todd and Low, 1960.

Family EPISTOMARIIDAE
- *Epistomaroides polystomelloides* (Parker and Jones): Cushman et al., 1954; Todd and Low, 1960.

Family SIPHONINIDAE
- *Siphonina tubulosa* Cushman: Cushman et al., 1954.
- *Siphoninoides echinata* (Brady): Cushman et al., 1954; Todd and Low, 1960.

Family AMPHISTEGINIDAE
- *Amphistegina bicirculata* Larsen, 1976.
  - *Amphistegina radiata* var. *venosa* (Fichtel and Moll): Cushman et al., 1954.
  - *Amphistegina madagascariensis* d'Orbigny: Cushman et al., 1954 (in part).
- *Amphistegina lessonii* (d'Orbigny): Halloch and Larsen, 1979.
  - *Amphistegina madagascariensis* d'Orbigny: Cushman et al., 1954 (in part): Todd and Low, 1960 (in part?).
- *Amphistegina lobifera* Larsen: Halloch and Larsen, 1979.
  - *Amphistegina madagascariensis* d'Orbigny: Cushman et al., 1954 (in part); Todd and Low, 1960 (in part?).
- *Amphistegina papillosa* Said.
  - *Amphistegina radiata* var. *papillosa* Said: Cushman et al., 1954.
- *Amphistegina* sp.
  - *Amphistegina radiata* (Fichtel and Moll): Cushman et al., 1954.
  - *Amphistegina radiata* var.: Cushman et al., 1954.

Family CIBICIDIDAE
- †*Cibicides cicatricosus* (Schwager): Cushman et al., 1954.
- *Cibicides lobatulus* (Walker and Jacob): Cushman et al., 1954; Todd and Low, 1960.
- *Cibicides mayori* (Cushman): Todd and Low, 1960.
- *Cibicides refulgens* Montfort: Todd and Low, 1960.
- *Cibicidella variabilis* (d'Orbigny): Cushman et al., 1954; Todd and Low, 1960.
- *Planulina ariminensis d'Orbigny, 1826.
- *Planorbulinoides retinaculatus* (Parker and Jones): Todd and Low, 1960.

Family PLANORBULINIDAE
- *Planorbulina acervalis* Brady: Cushman et al., 1954; Todd and Low, 1960.
- *Planorbulinella larvata* (Parker and Jones): Todd and Low, 1960.

Family ACERVULINIDAE
- *Acervulina inhaerens* Schultze: Cushman et al., 1954; Todd and Low, 1960.
- *Gypsina globula* (Reuss): Cushman et al., 1954; Todd and Low, 1960.
- *Gypsina plana* Carter: Todd and Low, 1960.
- *Gypsina vesicularis* (Parker and Jones) Cushman et al., 1954; Cole, 1957, Todd and Low, 1960.
- *Planogypsina squamiformis (Chapman, 1900).

Family CYMBALOPORIDAE
- *Cymbaloporella tabellaeformis (Brady, 1884).
- *Cymbaloporetta bradyi* (Cushman): Cushman et al., 1954; Todd and Low, 1960.
- *Cymbaloporetta squammosa* (d'Orbigny): Cushman et al., 1954; Todd and Low, 1960.
- *Pyropilus rotundatus* Cushman: Cushman et al., 1954; Todd and Low, 1960.

Family HOMOTREMIDAE
- *Biarritzina monticularis* (Carter).
  - *Carpenteria monticularis* Carter: Todd and Low, 1960.
- *Homotrema rubrum* (Lamarck): Cushman et al., 1954; Todd and Low, 1960.
- *Miniacina miniacea* (Pallas): Cushman et al., 1954.

‡Family GLOBOROTALIIDAE
- *Globorotalia crassaformis* Galloway and Whissler, 1927.

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*New Enewetak record.
†Not found in 1981 Enewetak collections.
‡Species names of family updated but not studied in 1981.

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TABLE 1 (cont'd)

Family GLOBOROTALIIDAE (cont'd)
Globorotalia crassa (d'Orbigny): Cushman et al., 1954.
Globorotalia cf. *hirsuta* (d'Orbigny): Cushman et al., 1954.
Globorotalia menardii (d'Orbigny): Cushman et al., 1954; Todd and Low, 1960.
Globorotalia truncatulinoides (d'Orbigny): Cushman et al., 1954.
Globorotalia tumida (Brady): Cushman et al., 1954.
‡Family HANKENTINIDAE
Hastigerina siphonifera (d'Orbigny, 1839).
Globogerinella aequilateralis (Brady): Cushman et al., 1954.
‡Family GLOBIGERINIDAE
Candeina nitida d'Orbigny: Cushman et al., 1954.
Globigerina bulloides d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
Globigerina eggeri Rhumbler: Todd and Low, 1960.
Globogerina subcretacea Lomnicki: Cushman et al., 1954.
Globigerina? sp.: Cushman et al., 1954.
Globigerinoides conglobatus (Brady): Cushman et al., 1954; Todd and Low, 1960.
Globigerinoides ruber (d'Orbigny): Cushman et al., 1954; Todd and Low, 1960.
Globigerinoides sacculifer (Brady): Cushman et al., 1954; Todd and Low, 1960.
Hastigerinella digitata (Rhumbler): Cushman et al., 1954.
Orbulina universa d'Orbigny: Cushman et al., 1954; Todd and Low, 1960.
Pulleniatina obliquiloculata (Parker and Jones): Cushman et al., 1954; Todd and Low, 1960.
Sphaeroidinella dehiscens (Parker and Jones): Cushman et al., 1954.
Family ROTALIIDAE
Ammonia beccarii tepida (Cushman).
Rotalia cf. *beccarii* var. *tepida* Cushman: Cushman et al., 1954.
Streblus beccarii tepida (Cushman): Todd and Low, 1960.
•*Carpenteria balaniformis* Gray, 1858.
Carpenteria utricularis (Carter, 1876).
Carpenteria proteiformis Goes: Todd and Low, 1960.
Family CALCARINIDAE
Calcarina hispida Brady: Cushman et al., 1954; Todd and Low, 1960; Todd, 1960.
Calcarina spengleri (Gmelin): Cushman et al., 1954; Todd and Low, 1960; Todd, 1960.
Family ELPHIDIDAE
Elphidium advenum (Cushman): Cushman et al., 1954; Todd and Low, 1960.
Elphidium advenum var. *dispar* Cushman: Cushman et al., 1954.
Elphidium jenseni (Cushman): Cushman et al., 1954; Todd and Low, 1960.
•*Elphidium oceanicum* Cushman, 1933.
Elphidium simplex Cushman: Cushman et al., 1954; Todd and Low, 1960.
Family NUMMULITIDAE
•*Cycloclypeus carpenteri* Brady, 1856.
Heterostegina suborbicularis d'Orbigny: Cushman et al., 1954; Cole, 1957; Todd and Low, 1960.
Operculina ammonoidea (Gronovius): Cushman et al., 1954.
Family CAUCASINIDAE
Cassidella earlandi (Cushman).
Virgulina earlandi Cushman: Cushman et al., 1954.
Sigmavirgulina tortuosa (Brady).
Bolivina tortuosa Brady: Cushman et al., 1954; Todd and Low, 1960.
Family LOXOSTOMATIDAE
Loxostomum convallarium (Millett): Cushman et al., 1954.
Loxostomum karrerianum (Brady): Todd and Low, 1960.
Loxostomum limbatum (Brady): Cushman et al., 1954; Todd and Low, 1960.
Loxostomum mayori (Cushman): Cushman et al., 1954.
Family CASSIDULINIDAE
†*Cassidulina angulosa* Cushman: Cushman et al., 1954.
Cassidulina costatula Cushman: Cushman et al., 1954.
•*Cassidulina crassa* d'Orbigny, 1839.
•*Cassidulina gemma* Todd: Todd, 1954.
Cassidulina marshallana Todd: Cushman et al., 1954.

•New Enewetak record.
†Not found in 1981 Enewetak collections.
‡Species names of family updated but not studied in 1981.

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TABLE 1 (cont'd)

Family CASSIDULINIDAE (cont'd)
Cassidulina minuta Cushman: Cushman et al., 1954.
**Cassidulina murrhyna* Schwager, 1866.
Cassidulina oriangulata Belford, 1966.
Cassidulina subglobosa Brady: Cushman et al., 1954 (in part).
Cassidulina patula Cushman: Cushman et al., 1954.
Cassidulina sulcata Belford, 1966.
Cassidulina delicata Cushman: Cushman et al., 1954.
†*Cassidulina subglobosa* Brady: Cushman et al., 1954.
†*Cassidulina subglobosa* Brady var: Cushman et al., 1954.
Ehrenbergina pacifica Cushman: Cushman et al., 1954.
**Ehrenbergina reticulata* Cushman, 1933.*
Family NONIONIDAE
**Astrononion tumidum* Cushman and Edwards: Cushman et al., 1954.
Nonion pacificum (Cushman): Todd and Low, 1960.
†*Nonionella* sp. A: Cushman et al., 1954.
Nonionella translucens Cushman: Cushman et al., 1954.
†*Pullenia salisburyi* Stewart and Stewart: Cushman et al., 1954.
Family ALABAMINIDAE
Alabamina tubulifera (Heron-Allen and Earland).
Epistominella tubulifera (Heron-Allen and Earland): Cushman et al., 1954; Todd and Low, 1960.
†*Gyroidina soldanii* d'Orbigny: Cushman et al., 1954.
†*Oridorsalis tenera* (Brady).
Eponides tenera (Brady): Cushman et al., 1954.
Family GAVELINELLIDAE
Anomalina cf. *glabrata* Cushman: Cushman et al., 1954.
Anomalinella rostrata (Brady): Cushman et al., 1954; Todd and Low, 1960.
Cibicidoides pseudoungerianus (Cushman).
Cibicides cf. *pseudoungerianus* (Cushman): Cushman et al., 1954.
Family CARTERINIDAE
Carterina spiculotesta (Carter): Cushman et al., 1954; Lipps and Enrico, 1973; Deutsch and Lipps, 1976; Conger et al., 1977.
Phylum CILIOPHORA
Class KINETOFRAGMINOPHORA
Subclass GYMNOSTOMATA
Order HAPTORIDA
Lacrymaria sp.: Hirshfield et al., 1957.
Order PLEUROSTOMATIDAE
Loxophyllum(?) sp.: Hirshfield et al., 1957.
Subclass VESTIBULIFERA
Order COLPODIDA
Colpoda sp.: Hirshfield et al., 1957.
Class OLIGOHYMENOPHORA
Subclass HYMENOSTOMATA
Order SCUTICOCILIATA
Cohnilembus verminus: Hirshfieid et al., 1957; Thompson, 1968.
Cyclidium sp.: Hirshfield et al., 1957.
Pseudochonilembus sp.: Hirshfield et al., 1957.
Uronema sp.: Hirshfield et al., 1957.
Subclass PERITRICHA
Order PERITRICHIDA
Syphidia sp.: Hirshfield et al., 1957.
Vorticella sp.: Hirshfield et al., 1957.
Class POLYHYMENOPHORA
Subclass SPIROTRICHA
Order HYPOTRICHIDA
Euplotes sp.: Hirshfield et al., 1957.
Stylonychia sp.: Hirshfield et al., 1957.

*New Enewetak record.
†Not found in 1981 Enewetak collections.
‡Species names of family updated but not studied in 1981.

TABLE 2

New Enewetak Records

Species	Location*	Depth	Substrate	Form†	Number‡
Bolivina abbreviata	L	50 m	Fine sand		1
Bolivina spinescens	L	52 m	Fine sand	Attached (brown)	17
Bolivina vadascens	L	5 to 23 m	Filamentous algae		2
	OS	100 to 140 m	Macro-algae		5
Cassidulinoides sp.	OS	400 m	Coarse sediment	Attached (gray)	5
Trifarina bradyi	OS	400 m	Coarse sediment		2
Trifarina scrobiculata	OS	400 m	Coarse sediment		2
Patellinella carinata	OS	200 m	Coarse sediment		2
Patellinella fijiana	L	55 m	Filamentous algae	Attached (brown)	12
Rosalina globularis	CH	20 to 27 m	Filamentous and macro-algae	Attached, free (brown)	21
	OS	80 to 100 m	Filamentous and macro-algae	Attached (brown)	3
Rosalina vilardeboana	L	52 m	Filamentous algae	Attached (brown)	15
	OS	80 to 140 m	Filamentous and macro-algae	Attached, free (brown)	46
Rotorbinella lobatulus	L	2 to 5 m	Macro-algae	Attached, free (brown)	9
	OS	100 m	Coarse sediment		3
Tretomphalus millettii	L	16 m	Algae	Free (brown)	1
	OS	80 to 400 m	Sand and algae on rocks	Free	6
Eponides berthelotianus	OS	200 to 230 m	Rock crevices	Attached (light brown)	5
Planulina ariminesis	OS	80 to 140 m	Rocks	Attached (reddish brown)	21
Planogypsina squamiformis	OS	80 to 300 m	Rocks and coarse sand	Encrusting (brown)	9
Cymbaloporella tabellaeformis	L	13 m	Rock with macro-algae		1
Carpenteria balaniformis	OS	80 to 230 m	Rocks	Encrusting (grayish brown)	17
Elphidium oceanicum	L	60 m	Fine sand		3
Cycloclypeus carpenteri	OS	140 to 200 m	Rock crevices	Attached (white)	3
Cassidulina crassa	OS	80 to 140 m	Coarse sand, rock crevices	Attached (brown)	30
Cassidulina gemma	L	55 to 60 m	Fine sand		2
	OS	80 to 140 m	Rock crevices		17
Cassidulina murrhyna	OS	230 to 400 m	Coarse sand		2
Ehrenbergina reticulata	OS	400 m	Coarse sand	Attached (grayish brown)	3
Placopsilina bradyi	OS	140 to 230 m	Rocks	Encrusting (tan)	12
Textularia sagitula var *fistulosa*	OS	2 m	Macro-algae	Attached (reddish brown)	6
Trochamina nitida	OS	300 m	Coarse sand		2
Nubeculina divaricata	OS	300 m	Coarse sand		2
Ptychomiliola separans	OS	12 m	Fine sand		1
Spiroloculina grateloupi	L	55 m	Fine sand		1
Spiroloculina sp. B	OS	100 to 200 m	Rock crevices		3
Articulina sagra	OS	80 m	Algae on rock		1
Pseudomassalina australis var	L	52 to 55 m	Macro-algae		4
reticulata	CH	20 to 27 m	Filamentous algae	Attached (pink)	14
Pyrgo fornasini	OS	400 m	Coarse sand		1
Quinqueloculina bosciana	L	52 to 55 m	Filamentous algae	Attached (brown)	18
Quinqueloculina lamarckiana	L	15 to 16 m	Filamentous and macro-algae		3
Quinqueloculina polygona	OS	140 m	Rock crevice		1
Triloculina linneiana	CH	2 to 33 m	Algae on rocks		3
Dentalina filiformis	OS	400 m	Coarse sand	Free (red)	3
Astacolus pacifica	OS	300 to 400 m	Coarse sand		2
Astacolus planulata	OS	400 m	Coarse sand		2
Robulus orbicularis	OS	300 to 400 m	Coarse sand	Free (pink)	4
Ramulina globulifera	OS	400 m	Coarse sand		1
Spirillina inaequalis	OS	200 to 300 m	Coarse sand		2

*L, lagoon; CH, channel; OS, outer slope.

†Living form (followed by color of protoplasm): encrusting, test cemented to substrate; attached, holding on to substrate with pseudopods; free, not attached to substrate.

‡Total number of intact specimens in all 42 samples, each containing 1 cc of sand or scraped material. (This table continued on next page.)

TABLE 2 (Cont'd)

Species	Location*	Depth	Substrate	Form†	Number‡
Ceratobulimina pacifica	OS	80 to 300 m	Crevices in rocks	Attached (brown)	4
Lamarckina scabra	OS	200 m	Rocks	Encrusting (reddish brown)	6
Mississippina concentrica	OS	300 m	Coarse sand		1
Alliatina excentrica	OS	400 m	Coarse sand		2

*L, lagoon; CH, channel; OS, outer slope.

†Living form (followed by color protoplasm): encrusting, test cemented to substrate; attached, holding on to substrate with pseudopods; free, not attached to substrate.

‡Total number of intact specimens in all 42 samples, each containing 1 cc of sand or scraped material.

The taxonomy to the generic level is based on Loeblich and Tappan (1964, 1974, 1981). Species were identified by Chave using Ellis and Messina (1940 et seq.) and a large number of publications of which Graham and Militante (1959), Barker (1960), Todd (1965), and Belford (1966) were especially useful.

CILIOPHORA

Several marine ciliates were collected at Enewetak from reef flat scum (Hirshfield et al., 1957). In addition, *Scyphidium* sp. was attached to unspecified invertebrates on the reef, and *Cyclidium* sp. was found with habitat unspecified (Hirshfield, op. cit.). Observations made by Patrick Colin from 1979 to 1980 off Runit Islet revealed discolored brownish areas on the lagoon bottom, which were found by Devaney to be formed by high concentrations of an undetermined peritrich ciliate that resembles *Scyphidia*.

During 1966, 42 hymenostomme ciliates were collected from the ocean and lagoon sides of nine islets at Enewetak Atoll. Permanent silver-impregnated slides were made of these protozoans from cultures (Thompson and Sellers, 1967), but species were not listed. Subsequently, Thompson (1968) described *Cohnilembus verminus* from Enewetak.

Berger (1964) noted that undetermined endocommensal ciliates were present in several unspecified regular sea urchins but were absent from at least two species (*Eucidaris metularia* and *Parasalinia gratiosa*) and from irregular urchins and other unspecified echinoderms examined. The classification for ciliophorans follows Corliss (1977).

OTHER PROTOZOANS

Fresh and brackish water protozoans at Enewetak revealed mainly amoeboid types from nearly 100 water and soil sites on nine islets. Additional fish, gecko, rat and bird blood, and other tissues were examined for protozoan parasites (Dillon and Kasweck, 1970).

NEW ENEWETAK RECORDS

In 1981, 42 samples were studied at Enewetak immediately after being collected from the lagoon at depths of from 1 to 61 m, in the channels from 1 to 33 m, and on the outer slopes from 1 to 400 m. Of the new Enewetak records, 23 species were represented by one to three specimens and 14 species were fairly common but were obtained by methods not used during the 1946 collections (hard surfaces were scraped by hand to depths of 33 m, and rocks were brought up from deep areas by the submersible *Makili'i*). The final 10 species were common in sediment samples and were not reported by Cushman et al. (1954).

Twenty-nine species listed by Cushman et al. (1954) were not found by the senior author. Twenty-seven of these species were listed as rare or from the 914 m station (op. cit.). Two species, *Hauerina serrata* and *Astrononion tumidum*, were listed as common in lagoon sediments (op. cit.).

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Chapter 5

Porifera of Enewetak Atoll

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The first sponges reported from Enewetak were based on collections made between 1946 and 1948 from a number of tropical Pacific areas (de Laubenfels, 1954). The Pacific Science Board of the National Research Council sponsored the collections project. Six of the 13 species recorded from Enewetak were collected by dredging near the center of the lagoon (8 km north of the south anchorage; approximately 11° 29′ N, 165° 15′ E, de Laubenfels, 1954) at a depth of 35 m. Another species came from the reef flat, and six were from unrecorded localities. Three new species were recorded from Enewetak, but only one *(Lissodendoryx calypta)* was unique to that atoll.

Three sponges, each prey for different species of dorid nudibranchs, have also been recorded from Enewetak (Young, 1967). The color, form, and habitat of these sponges were given.

Beginning in 1972, research was initiated on the biochemistry of Enewetak sponges (Middlebrook et al., 1972; Scheuer et al., 1974; Ravi and Scheuer, 1975; Scheuer et al., 1975; Chevolot et al., 1977; Yunker and Scheuer, 1978; Ravi et al., 1979). A sponge from the lagoon was used as a source of radionuclides concentrated in its siliceous spicules (Hurd and Lawson, 1975).

The need for valid identification of sponges is clearly indicated in research where chemical studies have been made on species that remain undetermined (Chevolot et al., 1977; Yunker and Scheuer, 1978; Ravi et al., 1979). Attempts to get Enewetak sponge material identified have resulted in 17 additional sponges receiving preliminary determinations by Klaus Ruetzler (personal communication, 1981). Examples of some or all of these species are deposited at U. S. National Museum of Natural History (USNM), Mid-Pacific Research Laboratory (MPRL), and the B. P. Bishop Museum (BPBM). Brief descriptions (color, external morphology, colony form) and habitat information on these sponges were prepared by Janet Lamberson for MPRL. The presence of several boring clionid sponges in four selected Enewetak corals has been noted by Highsmith (1981). The boring organisms were the most common infaunal associates of the corals studied, with 86% of the corals showing sponge bioerosion effects.

A calcarean "ear sponge" with fossil affinity collected on the ocean side of Biken (Leroy) is close to *Murrayona phaneolepis* but might be a new species (Reutzler, personal communication, 1977). It occurs on the roofs of small caves with sclerosponges, is flattened, and is green in color. Another calcarean sponge, *Neocoelia crypta,* and the sclerosponge, *Astrosclera willeyana*, have also been identified from Enewetak (Basile et al., in press). Kinzie (1973) found sclerosponges in a large crevasse that is considered a very prominent feature on the leeward side of Enewetak Atoll. Two species of sclerosponges were first described from Enewetak, as well as other parts of the tropical Indo-Pacific, by Hartman and Goreau (1975, 1976).

The Enewetak sponge fauna remains too poorly known at this time to reach zoogeographical conclusions and awaits the work of someone with extensive field and taxonomic research experience in the region to clarify the systematics of this fauna.

The classification scheme herein is based on Berquist (1978). Table 1 is a checklist of Enewetak Porifera.

TABLE 1

Checklist of Porifera at Enewetak Atoll

Class CALCAREA
- Subclass CALCINEA
  - Order LEUCELLIDA
    - Family LEUCELLIDAE
      - **Leucetta* sp.
- Subclass PHARETRONIDA
  - Order INOZOA
    - Family MURRAYONIDAE
      - **Murrayona* cf. *M. phanolepis* Kirkpatrick, 1910.

*New Enewetak record.

(This table continued on next page.)

TABLE 1 (cont'd)

Order SPHINCTOZOA
Family CRYPTOCOELIIDAE
**Neocoelia crypta* Vacelet, 1977.
Class DEMOSPONGIAE
Subclass TETRACTINOMORPHA
Order CHORISTIDA
Family STELLETIDAE
Ancorina acervus (Bowerbank, 1862).
Hezekia walkerri de Laubenfels, 1954.
Family JASPIDAE
Jaspis stellifera (Carter): de Laubenfels, 1954.
Order SPIROPHORIDA
Family TETILLIDAE
**Cinachyra* sp.
Order HADROMERIDA
Family SUBERITIDAE
Terpios aploos de Laubenfels: de Laubenfels, 1954. Young, 1967.
Family SPIRASTRELLIDAE
Spirastrella decumbens Ridley: de Laubenfels, 1954.
Spirastrella vagabunda Ridley, 1884.
Anthosigmella vagabunda (Ridley): de Laubenfels, 1954.
Family CLIONIDAE
Aka sp. cf. *A. diagonoxea* Thomas: Highsmith, 1981.
Aka spp. (3): Highsmith, 1981.
Cliona mucronata Sollas: Highsmith, 1981.
Cliona sp. cf. *C. quadrata* Hancock: Highsmith, 1981.
Cliona sp. cf. *C. viridis* Schmidt: Highsmith, 1981.
Cliothosa hancocki Topsent: Highsmith, 1981.
Family TETHYIDAE
Aaptos unispiculus (Carter): de Laubenfels, 1954.
**Tethya* sp.
Family CHONDROSIIDAE
Chondrilla australiensis Carter: de Laubenfels, 1954.
**Chondrosia* sp.
Chondrosia (?) *chucalla*: Ravi et al., 1979.
Order AXINELLIDA
Family AGELASIDAE
Agelas mauritiana (Carter): de Laubenfels, 1954.
Subclass CERACTINOMORPHA
Order HALICHONDRIDA
Family HYMENIACIDONIDAE
Prianos phlox de Laubenfels: Young, 1967.
Order POECILOSCLERIDA
Family CRELLIDAE
**Grayella* sp.
**Yvesia spinulata* (Hentschel, 1911).
Family MYXILLIDAE
Lissodendoryx calypta de Laubenfels: de Laubenefels, 1954.
Family CLATHRIIDAE
Clathria abietina (Lamarck): de Laubenfels, 1954.
Order HAPLOSCLERIDA
Family HALICLONIDAE
**Haliclona* sp. 1.
**Haliclona* sp. 2.
**Toxadocia* sp.
Family NIPHATIDAE
Cribrochalina olemda de Laubenfels, 1954.
Family ADOCIIDAE
**Adocia* sp.
Family CALLYSPONGIIDAE
Callyspongia fistularia (Topsent): de Laubenfels, 1954.
**Callyspongia* (?) *ridleyi* Burton, 1934.

*New Enewetak record.

(This table continued on next page.)

TABLE 1 (cont'd)

Order DICTYOCERATIDA
Family DYSIDEIDAE
**Dysidea* (?) *arenaria* Bergquist, 1965.
Family SPONGIIDAE
Heteronema erecta Keller, 1889.
Thorectopsamma mela de Laubenfels: de Laubenfels, 1954.
**Heteronema* sp.
Ircinia halmiformis (Lendenfeld): de Laubenfels, 1954.
Family DYSIDEIDAE
**Megalopastas* sp.
Order DENDROCERATIDA
Family APLYSILLIDAE
Aplysilla gracialis de Laubenfels: Young, 1967.
Order VERONGIDA
Family VERONGIIDAE
Psammaplysilla purpurea (Carter, 1880).
Thorectopsamma xana de Laubenfels: de Laubenfels, 1954.
Class SCLEROSPONGIAE
Order CERATOPORELLIDA
Family ASTROSCLERIDAE
**Astrosclera willeyana* Lister, 1900.
Order TABULOSPONGIDA
Family ACANTHOCHAETETIDAE
Acanthochaetetes wellsi Hartman and Goreau: Hartman and Goreau, 1975.
Stromatospongia micronesica Hartman and Goreau: Hartman and Goreau, 1976.

*New Enewetak record.

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Chapter 6

Sea Anemones of Enewetak Atoll

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INTRODUCTION

The sea anemones covered in this chapter were collected and/or photographed in part by Cutress during May and June 1955 and in part by Arneson from September through November 1980. Collection records are shown at the end of the chapter. Most identifications were made from preserved specimens, but a few were made from photographs alone. Available photographs of *Phymanthus strandesi* and *Physobrachia douglasi* are inadequate. *Heterodactyla hemprichi* was not photographed.

No published taxonomic work on Enewetak sea anemones exists. Dunn (1981), in a revision of the clownfish anemones, refers by catalog numbers to preserved specimens from Enewetak which she examined. Allen (1972) refers to and illustrates seven species of host anemones that he observed at Enewetak from 1968 to 1971. Josephson (1966) made physiological observations on *Calliactis polypus*, and Johannes et al. (1972) refer to an unidentified digging anemone subsequently identified as *Actinodendron plumosum*. Table 1 provides a checklist of Enewetak sea anemones.

TABLE 1

Checklist of Enewetak Sea Anemones

Phylum CNIDARIA
- Class ANTHOZOA
  - Order CORALLIMORPHARIA
    - Family ACTINODISCIDAE
      - *Actinodiscus neglectus* (Fowler, 1888)
      - *Rhodactis howesii* Saville-Kent, 1893
  - Order ACTINIARIA
    - Family EDWARDSIIDAE
      - *Edwardsia pudica* Klunzinger, 1877
      - *Edwardsia gilbertensis* Carlgren, 1931
    - Family BOLOCEROIDIDAE
      - *Bunodeopsis medusoides* (Fowler, 1888)
    - Family ALICIIDAE
      - *Triactis producta* Klunzinger, 1877
    - Family ACTINIIDAE
      - *Anthostella badia* (Carlgren, 1900)
      - *Anthopleura nigrescens* (Verrill, 1928)
      - *Physobrachia douglasi* Saville-Kent, 1893: Allen, 1972, pp. 91, 166, 167, 169, 173, 177, 179 Fig. 95, 183, 227, 229, 252, 256, I: *Entacmaea quadricolor* (Rueppel and Leuckart) [pro parte], Dunn, 1981,p. 15, 27.
      - *Actiniogeton sesere* (Haddon and Shackleton, 1893).
    - Family ACTINODENDRONIDAE
      - *Actinodendron plumosum* Haddon, 1898: Johannes et al., p. 542.
      - *Actinodendron glomeratum* Haddon, 1898
      - *Megalactis hemprichii* Ehrenberg, 1834

(This table continued on next page.)

TABLE 1 (cont'd)

Family THALASSIANTHIDAE
Heterodactyla hemprichii Ehrenberg, 1834
Cryptodendrum adhesivum Klunzinger, 1877: Dunn, 1981, p. 13.
Family PHYMANTHIDAE
Phymanthus strandesii Carlgren, 1900
Family STICHODACTYLIDAE
Stichodactyla mertensii Brandt, 1835: Dunn (1981), p. 99:
Stoichactis giganteum (Forsskål); Allen 1972, pp. 102, 105, 124, 166, 173, 178 Figs. 93-94, 184, 190, 193, 194 Fig. 102, 196, 200, 206 Fig 105, 237 Fig. 123, 252, 254, 255, 258, 259, II
Heteractis aurora (Quoy and Gaimard, 1833): Dunn, 1981, pp. 57, 66: *Radianthus simplex* (Haddon and Shackleton); Allen, 1972, pp. 124, 166, 177, 181, 190, 191 Fig. 100, 192 Fig 101, 193, 196, 197, 230, 250, 252, 258, 259, II.
Heteractis ritteri (Kwietniewski, 1897): *Heteractis magnifica* (Quoy and Gaimard) [pro parte], Dunn, 1981, p. 40:
Radianthus ritteri (Kwietniewski): Allen, 1972, pp. 166, 169, 175 Figs. 90-91, 176, Fig 92, 200, 220 Fig. 113, 222 Fig. 114, 228 Fig. 118, 232 Fig. 120, 233, 236, 250, 257, II.
Heteractis macrodactylum (Haddon and Shackleton, 1893):
Heteractis crispa (Ehrenberg) [pro parte], Dunn, 1981, p. 48:
Radianthus malu (Haddon and Shackleton): Allen, 1972, pp. 152 Fig. 75, 166, 168, 169, 170 Figs. 85-86, 171 Fig. 87, 172 Fig. 89, 200, 209, 225 Fig. 115, 228, Fig. 117, 229 Fig. 119, 233 Fig. 121, 254, 255, II.
Heteractis gelam (Haddon and Shackleton, 1893):
Macrodactyla doreensis (Quoy and Gaimard) [pro parte], Dunn (1981), p. 29: *Radianthus gelam* (Haddon and Shackleton): Allen, 1972, pp. 122 Fig. 56, 166, 168, 177, 186 Fig. 98, 187 Fig. 99, 200, 252, I.
Family ISOPHELLIIDAE
Telmatactis decora (Ehrenberg, 1834).
Telmatactis vermiformis (Haddon, 1898).
Family HORMATHIIDAE
Calliactis polypus (Forsskål, 1795): Josephson, 1966, p. 305.
Family SAGARTIIDAE
Verrillactis paguri (Verrill, 1869).
Family AIPTASIIDAE
Aiptasia pulchella Carlgren, 1943.
Order CERIANTHARIA
Family ARACHNANTHIDAE
Isarachnanthus bandanensis Carlgren, 1924.

BIOGEOGRAPHY

Discussion of the geographic ranges of tropical Pacific shallow-water sea anemones would, at this time, be meaningless. In the many papers on these anemones, species are often improperly or inadequately identified and improperly or inadequately synonymized.

Two corallimorpharians, 24 actiniarians, and one ceriantharian are presently known from Enewetak. Of these, nine have an Indo-Pacific range, and 18 are known only from the tropical Pacific. Cutress has also collected at Majuro, Marshall Islands; French Polynesia; and Hawaii. At Majuro (1 month), 19 actiniarians, one corallimorpharian, and one ceriantharian were collected. All species were identical to those from Enewetak. In French Polynesia (3 months), 14 actiniarians, two corallimorpharians, and one ceriantharian were collected. All species were identical to those from Enewetak. In Hawaii (6 years), 25 actiniarians, one corallimorpharian, and one ceriantharian were collected. Of these, only six species were identical to those from Enewetak.

With more collecting at Enewetak, additional species of sea anemones will certainly be found. This speculation is based on 10 species that are known from the Gilbert Islands or Kwajalein that have not yet been found at Enewetak.

KEY TO SPECIES

Corallimorpharia

Polyps often gregarious, small to medium sized. Column short, smooth. Tentacles very numerous, arranged in radial rows, sometimes rudimentary.

1. Discal tentacles dendritic, marginals simple. Crown diameter to 6 cm. General color ochre, brown, or greenish brown (Fig. 4c). *Rhodactis howesii* Saville-Kent

All tentacles alike: simple, wart-like, or rudimentary. Crown diameter to 4 cm. General color greenish brown to brown, area about mouth iridescent blue, oral disc often with white radial streaks (Fig. 4a). *Actinodiscus neglectus* (Fowler)

Actiniaria

Polyps flaccid or firm, with or without adhesive pedal disc, small to very large, short and broad to long and vermiform. Column clean or covered with cuticle, smooth, with warts of one kind or another, or with inflatable outgrowths. Tentacles cyclically or radially arranged, very long to very short, all alike or discals and marginals dissimilar; simple with swellings or branched; pointed, blunt, or capitate.

1. Tentacles branched, borne on long arm-like outgrowths of the oral disc. 2
   Tentacles borne on the oral disc proper. 4

2. Tentacles bilaterally arranged on sides of arms, tips conical. Crown diameter 30 cm. General color brown, oral disc with small white spots at base of arms (Fig. 2a). *Megalactis hemprichii* Ehrenberg
   Tentacles arranged more or less spirally all around arms. 3

3. Tentacles about as broad as long, conical. Crown diameter and column length to 25 cm. General color ochre to brown, proximal column with lilac to brownish spots, oral disc with radial rows of white spots (Fig. 3d). *Actinodendron plumosum* Haddon
   Most of tentacles broader than long, blunt or capitate. Crown diameter and column length 20 cm. General color gray, no markings (Fig. 3f). *Actinodendron glomeratum* Haddon

4. Oral disc bearing branched tentacles and nematospheres. 5
   Oral disc bearing unbranched tentacles only. 6

5. Tentacles very numerous, short. Nematospheres simple, club-shaped, occurring as a distinct, broad, peripheral band. Crown diameter to 36 cm. Color of tentacles and nematospheres variable, chartreuse, pink, gray, or brown (all may be present in one individual) (Fig. 2c). *Cryptodendrum adhesivum* Klunzinger
   Tentacles numerous, short. Nematospheres globular, appearing like bunches of grapes among the peripheral tentacles. Crown diameter to 20 cm. Tentacles green to greenish brown. Nematospheres frequently violet (not illustrated). *Heterodactyla hemprichii* Ehrenberg

6. Tentacles radially arranged (more than one communicating with a single endocoel). 7
   Tentacles cyclically arranged (never more than one tentacle communicating with a single endocoel). 12

7. Tentacles of two distinct kinds, wart-like discals and normal-length marginals with prominent lateral projections (not illustrated). *Phymanthus strandesi* Carlgren
   Tentacles not of two distinct kinds. 8

8. Tentacles very short, blunt, covering the oral disc from near mouth to margin. Crown diameter 50 cm (few 1 m). Oral disc and tentacles ochre to brown, sometimes tinged with pink (Fig. 2e). *Stichodactyla mertensii* Brandt
   Tentacles normal length to very long. 9

9. Tentacles with adoro-lateral protuberances, usually only a few extra ones per endocoel. Crown diameter to 25 cm. Tentacles brownish violet, protuberances white. Column with patches of bright orange or yellow (Fig 2f). *Heteractis aurora* (Quoy and Gaimard)
   Tentacles smooth. 10

10. Column smooth or with few inconspicuous warts in upper part. 11
    Column with numerous conspicuous warts. Tentacles, to 7.5 cm, pointed, flaccid, pale violet-gray, tipped with chartreuse (Fig. 2d). *Heteractis macrodactylum* (Haddon and Shackleton)

11. Tentacles, to 7 cm, blunt, many extra ones over older endocoels, greenish gray to greenish brown, white tipped (irregular branching due to *Chaetodon* browsing). Crown diameter to 25 cm. Column medium brown (Fig. 2b). *Heteractis ritteri* (Kwietniewski)
    Tentacles, to 5 cm, blunt, sometimes with subterminal swellings, usually only a few extra ones over older endocoels, greenish brown, tips white or magenta. Crown diameter to 25 cm. Column length to 30 cm, thin-walled, orange becoming pale violet gray near margin (Fig. 3c). *Heteractis gelam* (Haddon and Shackleton)

12. Column with inflatable, simple, or compound vesicles. 13
Column smooth or with solid warts. 14

13. Vesicles simple, of different sizes, scattered over proximal half of column. Tentacles deciduous. Column diameter and column length 1.5 cm. General color pale greenish brown, column often with alternate streaks of white, yellow, and violet (Fig. 4d). *Bunodeopsis medusoides* (Fowler)
Vesicles branched and compound, forming a ring around mid-column. Tentacles not deciduous. Crown diameter and column length 1.5 cm. General color dark brown (chartreuse when carried by *Lybia tesselata*) (Fig. 4f). *Triactis producta* Klunzinger

14. Column smooth. Margin without vesicles. 15
Column with or without warts. Margin with vesicles. 16

15. Tentacles to 4 cm, usually with subterminal inflations. Crown diameter to 8 cm. Column off white to pale greenish brown to pink to violet. Tentacles greenish brown, tips often white (not illustrated). *Physobrachia douglasi* Saville-Kent
Tentacles to 4 cm, evenly tapered to point. Mid-column with cinclides. Crown diameter and column length to 7 cm. General color pale to dark olive brown (Fig. 1e). *Aiptasia pulchella* Carlgren

16. Marginal vesicles prominent. Column without warts. Crown diameter and column length 1.5 cm. General color reddish brown, larger vesicles white (Fig. 3b). *Anthostella badia* Carlgren
Column with rows of prominent adhesive warts. 17

17. General color violet black, warts often white. Crown diameter to 2.5 cm (Fig. 3a). *Anthopleura nigrescens* (Verrill)
Tentacles bright green to brownish green. Column pale pink. Crown diameter to 2.5 cm (Fig. 3e). *Actinogeton sesere* (Haddon and Shackleton)

18. Column elongate to vermiform, with prominent cuticle. 19
Column short, cuticle inconspicuous. 22

19. Tentacles number 48 or more. 20
Tentacles fewer than 48. 21

20. Tentacles pointed. Column with thin sand-covered cuticle, length to 4 cm, diameter to 1.5 cm (Fig. 1c). *Telmatactis vermiformis* (Haddon)
Tentacles blunt to capitate. Column with thick, shaggy cuticle, length and diameter to 8.0 and 2.5 cm (Fig. 1a). *Telmatactis decora* (Ehrenberg)

21. Column length and diameter 25 and 2.5 cm (Fig. 4e). *Edwardsia pudica* Klunzinger
Column length and diameter to 4.0 and 0.4 cm (Fig. 4b). *Edwardsia gilbertensis* Carlgren

22. Column firm, lower part with one or more rings of prominent pores through which salmon-colored threads are frequently extruded. Color of column gray to rusty orange, often with streaks and blotches of dull plum red. Crown diameter to 5 cm. Lives with hermit crabs (Fig. 1d). *Calliactis polypus* (Forsskål)
Column lacking pores, white to gray, often with fine streaks of rusty orange. often thicker than rest. Crown diameter to 2 cm. Lives with hermit crabs (Fig. 1b). *Verrillactis paguri* (Verrill)

Ceriantharia

Solitary, elongate, tube-dwelling polyps, with tentacles divisible into short labials and long marginals. Only species recorded from Enewetak:

Tentacles numbering to 56, more commonly 48 or 52. Column length to 10 cm, crown diameter to 6 cm. General color reddish brown (copper) (Fig. 1f). *Isarachnanthus bandanensis* Carlgren

COLLECTION RECORDS

Actinodendron glomeratum Haddon
Enewetak: 60 feet, Sept. 1980.

Actinodendron plumosum Haddon
Chop Top: Sept. 23, 1980.

Actinodiscus neglectus (Fowler)
Lojwa: Sept. 1980.

Actinogeton sesere (Haddon and Shackleton)
Ananij: May 8, 1955.

Aiptasia pulchella Carlgren
Medren: May 15, 1955.

Anthopleura nigrescens (Verrill)
Igurin: May 11, 1955.

Anthostella badia Carlgren
Ananij: May 11, 1955.

Bunodeopsis medusoides (Fowler)
Ananij, Enewetak: June 21, 1955;
Chop Top: lagoon, 40 feet,
Sept. 22, 1980.

Calliactis polypus (Forsskål)
Medren: May 18, 1955.

Cryptodendrum adhesivum Klunzinger
Medren: June 25, 1955.

Edwardsia gilbertensis Carlgren
Bokoluo: 45 feet, Sept. 1980.

Edwardsia pudica Klunzinger
Medren, Runit: May 18, 1955;
Medren: 50 feet, Sept. 1980.

Heteractis aurora (Quoy and Gaimard)
Bokoluo: Sept. 1980.

Heteractis gelam (Haddon and Shackleton)
Medren: May 22, 1955.

Heteractis macrodactylum (Haddon and Shackleton)
Japtan: Cement ship, 30 feet, Sept. 1980.

Heteractis ritteri (Kwietniewski)
Medren: Sept. 1980.

Heterodactyla hemprichii Ehrenberg
No collection data now at hand but found
in 1955 and 1980.

Isarachnanthus bandenensis Carlgren
Medren: May 15, 1955;
Bokoluo: 45 feet, Sept. 1980.

Megalactis hemprichii Ehrenberg
Enewetak, Maggio: Sept. 1980.

Phymanthus strandesi Carlgren
Ananij: June 15, 1955.

Physobrachia douglasi Saville-Kent
Ananij: June 16, 1955;
Bokoluo: Sept. 1980.

Rhodactis howesii Saville-Kent
Medren: May 22, 1955.

Stichodactyla mertensii Brandt
Henry, Enewetak: Sept. 1980.

Telmatactis decora (Ehrenberg)
Ananij: May 8, 1955;
Enewetak: 60 feet, October 17, 1980.

Telmatactis vermiformis (Haddon)
Medren: May 15, 1955.

Triactis producta Klunzinger
Ananij: June 8, 1955.

Verrillactis paguri (Verrill)
Medren: May 18, 1955.

Plates 1-4

Fig. 1a, *Telmatactis decora* (Ehrenberg), live specimen from Hawaii; b, *Verrillactis paguri* (Verrill), live specimen from Hawaii; c, *Telmatactis vermiformis* (Haddon), preserved specimen from Majuro; d, *Calliactis polypus* (Forsskål), live specimen from Hawaii; e, *Aiptasia pulchella* Carlgren, live specimen from Hawaii; f, *Isarachnanthus bandanensis* Carlgren, live specimen from Hawaii. →

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Fig. 2a, *Megalactis hemprichii* Ehrenberg, live specimen in situ, Enewetak, 40 feet; b, *Heteractis ritteri* (Kwietniewski), live specimen in situ, Medren, Enewetak, patch reef, 10 feet; c, *Cryptodendrum adhesivum* Klunzinger, preserved specimen from Enewetak; d, *Heteractis macrodactylum* (Haddon and Shackleton), live specimen in situ, Cement ship, Enewetak, 30 feet; e, *Stichodactyla mertensii* Brandt, live specimen in situ, Henry, outside reef Enewetak, 30 feet; f, *Heteractis aurora* (Quoy and Gaimard), live specimen in situ, Enewetak. →

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Fig. 3a, *Anthopleura nigrescens* (Verrill), preserved specimen from Hawaii; b, *Anthostella badia* Carlgren, preserved specimen from Majuro; c, *Heteractis gelam* (Haddon and Shackleton), live specimen in situ, with *Amphriprion tinctus*, Bokoluo, Enewetak patch reef, 40 feet; d, *Actinodendron plumosa* Haddon, live specimen in situ, Chop Top, Enewetak, 30 feet; e, *Actinogeton sesere* (Haddon and Shackleton), live specimen from Hawaii; f, *Actinodendron glomeratum* Haddon, live specimen in situ, off Enewetak, 60 feet. →

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Fig. 4a, *Actinodiscus neglectus* (Fowler), live specimen in situ, Lajwa, Enewetak, 20 feet; b, *Edwardsia gilbertensis* Carlgren, preserved specimen from Majuro; c, *Rhodactis howesii* Saville-Kent, preserved specimen from Enewetak; d, *Bunodeopsis medusoides* (Fowler), live specimen from Hawaii; e, *Edwardsia pudica* Klunzinger, live specimen in situ, Runit, Enewetak, 30 feet; f, *Triactis producta* Klunzinger, live specimen from Hawaii. →

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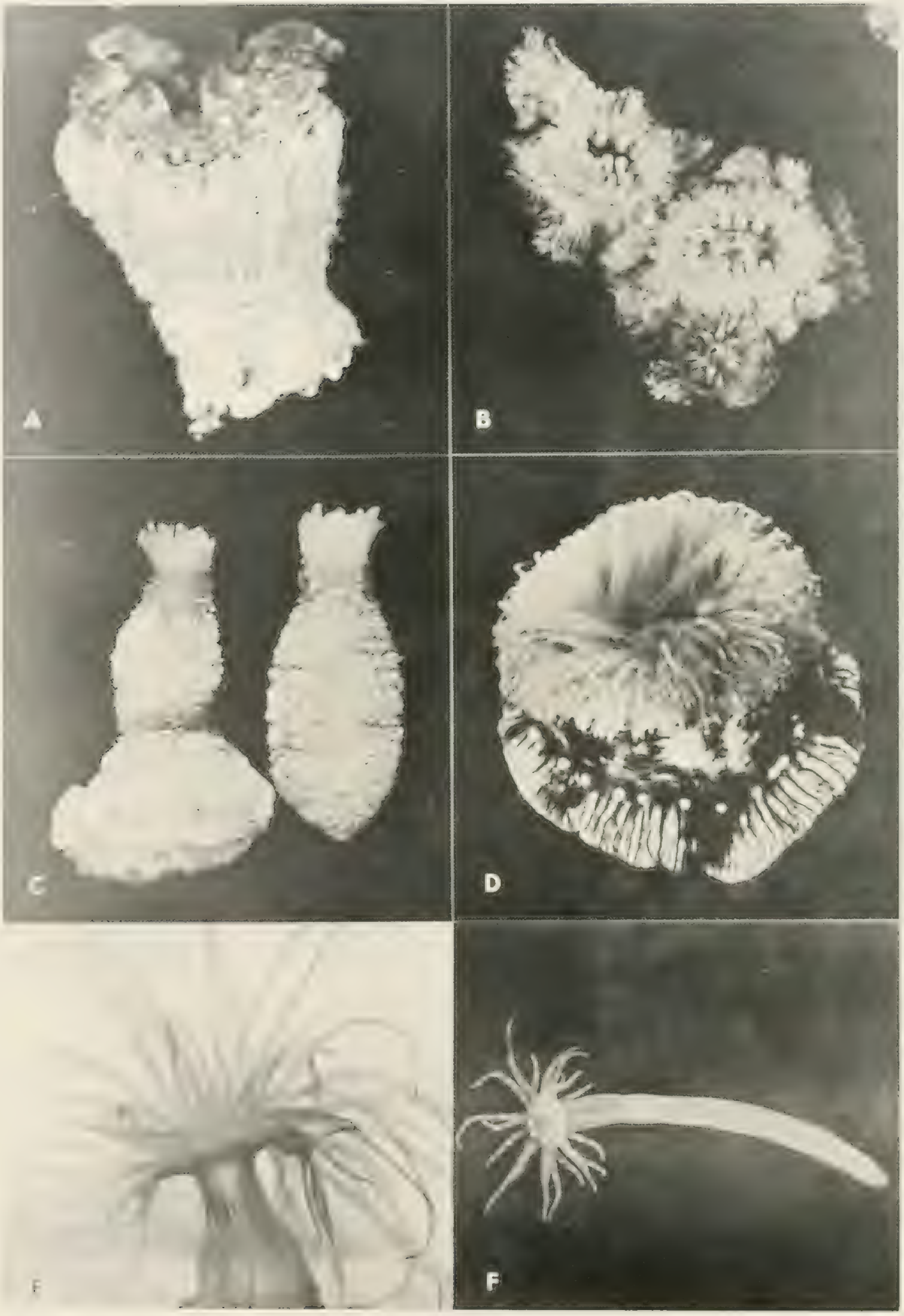

Fig. 1.

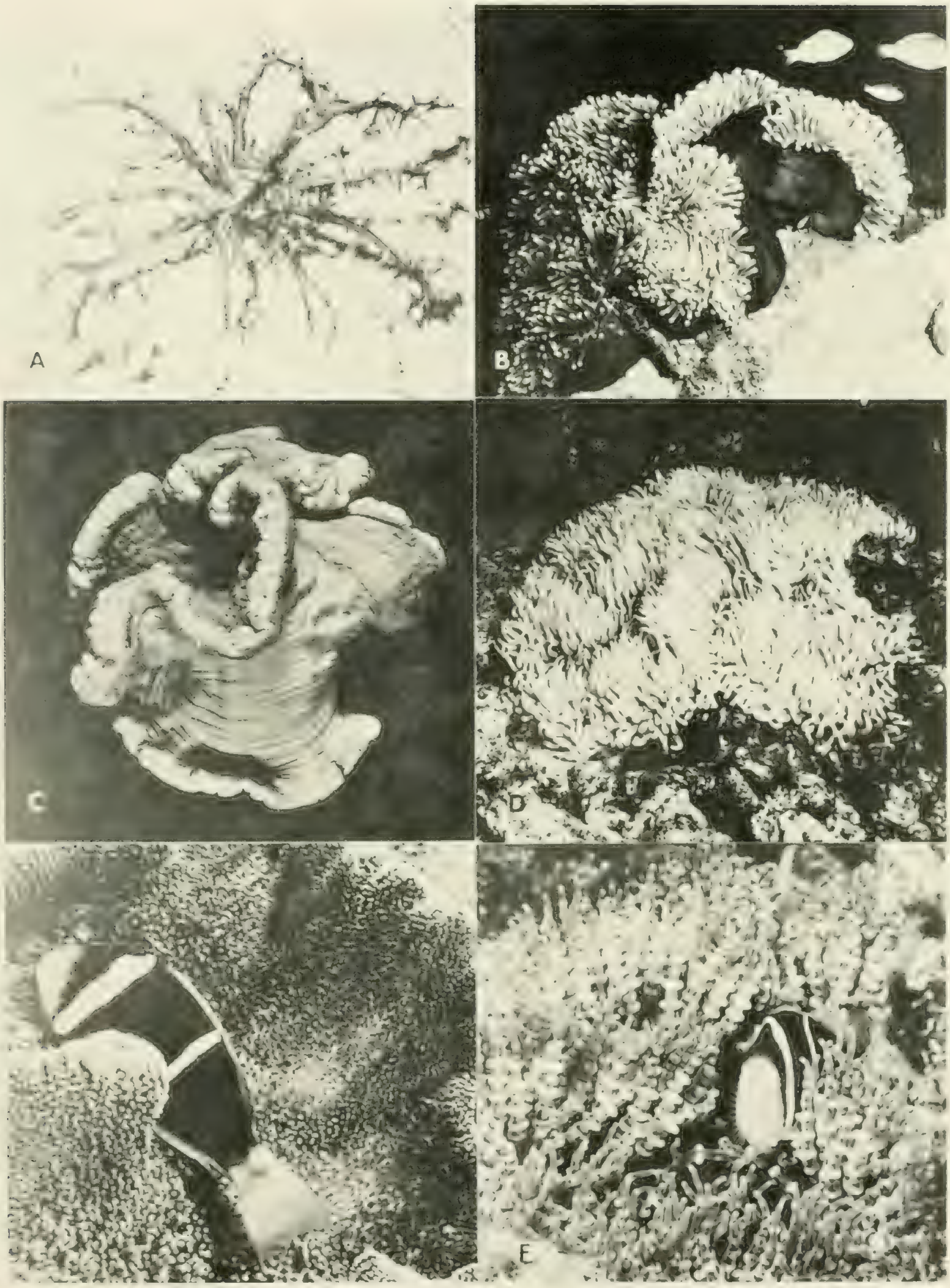

Fig. 2.

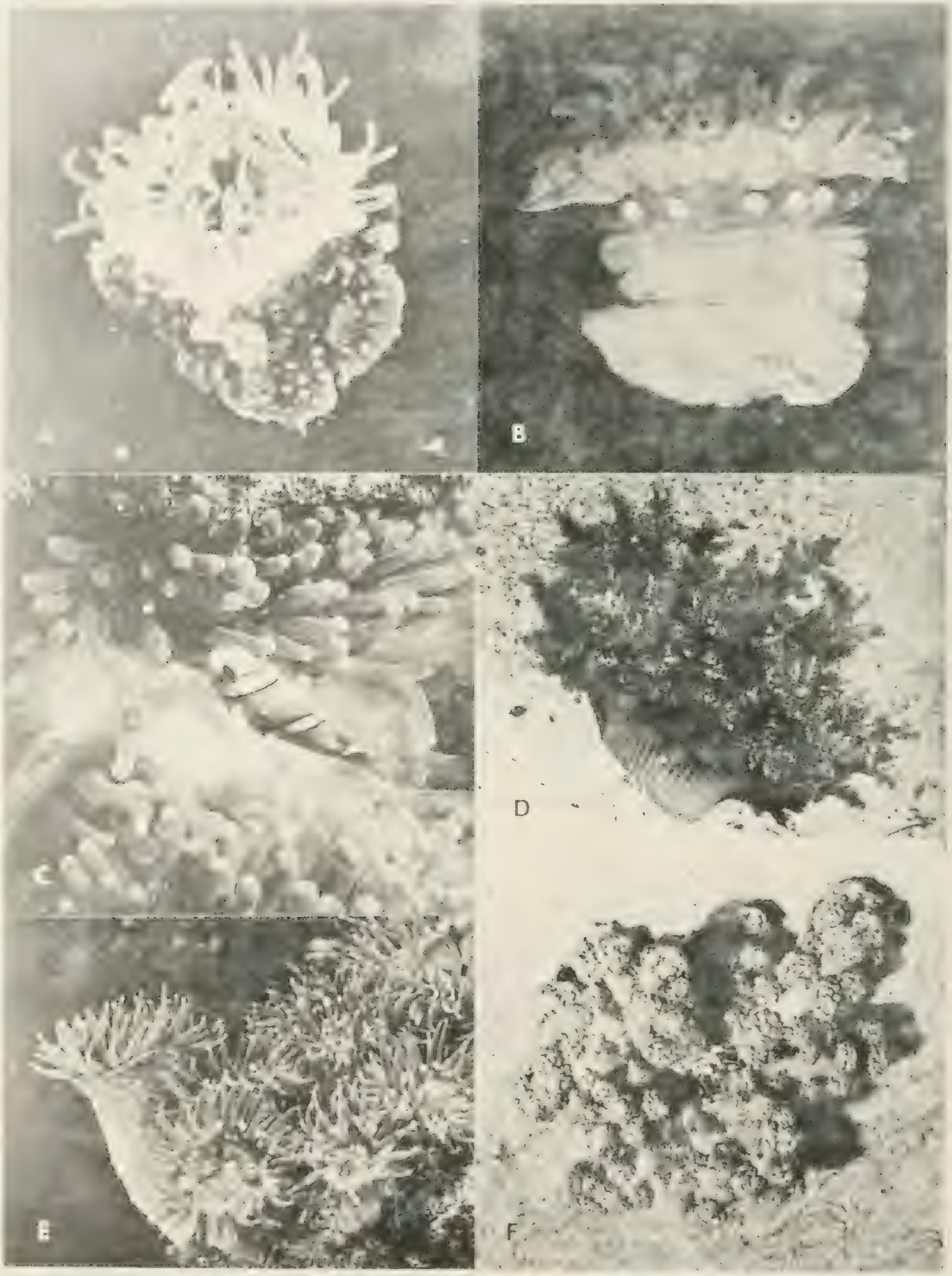

Fig. 3.

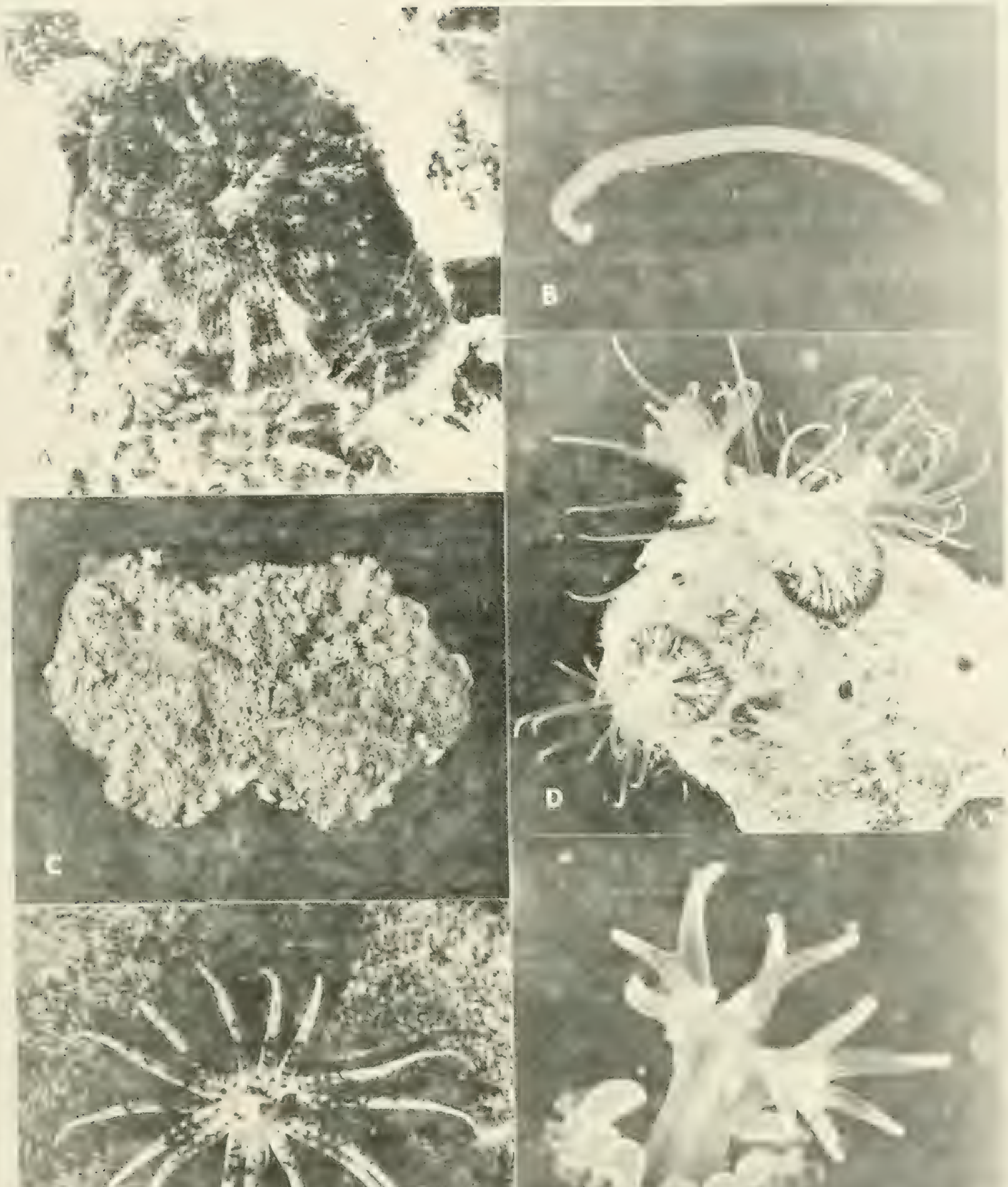

Fig. 4.

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Chapter 7

Octocorallia of Enewetak Atoll

[**Editor's Note:** The section on the Octocorallia was compiled by Dennis M. Devaney (B. P. Bishop Museum, Honolulu, Hawaii), but the collection data listing was not completed due to his untimely death. This unfinished section, with complete references, is included in order to round out the categories of organisms recorded from Enewetak.—*B. L. Burch*]

STOLONIFERA

Two widely distributed Indo-West Pacific stoloniferans including the distinctive organ-pipe coral, *Tubipora musica*, are present at Enewetak. This species occurs most abundantly on windward reef flats or just behind the algal ridge and less commonly on lagoon reefs (Wells, 1954). For *Pachyclavularia violacea*, see below.

TELESTACEA

One undetermined species of *Telesto* is represented in the Mid-Pacific Research Laboratory (MPRL) reference collection. It was found attached on the reef near the Medren cargo pier. This appears to be the first record of *Telesto* from the Marshall Islands; members of this genus may occur on ship hulls and be distributed as fouling organisms.

ALCYONACEA

Alcyonaceans are the most numerous octocorals represented in Enewetak shallow waters with approximately 20 species now known. The majority of these "soft corals" recorded herein are from the lagoon and submerged reef habitats. One alcyonacean was reported by Odum and Odum (1956) as one of the organisms encountered during their earlier coral reef studies on the atoll. Enewetak soft corals *(Sarcophyton* and *Heteroxenia)* were utilized in work on the nerve net system of cnidarians (Bullock and Thorson, 1962; Josephson, 1965). Six shallow-water alcyonaceans and one stoloniferan were reported by Verseveldt (1972) based on collections made in the search for crustacean copepod symbionts in July 1969. The stoloniferan, *Pachyclavularia violacea*, and three of the alcyonaceans were hosts for several of these crustaceans (Humes, 1973; Devaney, Chapter 19, Table 2, this volume).

Research at MPRL on marine natural products chemistry (Ciereszko et al., 1968; Schmitz et al., 1974; Vanderah et al., 1978) has been based in part on soft corals. In response to this work, eight alcyonaceans were determined from Enewetak by Verseveldt (1977) having been collected mainly through projects by the University of Hawaii's Department of Chemistry. In this publication, one new species *(Sinularia sandensis)* was described together with other more widely distributed Indo-West Pacific species all representing new records for the Marshall Islands. This led to a revision of the genus *Sinularia* in Verseveldt (1980). Furthermore, species identified by Verseveldt for Ciereszko (University of Oklahoma) in 1975, include five that are new Enewetak records (Table 1). Examples were deposited in the MPRL reference collection. *Nephthea*, *Sarcophyton*, and *Lobophytum* were genera reported in studies on the mucus chemistry and zooxanthellae of reef animals (Ciereszko and Ciereszko, 1978).

COENOTHECALIA

The blue-coral, *Heliopora coerulea*, distributed throughout much of the Indo-Pacific, was found at Enewetak and other Marshall Islands where colonies up to many meters in area were reported on the seaward reef flats (Wells, 1954).

GORGONACEA

The gorgonaceans (sea fans and sea whips) are represented by at least eight species in the suborders Scleraxonia and Holaxonia at depths from 5 to 45 m at Enewetak. These are known by collections made together with black corals to obtain information on their diversity and to measure the concentration and distribution of skeletal radioiodine (Goldberg, 1975). He also included information on colony form, color, habitat, and collection localities. Determination of species was made by F. M. Bayer and updated in 1982. Representatives of all but one of these taxa are in the United States National Museum (Smithsonian Institution). In another study of gorgonaceans from the Marshall Islands, Bayer (1949) recorded several species from Bikini Atoll. All but two of the Bikini specimens were

TABLE 1

Checklist of Octocorallia of Enewetak Atoll

Phylum COELENTERATA
Class ANTHOZOA
Subclass OCTOCORALLIA
Order STOLONIFERA
Family CLAVULARIIDAE
Pachyclavularia violacea (Quoy and Gaimard, 1833): Verseveldt, 1972; Humes, 1973.
Family TUBIPORIDAE
Tubipora musica Linnaeus, 1758: Wells, 1954.
Order TELESTACEA
Family TELESTIDAE
*_Telesto_ sp.
Order ALCYONACEA
Family ALCYONIIDAE
*_Cladiella pachyclados_ (Klunzinger, 1877).
Lobophytum borbonicum (Von Marenzeller, 1886): Verseveldt, 1977.
Lobophytum catalai Tixier-Durivault, 1957: Verseveldt, 1977.
Lobophytum denticulatum Tixier-Durivault, 1956: Verseveldt, 1977.
Lobophytum pauciflorum (Ehrenberg, 1834): Odum and Odum, 1956; Verseveldt, 1972. Humes, 1973; Verseveldt, 1977.
Sarcophyton glaucum (Quoy and Gaimard, 1833): Verseveldt, 1977.
Sarcophyton trocheliophorum Von Marenzeller, 1886: Verseveldt, 1972; 1977.
Sinularia densa (Whitelegge, 1897): Verseveldt, 1980. _Sinularia brongersmai_ Verseveldt, 1972: Verseveldt, 1972.
Sinularia leptoclados (Ehrenberg, 1834): Verseveldt, 1977.
Sinularia marenzelleri (Wright and Studer, 1889): Verseveldt, 1972.
Family ALCYONIIDAE (Cont'd)
Sinularia polydactyla (Ehrenberg, 1834): Verseveldt, 1972; Humes, 1973.
Sinularia rigida (Dana, 1846): Verseveldt, 1977.
Sinularia sandensis (Verseveldt, 1977): Verseveldt, 1977.
Family NEPHTHEIDAE
Dendronephthya (Roxasia) mirabilis Henderson, 1909: Verseveldt, 1977.
Nephthea chabrolii Audouin, 1828: Verseveldt, 1972; Humes, 1973.
*_Nephthea pacifica_ Kukenthal, ___.
*_Nephthea albida_ (Holm, 1894).
*_Stereonephthya unicolor_ (Gray, 1862).
Family XENIIDAE
*_Heteroxenia coheni_ Verseveldt, 1974.
Order COENOTHECALIA
Family HELIOPORIDAE
Heliopora coerulea (Pallas, 1766): Wells, 1954.
Order GORGONACEA
Suborder SCLERAXONIA
Family SUBERGORGIIDAE
*_Subergorgia nuttingi_ Stiasny, 1937.
*_Subergorgia reticulata_ (Ellis and Solander, 1786).
*_Subergorgia suberosa_ (Pallas, 1766).
Suborder HOLAXONIA
Family ACANTHOGORGIIDAE
*_Acanthogorgia_ sp.
Family PARAMURICEIDAE
*_Astrogorgia_ sp.
*_Astrogorgia_? sp.
Family PLEXAURIDAE
*_Rumphella antipathes_ (Linnaeus, 1758).
Family ELLISELLIDAE
*_Ellisella_ sp.

*New Enewetak record.

dredged from depths of 100 m or deeper. One species, recorded as _Subergorgia mollis_, is very close taxonomically to that determined as _S. reticulata_ from Enewetak, but further work is necessary before this question is resolved (Bayer, personal communication). Otherwise, none of the species so far identified is common to the two atolls. At least one more shallow-water gorgonacean, as yet unrecorded from Enewetak, was described from Arno Atoll in the southern Marshall Islands (Bayer, 1955). The gorgonacean _Rumphella antipathes_ has been utilized from specimens collected at Enewetak for biochemical studies (Ciereszko et al., 1968; Marsh and Ciereszko, 1973).

During submersible dives off the seaward side of three islets (Biken, Mut, and Enewetak) during July 1981, the author observed nephtheids and gorgonaceans as common faunal elements at depths from approximately 80 to 180 m. Several of these, as yet undetermined, were collected and were deposited at the Bishop Museum.

The classification of octocorals used herein follows that by Bayer (1956), although a revised classification has recently been proposed (Bayer, 1981).

ACKNOWLEDGMENTS

J. Verseveldt was most helpful in reviewing the discussion and checklist on the alcyonaceans and allowing the inclusion of the five new records that he determined. F. M. Bayer (USNM) provided updated names for the material collected by Goldberg and was most helpful in permitting their inclusion here.

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Josephson, R. K., 1965, *MPRL Ann. Rept. FY 1964–65*, p. 6.

Marsh, M. E., and L. S. Ciereszko, 1973, Alpha-Glyceryl Ethers in Coelenterates, *Proc. Oklahoma Acad. Sci.*, **53:** 53-56.

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Chapter 8

Scleractinia (Stony Corals) of Enewetak Atoll

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The first record of stony corals from Enewetak Atoll, in which five species were reported, appears to have been that of Yabe et al. (1936).

Wells (1954) later made a major systematic study of the corals of the Marshall Islands. Of 254 species and varieties in 57 genera recorded overall from this region, only 44 scleractinian species were listed as occurring at Enewetak. This disparity is understandable because much of the collecting effort was concentrated at Bikini Atoll. Most of these specimens are now deposited at the U. S. National Museum of Natural History (USNM).

When the Mid-Pacific Research Laboratory (MPRL) was established in 1954, one of its first goals was to have a labeled set of stony corals available for use by investigators at the laboratory. Specimens collected by R. Iverson at Enewetak in 1955 were partitioned among 115 scleractinian species by J. W. Wells and formed the nucleus of the MPRL reference collection. A list of the corals collected during the classical field study by Odum and Odum (1955) at Enewetak, and subsequently identified by Dr. Wells, was published by Odum and Odum in 1956.

In the summer of 1970, R. H. Randall collected 357 scleractinian specimens for an investigation of growth form and variation (Randall, 1971). As a result of this effort, 21 specimens were added to the Enewetak reference collection (the balance remains at the University of Guam Marine Laboratory). Weber and Haggerty (1976) collected stony corals of 48 genera and subgenera for stable isotopic studies of skeletal calcification. By then the coral reference collection at Enewetak contained representatives of about 124 species and varieties.

A more intensive effort was made to identify Enewetak scleractinians during the 1976 reef coral workshop. An international team of coral systematists from the United States, Australia, England, France, and the Netherlands gathered under the direction of J. C. Lang to (a) update the reference collection with a set of labeled coral specimens representative of each major reef habitat at Enewetak and (b) prepare a reef coral field identification guide for general use by scientists working at Enewetak. It was also hoped that the specimens and accompanying field observations would be used in individual systematic publications of the Enewetak scleractinians.

To date, approximately 170 species in 54 genera have been identified among the 2500 stony coral specimens which were collected from 28 sites around Enewetak Atoll. These have been deposited in major museums (B. P. Bishop Museum, United States National Museum, British Museum [Natural History], Rijksmuseum van Natuurlijke Historie, Queensland Museum), as well as in the Enewetak reference collection.

Although the field guide is still in preparation, a provisional checklist of scleractinian corals now believed to occur at Enewetak is presented in Table 1. In many families, the species-level classification generally follows that given in the recent publications about eastern Australian scleractinians by Veron and Pichon (1976, 1980, 1982), by Veron, Pichon, and Wijsman-Best (1977), and by Veron and Wallace (1984). Ecological and zoogeographic considerations will await the completed guide.

Stony corals collected at Enewetak during the workshop have contributed to several revisionary systematic studies. For example, range extensions were made by Wallace (1978) for species of *Acropora*; by Dinesen (1980) for a species of *Leptoseris*; and by Wijsman-Best (1980) for species in three faviid genera *(Cyphastrea, Leptastrea, Echinopora)*. Lamberts (1980, 1982) has also used Enewetak specimens to revise the genus *Astreopora*. Six of the nine species of *Astreopora* (two of which are new species) recognized by Lamberts (1982) have been collected at Enewetak, while two others occur elsewhere in the Marshall Islands.

In addition to these systematic studies, there are numerous publications on scleractinian biology or geology which have resulted from field work and collections made at Enewetak. A selection of these references, with the genera examined, is presented in Table 2. The authors of these nonsystematic papers are also cited in Table 1 under any species names given for these genera.

TABLE 1

Checklist of Stony Corals of Enewetak Atoll

Order SCLERACTINIA
Suborder ASTROCOENIINA
Family ASTROCOENIIDAE
Stylocoeniella armata (Ehrenberg, 1834): Hildemann et al., 1975a.
*† *Stylocoeniella guentheri* (Bassett-Smith, 1890).
Family THAMNASTERIIDAE
*† *Psammocora contigua* (Esper, 1795).
Psammocora digitata Milne Edwards and Haime, 1851.
Psammocora (Stephanaria) togianensis Umbgrove, 1940: Garth, 1964; Knutson et al., 1972; Buddemeier et al., 1974. Synonymy after Veron and Pichon (1976).
* *Psammocora explanulata* van der Horst, 1922.
* *Psammocora nierstrazi* van der Horst, 1921.
*† *Psammocora profundacella* Gardiner, 1898.
Family POCILLOPORIDAE
Pocillopora damicornis (Linnaeus, 1758): Garth, 1964; Johannes et al., 1972a; Clausen and Roth, 1975; Coles and Jokiel, 1977; Stimson, 1978; Richmond, 1982; Roth et al., 1982; Richmond and Jokiel, 1984.
Pocillopora setchelli Hoffmeister, 1929: Wells, 1954. Synonymy via J. Veron (personal communication).
Pocillopora eydouxi Milne Edwards and Haime, 1860: Garth, 1964; Pomeroy and Kuenzler, 1969; Buddemeier et al., 1974; Hildemann et al., 1975a, 1975b.
Pocillopora grandis Dana, 1846: Hildemann et al., 1975a, 1975b. Synonymy after Veron and Pichon (1976).
Pocillopora meandrina Dana, 1846: Banner and Banner, 1968; Muscatine and D'Elia, 1978.
Pocillopora elegans Dana, 1846: Wells, 1954; Odum and Odum, 1956; Garth, 1964; Hildemann et al., 1975a, 1975b; Coles et al., 1976; D'Elia and Webb, 1977; Stimson, 1978. Synonymy via J. Veron (personal communication).
Pocillopora verrucosa (Ellis and Solander, 1786): Wells, 1954; Odum and Odum, 1956; Garth, 1964; Pilson, 1974; Hildemann et al., 1975a, 1975b; Stimson, 1978.
Pocillopora danae Verrill, 1864: Odum and Odum, 1956; Knudsen, 1967; D'Elia, 1977. Synonymy via J. Veron (personal communication).
Seriatopora hystrix Dana, 1846: Wells, 1954; Garth, 1964; Young, 1971; Hildemann et al., 1975a; Stimson, 1978.
Seriatopora angulata Klunzinger, 1879: Wells, 1954. Synonymy after Veron and Pichon (1976).
Stylophora pistillata (Esper, 1795).
Stylophora mordax (Dana, 1846): Yabe et al., 1936; Wells, 1954; Odum and Odum, 1956. Synonymy after Veron and Pichon (1976).
Family ACROPORIDAE
*† *Acropora aculeus* (Dana, 1846).
Acropora acuminata (Verrill, 1864): Wells, 1954; Garth, 1964 (as "*A. formosa* or *A. acuminata*"); Hildemann et al., 1975a, 1975b.
Acropora aspera (Dana, 1846): Stimson, 1978.
Acropora hebes (Dana, 1846): Wells, 1954. Synonymy after Wallace (1978).
† *Acropora austera* (Dana, 1846): Wallace, 1978.
*† *Acropora cerealis* (Dana, 1846).
* *Acropora cuneata* (Dana, 1846).
Acropora cythera (Dana, 1846): Wallace, 1978.
Acropora reticulata (Brook, 1892): Vosburgh, 1977, 1978, 1982. Synonymy after Wallace (1978).
Acropora danai (Milne Edwards and Haime, 1860).
Acropora rotumana (Gardiner, 1898): Wells, 1954; Hildemann et al., 1975a, 1975b. Synonymy after Veron and Wallace (1984).
Acropora digitifera (Dana, 1846): Stimson, 1978.
Acropora echinata (Dana, 1846): Wells, 1954; Garth, 1964; Hildemann et al., 1975a.
† *Acropora florida* (Dana, 1846): Humes and Stock, 1973; Hildemann et al., 1975a; Humes, 1981; Humes and Dojiri, 1982.
Acropora formosa (Dana, 1846): Wells, 1954; Garth, 1964 (as "*A. formosa* or *A. acuminata*"); Cheney, 1975; Hildemann et al., 1975a, 1975b; Coles et al., 1976; Roth et al., 1982.
Acropora gemmifera Brook, 1892: Odum and Odum, 1955; in part as *Acropora humilis* (Dana, 1846) in Wells, 1954; ? in part in: Odum and Odum, 1956; Garth, 1964; Hildemann et al., 1975a, 1975b; Stimson, 1978. Revised by Veron and Wallace (1984).
Acropora granulosa (Milne Edwards and Haime, 1860).
Acropora rayneri (Brook, 1892): Wells, 1954. Synonymy after Wallace (1978).

*New Enewetak record.
†Not recorded from Marshall Islands by this name in Wells (1954).

(This table continued on next page.)

TABLE 1 (cont'd)

Family ACROPORIDAE (cont'd)

†*Acropora horrida* (Dana, 1846).

Acropora angulata (Quelch, 1886): Hildemann et al., 1975a. Synonymy after Wallace (1978).

Acropora humilis (Dana, 1846): in part in Wells, 1954; ? in part in: Odum and Odum, 1956; Garth, 1964; Hildemann et al., 1975a, 1975b; Stimson, 1978. Revised by Veron and Wallace (1984).

Acropora hyacinthus (Dana, 1846). Wells, 1954; Garth, 1964; Pomeroy and Kuenzler, 1969; Bruce, 1969; Coles et al., 1976; Smith and Harrison, 1977; D'Elia, 1977; Stimson, 1978.

Acropora corymbosa (Lamarck, 1816): in part in Wells, 1954; ? in part in: Odum and Odum, 1956; Garth, 1964. Stimson, 1978. Synonymy after Veron and Wallace (1984).

Acropora recumbens (Brooks, 1892): Odum and Odum, 1956. Synonymy after Wallace (1978).

Acropora? surculosa (Dana, 1846): Garth, 1964; Hildemann et al., 1975a. Synonymy after Veron and Wallace (1984).

Acropora loripes (Brook, 1892): Young, 1971; Hildemann et al., 1975b.

Acropora microphthalma (Verrill, 1869): Wallace, 1978.

Acropora millepora (Ehrenberg, 1834).

Acropora corymbosa (Lamarck, 1816): in part in Wells, 1954; ? in part in: Odum and Odum, 1956; Garth, 1964; Stimson, 1978. Synonymy via C. Wallace (personal communication).

Acropora nasuta (Dana, 1846): Wells, 1954; Hildemann et al., 1975a, 1975b; Stimson, 1978.

Acropora cymbicyathus (Brook, 1893): Wells, 1954; Odum and Odum, 1955; Garth, 1964. Synonymy after Wallace (1978).

Acropora palifera (Lamarck, 1816): Wells, 1954.

Acropora palmerae Wells, 1954: Odum and Odum, 1955; Bruce, 1969; Coles et al., 1976.

Acropora paniculata Verrill, 1902: Garth, 1964.

*†*Acropora robusta* (Dana, 1846).

Acropora samoensis (Brook, 1891): in part as *Acropora humulis* (Dana, 1846) in Wells, 1954; ? in part in: Odum and Odum, 1956; Hildemann et al., 1975a, 1975b; Stimson, 1978. Revised by Veron and Wallace (1984).

Acropora secale (Studer, 1878).

Acropora diversa (Brook, 1891): Wells, 1954. Synonymy after Veron and Wallace (1984).

*†*Acropora* "sp. called *A. polymorpha* (Brook, 1891)".

Acropora sp.?

Acropora conferta (Quelch, 1886): Wells, 1954; Odum and Odum, 1956; Goreau, 1959; Hildemann et al., 1975a. Equals *A. hyacinthus* (Dana, 1846) or *A. millepora* (Ehrenberg, 1834) (C. Wallace, personal communication).

Acropora delicatula (Brook, 1891): Coles et al., 1976.

Acropora grandis (Brook, 1892): Hildemann et al., 1975a Probably not this species (C. Wallace, personal communication).

Acropora syringoides (Brook, 1892): Stimson, 1978.

Acropora striata (Verrill, 1866): Wells, 1954; Stimson, 1978.

**Acropora tenella* (Brook, 1892).

**Acropora tenuis* (Dana, 1846).

Acropora teres (Verrill, 1866): Wells, 1954.

Acropora tubicinaria (Dana, 1846): Odum and Odum, 1956.

Acropora valida (Dana, 1846).

Acropora variabilis (Klunzinger, 1879): Garth, 1964; Hildemann et al., 1975a. Synonymy after Veron and Wallace (1984).

**Acropora vaughani* Wells, 1954.

†*Astreopora cucullata* Lamberts, 1980: Lamberts, 1982.

Astreopora gracilis Bernard, 1896: Lamberts, 1982.

Astreopora listeri Bernard, 1896: Lamberts, 1982.

Astreopora myriophthalma (Lamarck, 1816): Wells, 1954; Odum and Odum, 1956; Buddemeier et al., 1974; Highsmith, 1980b, 1981b; Lamberts, 1982.

†*Astreopora scabra* Lamberts, 1982.

Astreopora suggesta Wells, 1954; Lamberts, 1982.

†*Montipora aequituburculata*, Bernard, 1897.

Montipora composita Crossland, 1952: Odum and Odum, 1956.

Monitpora?verrilli Vaughan, 1907: Odum and Odum, 1956; Highsmith, 1980b.

Montipora?verrili [sic] Vaughan: Hildemann et al., 1975a.

*†*Montipora australiensis* Bernard, 1897.

†*Montipora berryi* Bernard, 1897: Highsmith, 1980b, 1981a.

**Montipora caliculata* (Dana, 1846).

*New Enewetak record.

†Not recorded from Marshall Islands by this name in Wells (1954).

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TABLE 1 (cont'd)

Family ACROPORIDAE (cont'd)

**Montipora conicula* Wells, 1954.
**Montipora danae* Milne Edwards and Haime, 1851.
*†*Montipora digitata* (Dana, 1846).
**Montipora ehrenbergii* Verrill, 1875.
**Montipora floweri* Wells, 1954.
*†*Montipora foliosa* (Pallas, 1766).
Montipora foveolata (Dana, 1846): Odum and Odum, 1956.
Montipora socialis Bernard, 1897: Wells, 1954; Highsmith, 1980b. Synonymy after Veron and Wallace (1984).
*†*Montipora hispida* (Dana, 1846).
Montipora hoffmeisteri Wells, 1954; Highsmith, 1980b.
Montipora informis Bernard, 1897: Hildemann et al., 1975a.
*†*Montipora lobulata* Bernard, 1897.
**Montipora marshallensis* Wells, 1954.
*†*Montipora* sp. cf. *M. monasteriata* (Forskål, 1775).
**Montipora myriophthalma* Bernard, 1897.
*†*Montipora porosa* Bernard, 1897.
Montipora sp.?
Montipora granulosa Bernard, 1897: Highsmith, 1980b.
**Montipora tuberculosa* (Lamarck, 1816).
Montipora venosa (Ehrenberg, 1834): Wells, 1954.
Montipora verrucosa (Lamarck, 1816): Hildemann et al., 1975a; Coles and Jokiel, 1977.

Suborder FUNGIINA

Family AGARICIIDAE

**Gardineroseris planulata* (Dana, 1846). As *Pavona (Polyastra) planulata* (Dana, 1846) from Arno in Wells (1954). Synonymy after Veron and Pichon (1980).
Leptoseris hawaiiensis Vaughan, 1907: Dinesen, 1980.
Leptoseris mycetoseroides Wells, 1954: Dinesen, 1980.
**Pachyseris speciosa* (Dana, 1846).
Pavona cactus (Forskål, 1775).
Pavona praetorta (Dana, 1846): Wethey and Porter, 1976a, 1976b. Synonymy after Veron and Pichon (1980).
Pavona clavus (Dana, 1846): Highsmith, 1981a, 1981b.
**Pavona maldivensis* (Gardiner, 1905). As *P. (Pseudocolumnastraea) pollicata* Wells, 1954 from Bikini and Arno (Wells, 1954). Synonymy after Veron and Pichon (1980).
*†*Pavona prismatica* Brüggemann, 1879.
* *Pavona varians* Verrill, 1864.
* *Pavona venosa* (Ehrenberg, 1834).

Family SIDERASTREIDAE

**Coscinaraea columna* (Dana, 1846).

Family FUNGIIDAE

*†*Cycloseris erosa* (Döderlein, 1901).
Cycloseris hexagonalis Milne Edwards and Haime, 1849: Wells, 1954.
Fungia (Ctenactis) echinata (Pallas, 1766).
Fungia echinata (Pallas, 1766): Young, 1971; Hildemann et al., 1975a, 1975b.
*†*Fungia (Danafungia) valida* Verrill, 1864.
Fungia (Fungia) fungites (Linneaus, 1758).
Fungia fungites (Linnaeus, 1758): Pomeroy and Kuenzler, 1967; Buddemeier et al., 1974; Hildemann et al., 1975a, 1975b.
**Fungia (Pleuractis) paumotensis* Stuchbury, 1833.
Fungia (Pleuractis) scutaria Lamarck, 1801.
Fungia scutaria Lamarck, 1801: Wells, 1954; Coles et al., 1976; D'Elia, 1977.
**Fungia (Verillofungia) concinna* Verrill, 1864.
**Fungia (Verrillofungia) repanda* Dana, 1846.
**Halomitra pileus* (Linnaeus, 1758). As *H. philippinensis* Studer 1901 from Jaluit and Arno (Wells, 1954). Synonymy after Veron and Pichon (1980).

*New Enewetak record.
†Not recorded from Marshall Islands by this name in Wells (1954).

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TABLE 1 (cont'd)

Family FUNGIIDAE (cont'd)
*†*Herpetoglossa simplex* (Gardiner, 1905).
 Herpolitha limax (Houttuyn, 1772).
 Herpolitha limax (Esper, 1795) [sic]: Young, 1971; Buddemeier et al., 1974.
*†*Lithophyllon* sp. cf. *L. edwardsi* (Rousseau, 1854).
*†*Podabacia crustacea* (Pallas, 1776).
 Parahalomitra robusta (Quelch, 1886): Buddemeier et al., 1974.
*†*Zoopilus echinatus* Dana, 1846.
Family PORITIDAE
*†*Alveopora verrilliana* Dana, 1872.
*†*Goniopora tenuidens* (Quelch, 1886).
 Porites australiensis Vaughan, 1918: Wells, 1954.
 Porites cylindrica Dana, 1846.
  Porites andrewsi Vaughan, 1918: Garth, 1964; Hildemann et al., 1975a, 1975b. Synonymy after Veron and Pichon (1982).
 **Porites lichen* Dana, 1846.
 Porites lobata Dana, 1846: Odum and Odum, 1955, 1956; Pomeroy and Kuenzler, 1969; Buddemeier et al., 1974.
  Porites lopata [sic]: Hildemann et al., 1975a, 1975b.
 Porites lutea Milne Edwards and Haime, 1851: Wells, 1954; Odum and Odum, 1956; Knutson et al., 1972; Knutson and Buddemeier, 1973; Buddemeier et al., 1974; Coles et al., 1976; Muscatine and D'Elia, 1978; Highsmith, 1979, 1980a, 1980b, 1981a, 1981b, 1981c.
 **Porites (Synaraea) monticulosa* (Dana, 1846). As *Porites (Synaraea) iwayamaensis* Eguchi, 1938 from Jaluit, and as *Porites (Synaraea) monticulosa* (Dana, 1846) from Jaluit and Arno, in Wells (1954). Considered to be a junior synonym of *Porites (Synaraea) rus* [Forskål, 1775) by Veron and Pichon (1982).
*†*Porites (Synaraea) rus* (Forskål, 1775).
Suborder FAVIINA
Family FAVIIDAE
*†*Caulastrea furcata* Dana, 1846.
 Cyphastrea chalcidicum (Forskål, 1775): Odum and Odum, 1956; Wijsman-Best, 1980.
 †*Cyphastrea microphthalma* (Lamarck, 1816): Bruce, 1979; Wijsman-Best, 1980.
 †*Cyphastrea ocellina* (Dana, 1846): Wijsman-Best, 1980.
 Cyphastrea serailia (Forskål, 1775): Wells, 1954; Odum and Odum, 1955; Wijsman-Best, 1980.
 Echinopora lamellosa (Esper, 1795): Odum and Odum, 1956; Wijsman-Best, 1980.
 **Favia amicorum* complex. Veron and Pichon (1982) now consider most east Australian specimens of the *Favia amicorum* complex of Veron et al. (1977) to be *Barabattoia amicorum* (Milne Edwards & Haime, 1850).
 **Favia helianthoides* Wells, 1954.
*†*Favia matthaii* Vaughan, 1918.
 Favia pallida (Dana, 1846): Wells, 1954; Odum and Odum, 1955; Odum and Odum, 1956; Highsmith, 1979, 1980b, 1981a, 1981b, 1981c; Haggerty et al., 1980.
 Favia speciosa (Dana, 1846): Wells, 1954; Knutson et al., 1972; Knutson and Buddemeier, 1973; Buddemeier et al., 1974.
 Favia stelligera (Dana, 1846): Wells, 1954; Odum and Odum, 1956; Buddemeier et al., 1974; Haggerty et al., 1980.
 Favites abdita (Ellis and Solander, 1786): Odum and Odum, 1956; Hildemann et al., 1975a.
 Favites flexuosa (Dana, 1846): Hildemann et al., 1975a.
 Favites halicora (Ehrenberg, 1834): Odum and Odum, 1956.
*†*Favites rotundata* Veron, Pichon and Wijsman-Best, 1977.
 **Favites russelli* (Wells, 1954). As *Plesiastrea russelli* Wells, 1954 from Bikini (Wells, 1954). Synonymy after Veron et al. (1977).
 Favites sp.?
  Favites yamanarii Yabe and Sugiyama, 1935: Hildemann et al., 1975a. Veron et al. (1977) considered this species to be a junior synonym of *Favites chinensis* (Verrill, 1866).
 †*Goniastrea edwardsi* Chevalier, 1971.
  Goniastrea parvistella (Dana, 1846) *sensu*: Knutson et al., 1972; Knutson and Buddemeier, 1973; Buddemeier et al., 1974. Synonymy after Veron et al. (1977).
 **Goniastrea pectinata* (Ehrenberg, 1834).
 Goniastrea retiformis (Lamarck, 1816): Yabe et al., 1936; Wells, 1954; Odum and Odum, 1956; Knutson et al., 1972; Buddemeier et al., 1974; Highsmith, 1979, 1980b, 1981a, 1981b, 1981c.
 **Hydnophora exesa* (Pallas, 1776).
 Hydnophora microconos (Lamarck, 1816): Yabe et al., 1936; Wells, 1954; Buddemeier et al., 1974.

*New Enewetak record.
†Not recorded from Marshall Islands by this name in Wells (1954).

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TABLE 1 (cont'd)

Family FAVIIDAE (cont'd)
- **Hydnophora rigida* (Dana, 1846).
- †*Leptastrea pruinosa* Crossland, 1952: Wijsman-Best, 1980.
- *Leptastrea purpurea* (Dana, 1846): Pomeroy and Kuenzler, 1969; Wijsman-Best, 1980.
- *Leptastrea transversa* Klunzinger, 1879: Wijsman-Best, 1980.
- *Leptoria phrygia* (Ellis and Solander, 1786): Yabe et al., 1936; Wells, 1954.
- *†*Montastraea annuligera* (Milne Edwards and Haime, 1849).
- *†*Montastraea curta* (Dana, 1846).
- *Oulophyllia crispa* (Lamarck, 1816): Highsmith, 1981a, 1981b.
  - *Oulophyllia aspera* (Quelch, 1886): Buddemeier et al., 1974. Synonymy after Veron et al. (1977).
- *Platygyra daedalea* (Ellis and Solander, 1786).
  - *Platygyra rustica* (Dana, 1846): Wells, 1954; Odum and Odum, 1956. Synonymy after Veron et al. (1977).
- †*Platygyra lamellina* (Ehrenberg, 1834): Buddemeier et al., 1974; Highsmith, 1980b, 1981b.
- *†*Platygyra pini* Chevalier, 1975.
- **Platygyra sinensis* (Milne Edwards and Haime, 1849).
- *Plesiastrea versipora* (Lamarck, 1816): Yabe et al., 1936; Wells, 1954; Odum and Odum, 1956.

Family RHIZANGIIDAE
- **Culicia rubeola* (Quoy and Gaimard, 1833).

Family OCULINIDAE
- **Acrhelia horrescens* (Dana, 1846).

Family MERULINIDAE
- **Merulina ampliata* (Ellis and Solander, 1786).
- **Scapophyllia cylindrica* Milne Edwards and Haime, 1848.

Family MUSSIDAE
- **Acanthastrea echinata* (Dana, 1846).
- *Lobophyllia corymbosa* (Forskål, 1775): Odum and Odum, 1956; Young, 1971.
- **Lobophyllia hemprichii* (Ehrenberg, 1834).
- *†*Scolymia* sp. cf. *S. vitiensis* Brüggemann, 1877.
- *†*Symphyllia agaricia* Milne Edwards and Haime, 1849.
- *†*Symphyllia radians* Milne Edwards and Haime, 1849.
- *Symphyllia* sp.?
  - *Symphyllia nobilis* (Dana, 1846): Wells, 1954. Veron and Pichon (1980) considered this species to be a junior synonym of *Symphyllia* cf. *recta* (Dana, 1846).

Family PECTINIIDAE
- **Echinophyllia aspera* (Ellis and Solander, 1786).
- *†*Pectinia lactuca* (Pallas, 1766).

Suborder CARYOPHYLLIINA

Family CARYOPHYLLIIDAE
- **Euphyllia glabrescens* (Chamisso and Eysenhardt, 1821).
- **Physogyra lichtensteini* (Milne Edwards and Haime, 1851).
- *†*Plerogyra sinuosa* (Dana, 1846).

Suborder DENDROPHYLLIINA

Family DENDROPHYLLIIDAE
- **Endopsammia* sp.
- *†*Tubastraea coccinea* Lesson, 1829.
- **Turbinaria crater* (Pallas, 1766). B. R. Rosen and R. A. Kinzle (personal communication) working with Enewetak *Turbinaria* only recognize this species among a number of specimens examined.
  - *Turbinaria danae* Bernard, 1896: Garth, 1964; Hildemann et al., 1975a, 1975b. Considered to be a junior synonym of *Turbinaria frondens* (Dana, 1846) by Veron and Pichon (1980).
  - *Turbinaria globularis* Bernard, 1896: Odum and Odum, 1956. Considered to be a junior synonym of *Turbinaria stellulata* (Lamarck, 1816) by Veron and Pichon (1980).
  - *Turbinaria mesenterina* (Lamarck, 1816): Odum and Odum, 1955. Considered to be a valid species by Veron and Pichon (1980).

*New Enewetak record.
†Not recorded from the Marshall Islands by this name in Wells (1954).

TABLE 2

Selections of Nonsystematic Stony Coral Research at Enewetak Atoll*

Type of study	Coral genera*	Reference
	Biochemistry	
Skeletal organic composition	*Acropora, Fungia, Herpolitha, Lobophyllia, Seriatopora, Turbinaria*	Young, 1971
	Ecology	
Asexual dispersal	*Porites*	Highsmith, 1980a
Bioerosion	*Astreopora, Favia, Goniastrea, Montipora, Oulophyllia, Pavona, Platygyra, Porites*	Highsmith, 1980b, 1981a, 1981b, 1981c
Biomechanics	*Acropora*	Vosburgh, 1977, 1978, 1982
Environmental health	*Acropora* sp., *Astreopora* sp., *Favia* sp., *Favites* sp., *Fungia* sp., *Montipora* sp., *Plesiastrea* sp., *Psammocora* sp., *Symphyllia* sp., *Turbinaria* sp.	Johannes et al., 1972a
Invertebrate associates	*Acropora* sp., *Pocillopora, Porites* sp.	Banner and Banner, 1968
	Acropora	Bruce, 1969
	Cyphastrea	Bruce, 1979
	Acropora, Pocillopora, Porites, Psammocora, Seriatopora, Turbinaria	Garth, 1964
	Astreopora, Favia, Goniastrea, Montipora, Oulophyllia, Pavona, Platygyra, Porites	Highsmith, 1980b, 1980c, 1981b, 1981c
	Acropora	Humes, 1981; Humes and Dojiri, 1982; Humes and Stock, 1973
	Acropora sp., *Pocillopora*	Knudsen, 1967
Productivity and trophic structure	*Acropora* sp., *Fungia* sp., *Pocillopora*	Johannes et al., 1972b
	Acropora, Astreopora sp., *Cyphastrea, Favia, Lepastrea,*† *Lobophyllia* sp., *Montipora* sp., *Pocillopora* sp., *Porites, Stylophora* sp., *Turbinaria*	Odum and Odum, 1955
	Acropora, Astreopora, Cyphastrea, Echinopora, Favia, Favites, Goniastrea, Lobophyllia, Montipora, Platygyra, Plesiastrea, Pocillopora, Porites, Stylophora, Turbinaria	Odum and Odum, 1956
	Acropora	Smith and Harrison, 1977
	Pavona	Wethey and Porter, 1976a, 1976b
	Geochemistry	
Radionuclides in skeletons	*Astreopora, Favia, Fungia, Goniastrea, Herpolitha, Hydnophora, Oulophyllia, Parahalomitra, Platygyra, Pocillopora, Porites, Psammocora*	Buddemeier et al., 1974
	Astreopora sp., *Favia, Goniastrea, Porites*	Knutson and Buddemeier, 1973
Stable isotopic composition of skeletons	*Favia*	Haggerty et al., 1980
Alkaline earth chemistry	*Acropora* sp., *Favia* sp., *Montipora* sp., *Platygyra* sp., *Pocillopora* sp., *Porites* sp., *Psammocora* sp.	Buddemeier et al., 1982

*Any species names given for each of these genera can be found in the checklist of corals (Table 1).
†Reclassified as a species of *Plesiastrea* in Odum and Odum (1956).

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TABLE 2 (cont'd)

Type of study	Coral genera*	Reference
	Immunology	
Immunorecognition	*Acropora, Cyphastrea* sp., *Favites, Fungia, Montipora, Pocillopora, Porites, Psammocora* sp., *Seriatopora, Stylocoeniella, Turbinaria*	Hildemann et al., 1975a, 1975b
	Physiology	
Abnormal growth	*Acropora*	Cheney, 1975
Calcification	*Acropora*	Goreau, 1959
Chemical uptake and release	*Acropora, Fungia, Pocillopora*	D'Elia, 1977
	Pocillopora	D'Elia and Webb, 1977
	Acropora sp., *Pocillopora, Porites*	Muscatine and D'Elia, 1978
	Pocillopora	Pilson, 1974
	Acropora, Fungia, Leptastrea, Pocillopora, Porites	Pomeroy and Kuenzler, 1969
	Acropora sp.	Pomeroy et al., 1974
Growth rate	*Astreopora, Favia, Fungia, Goniastrea, Herpolitha, Hydnophora, Oulophyllia, Parahalomitra, Platygyra, Pocillopora, Porites, Psammocora*	Buddemeier et al., 1974
	Favia, Goniastrea, Porites	Highsmith, 1979
	Favia	Haggerty et al., 1980
	Favia, Goniastrea, Porites, Psammocora	Knutson et al., 1972
	Acropora, Pocillopora	Roth et al., 1982
Mucus release	*Acropora* sp., *Porites* sp.	Coles and Strathmann, 1973
Temperature adaptation and tolerance	*Pocillopora*	Clausen and Roth, 1975
	Montipora, Pocillopora	Coles and Jokiel, 1977
	Acropora, Fungia, Leptastrea, Porites, Pocillopora	Coles et al., 1976
	Sexual Reproduction	
	Pocillopora	Richmond, 1982
	Pocillopora	Richmond and Jokiel, 1984
	Acropora, Pocillopora, Seriatopora	Stimson, 1978

*Any species names given for each of these genera can be found in the checklist of corals (Table 1).
†Reclassified as a species of *Plesiastrea* in Odum and Odum (1956).

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Chapter 9

Brachiopods of Enewetak Atoll

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Brachiopods have one of the longest continuous histories of any extant group of metazoans, originating in the early Cambrian period and still thriving in modern seas. Although brachiopods have long been considered rare and in evolutionary decline, modern studies show they are abundant, widespread, and highly diverse. Living brachiopods are classified into about 100 genera and occupy niches from tide pools to the abyss; their apparent rarity is partly the result of their patchy distribution. Those on Enewetak are small and inconspicuous, living in "cryptic" habitats under the shade of coral fronds, in recesses in the reef, or on lagoon pinnacles. Hitherto, the only published account of them at Enewetak is as fossils from drill holes (Cooper, 1964), although their presence alive on the reef is well-known (Grant, 1971; Zumwalt, 1978).

Three species, *Thecidellina congregata* Cooper, *Frenulina sanguinolenta* Gmelin, and *Argyrotheca arguta* Grant, are known at Enewetak from shells. In addition, *Lingula* sp. is known by larvae taken in plankton tows in the lagoon (Gilmartin, 1958), and a species of *Crania* is expected based on specimens found at Bikini (Cooper, 1954). These taxa seem to constitute a suite of brachiopods that characterizes the shallow waters of tropical islands, not only in the Pacific (Cooper, 1954) but also in the Caribbean and, with some different species, in the Red Sea (Jackson et al., 1971). (See Table 1 for checklist of Enewetak species and Fig. 1 for map of Enewetak.)

TABLE 1

Checklist of Enewetak Brachiopods

Class INARTICULATA
  Order LINGULIDA
    Superfamily LINGULACEA
      Family LINGULIDAE
        Lingula sp., larvae: Gilmartin, 1958.
Class ARTICULATA
  Order TEREBRATILIDA
    Superfamily TEREBRATELLACEA
      Family MEGATHYRIDIDAE
        Argyrotheca arguta Grant: Grant, 1983.
        (=*Argyrotheca* sp. Cooper, 1954.)
      Family DALLINIDAE
        **Frenulina sanguinolenta* Gmelin, 1792.
  Order THECIDEIDA
    Superfamily THECIDEACEA
      Family THECIDELLINIDAE
        Thecidellina congregata Cooper, 1954.
        (=*Thecidellina maxilla* Hedley: Grant, 1972.)

*New Enewetak record.

METHODS

Brachiopods were collected during September 1969 by the author using scuba equipment to depths of about 50 m. Further collections of *Thecidellina congregata* to a depth of about 65 m were made in 1972 by G. S. Zumwalt. His specimens are deposited in the United States National Museum of Natural History (USNM) and were used to supplement material for this report. Each station where brachiopods were obtained has been assigned a number in the USNM register of localities, Department of Paleobiology. Station data are summarized in Table 2. The Enewetak brachiopods cannot be seen under water because they are small and live in dark habitats; therefore, collecting had to be somewhat random. Pieces of coral were broken out of likely looking habitats and brought to the surface for examination, much in the manner described by Jackson et al. (1971) although not on so vast a scale. Most individuals were left attached to their coral slabs and were dried in the sun; those that became detached were preserved in alcohol for immediate study and were dried later.

ECOLOGY

Brachiopods were found on Enewetak at depths ranging from 5 m to 65 m, the limit of scuba equipment. At Bikini, where they were collected by dredging, they are reported as deep as 480 m (Cooper, 1954). The shallowest occurrence was a small *Frenulina sanguinolenta* on a

Fig. 1 Map of Enewetak showing where brachiopods were collected. Numbers are last digits of USNM locality numbers 32007-22.

coral frond at 5 m. The abundance and diversity of brachiopods increase with depth and with increased darkness in small caves and recesses in the reef. On the seaward side of Biken Island, one piece of coral-*cum*-sponge contained a density of *Thecidellina congregata* that by extrapolation amounts to 7000/m^2, and another has 40 individuals on a surface 7 × 17 cm, amounting to about 3400/m^2 (Figs. 6 through 8). These densities compare to those found by Jackson et al. (1971) at Jamaica and Curaçao where densities of 5000 to 10,000/m^2 were encountered. These figures may appear to exaggerate the density of brachiopods on these reefs, because the common impression is that brachiopods are rare. Most divers do not encounter brachiopods, however, because they do not search for them deliberately, and brachiopods are essentially invisible under water. In addition, the distribu-

TABLE 2

Station Data for Enewetak Brachiopods Collected in 1969 and 1972

Station*	Locality	Bottom depth, m	Sample depth, m	Taxa	No. of specimens
	Grant's 1969 Localities				
32007	Enewetak Islet, ~1200 m off personnel pier	18	17	*F. sanguinolenta*	1
32008	~1500 m off personnel pier: low bioherms	21	14	*F. sanguinolenta*	1
32009	Same bioherm as 32008	21	21	*F. sanguinolenta*	2
32010	Jinimi Islet ~400 m east	14	12	*F. sanguinolenta*	3
32010a	Jinimi Islet, same area as 32010	21	21	*F. sanguinolenta*	3
32011	Pinnacle, 11 km offshore bearing 320° from personnel pier	—	20	*F. sanguinolenta*	1
				T. congregata	9
32012	Jinedrol Islet, ~2000 m offshore, bearing 285°, broken coral	18	17	*F. sanguinolenta*	29
				T. congregata	2
32013	Kidrenen Islet, ~1000 m offshore, bearing 25°, low bioherms and dead coral	26	24	*F. sanguinolenta*	11
				T. congregata	13
32013a	Kidrenen Islet, ~400 m offshore, shallow slope	—	5	*F. sanguinolenta*	1
32014	Ikurin Islet, 1500 m, 10° off east end, dying bioherms	18	14	*T. congregata*	1
				A. arguta	19
32015	Pinnacle Qk FIR (map 6033) 6 km off personnel pier	35	30	*F. sanguinolenta*	3
32016	Medren Islet, ~ 1000 m offshore, bearing 270°, low bioherms	21	21	*T. congregata*	2
32017	Medren Islet, higher pinnacles (same region as 32016)	21	12	*T. congregata*	1
32018	Medren Islet pinnacles (same region as 32016)	21	8	*F. sanguinolenta*	5
32019	Biken Islet, wall of channel just SW of islet	9	9	*F. sanguinolenta*	1
				T. congregata	60
32020	Biken Islet, steep reef slope	120+	14	*T. congregata*	1
32021	Biken Islet, steep reef slope	120+	23	*F. sanguinolenta*	1
				T. congregata	71
32022	Biken Islet, steep reef slope	120+	35	*T. congregata*	210
				A. arguta	13
	Zumwalt's 1972 Localities				
	Medren Islet, ~1000 m NW of islet, deep channel reef	20–40	20–30	*T. congregata*	
	Pole pinnacle, lagoonward extension of channel, 1 km offshore	37	37	*T. congregata*	
	Biken Islet, steep seaward slope	120+	37+	*T. congregata*	

*Stations 32007 to 32018 are lagoon stations, stations 32019 to 32022 are seaward stations.

tion of brachiopods is patchy, so it can be said that under the best conditions of light and depth the local density of brachiopods, especially *T. congregata,* can be very great.

Brachiopods tend to associate with bryozoans, a combination that dates as far back as the Ordovician period. The undersides of many coral fronds also contain encrusting sponges along with the brachiopods, an association so consistent that Jackson et al. (1971) refer to a "brachiopod–coralline sponge community." They note that true coral reefs of the modern type originated in the Jurassic period and that the light dependency of scleractinians necessarily produces a foliaceous framework with numerous cavities, because light-dependent corals cannot fill their own gaps. The association of *Thecidellina* and *Argyrotheca* (plus various terebratulinids) dates at least as far back as the Eocene in the Pacific area (Cooper, 1971), indicating that the cryptic environment produced by the foliaceous reef has been exploited for a long time. Surlyk (1972, Fig. 12) cites a Cretaceous association of a thecidean and two species of *Argyrotheca* but shows them occupying exposed hardgrounds.

Jackson et al. (1971) noted that the competition for space on the undersides of corals is keen, an observation that is confirmed at Enewetak. The shapes of the two forms that are tightly attached, *T. congregata* and *Argyrotheca arguta,* are clearly adapted to avoid encrustation by the ubiquitous sponges and algae; they grow away from the substrate and thus keep the commissure elevated from the encrusters. *Frenulina sanguinolenta* attaches by a pedicle that holds the shell well above the substratum (actually *below* it, on these undersides) and affords some rotational mobility that can help to ward off encrustation.

Frenulina sanguinolenta is not as negative to light as is *T. congregata*. Several samples with *F. sanguinolenta* also contain abundant *Halimeda* algae, but other pieces in the collection have *F. sanguinolenta* and *T. congregreta* in association. The brachiopod found in the shallowest habitat was *F. sanguinolenta* in 5 m off Kidrenen (loc. 32013a) where a single tiny individual was taken from a shady place in a niche under an overhang. Apparently the somewhat warmer water at this shallow depth was more a factor than shelter from light in limiting the presence of brachiopods.

Two representatives of the Class Inarticulata also probably occur at Enewetak. The larva of *Lingula* sp. is reported in plankton hauls made in transects across the southern part of the lagoon (Gilmartin, 1958). Species of *Lingula* normally burrow in unconsolidated sediment in the intertidal and shallow subtidal zones. This habitat was not explored thoroughly, but the presence of the larva indicates that such a search would produce specimens of a *Lingula*. Another inarticulate genus that can be expected to be found at Enewetak is *Crania*. An undetermined species in this genus was reported from Bikini where the fauna is essentially the same as at Enewetak (Cooper, 1954). Its small size and tightly cemented habit make it difficult to find (it looks like a small, very flat limpet); the largest specimen reported by Cooper is 3 mm wide, a pale salmon color that blends into the surroundings, and a shape that tends to conform to the contours of the substrate.

ARTICULATA

Argyrotheca arguta is characterized by its small size and white, clear, or translucent shell (Figs. 2 and 3) with weak to absent costae. It had been recognized from Enewetak as not belonging to any described species (Cooper, 1954) but was not described for fear that it was represented only by juveniles. The present Enewetak sample is adequate, however, and contains small shells along with the majority that seem to cease growth between 2 and 3 mm in width (Table 3). The narrow outline, lack of costae (other species are typically strongly costate), and lack of pigmentation make it unique among species of *Argyrotheca*. It was described recently (Grant, 1983), is known only from Enewetak and Bikini so far, and may prove to be endemic to the Marshall Islands.

The two Pacific species described by Blochmann (1910, 1914) from Australia and Tasmania, *A. australis* and *A. mayi*, are much longer than *A. arguta* and have the strong costae that characterize most species of the genus.

Fig. 2 ***Argyrotheca arguta*** **from underside of coral in lagoon off Ikurin Island at depth 15 m, locality 32014; juvenile in small depression (4×).**

Fig. 3 ***Argyrotheca arguta*** **on same slab from 32014 as in Fig. 2; adult and juvenile shells in close proximity (4×).**

The colorless shell of *A. arguta* is another distinguishing feature. *Argyrotheca arguta* differs from the other pediculate species of Enewetak, *Frenulina sanguinolenta,* in its smallness, its flatter profile, its wide hinge, its triangular rather than round foramen, and, especially, its pellucid shell material.

Argyrotheca arguta attaches to the substrate by means of a short pedicle. It attaches somewhat loosely, i.e., the pedicle is longer than is normal in other members of the genus. *Argyrotheca arguta* favors cryptic habitats under coral fronds and in recesses, as would be expected from its colorless and translucent shell. At Enewetak it was found

TABLE 3

Measurements of *A. arguta* in mm from Ikurin (sta. 32014)*

Width	Length
0.8	–
1.5	1.4
1.6	1.2
1.8	1.4
2.1	2.0
2.5	2.6
2.8	3.2†

*Most specimens are preserved still attached to their substrates, so the thickness measurement was impossible to obtain.

†Holotype: USNM 265875

Fig. 5 *Frenulina sanguinolenta* from niches at 24 m depth in the lagoon, shown attached to substrate (4×). Shells are pink with white stripes or solid pink.

only at two localities, both in association with *Thecidellina congregata*. One locality is on the seaward side of the reef and the other on the lagoon side; both are on the southwest segment of the atoll [Biken and Ikurin where 13 and 19 specimens were found, respectively (Table 2)].

The shell of *Frenulina sanguinolenta* is small for brachiopods in general and even for a species of *Frenulina*, yet this is the largest brachiopod at Enewetak. Adults normally are slightly wider than long, and the shape is that of a generalized terebratulide, with biconvex profile and apical circular foramen (Figs. 4 and 5) that earned the brachiopod the vernacular name "lamp shell" (the ancient oil lamp). The color is distinctive, normally white with pink stripes or pink mottling in irregular rows but occasionally a solid pink or red color without stripes. The dorsal valve bears a shallow median depression resulting in a sulcate anterior commissure.

Fig. 4 *Frenulina sanguinolenta* from pinnacle in lagoon, locality 32010; the largest specimen collected (w is 12.3 mm) and a smaller one (w is 6.9) with pedicle and loose pedicular fibers (2×).

The dorsal loop consists of a large "hood" of thin shell material attached to a short slim median septum by means of two broad lateral bands. The ventral valve has deltidial plates outlining the anterior part of the foramen, which are conjunct in some specimens but disjunct in most. The species thus is variable, but unmistakable, in the Enewetak brachiopod fauna.

Frenulina sanguinolenta is the most widespread and smallest living species of the genus (Hatai, 1940; Cooper, 1957). This species like other brachiopods at Enewetak prefers cryptic habitats. It is not as abundant locally as *T. congregata* but was found at more localities than any other brachiopod species, being present at 14 of the 18 localities sampled (Table 2). Most specimens remain attached to their substrates by the pedicle, so only the width measurement could be made without danger of damage to the shells. Table 4 compares the length, width, and thickness of 14 Enewetak specimens. However, the smallest specimen examined had a width of 0.8 mm. The beak curves toward the substrate, so the dorsal valve is held facing the coral frond or other "overhang" that the shells cling to. Relative to the sea floor, the dorsal is thus upper

TABLE 4

Shell Measurements of *Frenulina sanguinolenta* in mm

Width	Length	Thickness	Locality
2.9	2.9	1.2	32018
3.7	3.8	1.6	32018
4.0	4.6	2.5	32018
4.1	4.0	1.7	32018
4.8	4.4	2.0	32010
4.8	4.6	2.1	32008
6.3	6.3	3.4	32017
6.9	6.6	3.1	32010
6.9	6.4	3.0	32013
7.3	6.9	3.5	32017
7.4	7.0	3.6	32017
8.6	8.8	–	32010
10.0	9.6	5.4	32017
11.4	12.3	5.7	32010

and the ventral lower as the shells hang from the ceilings of their cryptic recesses. The red color looks greenish under water, and the stripes render the shells nearly invisible to the human eye in the dim and shimmering light.

Thecidellina congregata was described originally from Bikini Atoll where it occurred as deep as 480 m (Cooper, 1954). It is the most abundant brachiopod at Enewetak, although not the most widespread. *Thecidellina congregata* can be identified by its cemented habit, with low cup-shaped ventral valve and lid-like dorsal valve (Figs. 6 through 9). Its color ranges from white (mostly dead shells) to bluish gray in the majority of living shells. It is not immediately distinguishable from *T. maxilla,* known from Bikini (Cooper, 1964), although close inspection reveals several differences. *Thecidellina congregata* is smaller (Table 5), has the blue-gray color, and the dorsal median septum is wider at the anterior than at the posterior, where that of *T. maxilla* maintains nearly a uniform width from back to front.

Zumwalt (1978) conducted a detailed anatomical and functional study of this species, based upon material he collected at Enewetak. He found that both the diductor and the adductor muscles insert in the hemispondylium, which is a muscle platform that changes length and shape with growth and general configuration of the valve, to produce the most advantageous angles for muscle action. Hence the hemispondylium varies from one individual to the next.

As implied by the name, *T. congregata* can occur in abundant patches where extrapolated densities run to several thousand per square meter. Judging from the samples taken at Enewetak and reports of other species of *Thecidellina* from elsewhere (e.g., Jackson et al., 1971), *Thecidellina* survives best in cryptic habitats. It feeds by opening the valves and exposing the lophophore to the seawater, which is then pumped across the filaments of the lophophore. The lophophore is considered a modified

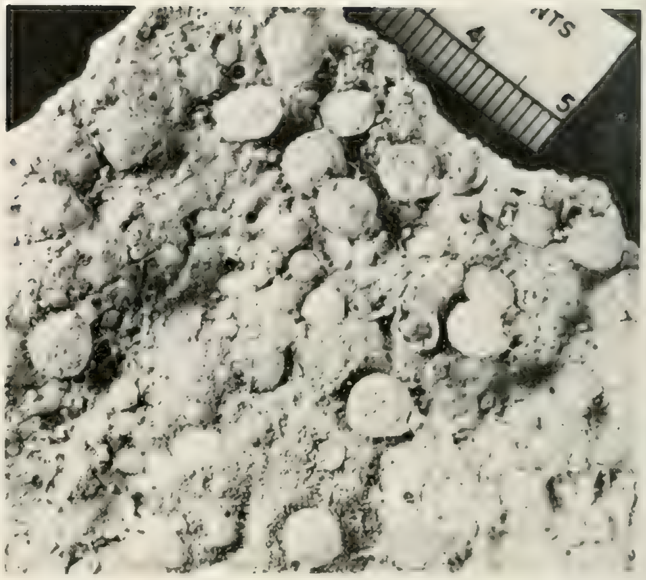

Fig. 6 ***Thecidellina congregata*** **clustered on underside of coral frond from sea side of Biken Island at USNM locality 32022 (2×). These are the specimens whose measurements in the species description indicate a width range from 0.5 to 5.2 mm.**

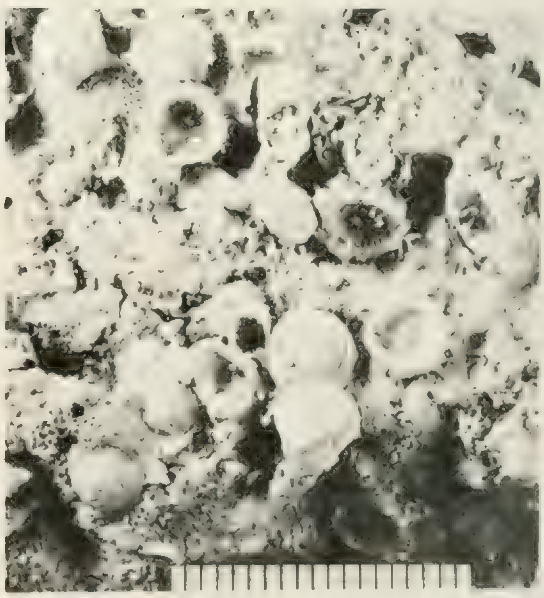

Fig. 7 ***Thecidellina congregata*** **from shallow cave at depth about 33 m on sea side of Biken Island, USNM locality 32022; combination of living shells and dead empty ventral valves with narrow variation in size.**

trocholophe, with a deep median indentation along the sides of the dorsal median septum. The normal position for feeding seems to be with the dorsal valve open to a position nearly perpendicular to the margin of the ventral valve

Fig. 8 ***Thecidellina congregata*** **on coral frond from same place as Fig. 7. Specimen at broken edge has grooves on the dorsal valve reflecting grooved surface to which ventral valve is attached. Such dorsal reflection of ventral irregularities is common in brachiopods.**

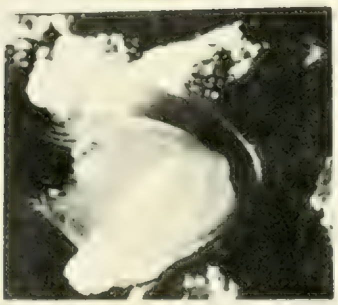

Fig. 9 ***Thecidellina*** **sp. in feeding position (specimen from Curaçao, photo courtesy D. L. Meyer, shown in Grant, 1972).**

(Fig. 5; and Grant, 1972: pl. 5, Fig. 21). This position would be highly vulnerable to predators and damage by grazing fish, possibly accounting for the preference toward sheltered environments and development of a muscle system with a quick closing mechanism (Rudwick, 1961; Zumwalt, 1978).

Thecidellina congregata occurs at 10 of the 18 localities where brachiopods were recovered, fewer than the more widespread species *F. sanguinolenta*. It is, however, the most abundant species, being represented by at least 370 specimens (both dead and alive). Of this number, 340 were obtained from Biken Islet, on the seaward slope or the seaward end of the channel leading out to that slope. Its abundance increases with depth, to 65 m, but it is doubtful that the abundance continues to increase to depths as great as the 480 m reported by Cooper (1954).

TABLE 5

Shell Measurements of *Thecidellina congregata* in mm*

Length	Width	Length	Width	Length	Width
0.5	0.4	1.3	1.5	2.9	2.5
0.6	0.6	1.4	1.2	4.2	4.0
0.8	0.6	1.4	1.3	4.4	4.0
0.8	0.7	2.0	1.8	4.4	4.5
0.8	0.9	2.3	2.4	4.7	4.5
0.9	0.7	2.3	2.6	4.8	4.7
0.9	1.1	2.5	2.8	5.1	4.6
1.2	1.1	2.6	2.7	5.1	5.2
1.2	1.4	2.6	2.8	5.2	4.9

*Specimens cemented to substrate permit only length and width measurements, but these afford an idea of size and variation. All measured specimens are from the underside of a thin coral frond from locality 32022 (Biken, 28 m).

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Chapter 10

Reef-Dwelling Bryozoans of Enewetak Atoll

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INTRODUCTION

Purpose

The goals of this report are to list the bryozoans found on the modern reefs of Enewetak Atoll, illustrate the most conspicuous species, indicate their biogeographic implications, and summarize their ecology (particularly ecozonal distributions and constructional roles).

Significance

The contribution made by the phylum Bryozoa to the Enewetak reefs, although known in general terms (Cuffey, 1970, 1973, 1978), has not until now been detailed at the species level for the benefit of those concerned with various aspects of the Enewetak ecosystem. Such information will also constitute a precise data base for comparative studies of fossil reefs containing these animals. Moreover, the Enewetak species are of special broader interest because they represent the first modern atoll-reef bryozoan fauna to be analyzed thoroughly. Their distributions thus will shed light on bryozoan involvement in reefs in general.

Collections

Over 40 localities on Enewetak Atoll were sampled by scuba diving and reef walking in late 1969. Sites were selected to provide balanced but comprehensive coverage of the major environments, particularly ecozones, developed on the atoll (Cuffey, 1973, pp. 26, 36-38; Cuffey, 1978, pp. 68, 72; Haggerty, Weber, Cuffey, and Deines, 1980, p. 97; Basile, Cuffey, and Kosich, 1984, Fig. 1). However, no samples were dredged from below 40 m (135 ft).

Literature

Most useful in identifying the Enewetak bryozoans were the monographs by Canu and Bassler (1927, 1929), Harmer (1915, 1926, 1934, 1957), Osburn (1950, 1952, 1953), Levinsen (1909), and Soule and Soule (1973). Additional papers too numerous to list here include occasional relevant species descriptions as well.

FAUNAL COMPOSITION

Overall, 84 bryozoan species, 73 cheilostomes and 11 cyclostomes in 61 genera have been identified on Enewetak (Table 1). Of these species, six are new, being published elsewhere (Cox and Cuffey, submitted). In order to refer to these without creating taxonomic problems, they are denoted simply as "n. sp." followed by the proposed trivial name in quotation marks and parentheses. Among the remaining species, several generic reassignments were required (incorporated in Table 1) due to changes in concepts since publication of the earlier monographs cited above.

Certain species are particularly conspicuous among the Enewetak bryozoans and so comprise a distinctive assemblage (Figs. 1 and 2) characteristic of this atoll and possibly others. Such species appear conspicuous for different reasons. Some are represented by several large colonies, others by many small colonies, still others by a large total substrate area encrusted, and others yet by a high proportion of the bryozoan fauna at individual localities. These species are also differently distributed within the atoll, as discussed below.

The Enewetak bryozoan species are characterized by relatively few colony growth forms (Cuffey, 1973, pp. 29-31 and references therein). Most numerous by far (both colonies and species) are encrusting cheilostomes, thin sheets or crusts ranging from many square millimeters in area down to a few zooecia. Most of the Enewetak cheilostome families (Table 1) studied by Cox (1983; also Cox and Cuffey, submitted) grow as encrusting sheets. A few sheets consist of more than one layer of zooecia, but none encountered were thickened into multilaminar nodular masses (not even *Celleporaria albirostris*, which does form such masses in Bahamian bryozoan reefs; Cuffey, Gebelein, Fonda, Bliefnick, Kosich, and Soroka, 1977). More regular

TABLE 1

Enewetak Atoll Bryozoans

Systematics	Biogeography*	Ecology†
Phylum BRYOZOA		
Class GYMNOLAEMATA		
Order CHEILOSTOMIDA		
Suborder ANASCINA		
Infraorder INOVICELLATA		
Family AETEIDAE		
Aetea truncata	P,I,C	Lg;d
Infraorder MALACOSTEGA		
Family CALLOPORIDAE		
Alderina brevispina	P	Ol;s
Family HINCKSINIDAE		
Antropora claustracrassa	P	Lg;d
A. laguncula	P	Lg;d
‡*A. ovata*	P	Ol,Lg;d,s
Cauloramphus cf. *brunea*	P	Lg;d
‡*Cranosina coronata*	P,I	Ol,Ow,Lg;d,s,f
Infraorder COELOSTEGA		
Family ONYCHOCELLIDAE		
‡*Smittipora americana*	P,C	Ol,Ow,Lg;d,s
Family MICROPORIDAE		
Caleschara levinseni	P,I	Ol;d
Family THALAMOPORELLIDAE		
Thalamoporella distorta	C	Ol,Lg;d,s
‡*T. expansa*	P	Ol,Ow,Lg;d
Infraorder PSEUDOSTEGA		
Family ASPIDOSTOMATIDAE		
Monoporella fimbriata	P	Ol,Ow,Lg;d,s
Infraorder CELLULARINA		
Family FARCIMINARIIDAE		
Didymozoum marginatum	P	Lg;d
Nellia cf. *tenuis*	P,C	Lg;d
Family BUGULIDAE		
Caulibugula ciliata	P	Lg;d
Family BEANIIDAE		
Beania cupulariensis	P,C	Lg;d
Family SCRUPOCELLARIIDAE		
Caberea ellisi	P	Ol;s
Scrupocellaria longispinosa	P	Ol,Lg;d,s
Suborder CRIBRIMORPHINA		
Family CRIBRILINIDAE		
Cribrilaria calamorpha	F	Ol,Lg;d,s
C. radiata	P,I,C	Ol,Lg;d,s
C. simulator	F	Lg;d,s
Figularia n. sp. (*"cribricapitata"*)	E	Lg;d
Suborder ASCOPHORINA		
Family ADEONIDAE		
Reptadeonella flagellifera	I	Ol,Lg;d,s
‡*R. joloensis*	P,I	Ol,Lg;d,s

*Geography: P, Pacific Ocean; I, Indian Ocean; C, Caribbean and western Atlantic; E, Enewetak endemic; F, previously known only as fossils.

†Ecozone: Ol, Ow, oceanward reefs on leeward or windward sides of atoll, respectively; Lg, lagoonal reefs. Depth: d, deep reefs; s, shallow reefs; f, reef flats.

‡The several most conspicuous species on Enewetak (Figs. 1 and 2).

(This table continued on next page.)

TABLE 1 (cont'd)

Systematics	Biogeography*	Ecology†
Family CELLEPORARIIDAE		
Celleporaria albirostris	P,I,C	Lg;d,s
C. columnaris	P,I	Lg;s
C. n. sp. *("eniwetokensis")*	E	Lg;s
C. granulosa	P,I	Lg;d,s
C. labelligera	P,I	Ol;d,s
C. vagans	P,I,C	Lg;d,s
Trematooecia turrita	P,I,C	Lg;s
Family EXECHONELLIDAE		
Exechonella magna	P	Ol,Lg;d,s
E. tuberculata	P,I	Ol,Ow,Lg;d,s
Family PETRALIELLIDAE		
Mucropetraliella robusta	P	Ol,Lg;d
Robertsonidra argentea	P,I	Lg;s
Family ARACHNOPUSIIDAE		
‡*Arachnopusia spathulata*	P	Ol,Ow,Lg;d,s,f
Family CHORIZOPORIDAE		
‡*Chorizopora ventricosa*	P	Ol,Ow,Lg;d,s
Family HIPPOTHOIDAE		
‡*Trypostega venusta*	P,I,C	Ol,Ow,Lg;d,s
Family HIPPOPORINIDAE		
Stephanosella bernardii	P,I	Ol,Lg;d,s
Family HIPPOPODINIDAE		
‡*Hippopodina feegeensis*	P,I,C	Lg;s
H. pulcherrima	I,C	Ow,Lg;d,s
Family CREPIDACANTHIDAE		
Crepidacantha grandis	P	Ol,Lg;d,s
C. poissonii	P,I,C	Ol,Lg;d
Family SMITTINIDAE		
Codonellina montferrandii	P,I,C	Lg;d
‡*Parasmittina alanbanneri*	P	Ol,Lg;d,s
P. crosslandi	P,C	Lg;d,s
P. raigiformis	P	Lg;d,s
P. spathulata	P,C	Lg;d,s
P. cf. *tropica*	P,I	Lg;s
Porella n. sp. *("ikurenensis")*	E	Ol,Lg;d,s
Rimulostoma signata	P,I,C	Lg;d,s
Smittoidea pacifica	P	Ol,Ow,Lg;d,s
Family TEUCHOPORIDAE		
Teuchopora verrucosa	P,I	Lg;d
Family SCHIZOPORELLIDAE		
Arthropoma circinatum	P,I	Ol,Lg;d,s
‡*Calyptotheca impar*	P,I	Ol,Ow,Lg;d,s
Escharina pesanseris	P,I,C	Ol,Ow,Lg;d,s
Stylopoma duboisii	P,I	Ol,Lg;d,s
Family GIGANTOPORIDAE		
Cosciniopsis coelatus	P	Ol,Lg;d,s
‡*C.* n. sp. *("enewetakensis")*	E	Ol,Ow,Lg;d,s
Gigantopora pupa	P,C	Lg;d
Thornelya n. sp. *("aniyaaniensis")*	E	Lg;d,s
T. n. sp. *("marshallensis")*	E	Lg;d,s

*Geography: P, Pacific Ocean; I, Indian Ocean; C, Caribbean and western Atlantic; E, Enewetak endemic; F, previously known only as fossils.

†Ecozone: Ol, Ow, oceanward reefs on leeward or windward sides of atoll, respectively; Lg, lagoonal reefs. Depth: d, deep reefs; s, shallow reefs; f, reef flats.

‡The several most conspicuous species on Enewetak (Figs. 1 and 2).

(This table continued on next page.)

TABLE 1 (cont'd)

Systematics	Biogeography*	Ecology†
Family CLEIDOCHASMATIDAE		
‡*Cleidochasma porcellanum*	P,I,C	Ol,Ow,Lg;d,s
Hippoporella spinigera	P,I	Lg;d
Family MICROPORELLIDAE		
Fenestrulina malusii	P,I,C	Ow,Lg;d,s
Family RETEPORIDAE (encrusting species)		
Drepanophora incisor	I	Lg;d
D. tuberculata	P,C	Lg;d,s
‡*Rhynchozoon curtum*	F	Lg,d,s
R. solidum	C	Lg;d,s
Family RETEPORIDAE (fenestrated species)		
Triphyllozoon cuspidatum	P	Ol,Lg;d
Family SAVIGNYELLIDAE		
Savignyella lafontii	P,I,C	Lg;d
Family TETRAPLARIIDAE		
Tetraplaria veleroae	P	Ol,Lg;d,s
Family TUBUCELLARIIDAE		
Tubucellaria fusiformis	P,I	Ol;Lg;d,s
Class STENOLAEMATA		
Order CYCLOSTOMIDA		
Suborder TUBULIPORINA		
Family DIASTOPORIDAE		
Stomatopora cf. *grandipora*	P	Ol;d
Family TUBULIPORIDAE		
Idmidronea flexuosa	P,C	Lg;d
Platonea philippsae	P	Ol,Lg;d,s
Tubulipora pulcherrima	P,I	Lg;d,s
Family ONCOUSOECIIDAE		
Oncousoecia cf. *abrupta*	P	Ol,Lg;d,s
Proboscina cf. *dichotoma*	P	Ol,Lg;d,s
Family DIAPEROECIIDAE		
Diaperoecia aff. *rosea*	P	Ol,Lg;d,s
Suborder ARTICULINA		
Family CRISIIDAE		
Crisia elongata	P,I,C	Ol,Lg;d,s
C. cf. *kerguelensis*	P,I	Ol,Lg;d,s
Suborder RECTANGULINA		
Family LICHENOPORIDAE		
Disporella cf. *buski*	P,C	Lg;d
Lichenopora novazelandiae	P,I	Lg;d

*Geography: P, Pacific Ocean; I, Indian Ocean; C, Caribbean and western Atlantic; E, Enewetak endemic; F, previously known only as fossils.

†Ecozone: Ol, Ow, oceanward reefs on leeward or windward sides of atoll, respectively; Lg, lagoonal reefs. Depth: d, deep reefs; s, shallow reefs; f, reef flats.

‡The several most conspicuous species on Enewetak (Figs. 1 and 2).

in outline, but always small and much rarer, are thin encrusting disks, lichenoporid cyclostomes. Also along the substrate are encrusting threads (aeteid cheilostomes, diastoporid cyclostomes); encrusting branches (some tubuliporine cyclostomes); and recumbent, though slightly elevated, branching tubes (other tubuliporine cyclostomes; Cuffey, 1985). Erect rigid lattices are certain reteporid cheilostomes (Cuffey and McKinney, 1982). Erect flexible or jointed tufts include both extremely delicate crisiid cyclostomes and somewhat more robust cheilostomes (cellularine, savignyellid, cheiloporinid, and tubucellariid cheilostomes). None of the Enewetak reefal bryozoans were observed to grow as erect cylindrical or flattened branches.

All the Enewetak bryozoans mentioned above are geologically modern. Deep drilling into the late Cenozoic

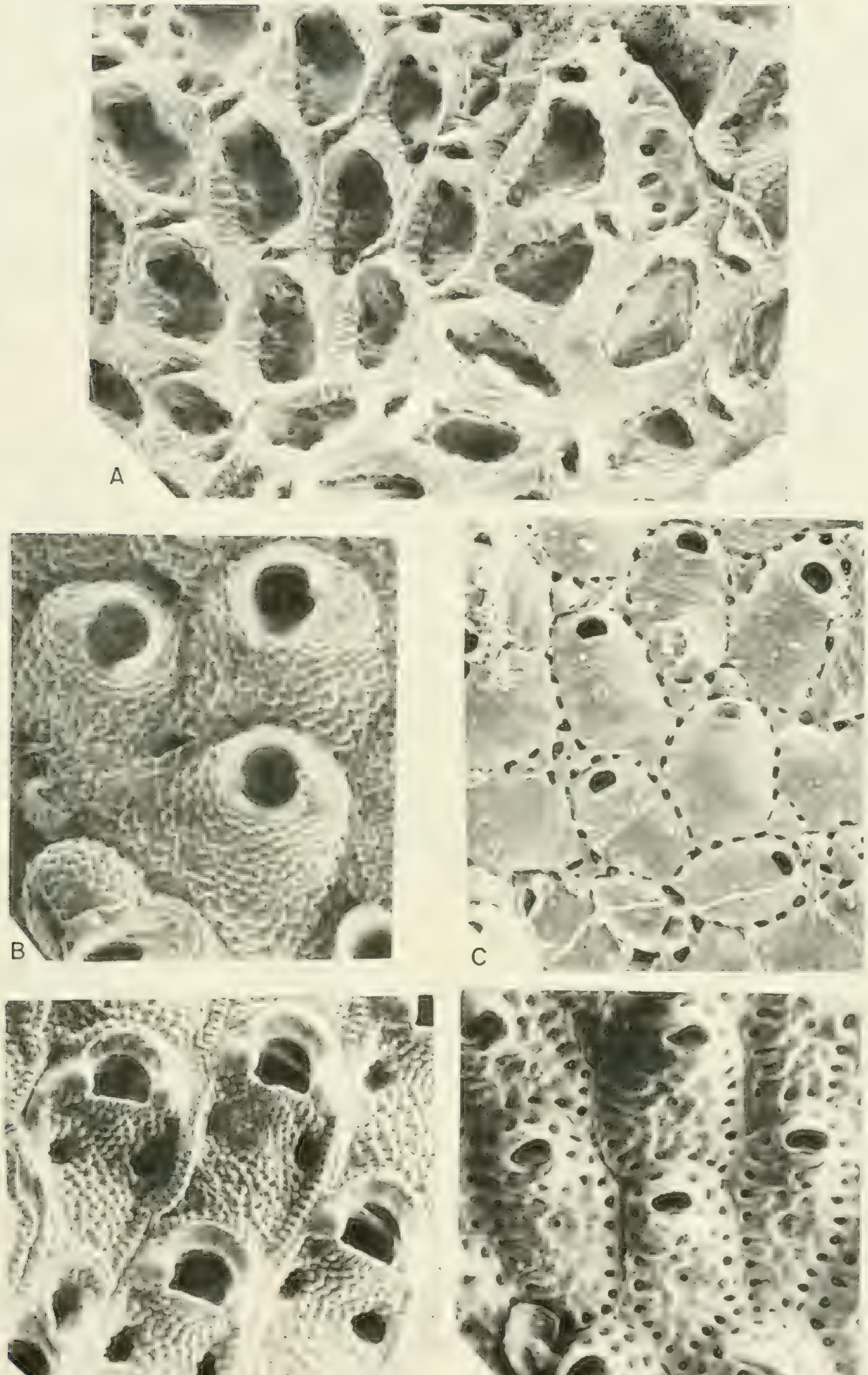

Fig. 1 The most abundant Enewetak bryozoans (width of each field in mm; specimens numbered within "MAPENI" suite in Paleobryozoological Research Collection at Pennsylvania State University). (a) *Cranosina coronata*, field 2.43 mm wide, 27-A-1; (b) *Cosciniopsis* n. sp. *("enewetakensis")*, field 1.54 mm wide, 16-G-12; (c) *Chorizopora ventricosa*, field 1.01 mm wide, 27-A-1a; (d) *Thalamoporella expansa*, field 1.51 mm wide, 17-B-2; (e) *Reptadeonella joloensis*, field 1.02 mm wide, 16-G-8.

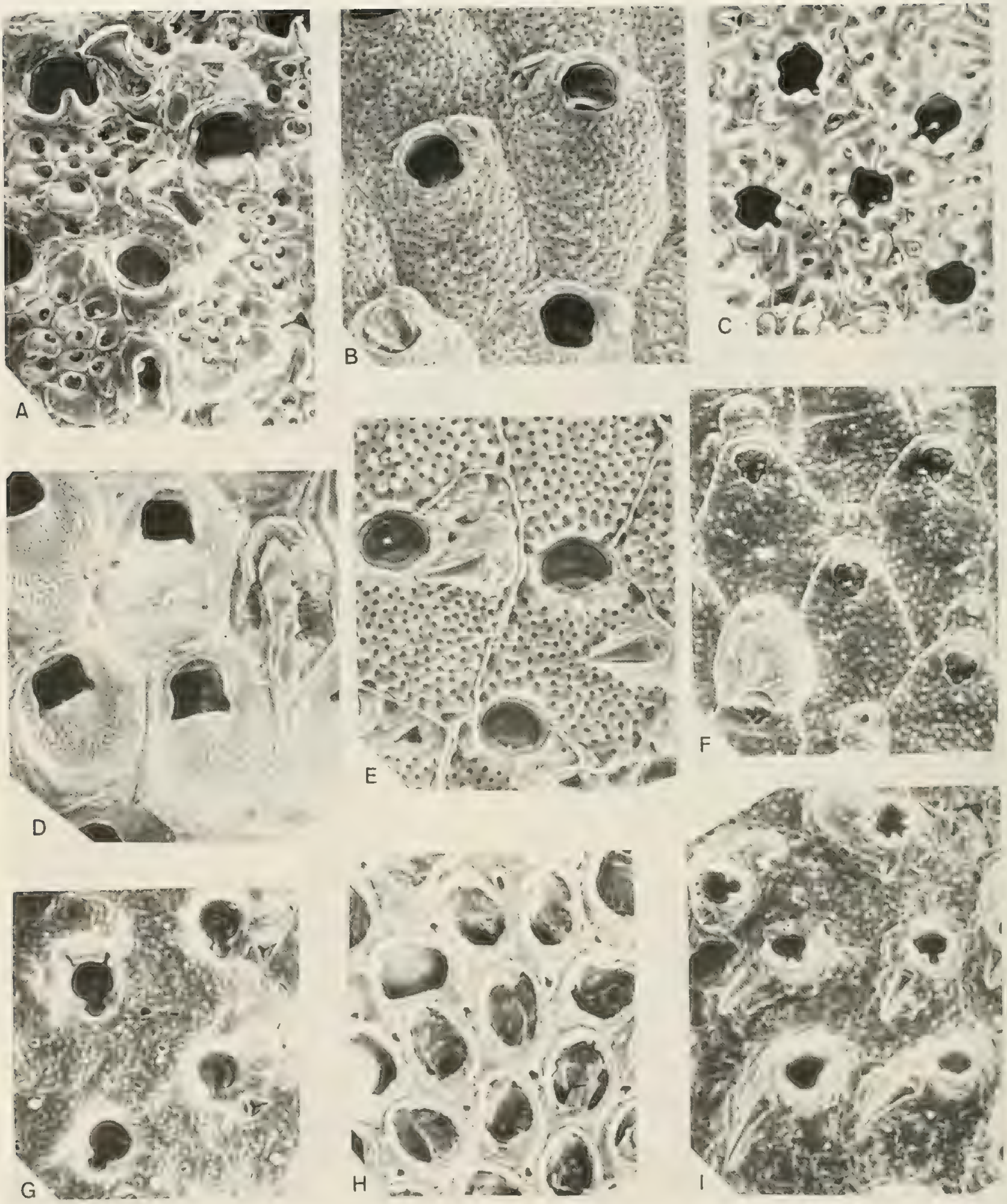

Fig. 2 The other common Enewetak bryozoans (sizes and numbers as in Fig. 1). (a) *Arachnopusia spathulata*, field 0.84 mm wide, 14-A-37; (b) *Hippopodina feegeensis*, field 1.27 mm wide, 31-C-4; (c) *Rhynchozoon curtum*, field 0.78 mm wide, 3-B-12; (d) *Smittipora americana*, field 0.94 mm wide, 21-B-4; (e) *Calyptotheca impar*, field 0.89 mm wide, 21-A-3; (f) *Trypostega venusta*, field 0.86 mm wide, 15-A-2; (g) *Cleidochasma porcellanum*, field 0.78 mm wide, 21-A-8; (h) *Antropora ovata*, field 0.79 mm wide, 25-A-22; (i) *Parasmittina alanbanneri*, field 0.88 mm wide, 20-B-12.

limestone cap atop Enewetak's volcanic pedestal yielded fossil remnants of encrusting cheilostomes (*Escharoides?* sp. and possibly *Cosciniopsis* aff. *coelatus*), a tuft-like cheilostome (*Nellia* aff. *oculata*), an unidentified reteporid cheilostome, and a tubuliporine cyclostome (*Diastopora?* sp.) (Brown, 1964).

BIOGEOGRAPHIC IMPLICATIONS

These bryozoan records from Enewetak (Table 1) extend the published ranges of all the species onto that atoll and probably also into the Marshall Islands and Micronesia overall. [A small Enewetak collection years ago was not published (D. Soule and J. Soule, 1971, personal communication)]. Most of the Enewetak species have been recorded previously from elsewhere in the Indian Ocean or western Pacific; therefore, this atoll's bryozoans do appear typically Indo-Pacific.

Several of the Enewetak species range more widely than Indo-Pacific. A few are even circumtropical or nearly cosmopolitan, most noticeably *Aetea truncata, Cleidochasma porcellanum, Crepidacantha poissonii, Cribrilaria radiata, Crisia elongata, Escharina pesanseris, Fenestrulina malusii, Hippopodina feegeensis, Savignyella lafontii*, and *Trypostega venusta*.

Two Enewetak forms, *Rhynchozoon solidum* and *Thalamoporella distorta*, represent substantial range extensions from the Caribbean region. Moreover, three others, *Cribrilaria calamorpha, C. simulator*, and *Rhynchozoon curtum*, were previously known only as lower and mid-Tertiary fossils from lands near the Gulf of Mexico.

It is interesting to compare the Enewetak fauna with other reefal bryozoans investigated by similar methods. Several species (25), more than a quarter of the Enewetak fauna, also occur on Caribbean or western Atlantic reefs. If genera are considered, even more (34), about half the fauna, are common to Enewetak and the Bermuda–Bahamas reefs (Fonda and Cuffey, 1976; Cuffey and Fonda, 1977, 1979).

Bryozoan endemism is difficult to establish with any confidence at present because so few reef sites have been studied comprehensively for these animals. However, it is noteworthy that among the 62 encrusting cheilostome species identified from Enewetak (Table 1; Cox, 1983), six are new to science. These six species may be narrowly endemic to Enewetak or instead may be more widely distributed in the surrounding region (and were discovered here simply because this atoll was the first investigated bryozoologically). Comparable reefal-bryozoan surveys on several other atolls will be required before any degrees of endemism can be determined.

ECOLOGIC DISTRIBUTIONS

Like other Pacific atolls, Enewetak exhibits distinct ecozones developed across its prevailing windward–leeward gradient (northeast–southwest, respectively; Cuffey, 1973, pp. 35-40). Recognition of similar zones in fossil reefs is essential for interpreting those deposits; hence, ecozonal distributions of species in modern reefs like Enewetak Atoll are of the greatest interest for comparative paleoecologic studies.

Unlike certain Caribbean coral species, the Enewetak bryozoans do not fall into sharply defined, ecozonally restricted assemblages. Instead, the conspicuous species (Figs. 1 and 2) characterize somewhat different parts of the atoll in a more generalized fashion. Consequently, it is sufficient here to contrast oceanward reefs with lagoonal, and deep reefs (10 to 40 m or 30 to 135 ft), shallow reefs (0 to 10 m or 0 to 30 ft), and reef flats (intertidal). The oceanward reefs that were examined for bryozoans are nearly vertical coral-rock cliffs on the leeward side of the atoll and sloping coral pavements on its windward side. The lagoonal reefs, all surrounded by barren sand bottoms, range from low coral knolls to platform-like patch reefs to tall steep-sided pinnacles. The rarer Enewetak bryozoan species are sparsely scattered in a few ecozones but are without immediately obvious patterns (clearly a subject for further research).

Overall, bryozoan colonies appear most abundant on the deeper Enewetak reefs (below 10 m or 30 ft) and on the leeward-oceanward, and lagoonal reefs.

Cranosina coronata, recognized by its large open opesia and crenulated mural rims (Fig. 1a), forms by far the greatest number of colonies, particularly large ones, in our collections. It thus appears as the most conspicuous Enewetak bryozoan species, occurring almost ubiquitously on deep and shallow oceanward (leeward and windward) and lagoonal reefs, and locally also on the windward reef flat. *Arachnopusia spathulata*, much less numerous though still common, exhibits the same distribution; it has a calcareous frontal perforated by large pores (Fig. 2a). Similarly distributed, except for not inhabiting reef flats, are the next most important Enewetak bryozoans in terms of colony numbers, *Cosciniopsis* n. sp. *("enewetakensis")* with large peristomes and granulate frontals (Fig. 1b) and *Chorizopora ventricosa* with transversely striate frontals (Fig. 1c).

Two species each encrust substantially larger total substrate areas than any others and therefore appear especially conspicuous in the Enewetak fauna. *Thalamoporella expansa*, distinguished by opesiules and opesium-flank swellings (Fig. 1d), is abundant on the deep oceanward and lagoonal reefs. *Reptadeonella joloensis*, with coarse areolar pores, conspicuous peristomes, and violet-stained frontals (Fig. 1e), is especially abundant on deep and shallow lagoonal reefs but is also found on leeward oceanward reefs.

Two common species are restricted to lagoonal reefs, *Hippopodina feegeensis* (convex granulate frontals, nearly circular apertures, Fig. 2b) on shallow reefs, and *Rhynchozoon curtum* (large areolar pores, slit-like apertural sinus, Fig. 2c) on deep reefs.

Four species—*Smittipora americana* (opesiular notches, Fig. 2d), *Calyptotheca impar* (raised interzooecial threads, Fig. 2e), *Trypostega venusta* (zooeciules and minute frontal pores, Fig. 2f), *Cleidochasma porcellanum* (keyhole-shaped apertures, Fig. 2g)—are common on deep and shallow oceanward (leeward and windward) and lagoonal reefs. Comparably distributed, except not on windward oceanward reefs, are *Antropora ovata* (many tiny avicularia, Fig. 2h) and *Parasmittina alanbanneri* (long curved avicularia, Fig. 2i).

Bryozoan roles in reef construction are as important to the paleoecologist as ecozonal distributions (Cuffey, 1977). The Enewetak bryozoans are all cryptic or coelobitic, functioning mostly as hidden encrusters under coral fronds, coral-rock ledges, detached rubble, and occasional shells. A few are locally cavity dwellers, but none were observed to be cavity fillers, frame builders, or sediment producers. The Enewetak bryozoans thus are more restricted in constructional roles than certain cavity-filling and rock-building Bahamian relatives (Storr, 1964; Cuffey, Gebelein, Fonda, Bliefnick, Kosich, and Soroka, 1977; Cuffey and Fonda, 1979).

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Chapter 11

Sipunculans and Echiurans of Enewetak Atoll

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SIPUNCULA

In 1950, a new sipunculan species, *Siphonosoma eniwetoki*, was described by Fisher from an intertidal lagoon area off Boken Islet. Studies on the bioerosion of coral and coral rubble by Highsmith (1981) revealed six identified aspidosiphonid sipunculans from Enewetak (reduced to five herein). These sipunculans were considered to be "responsible for more excavations in rubble than in any of the coral species studied" (p. 360). The high proportion of both sipunculans and polychaetes in rubble, compared to those living in coral, was attributed to their feeding on detritus and algae from the rubble surfaces.

In another study, examination of deeper parts of the lagoon in September 1980 by the author and Patrick Colin revealed additional sipunculans which were determined by S. J. Edmonds (South Australian Museum). An airlift was used to collect the fauna from soft lagoonal sediment and loose coral rock. *Sipunculus indicus*, an undetermined juvenile *Sipunculus* (not *S. indicus*), and *Siphonosoma (Damosiphon) cumanense* were recovered at depths between 9 and 21 m. At 15 m under coral rock in the lagoon, a specimen considered to be *Paraspidosiphon johnstoni* was also collected. In July 1981 a specimen of *Phascolosoma nigrescens* was recovered from hard substratum off the wall of a lagoonal crater (Mike) made by a nuclear detonation. Presently, at least 10 identified species of sipunculans are considered to occur at Enewetak. A checklist is shown in Table 1. Additional species have been found in a recent (1982) examination of bioturbation-causing organisms in the lagoon sediments (Suchanek and Colin, 1986).

Stephen and Edmonds (1972) record at least five additional sipunculans from the Marshall Islands: *Siphonosoma vastum*, *Aspidosiphon spinalis*, *Paraspidosiphon steenstrupii*, and *Lithacrosiphon cristatus* all from Jaluit Atoll. The last three species are reported in Ikeda (1924). Fischer (1928) described *Siphonosoma parvum* from the Marshall Islands without further locality. Geographic range of sipunculans is shown in Table 2.

TABLE 1

Checklist of Enewetak Sipuncula and Echiura

Phylum SIPUNCULA
- Family SIPUNCULIDAE
  - **Siphonosoma (Damosiphon) cumanense* (Keferstein, 1867).
  - **Siphonosoma (Siphonosoma) rotumanum* (Shipley, 1898) as
    - **Siphonosoma (Siphonosoma) eniwetoki* Fisher, 1950; Fisher, 1950; Stephen and Edmonds, 1972.
  - **Sipunculus indicus* Peters, 1850.
- Family ASPIDOSIPHONIDAE
  - *Aspidosiphon muelleri* Diesing, 1851: Highsmith, 1981.
  - *Cloeosiphon aspergillus* (Quatrefages, 1865): Highsmith, 1981.
  - *Lithacrosiphon cristatus* (Sluiter, 1902).
    - *Lithacrosiphon gurjanovae* Murina, 1967: Highsmith, 1981.
    - *Lithacrosiphon odhneri* Fischer, 1922: Highsmith, 1981.
    - *Lithacrosiphon* (?) *uniscutatus* (Ikeda, 1904): Highsmith, 1981.
    - *Paraspidosiphon gigas* (Sluiter, 1884): Highsmith, 1981.
  - **Paraspidosiphon johnstoni* Edmonds, 1980.
- Family PHASCOLOSOMATIDAE
  - **Phascolosoma (Phascolosoma) nigrescens* Keferstein, 1865.

Phylum ECHIURA
- Order ECHIUROINEA
  - Family BONELLIIDAE
    - **Achaetobonellia maculata* Fisher, 1953.
  - *Family ECHIURIDAE
    - *Anelassorhynchus*? sp.

*New Enewetak record.

ECHIURA

Echiurans are previously unrecorded from Enewetak or the other Marshall Islands. However, the bifurcate-tipped proboscis (sometimes up to a meter in length) of a bonellid echiuran has been observed in the shallower waters of Enewetak Lagoon extending from beneath attached coral reef outcrops. Two specimens which appear to be of the

TABLE 2

Identified Enewetak Sipunculans Recorded and Their Geographic Range*

Siphonosoma (D.) cumanense	Pan-tropical
Siphonosoma (S.) rotumanum	Marshall Islands (Enewetak)
Sipunculus inducus	East African coast to Caroline Islands
Aspidosiphon muelleri	Atlantic boreal; W. Indian Ocean; Japan
Cloeosiphon aspergillus	Indo-West Pacific
Lithacrosiphon cristatus	Indonesia, tropical Pacific and Caribbean, Japan, Australia
Phascolosoma (P.) nigrescens	Pan-tropical

*Based on Stephen and Edmonds, 1972; Edmonds, 1980.

same form were collected at Kawajalein Atoll in 1982 by Scott Johnson. S. J. Edmonds has identified these as *Achaetobonellia maculata* Fisher, previously recorded from Onotaa in the Gilbert Islands. Also a complete specimen member of the family Echiuridae was collected in the intertidal area of a shallow channel beneath rocks. The latter is tentatively determined as a member of the genus *Anelassorhynchus*. Additional material is required before a final determination is possible (S. J. Edmonds, personal communication).

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Chapter 12

Platyhelminthes, Nemertea, and Nematoda of Enewetak Atoll

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INTRODUCTION

Except for some reports on parasitic nematodes and platyhelminthes in oysters, fish, and porpoises, little has been written about the platyhelminthes, nemertina, and nematoda of Enewetak Atoll. Little has been done on free-living nemertines or nematodes, although both groups must be abundant. The checklist in Table 1 gives the taxonomics of these species.

TABLE 1

Checklist of Platyhelminthes, Nemertea, and Nematoda of Enewetak Atoll

Phylum PLATYHELMINTHES
  Class CESTODA
    Subclass EUCESTODA
      Order TETRAPHYLLIDEA
        Family PHYLLOBOTHRIIDAE
          Anthobothrium sp.: Alexander, 1971.
          Crossobothrium spp. (8): Alexander, 1971.
        Family ONCHOBOTHRIIDAE
          Platybothrium spp. (3): Alexander, 1971.
          Phoreibothrium spp. (2): Alexander, 1971.
      Order TRYPANORHYNCHIDEA
          (8 undetermined spp.): Alexander, 1971.
      Order LECANICEPHALIDEA
        Family DISCOCEPHALIDAE
          Disculiceps spp. (2): Alexander, 1971.
        Family CEPHALOBOTHRIIDAE
          Tylocephalum sp.: Rifkin, 1970.
  Class TREMETODA
    Order DIGENEA
      Suborder PROSTOMATA
        Family FELLODISTOMIDAE
          Paradiscogaster eniwetokensis Martin

TABLE 1 (cont'd)

  Class TURBELLARIA
    Order POLYCLADIDA
      Suborder ACOTYLEA
        Family LEPTOPLANIDAE
          Stylochoplana (?) *minuta* Hyman: Hyman, 1959.
        Family PLANOCERIDAE
          Paraplanocera fritillata Hyman: Hyman, 1959.
      Suborder COTYLEA
        Family PROSTHIOSTOMIDAE
          Prosthiostomum exiguum Hyman: Hyman, 1959.
          Prosthiostomum griseum Hyman: Hyman, 1959.
    Order RHABDOCOELA
          Undetermined fresh water form: Maguire, 1967.

Phylum NEMERTEA
  Class ANOPLA
    Order HETERONEMERTEA
          Baseodiscus delineatus (Delle Chiaje): Coe, 1947.

Phylum NEMATODA
  Class SECERNENTEA (PHASMIDA)
    Order SPIRURIDA
      Family SPIRURIDAE
          Protospirura muricola: Jackson and Bastian, 1975.

PLATYHELMINTHES (Tapeworms, Flukes, Flatworms)

Bivalve mollusks were examined for the presence of lecanicephalid cestode larvae at Enewetak in June 1969. Of 12 bivalve species examined, only an oyster *(Margaritifera vulgaris)* was found infected with an undetermined species of *Tylocephalum* together with another large larval cestode (Rifkin, 1970). Sharks are the definitive hosts of *Tylocephalum,* and at least four shark species at Enewetak were the reported hosts for over 20 other cestodes (Alexander, 1971). Specimens of another cestode were recovered from the feces of a large ray collected in the Enewetak lagoon during July 1981.

A collection of worm parasites from fishes, fish-eating birds, and mammals was made in 1957 at Mid-Pacific

Research Laboratory (MPRL) (Martin, 1957). As a result, one new species of trematode (fluke) was described from specimens of a butterfly fish (Martin and Hammerich, 1970).

Four new species of turbellarian polyclad flatworms were reported by Hyman (1959) from Enewetak as a result of collections made by D. I. Reish in the summer of 1956 from reef flat rocks and algal thalli. An undetermined rhabdocoel was collected from a shell and coconut containing fresh water found on the ground during the summer of 1963 (Maguire, 1967).

NEMERTEA (Ribbon Worms)

Three species of benthic nemertine worms found at Bikini and Enewetak in 1946 included only one—*Baseodiscus delineatus*, 30 cm long, 4 to 5 mm wide—from Enewetak (Coe, 1947). This specimen was collected in shallow water on the lagoon side of Bogon, (Boken) Islet. Subsequently, it was noted that nemerteans made up 25% of the meiobenthos from interstitial sands examined at Enewetak. Two undetermined nemerteans, collected on the reef flat beachrock near the quarry on Enewetak islet, have been deposited in the MPRL reference collection.

NEMATODA (Roundworms)

The distribution and biological relations of a stomach nematode, *Protospirura muricola*, found in rats and house mice at Enewetak were reported by Jackson and Bastian (1975). Undetermined nematodes have been recovered from the gut of a porpoise and from the feces of a large ray collected at Enewetak. No study has yet been made on the free-living nematodes from the atoll's marine or terrestrial environment.

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Chapter 13

Polychaetes of Enewetak Atoll

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POLYCHAETA

The first record of polychaetes from Enewetak is based on collections made during Operation Crossroads between 1946 and 1952 (Hartman, 1954). Earlier reports on polychaetes from the Marshall Islands (Chamberlin, 1919; Gustafson, 1930) did not refer directly to Enewetak as a collection locality. Just over 70 polychaete species (20 of which could not be specifically determined) were identified by Hartman (1954). Most of the polychaetes were collected in shallow reef flat areas on lagoon and seaward sides of windward and leeward islands. Specimens from these collections have been deposited in the U. S. National Museum of Natural History (USNM) and Allan Hancock Foundation. Hartman suggested that many of the polychaetes had an erosive effect on the reefs because they are known to bore into coral rock. Most of the identified species are represented in other parts of the Indo-West Pacific, and three new species, *Dodecaceria laddi*, *Leaena minuta*, and *Sphaerodorum pacificum*, were described from Enewetak (Hartman, 1954). Table 1 provides a checklist of polychaetes of Enewetak Atoll.

Due to the importance of polychaetes as bioeroders, food for fishes and invertebrates, and components of the coral reef biota, Mid-Pacific Research Laboratory contracted for further collections to be made between 1956 and 1957. As a result, a series of identified species was deposited in the reference collection at Enewetak and the USNM, and three publications added 10 new species to the atoll polychaete fauna (Reish, 1961, 1968; Woodwick, 1964). Of the 29 newly recorded species from Enewetak, 13 were cosmopolitan, eight were range extensions from the Indian Ocean and Red Sea, and five were from nontropical areas (Reish, 1968). This latter reference is valuable in enumerating and in giving keys to species within 29 families of polychaetes known from the Marshall Islands at that time.

Two ectocommensal polychaetes have been recorded as symbionts from echinoderms at Enewetak. Hartman (1954) reported *Gastrolepidia clavigera* associated with the sea cucumbers *Stichopus horrens* at Bikini, Enewetak, and Rongelap and with *Holothuria gyrifer* at Enewetak. Two additional holothuroids (*Actinopyga mauritiana* and *Holothuria atra*) were recorded as hosts for this polynoid by Reish (1968). Devaney (1967) noted *Hololepidella nigropunctata* as a symbiont with the brittle-star *Ophiocoma anaglyptica* at Enewetak. Straughan (1969) made the first identifications of spirorbid tube worms from Enewetak. Two species were recognized. One, erroneously described as a new species, is the sinistrally coiled species *Vinearia koehleri* [as *Spirorbis (Pileolaria) polyoperculatus* Straughan, (1969)]; the other is a dextral species, *Neodexiospira brasiliensis* [as *Spirorbis (Circeis) bellulus* Bush]. Young (1969) recorded a nudibranch that preyed on the above two species and on a serpulid.

Leviten (1976, 1978) recorded polychaetes from the families Eunicidae and Nereididae that served as prey for several conid gastropods on the seaward reef bench at Enewetak Islet and elsewhere in the Indo-West Pacific. Kohn (1981), in his continuing ecological studies on *Conus*, reported representatives of eight polychaete families that are prey for several of these gastropods. Some of the identified polychaetes are apparently the first records of these species from Enewetak where they occurred mainly in the sandy lagoon among algae (*Halimeda* spp.).

An understanding of the habitat preferences and diversity of reef flat polychaetes along the seaward side of Enewetak Islet was greatly enhanced through a study conducted in 1976 and 1978 under laboratory support by Bailey-Brock et al. (1980). As a result of this work, it was determined that 44 polychaete taxa included 18 identified species that were new Enewetak records, with representatives of two additional families (Paraonidae and Scalibregmidae). Over 20 of the 31 syllids had been previously unrecorded, but 12 have yet to be assigned specific names.

Polychaetes representing 26 families were abundant infaunal components associated with selected Enewetak corals and coral rubble (Highsmith, 1981). The polychaetes were the most common invertebrates found in the coral heads, with over 80% of all individuals represented

TABLE 1

Checklist of Polychaetes of Enewetak Atoll*

- ANNELIDA
  - Class POLYCHAETA
    - Family POLYNOIDAE
      - *Gastrolepidia clavigera* Schmarda, 1861: Hartman, 1954.
        - *Gastrolepidia claverigera* [sic] Schmarda: Reish, 1968.
      - *Harmothoe (?) imbricata* (Linnaeus, 1767): Hartman, 1954; Reish, 1968.
      - *Hololepidella nigropunctata* (Horst, 1915): Devaney, 1967.
      - *Iphione muricata* Savigny, 1818: Reish, 1968.
      - *Paralepidonotus ampulliferus* (Grube, 1878).
        - *Paralepidonotus ampullifera* Hartman, 1954; Reish, 1968.
    - Family PALMYRIDAE
      - *Palmyra aurifera* Savigny, 1818: Hartman, 1954; Reish, 1968.
    - Family CHRYSOPETALIDAE
      - *Bhawania goodei* Webster, 1884: Reish, 1968.
        - *Bhawania cryptocephala* Gravier, 1901: Hartman, 1954.
      - *Chrysopetalum ehlersi* Gravier, 1902: Hartman, 1954; Reish, 1968.
      - *Palaeonotus debilis* (Grube, 1855).
        - *Palaeonotus debilis* [sic]: Bailey-Brock et al., 1980.
    - Family AMPHINOMIDAE
      - *Eurythoe complanata* (Pallas, 1766): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
        - *Eurythoe pacifica* Kinberg, 1857: Pomeroy and Kuenzler, 1967.
      - *Pseudeurythoe oculifera* (Augener, 1913): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
    - Family EUPHROSINIDAE
      - *Euphrosine myrtosa* Savigny, 1818: Hartman, 1954; Reish, 1968.
    - Family PHYLLODOCIDAE
      - *Anaitides madeirensis* (Langerhans, 1880): Hartman, 1954; Reish, 1968.
      - *Eulalia viridis* (Linnaeus, 1767): Bailey-Brock et al., 1980.
        - *Eulalia tenax* Grube, 1878: Hartman, 1954; Reish, 1968.
      - *Eumida sanguinea* (Oersted, 1843): Reish, 1968.
      - *Genetyllis gracilis* (Kinberg, 1866): Hartman, 1954; Reish, 1968.
      - *Phyllodoce marquesensis* ? Monro, 1939: Hartman, 1954; Reish, 1968.
      - *Phyllodoce pruvoti* Fauvel, 1930: Hartman, 1954; Reish, 1968.
    - Family HESIONIDAE
      - *Hesione genetta* Grube, 1866: Hartman, 1954; Reish, 1968.
      - *Leocrates chinensis* Kinberg, 1866: Hartman, 1954; Reish, 1968.
      - *Podarke augustifrons* (Grube, 1878): Reish, 1968.
        - *Irma? augustifrons* Hartman, 1954.
    - Family PILARGIDAE
      - *Synelmis albini* (Langerhans, 1881) in Pettibone, 1966.
        - *Ancistrosyllis rigida* Fauvel, 1919: Hartman, 1954; Reish, 1968.
    - Family SYLLIDAE
      - Subfamily SYLLINAE
        - *Langerhansia cornuta* (Rathke, 1843).
          - *Ehlersia cornuta*: Bailey-Brock et al., 1980.
        - *Langerhansia* sp. A: Bailey-Brock et al., 1980.
        - *Langerhansia* sp. B: Bailey-Brock et al., 1980.
        - *Haplosyllis aberrans* (Fauvel, 1939): Hartman, 1954; Reish, 1968.
        - *Haplosyllis spongicola* (Grube, 1855): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
        - *Opisthosyllis australis* Augener, 1913: Bailey-Brock et al., 1980.
          - *Opistosyllis* [sic] *australis* Reish, 1968.
        - *Opisthosyllis brunnea* Langerhans, 1879: Bailey-Brock et al., 1980.
          - *Opistosyllis* [sic] *brunnea* Reish, 1968.
        - *Opisthosyllis corallicola* (Hartmann-Schröder, 1965): Bailey-Brock et al., 1980.
        - *Opithosyllis longicirrata* Monro, 1939.
          - *Opistosyllis* [sic] *longicirrata*: Reish, 1968.
        - *Syllis gracilis* Grube, 1840: Hartman, 1954; Reish, 1968.

*The authors and dates for species have been checked using Hartman (1959) and Day (1967). References following the colon are Enewetak records.

(This table continued on next page.)

TABLE 1 (cont'd)

Family SYLLIDAE (cont'd)
- *Trypanosyllis zebra* (Grube, 1860): Hartman, 1954; Reish, 1968.
- *Branchiosyllis exilis* (Gravier, 1900) in Westheide, 1974.
  - *Typosyllis* (?) *exilis*: Bailey-Brock et al., 1980.
- *Typosyllis alternata* (Moore, 1908): Bailey-Brock et al., 1980.
- *Typosyllis armillaris* (Müller, 1771): Reish, 1968; Bailey-Brock et al., 1980.
- *Typosyllis bouvieri* (Gravier, 1900): Bailey-Brock et al., 1980.
- *Typosyllis brachychaeta* (Schmarda, 1861): Hartman, 1954; Reish, 1968.
- *Typosyllis cirropunctata* (Michel, 1909): Reish, 1968.
- *Typosyllis closterobranchia* (Schmarda, 1861): MPRL Collection.
- *Typosyllis hyalina* (Grube, 1863): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
- *Typosyllis prolifera* (Krohn, 1852): Reish, 1968; Bailey-Brock et al., 1980.
- *Typosyllis taprobanensis* (?) Willey, 1905: Bailey-Brock et al., 1980.
- *Typosyllis variegata* (Grube, 1860): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
- *Typosyllis* sp. A: Bailey-Brock et al., 1980.
- *Typosyllis* sp. B: Bailey-Brock et al., 1980.
- *Typosyllis* sp. C: Bailey-Brock et al., 1980.
- *Typosyllis* sp. D: Bailey-Brock et al., 1980.

Subfamily EUSYLLINAE
- *Odontosyllis hyalina* Grube, 1878: Reish, 1968.

Subfamily EXOGONINAE
- *Brania rhopalophora* (Ehlers, 1897): Bailey-Brock et al., 1980.
- *Brania* sp. A: Bailey-Brock et al., 1980.
- *Brania* sp. B: Bailey-Brock et al., 1980.
- *Exogone verugera* Claparède, 1868: Reish, 1968; Bailey-Brock et al., 1980.
- *Exogone* sp. A: Bailey-Brock et al., 1980.
- *Parasphaerosyllis indica* Monro, 1937: Hartman, 1954; Reish, 1968.
- *Sphaerosyllis ovigera* Langerhans, 1879: Bailey-Brock et al., 1980.
- *Sphaerosyllis pirifera* Claparède, 1868: Reish, 1968.
- *Sphaerosyllis sublaevis* Ehlers, 1913: Bailey-Brock et al., 1980.
- *Sphaerosyllis* sp.: Hartman, 1954.
- *Sphaerosyllis* sp. A: Bailey-Brock et al., 1980.

Subfamily AUTOLYTINAE
- *Autolytus* sp.: Bailey-Brock et al., 1980.

Subfamily EURYSYLLINAE
- *Eurysyllis pacificus* (Hartman, 1954): Hartman, 1965.
- *Sphaerodorum pacificum* Hartman, 1954; Reish, 1965.

Undetermined SYLLIDAE
- Undet. sp. A: Bailey-Brock et al., 1980.
- Undet. sp. Y: Bailey-Brock et al., 1980.

Family NEREIDIDAE
- *Websterinereis foli* (Fauvel, 1930): Pettibone, 1971.
  - *Ceratocephala corallicola* Reish, 1968: Reish, 1968.
- *Ceratonereis tentaculata* Kinberg, 1866; Perkins, 1980.
  - *Ceratonereis mirabilis* Kinberg, 1866; Hartman, 1954; Reish, 1968; Leviten, 1976, 1978; Bailey-Brock et al., 1980; Kohn, 1981.
- *Micronereis eniwetokensis* Reish, 1961; Reish, 1961, 1968; Bailey-Brock et al., 1980; Paxton, 1983.
- *Neanthes acuminata* (Ehlers, 1868).
  - *Neanthes arenaceodentata* (Moore, 1903): Reish, 1968.
- *Neanthes dawydovi* (Fauvel, 1937): Hartman, 1954; Reish, 1968.
- *Nereis persica* Fauvel, 1911.
  - *Nereis zonata persica* Fauvel, 1911: Reish, 1968.
- *Nereis zonata perisca* [sic] Bailey-Brock et al., 1980.
- *Nereis* sp. A: Bailey-Brock et al., 1980.
- *Nereis* (?) sp.: Bailey-Brock et al., 1980.
- *Perinereis cultrifera* (Grube, 1840).
  - *Perinereis cultifera* [sic] Grube: Reish, 1968.
- *Perinereis helleri* (Grube, 1878): Reish, 1968.
- *Perinereis nigropunctata* (Horst, 1889): Reish, 1968.

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TABLE 1 (cont'd)

- Family NEREIDIDAE (cont'd)
  - *Platynereis dumerilii* (Audouin and Milne Edwards, 1833): Kohn, 1981.
  - *Platynereis polyscalma* Chamberlin, 1919: Reish, 1968.
  - *Platynereis pulchella* Gravier, 1901: Reish, 1968; Bailey-Brock et al., 1980.
  - *Pseudonereis anomala* Gravier, 1901: Hartman, 1954; Reish, 1968.
  - *Pseudonereis variegata* (Grube, 1857): Bailey-Brock et al., 1980.
    - *Pseudonereis gallapagensis* Kinberg, 1866: Hartman, 1954; Reish, 1968.
- Family NEPHTYIDAE
  - *Micronephtys sphaerocirrata* (Wesenberg-Lund, 1949): Reish, 1968.
- Family SPHAERODORIDAE
  - *Sphaerodoridium capense* (Day, 1963).
    - *Sphaerodoropsis capense* Day: Bailey-Brock et al., 1980.
- Family GLYCERIDAE
  - *Glycera tesselata* Grube, 1863: Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980; Kohn, 1981.
  - *Glycera* sp.: Hartman, 1954.
- Family EUNICIDAE
  - *Eunice afra* Peters, 1854: Hartman, 1954; Reish, 1968; Leviten, 1976, 1978; Bailey-Brock et al., 1980; Highsmith, 1981.
  - *Eunice antennata* (Savigny, 1820): Hartman, 1954; Reish 1968; Highsmith, 1981.
  - *Eunice australis* Quatrefages, 1865: Reish, 1968; Highsmith, 1981.
  - *Eunice (Nicidion) gracilis* Crossland, 1904: Reish, 1968.
  - *Eunice vittata* (Delle Chiaje, 1828): Kohn, 1981; Highsmith, 1981.
  - *Lysidice ninetta* Audouin and Milne Edwards, 1833.
    - *Lysidice collaris* Grube, 1868: Hartman, 1954; Reish, 1968; Leviten, 1976, 1978; Bailey-Brock et al., 1980; Highsmith, 1981.
  - *Nematonereis unicornis* (Grube, 1840): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980; Highsmith, 1981.
  - *Palola siciliensis* (Grube, 1840): Hartman, 1954; Reish, 1968; Leviten, 1976, 1978; Bailey-Brock et al., 1980; Kohn, 1981.
    - *Eunice siciliensis* Grube: Highsmith, 1981.
  - *Paramarphysa orientalis* Willey, 1905: Hartman, 1954; Reish, 1968.
- Family LUMBRINERIDAE
  - *Lumbrineris latreilli* Audouin and Milne Edwards, 1834: Bailey-Brock et al., 1980.
  - *Lumbrineris sphaerocephala* (Schmarda, 1861): Hartman, 1954; Reish, 1968.
- Family ARABELLIDAE
  - *Arabella iricolor* (Montagu, 1804): Hartman, 1954; Reish, 1968.
  - *Arabella mutans* (Chamberlin, 1919): Hartman, 1954; Reish, 1968; Kohn, 1981.
  - *Drilonereis* sp. cf. *D. major* Crossland, 1924: MPRL Collection.
- Family LYSARETIDAE
  - *Oenone fulgida* Savigny, 1818: Bailey-Brock et al., 1980; Highsmith, 1981.
    - *Aglaurides fulgida* (Savigny): Hartman, 1954; Reish, 1968.
- Family DORVILLEIDAE
  - *Dorvillea pseudorubrovittata* Berkeley, 1927: Highsmith, 1981.
  - *Dorvillea similis* Crossland, 1924: Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
  - *Papilliodorvillea gardineri* (Crossland, 1924): Reish, 1968.
    - *Dorvillea gardineri* (Crossland): Hartman, 1954; Highsmith, 1981.
- Family ORBINIIDAE
  - *Naineris* sp.: Hartman, 1954; Reish, 1968.
  - *Scoloplos* sp.: Bailey-Brock et al., 1980.
- Family PARAONIDAE
  - *Levinsenia gracilis* (Tauber, 1879); Hartley, 1981.
    - *Paraonis gracilis*: Bailey-Brock et al., 1980.
- Family SPIONIDAE
  - *Laonice cirrata* (?) (Sars, 1851): Hartman, 1954.
  - *Malacoceros (Malacoceros) indicus* (Fauvel, 1928): Reish, 1968.
  - †*Microspio microcera* (Dorsey, 1977): Bailey-Brock et al., 1980.
  - *Polydora armata* Langerhans, 1880: Woodwick, 1964; Reish, 1968; Bailey-Brock et al., 1980.
    - *Polydora* cf. *P. armata* Langerhans: Hartman, 1954.
  - *Polydora tridenticulata* Woodwick, 1964: Woodwick, 1964; Reish, 1968.

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[*] The authors and dates for species have been checked using Hartman (1959) and Day (1967). References following the colon are Enewetak records.

†Needs re-confirmation, possibly referrable to *Microspio granulata* Blake and Kudenov, 1978 (Linda Ward, personal communication).

(This table continued on next page.)

TABLE 1 (cont'd)

Family SPIONIDAE (cont'd)
Minuspio cirrifera (Wirén, 1883); Foster, 1971.
Prionospio cirrifera Wirén, 1883: Reish, 1968.
Pseudopolydora antennata (Claparède, 1870): Woodwick, 1964; Reish, 1968; Bailey-Brock et al., 1980.
Pseudopolydora corallicola Woodwick, 1964: Woodwick, 1964; Reish, 1968.
Pseudopolydora pigmentata Woodwick, 1964: Woodwick, 1964; Reish, 1968.
Caraziella reishi (Woodwick, 1964): Blake, 1979.
Pseudopolydora reishi: Woodwick, 1964; Reish, 1968; Bailey-Brock et al., 1980.
Scolelepis (Scolelepis) bonnieri (Mesnil, 1896): Reish, 1968.
Spio sp.: Hartman, 1954.
Tripolydora spinosa Woodwick, 1964: Woodwick, 1964; Reish, 1968; Blake and Woodwick, 1981.
Family CHAETOPTERIDAE
Chaetopterus sp.: Reish, 1968.
Mesochaetopterus sagittarius (Claparède, 1870): Bailey-Brock et al., 1980.
Mesochaetopterus minutus Potts, 1914: Hartman, 1954; Reish, 1968; Kohn, 1981.
Phyllochaetopterus ramosus Willey, 1905: Reish, 1968.
Phyllochaetopterus racemosus: Bailey-Brock et al., 1980.
Phyllochaetopterus socialis Claparède, 1870: Reish, 1968.
Phyllochaetopterus pictus Crossland, 1903: Hartman, 1954.
Phyllochaetopterus sp. cf. *P. arabicus* Grube, 1870: Kohn, 1981.
Family SCALIBREGMIDAE
Hyboscolex longiseta Schmarda, 1861: Bailey-Brock et al., 1980.
Family MAGELONIDAE
Magelona sp.: Reish, 1968.
Family CIRRATULIDAE
Cirratulus sp.: Hartman, 1954; Reish, 1968.
Cirriformia punctata (Grube, 1859): Kohn, 1981.
Cirriformia semicincta (Ehlers, 1905): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
Dodecaceria laddi Hartman, 1954: Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
Family CTENODRILIDAE
Ctenodrilus serratus (Schmidt, 1857): Reish, 1968.
Family OPHELIIDAE
Armandia intermedia Fauvel, 1901.
Armandia lanceolata Willey, 1905: Reish, 1968.
Polyophthalmus pictus (Dujardin, 1839): Hartman, 1954; Reish, 1968; Bailey-Brock et al., 1980.
Family CAPITELLIDAE
Capitella capitata (Fabricius, 1780): Reish, 1968; Bailey-Brock et al., 1980.
Dasybranchus caducus (Grube, 1846): Hartman, 1954; Reish, 1968; Kohn, 1981.
Dasybranchus lumbricoides Grube, 1878: Hartman, 1954; Reish, 1968.
Dasybranchus sp.: Bailey-Brock et al., 1980.
Decamastus sp.: Bailey-Brock et al., 1980.
Heteromastides bifidus Augener, 1914: Reish, 1968; Bailey-Brock et al., 1980.
Leiochrides sp.: Bailey-Brock et al., 1980.
Notomastus latericeus Sars, 1851: Bailey-Brock et al., 1980.
Pulliella sp.: Bailey-Brock et al., 1980.
capitellid sp.: Bailey-Brock et al., 1980.
Family ARENICOLIDAE
Branchiomaldane vincentii Langerhans, 1881: Hartman, 1954; Reish, 1968.
Family MALDANIDAE
Axiothella australis Augener, 1914: Reish, 1968.
Euclymene sp.
maldanid sp.: Bailey-Brock et al., 1980.
Family TEREBELLIDAE
Eupolymnia trigonostoma (Schmarda, 1861).
Eupolymnia trigostoma [sic] (Schmarda): Reish, 1968.
Leaena minuta Hartman, 1954: Hartman, 1954: Hartman, 1954; Bailey-Brock et al., 1980.
Terebella ehrenbergi Grube, 1870: Reish, 1968.
Terebella ehrenbergi (?) Grube: Hartman, 1954.

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TABLE 1 (cont'd)

Family TEREBELLIDAE (cont'd)
- *Thelepus* sp.: Reish, 1968.
- terebellid sp.: Bailey-Brock et al., 1980.

Family SABELLIDAE
- *Euchone eniwetokensis* Reish, 1968: Reish, 1968.
- *Notaulax phaeotaenia* (Schmarda, 1861).
  - *Hypsicomus phaeotaenia* [sic]: Hartman, 1954; Reish, 1968.
- *Megalomma trioculatum* Reish, 1968: Reish, 1968.
- *Sabella notata* Grube, 1878: Hartman, 1954; Reish, 1968.
- sabellid sp.: Bailey-Brock et al., 1980.

Family SERPULIDAE
- *Hydroides albiceps* (Grube, 1870).
  - *Eupomatus albiceps* Grube: Hartman, 1954; Reish, 1968.
- *Pomatostegus stellatus* (Abildgaard, 1789): Bailey-Brock unpubl.
- *Filograna implexa* Berkeley, 1835.
  - *Salmacina dysteri* (Huxley, 1855): Young, 1969.
- *Salmacina incrustans* Claparède, 1870: Reish, 1968.
  - *Salmacina* sp.: Hartman, 1954.
- Serpula hartmanae Reish, 1968: Reish, 1968.
  - Serpula sp.: Hartman, 1954.
- *Spirobranchus giganteus* (Pallas, 1766): Hartman, 1954; Reish, 1968.
- *Vermiliopsis glandigerus* Gravier, 1906: Reish, 1968; Bailey-Brock et al., 1980.
  - *Vermiliopsis* sp.: Hartman, 1954.
- serpulid sp.: Bailey-Brock et al., 1980.

Family SPIRORBIDAE
- *Neodexiospira brasiliensis* (Grube, 1872); Knight-Jones, 1984.
  - *Spirorbis bellulus* Bush [sic]: Young, 1969.
- *Vinearia koehleri* (Caullery and Mesnil, 1897); Knight-Jones, 1984.
  - *Spirorbis (Pileolaria)* n. sp.: Young, 1969.
- spirorbids, dextral: Hartman, Reish, 1968.
- spirorbids, sinistral: Hartman, 1954; Reish, 1968.
- spirorbid sp.: Bailey-Brock et al., 1980.

by this group. Highsmith indicated that most of the polychaetes found in association with the corals were "nestlers" rather than bioeroders (borers). Eunicids and syllids were most numerous among the polychaete families, with the former having a far greater biomass. Polychaetes, together with sipunculans, were found to be the most common invertebrates associated with rubble in Highsmith's study. Six identified eunicids, two dorvilleids, including one new Enewetak record and one lysaretid, were among the species enumerated, together with undetermined members from other families. The family Aphroditidae was recorded for the first time from Enewetak in that paper, but no genera or species was listed. A great deal of work on the annelids of Enewetak remains to be done. This is especially true of the soft bottom in the lagoon where this fauna has yet to be investigated to any extent.

One hundred thirty-two polychaete species have been identified from Enewetak Atoll. Of them, 52 species (40%) are also found in the high Hawaiian Islands (Bailey-Brock and Hartman, 1984) and 43 (33%) are known from the Solomon Islands (Gibbs, 1971). Twenty-seven Enewetak species occur on the shallow coral reefs of Sumatra and Thailand, and 20 are from Easter Island, representing 21 and 15%, respectively (Kohn and Lloyd, 1973a, b). Collections from Heron Island reefs off Australia (Reichelt, 1979) comprised mostly errant polychaetes (Eunicidae and Syllidae) and shared only 10% of the species with Enewetak. All these collections were from similar habitats—hard substrata of shallow coral reefs—except for Reichelt's, which was restricted to the infauna of sand and rubble from underneath small coral boulders. These numbers suggest faunal similarities of Enewetak polychaetes with both the Solomon and Hawaiian Islands. The high number for Hawaii probably reflects more intensive sampling and research there than elsewhere in the tropical Pacific. It is expected that the similarity between Enewetak and west Pacific locations will increase as the polychaetes from those areas become better known.

Among the Enewetak polychaetes, two syllid species (*Haplosyllis spongicola* and *Exogone verugera*) and two eunicids (*Nematonereis unicornis* and *Palola siciliensis*) have been found at the Indian and Pacific Ocean locations mentioned above. Other species with broad Pacific distributions are the amphinomid *Eurythoe complanata*, which occurs also on Guam and Australian reefs (Bailey-Brock, personal observation), *Typosyllis prolifera*, *Ceratonereis tentaculata (C. mirabilis)*, *Lysidice ninetta (L. collaris)*, and *Mesochaetopterus sagittarius (M. minutus)*. These syllids and nereidids are typically associated with algal turf and encrusting sponges. *Lysidice ninetta* and *P. siciliensis* are known to bore in coral, and the tube builder, *M. sagittarius*, forms dense aggregations in sand patches on intertidal reefs and benches. Many species, presently only identified to genus, may eventually further relate the Enewetak polychaete fauna to that occurring on other coral islands in the Pacific.

Little is known about the interstitial annelids at Enewetak. However, nearly 50% of the meiobenthic fauna from sands around the atoll was found to be composed of polychaetes by MacCoy (1967). Further research is necessary to define this fauna systematically.

MYZOSTOMATIDA

At least two, as yet undetermined, myzostomatid species have been found on comatulid crinoids collected at Enewetak (Devaney, personal observation).

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Chapter 14

Mollusca of Enewetak Atoll

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INTRODUCTION

The mollusks of the Marshall Islands were first studied by Demond (1957)* for a summary of the ecology and zoogeography of central Pacific mollusks. Her summary was based on collections made between 1944 and 1957 in the Marshall, Caroline, Gilbert, and Mariana Islands. Although Demond's paper does not specifically cite species from Enewetak, her work was derived in part from study of collections made in 1946 and 1947 at Enewetak by the late J. P. E. Morrison of the National Museum of Natural History during Operation Crossroads and from collections made in 1952 at Enewetak by H. S. Ladd, M. Russell, and R. C. Townsend of the U. S. Geological Survey. These Enewetak collections are deposited in the National Museum of Natural History (USNM), Washington, D. C. Another reference collection of Enewetak mollusks was begun in 1955 when approximately 180 species collected by A. D. Hinckley were determined by Demond (Hiatt, 1956, 1957) and deposited at the Enewetak Marine Biological Laboratory (EMBL). Subsequently, cephalopods collected and identified by S. J. Townsley (Hiatt, 1957) and other mollusks collected by EMBL visitors and by the authors were added to the EMBL collections. A checklist of the Mollusca of Enewetak Atoll is provided in Table 1.

Records of the mollusks of Enewetak are found in a wide range of publications.† Monographic treatments of families and genera which record shells from Enewetak are those on *Assiminea* (Abbott, 1958); Strombidae (Abbott, 1960, 1961; Jung and Abbott, 1967); Vasidae (Abbott,

*Earlier records of the mollusks of the Marshall Islands include those of Escholtz (1826), Hoffman (1928), Hatai (1941), and Dietrich and Morris (1953). None mentions Enewetak.

†Abstracts from the annual EMBL (later known as MPML) reports are cited only if we could not trace subsequent publication.

TABLE 1

Annotated Checklist of Mollusks from Enewetak Atoll*

Phylum MOLLUSCA
  Class GASTROPODA
    Subclass PROSOBRANCHIA
      Order ARCHAEOGASTROPODA
        Family HALIOTIDAE
          Haliotis clathrata Reeve, 1846; Talmadge, 1963: 132; as *H. ruber clathrata* Reeve.
          Haliotis gemma Reeve, 1846; Talmadge, 1963: 136, pl. 14, Fig. 8; as *H. jacnensis* Reeve.
          H. ovina Gmelin, 1791; [Cernohorsky, 1972: 33, pl. 2, Fig. 3].
          H. planata Sowerby, 1833; [Talmadge, 1963: 135, pl. 14, Fig. 2].
          H. varia Linnaeus, 1758; [Cernohorsky, 1972: 34, pl. 2, Fig. 5].

*This checklist represents all of the mollusks presently known from Enewetak, both living and fossil. Specimens of species recorded as living at Enewetak are deposited in the National Museum of Natural History, Washington, D.C., and/or Bernice P. Bishop Museum, Honolulu, Hawaii. The following conventions are used in the checklist: (1) species found living at Enewetak are listed with a citation to a reference figure in square brackets; where species have been previously recorded, the reference is also cited; (2) families are given in approximate phylogenetic sequence, and within each family the genera and species are listed alphabetically.

(This table continued on next page.)

TABLE 1 (cont'd)

Family SCISSURELLIDAE

Scissurella concinna A. Adams, 1862; [Habe, 1951: 5, pl. 11, Figs. 10, 11].
S. coronata Watson, 1886; Ladd, 1966: 26–27, pl. 2, Figs. 7, 8; Holocene.
S. declinans Watson, 1886; Ladd, 1966: 27, pl. 2, Fig. 6; Holocene.
S. equatoria Hedley, 1899; Ladd, 1966: 27, pl. 2, Figs. 9, 10; Holocene.

Family FISSURELLIDAE

Diodora foveolata Garrett, 1872; Fig. 1A.
D. granifera (Pease, 1861); Ladd, 1966: 31–32, pl. 3, Figs. 3, 4; Holocene; [Kay, 1979: Figs. 11E–F].
†*D. marshallensis* Ladd, 1966; Ladd, 1966: 31, pl. 3, Figs. 1, 2; late Miocene.
D. ruppelli (Sowerby, 1834); [Kay, 1979: 42, Figs. 11C–D].
Emarginula bicancellata Montrouzier, 1860; Ladd, 1966: 28, pl. 2, Figs. 11, 12; Holocene.
E. concinna A. Adams, 1852; Figs. 1B, 1C.
†*E.* cf. *E. clypeus* A. Adams, 1851; Ladd, 1966: 28, pl. 2, Figs. 15, 16; Holocene.
E. cf. E. dilecta A. Adams, 1852; Ladd, 1966: 28, pl. 2, Figs. 13, 14; as *Emarginula* sp. cf. *peasei* Thiele, 1915; Holocene.
E. nigromaculata Thiele, 1915; Fig. 1D.
E. souverbiana Pilsbry, 1890; Ladd, 1966: 28, pl. 2; Figs. 17, 18; Holocene.
†*Emarginula* sp. B; Ladd, 1966: 29, pl. 2, Figs. 21, 22; Holocene.
Puncturella sp.
†*Hemitoma bikiniensis* Ladd, 1966; Ladd, 1966: 29, pl. 2, Figs 24, 25; Holocene.
†*H. (Montfortia)* sp. A; Ladd, 1966: 29, pl. 2, Figs. 26, 27; Holocene.
Rimula mariei Crosse, 1866; Ladd, 1966: 30, pl. 2, Figs. 32, 33; as *Rimula* sp.; Miocene?; Holocene.
†*Scutus* sp. A.; Ladd, 1966: 31, pl. 2, Figs. 34, 35; late Miocene.
†*Scutus* sp. B.; Ladd, 1966: 31, pl. 2, Figs. 36, 37; late Miocene.

Family PATELLIDAE

Patella flexuosa (Quoy and Gaimard, 1834); Ladd, 1966: 32, pl. 3, Fig. 7; as *P. stellaeformis* Reeve, 1842; Holocene.

Family ACMAEIDAE

Patelloida sp.

Family TROCHIDAE

Angaria delphinus (Linnaeus, 1758); [Cernohorsky, 1972: 42, text Fig. 4].
Astele engebiensis Ladd, 1966; Ladd, 1966: 37, pl. 4, Figs. 11–13; early Miocene; Fig. 1F.
Calliostoma sp; Zmarzly, 1984: 15; Fig. 1E.
Clanculus atropurpureus (Gould, 1849); Zmarzly, 1984: 115; [Cernohorsky, 1978: 32, pl. 8, Fig. 3].
C. clanguloides (Wood, 1828); [Cernohorsky, 1972: 40, pl. 8, Fig. 8].
C. margaritarius Philippi, 1847; [Cernohorsky, 1972: 40, pl. 8, Fig. 9].
Euchelus angulatus Pease, 1867; Ladd, 1966: 34, pl. 3, Figs. 17–19; Holocene.
E. atratus (Gmelin, 1791); [Cernohorsky, 1972: 40, pl. 8, Fig. 7].
E. foveolatus (A. Adams, 1852); [Marshall, 1979: 524, Figs. 2A–E].
E. instrictus (Gould, 1849); Ladd, 1966: 33, pl. 3, Figs. 11–13; Miocene?; Pleistocene.
E. pauperculus (Lischke, 1872); [Cernohorsky, 1978: 33, pl. 8, Fig. 7].
†*E.* cf. *E. quadricarinatus* (Dillwyn, 1817); Ladd, 1966: 33, pl. 3, Figs. 9, 10; late? Miocene; Holocene.
†*Euchelus* sp. A.; Ladd, 1966: 34, pl. 3, Figs 20–22; Holocene.
†*Gibbula engebiensis* Ladd, 1966; Ladd, 1966: 36, pl. 4, Figs. 6, 7; early Miocene.
G. marmorea (Pease, 1861); Ladd, 1966: 36, pl. 4, Figs. 8–10; as *Fossarina hoffmeisteri* Ladd, 1966; Miocene.
Hybochelus cancellatus orientalis Pilsbry, 1904; Ladd, 1966: 34–35, pl. 3, Figs. 23, 24; Holocene.
Isanda apicina (Gould, 1862); Ladd, 1966: 39–40, pl. 5, Figs. 1–4; Holocene.
Monilea belcheri (Philippi, 1849); [Cernohorsky, 1972: 41, pl. 8, Fig. 11].
M. danieli Crosse 1862; [Cernohorsky, 1972: 41, pl. 8, Fig. 12; as *M. philippiana* Dunker, 1871].
†*M. marshallensis* Ladd, 1966; Ladd, 1966: 40, pl. 5, Figs. 9–12; early Miocene.
M. vernicosa Gould, 1861; Ladd, 1966: 40–41, pl. 5, Figs. 13, 14; as *M. lifuana* Fischer, 1878; Holocene; [Cernohorsky, 1978: pl. 9, Fig. 7].
Tectus fenestratus (Gmelin, 1791); [Cernohorsky, 1972: 39, pl. 6, Fig. 7].
T. hirasei Pilsbry, 1904; [Pilsbry, 1904: 32, pl. 5, Figs. 52, 52a].
T. pyramis (Born, 1778); [Cernohorsky, 1972: 39, pl. 8, Fig. 4].
†*Thalotia berauensis* (Beets, 1941); Ladd, 1966: 34–35, pl. 3, Figs. 27, 28; late Miocene.
T. gilberti (Fischer, 1878); [Cernohorsky, 1978: 34, pl. 8, Fig. 10; as *Cantharidus*].
Tosatrochus attenuatus (Jonas, 1844); [Ladd, 1966: 35, pl. 3, Fig. 29; as *Thalotia* aff. *elongatus* (Wood, 1828)].
Trochus histrio Reeve, 1848; Ladd, 1966: 37, pl. 4, Figs. 16–18; Holocene; [Cernohorsky, 1978: 32, pl. 8, Fig. 1].
T. niloticus Linnaeus, 1767; introduced by the Japanese about 1935; [Cernohorsky, 1972: 38, pl. 8, Fig. 1].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family TROCHIDAE (cont'd)
T. ochroleucus Gmelin, 1791; Ekdale, et al., 1979: Table 2; as *Trochus maculatus*; [Demond, 1957: 286, Fig. 2].
Turcica morrisoni Ladd, 1966; [Ladd, 1966: 36, pl. 3, Fig. 31; pl. 4, Figs. 1–5].
Family STOMATELLIDAE
Broderipia iridescens (Broderip, 1834); [Cernohorsky, 1978: 38, text Fig. 6].
Pseudostomatella decolorata (Gould, 1848); [Cernohorsky, 1972: 44, pl. 9, Fig. 4].
P. lyrata Pilsbry, 1890; [Hirase, 1951: pl. 64, Fig. 1].
P. maculata (Quoy and Gaimard, 1834); [Cernohorsky, 1972: 43, pl. 9, Fig. 2].
Stomatella auricula (Lamarck, 1816); [Cernohorsky, 1972: 43, pl. 9, Fig. 4].
Stomatia heckliana (Crosse, 1871); [Cernohorsky, 1978: 36, pl. 9, Fig. 9].
S. cf. *S. phymotis* Helbling, 1779; [Cernohorsky, 1972: 43, pl. 8, Fig. 14].
S. tuberculata (A. Adams, 1850); [Cernohorsky, 1978: 36, pl. 9, Fig. 8].
Synaptocochlea concinna (Gould, 1845); Ladd, 1966: 42, pl. 5, Figs. 20–23; Holocene.
†*S. marshallensis* Ladd, 1966; Ladd, 1966: 42, pl. 5, Figs. 27, 28; late Miocene.
†*S. rosacea* (Pease, 1867); Ladd, 1966: 42, pl. 5, Fig. 24; Holocene.
Family SKENEIDAE
Cyclostremiscus emery Ladd, 1966; Ladd, 1966: 80, pl. 16, Figs. 9–11; Miocene.
†*C. novemcarinatus* Ladd, 1966; Ladd, 1966: 80, pl. 16, Figs. 12–14; early Miocene.
C. striatus Kay, 1979; [Kay, 1979: 54, pl. 15A–E].
†*Haplocochlias* sp. A.; Ladd, 1966: 76, pl. 14, Figs. 28, 29; late Miocene.
Family TURBINIDAE
†*Astraea enewetokensis* Ladd, 1966; Ladd, 1966: 43, pl. 6, Figs. 7–9; late Miocene.
A. rhodostoma (Lamarck, 1822); [Cernohorsky, 1972: 47, pl. 10, Fig. 4].
†*Astraea* sp. A.; Ladd, 1966: 44, pl. 6, Figs. 13–15; late Miocene.
†*Astraea* sp. C.; Ladd, 1966: 44, pl. 6, Figs. 19, 20; early Miocene; late Miocene; post-Miocene.
†*Astraea* sp. D.; Ladd, 1966: 44, pl. 6, Figs. 21–23; Miocene.
†*Astraea* sp. E.; Ladd, 1966: 44–45, pl. 6, Figs. 24–26; early Miocene.
†*Cynisca pacifica* Ladd, 1966; Ladd, 1966: 49, pl. 6, Figs. 5–7; early Miocene.
†*Leptothyra candida* (Pease, 1861); Ladd, 1966: 51, pl. 9, Figs. 7–9; Holocene.
L. emenana Ladd, 1966; Ladd, 1966: 53, pl. 9, Figs. 24–26; Miocene; Pliocene.
L. glareosa marshallensis Ladd, 1966; Ladd, 1966: 52, pl. 9, Figs. 16–20; Miocene; Holocene; [Cernohorsky, 1978: 39, pl. 10, Fig. 5; as *Leptothyra nanina* Souverbie].
†*L. harlani* Ladd, 1966; Ladd, 1966: 50–51, pl. 8, Figs. 14–20; Miocene.
†*L. inepta* (Gould, 1861); Ladd, 1966: 50, pl. 8, Figs. 14–22; Holocene.
†*L.* cf. *L. laeta* (Montrouzier, 1863); Ladd, 1966: 51, pl. 9, Figs. 4–6; early Miocene.
†*L. maculosa* (Pease, 1868); Ladd, 1966: 50, pl. 8, Figs. 8–13; post-Miocene.
†*L. picta* (Pease, 1868); Ladd, 1966: 53, pl. 9, Figs. 21–23; Holocene.
L. rubricincta (Mighels, 1845); [Kay, 1979: 58, Fig. 16B].
†*L. verruca* (Gould, 1845); Ladd, 1966: 51–52, pl. 9, Figs. 10–12; as *L. balnearii* Pilsbry, 1920; early Miocene; late Miocene; Holocene.
†*L. wellsi* Ladd, 1966; Ladd, 1966: 52, pl. 9, Figs. 13–15; Miocene?.
†*Leptothyra* sp. A.; Ladd, 1966: 53, pl. 9, Figs. 27–29; late Miocene.
Turbo argyrostomus Linnaeus, 1758; Ladd, 1966: 48; late? Miocene; Holocene; [Cernohorsky, 1972: 45, pl. 9, Fig. 11].
T. petholatus Linnaeus, 1758; [Cernohorsky, 1972: 44, pl. 10, Fig. 1].
T. setosus Gmelin, 1791; [Cernohorsky, 1972: 45, pl. 10, Fig. 1].
Family PHASIANELLIDAE
Gabrielona raunana raunana Ladd, 1966; Ladd, 1966: 54, pl. 10, Figs. 1–5; as *Gabrielona raunana*; Holocene; Robertson, 1973: 50–51, pl. 44, Figs. 4–6; pl. 45, Fig. 7; pl. 46, Figs. 1, 2.
†*Phasianella* sp. (operculum only); Ladd, 1966: 53, pl. 10, Figs. 10, 11; late Miocene.
Tricolia variabilis (Pease, 1861); Ladd, 1966: 54, pl. 10, Figs. 6, 7; late Miocene; Holocene.
Family NERITIDAE
Nerita albicilla Linnaeus, 1758; Stokes, 1966; Menge, 1973; [Cernohorsky, 1972: pl. 10, Fig. 8].
†*N. insculpta* Recluz, 1844; Ladd, 1966: 55, pl. 10, Figs. 15, 16; late Miocene.
N. maxima Gmelin, 1791; [Maes, 1967: 107, pl. 4G].
N. plicata Linnaeus, 1758; Stokes, 1966; Menge, 1973; [Cernohorsky, 1972: pl. 11, Fig. 6].
N. polita Linnaeus, 1758; Ladd, 1966: 56, pl. 10, Figs. 17, 18; as *N.* aff. *polita;* Miocene; Stokes, 1966; [Kay, 1979: 64, Fig. 19C–E].
N. reticulata Karsten, 1789; [Cernohorsky, 1972: 52, pl. 11, Fig. 10].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family NERITIDAE (cont'd)
†*Pisulina adamsiana* G. and H. Nevill, 1869; Ladd, 1977: 14, pl. 1, Figs. 1, 2; Holocene.
Puperita cf. P. bensoni (Recluz, 1850); Fig. 1P, 1Q.
†*Smaraqdia colei* Ladd, 1966; Ladd, 1966: 58–59, pl. 11, Figs. 5–7; Miocene.
†*S. joqjacartensis* (Martin, 1916); Ladd, 1966: 58, pl. 10, Figs. 28–31; Miocene.
†*Smaraqdia* sp. A.; Ladd, 1966: 59, pl. 11, Figs. 8, 9; late Miocene.
[*Nerita picea* Recluz, 1841, reported by Stokes (1966) and Kay (1979) has not been confirmed].
Family NERITOPSIDAE
Neritopsis radula (Linnaeus, 1758); Ladd, 1966: 55 pl. 10, Figs. 12–14; Miocene.
Family PHENACOLEPADIDAE
Phenacolepas granocostata (Pease, 1868); [Kay, 1979: 68, Fig. 21A].
P. scobinata (Gould, 1859); [Kay, 1979: 68, Fig. 21B].
Order MESOGASTROPODA
Family LITTORINIDAE
Littorina coccinea (Gmelin, 1791); Rosewater, 1970: 439, pl. 325, Figs. 11, 12.
L. pintado (Wood, 1828); Rosewater, 1970: 447, pl. 325, Figs. 15, 16.
L. scabra Linnaeus, 1758; Rosewater, 1970: 436, pl. 325, Figs. 8–10.
L. undulata Gray, 1839; Rosewater, 1970: 298, pl. 325, Figs. 8–10.
Nodilittorina millegrana (Philippi, 1848); Rosewater, 1970: 491, pl. 378, Figs. 13, 14.
Peasiella tantilla (Gould, 1849); [Kay, 1979: 74, Fig. 24A].
†*Tectarius rehderi* Ladd, 1966; Ladd, 1966: 59, pl. 11, Figs. 11–13; Miocene.
Family RISSOIDAE
Alvania crystallina Garrett, 1873; Fig. 1L.
A. isolata (Laseron, 1956); [Kay, 1979: 77, Fig. 27C].
Brookula sp., Fig. 1M.
†*Cinqula parryensis* Ladd, 1966; Ladd, 1966: 61, pl. 11, Figs. 23, 24; Miocene.
C. cf. *C. roseocincta* (Suter, 1908); Ladd, 1966: 61, pl. 11, Figs. 25, 26; Miocene; Holocene.
†*Merelina pisinna* (Melville and Standen, 1890); Ladd, 1966: 63, pl. 12, Figs. 4, 5; Miocene.
M. wanawana Kay, 1979; [Kay, 1979: 82, Figs. 28 A, B].
Parashiela beetsi Ladd, 1966; Ladd, 1966: 64, pl. 12, Figs. 8, 9; Holocene.
†*Pusillina jeffcoati* (Ladd, 1966); Ladd, 1966: 62, pl. 11, Figs. 27–31; Miocene; Holocene; Ponder, 1985: 30.
P. marmorata (Hedley, 1907); [Kay, 1979: 79, Figs. 27 E, F; as *Vitricithna*].
†*Putilla morana* Ladd, 1966; Ladd, 1966: 16, pl. 11, Figs. 16, 17; Miocene.
†*Rissoina abbotti* Ladd, 1966; Ladd, 1966: 70, pl. 13, Figs. 19–21; Miocene.
R. abrardi (Ladd, 1966); Ladd, 1966: 65, pl. 12, Figs. 15–18; as *Zebina;* early Miocene; Holocene; Ponder, 1985; 80.
†*R. ailinana* Ladd, 1966; Ladd, 1966; 70-71, pl. 13, Fig. 26; Miocene.
†*R. alexisi* Ladd, 1966; Ladd, 1966: 70, pl. 13, Figs. 13–16; Miocene.
R. ambiqua (Gould, 1849); Ladd, 1966: 71, pl. 14, Figs. 23, 24; Holocene.
†*R. ambiqua parryensis* Ladd, 1966; Ladd, 1966: 72, pl. 14, Figs. 25, 26; early Miocene.
R. andamanica Weinkauff, 1885; Ladd, 1966: 67, pl. 12, Figs. 22–25; as *R. mijana* Ladd, 1966; early Miocene; Holocene; [Cernohorsky, 1978: 44, pl. 11, Fig. 7].
R. balteata Pease, 1869; Ladd, 1966: 69, pl. 13, Figs. 5–8; early Miocene; Holocene.
†*R. bikiniensis* Ladd, 1966; Ladd, 1966: 69, pl. 13, Figs. 9, 10, 17, 18; Miocene; Ponder, 1985: 84.
R. clathrata (A. Adams, 1853); [Cernohorsky, 1978: 47, pl. 12, Fig. 4].
†*R. concinna* A. Adams, 1851; Ladd, 1966: 72, pl. 13, Fig. 33; Miocene.
R. ekkanana Ladd, 1966; Ladd, 1966: 71, pl. 13, Figs. 31, 32; Holocene.
†*R. emnanana* Ladd, 1966; Ladd, 1966: 67, pl. 12, Figs. 31, 32; Miocene.
R. fimbriata (Souverbie, 1872); [Cernohorsky, 1978: 45, pl. 11, Fig. 9].
R. cf. R. flexuosa Gould, 1861; Ladd, 1966: 66, pl. 12, Figs. 21, 22; Holocene.
†*R. herringi* Ladd, 1966; Ladd, 1966: 74, Fig. 14, Figs. 13, 14; late Miocene.
R. illustris Sowerby, 1894; Ladd 1966: 66, pl. 14, Figs. 5–8; as *R. ephamilla* Watson, 1886; early Miocene; Holocene.
R. imbricata Gould, 1832; [Kay, 1979: 86, Fig. 29L; as *Zebina*].
†*R.* cf. *R. indrai* Beets, 1941; Ladd, 1966: 66–67, pl. 12, Figs. 23, 24; early Miocene.
R. lamberti Souverbie, 1870; [Cernohorsky, 1978: 46, pl. 12: 2].
†*R. lomaloana* Ladd, 1966; Ladd, 1966: 72, pl. 13, Figs. 27, 28; Miocene.
†*R. marshallensis* Ladd, 1966; Ladd, 1966: 73, pl. 13, Figs. 38–40; pl. 14, Figs. 1–4; Miocene.
R. mejilana Ladd, 1966; Ladd, 1966: 67, pl. 12, Figs. 25, 26; early Miocene.

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†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family RISSOIDAE (cont'd)
R. plicata A. Adams, 1851; Ladd, 1966: 74–75, pl. 14, Figs. 21, 22; early Miocene.
R. reticulata (Sowerby, 1824); [Cernohorsky, 1978: 46, pl. 12: 1].
†*R.* cf. *R. supracostata* Garrett, 1873; Ladd, 1966: 68, pl. 12, Figs. 35, 36; early Miocene.
R. tenuistriata Pease, 1868; Ladd, 1966: 68, pl. 12, Figs. 33, 34; early Miocene; Holocene.
R. tornatilis Gould, 1861; Ladd, 1966: 69, pl. 13, Figs. 11, 12; as *R. transenna* Watson, 1886; early Miocene; Holocene; [Cernohorsky, 1978: 48, pl. 12: 8].
R. turricula Pease, 1861; Ladd, 1966: 72, pl. 13, Figs. 36, 37; Miocene; Holocene.
Schwartziella triticea (Pease, 1861); [Kay, 1979: 86, Fig. 29I].
†*Stosicia gardnerae* (Ladd, 1966); Ladd, 1966: 60, pl. 11, Figs. 14, 15; as *Iravadia;* Miocene; Ponder, 1985: 94.
†*Zebina* cf. *Z. cooperi* (Oliver, 1915); Ladd, 1966: 65, pl. 12, Figs. 11, 12; as *Zebina;* Holocene.
Z. killeblebana Ladd, 1966; Ladd, 1966: 65, pl. 12, Figs. 13, 14; early Miocene.
Z. semiplicata (Pease, 1862); Ladd, 1966: 64, pl. 12, Fig. 10; as *Z. metaltilana* Ladd, 1966; early Miocene; Holocene; [Kay, 1979: 86, Fig. 29K].
Z. striatula (Gould, 1861); [Kay, 1979: 86, Fig. 29L].
Z. tridentata Michaud, 1830; [Kay, 1979: 86, Fig. 29J].

Family ASSIMINEIDAE
†*Assiminea nitida eniwetokensis* Ladd, 1966; Ladd, 1966: 75, pl. 10, Fig. 8; Miocene.
A. nitida marshallensis Abbott, 1958; Abbott, 1958: 256, pl. 15, Fig. 8; holotype from Japtan Island, Enewetak.

Family BARLEEIDAE
†*Protobarleeia myersi* (Ladd, 1966); Ladd, 1966: 62, pl. 11, Figs. 32, 33; as *Amphithalamus (Ceratostraca?) myersi;* late Miocene; Ponder, 1983: 243; [Ponder, 1983b: 243, Figs. 11E–I]

Family CAECIDAE
†*Caecum berberense* Ladd, 1972; Ladd, 1972: 22, pl. 5, Figs. 11, 12; early Miocene; Pliocene.
C. cf. *C. folini* Kisch, 1959; Fig. 2B.
C. cf. C. glabellum A. Adams, 1868; [Kay, 1979: 110, Fig. 42G].
†*C. parryensis* Ladd, 1972; Ladd, 1972: 23, pl. 5, Figs. 1–7; early Miocene.
C. sepimentum de Folin, 1867; [Kay 1979: 109, Fig. 42B].
†*C. vertebrale* Hedley, 1899; Ladd, 1972: 22, pl. 5, Figs. 8–10; Pleistocene; Holocene.
†*Elephantenellum* sp. A.; Ladd, 1972: 23, pl. 5, Fig. 15; post-Miocene.
†*Fartulum* cf. *F. amputatum* (Hedley, 1893); Ladd, 1972: 24, pl. 5, Figs. 16, 17; early Miocene.
†*Fartulum* sp. A.; Ladd, 1972: 24, pl. 5, Fig. 18; post-Miocene.
Micranellum schlangeri Ladd, 1972; Ladd, 1972: 23, pl. 5, Figs. 13, 14; Miocene; Holocene.

Family VITRINELLIDAE
Leucorhyncha caledonica Crosse, 1867; Ladd, 1966: 76, pl. 14, Figs. 30, 31; Holocene.
L. crossei Tryon, 1888; Ladd, 1966: 78, pl. 14, Figs. 32, 33; Holocene.
†*L. stephensonii* Ladd, 1966; Ladd, 1966: 76, pl. 14, Figs. 34, 35; early Miocene.
Liotina cf. *L. botanica* (Hedley, 1914); Ladd, 1966: 46, pl. 7, Figs. 9–11; Holocene.
L. loculosa (Gould, 1862); Ladd, 1966: 46, pl. 7, Figs. 12–14; Holocene.
L. peronii (Kiener, 1839); [Cernohorsky, 1972: pl. 10, Fig. 7].
Liotina sp. A.; Ladd, 1966: 47, pl. 7, Figs. 15–17; early Miocene.
Lophocochlias minutissimus (Pilsbry, 1921); Ladd, 1966: 77, pl. 15, Figs. 3–5; early Miocene.
†*L. paucicarinatus* Ladd, 1966; Ladd, 1966: 77, pl. 15, Figs. 6–8; early Miocene.
†*Lydiphnis enewetokensis* Ladd, 1966; Ladd, 1966: 79, pl. 16, Figs. 6–8; early Miocene; Pliocene.
Marelepetopoma sp.; Fig. 1q.
Microliotia dautzenbergi (Bavay, 1917); Fig. 1R.
†*Munditella parryensis* Ladd, 1966; Ladd, 1966: 78, pl. 15, Figs. 12–14; late Miocene; Holocene.
M. gualum (Hedley, 1899); Ladd, 1966: 78, pl. 15, Figs. 9–11; Pleistocene.
Sansonia andamanica (Preston, 1908); [Iredale, 1917: 372, Fig. 8]; Fig. 1N.
S. corayi (Ladd, 1966); Ladd, 1966: 63, pl. 12, Fig. 2; as *Alvania (Taramellia);* Holocene.
†*S. kenneyi* (Ladd, 1966); Ladd, 1966: 63, pl. 12, Fig. 3; as *Alvania (Taramellia);* Miocene.
Solariorbis tricarinata (Melville and Standen, 1896); Ladd, 1966: 79, pl. 16, Figs. 1–3; early Miocene.
Teinostoma engebiense Ladd, 1966; Ladd, 1966: 78, pl. 15, Figs. 15–17; Holocene.
T. marshallense Ladd, 1966; Ladd, 1966: 78, pl. 15, Figs. 18–20; early Miocene.
T. parvulum Hedley, 1899; [Hedley, 1899: 553, Fig. 64].
Teinostoma sp.; Fig. 1I, 1J.

Family ORBITESTELLIDAE
Orbitestella sp.; Fig. 1G, 1H.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family OMALOGYRIDAE
Omalogyra japonica (Habe, 1972); [Kay, 1979: 92, Figs. 32A–C].
Family CINGULOPSIDAE
Rufodardanula sp.; Fig. 1K.
Family TURRITELLIDAE
†*Turritella* cf. *T. cingulifera* Sowerby, 1825; Ladd, 1972: 14, pl. 1, Fig. 1; early Eocene to early Miocene.
Turritella sp. A.; Fig. 2C.
Turritella sp. B.; Fig. 2D.
Vermicularia sp. A.; Ladd 1972, pl. 2, Figs. 5–7; early Miocene; Fig. 2K.
Family TRUNCATELLIDAE
Truncatella guerinii A. and J. Villa, 1841; [Cernohorsky, 1972: 58, pl. 12, Fig. 16].
Family VERMETIDAE
Dendropoma gregaria Hadfield and Kay, 1972; [Kay, 1979: 103, Fig. 38].
D. meroclista Hadfield and Kay, 1972; [Kay, 1979: 104, Fig. 39A].
D. platypus (Morch, 1861); [Kay, 1979: 106, Fig. 39B].
D. psarocephala Hadfield and Kay, 1972; [Kay, 1979: 106, Fig. 39D].
D. rhyssoconcha Hadfield and Kay, 1972; [Kay, 1979: 106, Fig. 39C].
Petaloconchus keenae Hadfield and Kay, 1972; [Kay, 1979: 108, Fig. 40A–B].
†*P. lamellosus* Ladd, 1972; Ladd, 1972: 20, pl. 3, Fig. 13; late Miocene.
†*P. merkana* Ladd, 1972; 20, pl. 3, Figs. 4–12; early Miocene; Holocene.
P. tokyoensis (Pilsbry, 1895); [Pilsbry, 1895: 61, pl. 1, Figs. 9–11].
†*Serpulorbis* cf. *S. javanus* Martin, 1879; Ladd, 1972: 20–21, pl. 3, Figs. 14, 51; late Miocene.
S. variabilis Hadfield and Kay, 1972; [Kay, 1979: 108, Figs. 40 E, F].
Vermetus alii Hadfield and Kay, 1972; [Kay, 1979: 108, Figs. 40 C, D].
Family SILIQUARIDAE
Stephopoma cf. *S. roseum* Quoy and Gaimard, 1833.
Family PLANAXIDAE
Planaxis sulcatus (Born, 1780); [Cernohorsky, 1972: 58, pl. 12, Fig. 17].
P. zonatus A. Adams, 1851; Fig. 2A.
Family CERITHIIDAE
Bittium impendens (Hedley, 1899); Ladd, 1972: 30, pl. 7, Fig. 15; Holocene.
B. sergentum (Jousseaume, 1930); Ladd, 1972: 30–31, pl. 7, Figs. 16–20; early Miocene; Holocene.
B. zebrum (Kiener, 1841); Ladd, 1972: 31, pl. 7, Figs. 21, 22; as *B. ianthinum;* Holocene; Ladd, 1972: 31, pl. 4, Fig. 13; as *B. eniwetokensis* Ladd, 1972; early Miocene; Ladd, 1972: 32, pl. 4, Figs. 14–16; as *B. toddae;* late Miocene.
Cerithium alveolus Hombron and Jaquinot, 1841; [Cernohorsky, 1972: 68, pl. 15, Fig. 8].
C. atromarginatum Dautzenberg and Bouge, 1933; [Kay, 1979: Fig. 45 F].
C. claviforme Schepman, 1901; Fig. 2L.
C. columna Sowerby, 1834; Ladd, 1972: 39, pl. 10, Fig. 2; Holocene.
C. echinatum (Lamarck, 1822); Ladd, 1972: 37, pl. 9, Fig. 6; Holocene; as *C. mutatum* Sowerby, 1834; Houbrick, 1974; [Kay, 1979: 122, Fig. 45L; as *C. mutatum* Sowerby, 1834].
C. egenum Gould, 1849; Ladd, 1972: 39, pl. 9, Figs. 9, 10; Holocene.
†*C. eniwetokensis* (Ladd, 1972); Ladd, 1972: 37, pl. 9, Figs. 1, 2; Miocene; as *Rhinoclavis*.
†*C. floranensis* (Ladd, 1972); Ladd, 1972: 37, pl. 9, Figs. 4, 5; Miocene; as *Rhinoclavis*.
C. cf. *interstriatum* Sowerby, 1855; [Kay, 1979: 122, Fig. 45R].
†*C. marshallensis* (Ladd, 1972); Ladd, 1972: 34–35, pl. 8, Figs. 12, 13; Miocene; as *Rhinoclavis*.
C. munitum Sowerby, 1855; Ladd, 1972: 39, pl. 10, Fig. 2; Holocene; as *Cerithium* aff. *C. columna*.
C. nesioticum (Pilsbry and Vanatta, 1905); [Kay, 1979: 123, Fig. 45H].
C. nodulosum Bruguière, 1792; Houbrick, 1971: 560-565; 1974: 20; [Cernohorsky, 1972, pl. 13, Fig. 8].
C. cf. *C. planum* Anton, 1839; [Cernohorsky, 1972: pl. 14, Fig. 7].
C. rostratum Sowerby, 1855; Ladd, 1972: 32, pl. 4, Fig. 17; as *Colina rostrata;* Pleistocene; Holocene.
C. salebrosum Sowerby, 1855; Ladd, 1972: 37, pl. 9, Fig. 12; Pliocene; Holocene.
C. tenuifilosum Sowerby, 1866; Ladd, 1972: 38, pl. 9, Fig. 15; as *C. tenellum* Sowerby, 1855; Pleistocene; Holocene; [Cernohorsky, 1972: 70, pl. 14, Fig. 3].
C. trailii (Sowerby, 1855); [Cernohorsky, 1972: 71, pl. 16, Fig. 10].
Clypeomorus batillariaeformis Habe and Kosuge, 1966; Ladd, 1972: 37, pl. 9, Figs. 7, 8 as *Cerithium alveolus* Hombron and Jaquinot, 1841; Holocene; Houbrick, 1974; as *Cerithium sejunctum* Iredale; [Houbrick, 1985: 51–52, Fig. 23].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family CERITHIIDAE (cont'd)

C. bifasciata bifasciata (Sowerby, 1855); Ladd, 1972: 40, pl. 9, Fig. 11; as *Cerithium (Conocerithium)* aff. *egenum;* late Miocene; [Houbrick, 1985: 24–27, Fig. 10].
C. brevis (Quoy and Gaimard, 1834); Houbrick, 1974: 21; as *Cerithium morum;* Houbrick, 1985: 50; [Houbrick, 1985: 44, pl. 19].
C. nympha Houbrick, 1985; Houbrick, 1985: 119, Fig. 56e.
†*C. verbeeki* (Woodward, 1879); Ladd, 1972: 40, pl. 10, Fig. 5; late Miocene.
†*Liocerithium kayae* Ladd, 1972; Ladd, 1972: 40, pl. 4, Figs. 7–12; Miocene.
†*Plesiotrochus marshallensis* Ladd, 1972; Ladd, 1972: 42, pl. 10, Figs. 13–15; Miocene.
†*P. pagodiformis* Hedley, 1907; Ladd, 1972: 41, pl. 10, Fig. 10; post Miocene.
†*P. talinana* Ladd, 1972; Ladd, 1972: 42, pl. 10, Figs. 11, 12; early Miocene.
P. unicinctus A. Adams, 1853; Ladd, 1972: 41, pl. 10, Figs. 8, 9; as *P. luteus* (Gould, 1861); late Miocene; Holocene.
†*P. whitmorei* Ladd, 1972; Ladd, 1972: 42, pl. 11, Figs. 2, 3; Miocene.
†*Plesiotrochus* sp. A. Ladd, 1972; Ladd, 1972: 42, pl. 11, Fig. 1; Pliocene.
Rhinoclavis articulata (Adams and Reeve, 1850); Houbrick, 1978: 302, pl. 1, Figs. 25–31.
R. aspera (Linnaeus, 1758); Ladd, 1972: 34, pl. 8, Figs. 8, 9; late Miocene; Holocene; Houbrick, 1974: 21; 1978: 289–294, pl. 1, Figs. 9–14.
R. diadema Houbrick, 1978; Houbrick, 1978: 318-320, pls. 33–35.
R. fasciata (Bruguière, 1792); Houbrick, 1974; as *R. pharos;* 1978: 295–302, pl. 2.
†*R. lowae* Ladd, 1972; Ladd, 1972: 36, pl. 9, Fig. 3; Miocene.
†*R. powelli* Ladd, 1972; Ladd, 1972: 35, pl. 8, Figs. 14, 15; late Miocene.
R. sinensis (Gmelin, 1791); Ladd, 1972: 34, pl. 8, Fig. 11. *R.* aff. *sinensis;* late Miocene; Ladd, 1972: 39, pl. 10, Figs. 3, 4; as *Cerithium tuberculatum* (Linnaeus, 1791); Houbrick, 1974: 21; 1978: 53, pl. 1, Figs. 15–24.
Royella sinon Bayle, 1880; [Houbrick, 1984: 12].

Family POTAMIDIDAE

†*Potamides wardi* Ladd, 1972; Ladd, 1972: 25, pl. 6, Figs. 4, 5; Miocene.
†*Potamides* sp. A. Ladd, 1972; Ladd, 1972: 25–26, pl. 6, Fig. 6; late Miocene.
†*Potamides* sp. B. Ladd, 1972; Ladd, 1972: 26, pl. 6, Fig. 7; late Miocene.
†*Terebralia sulcata* Born, 1778; Ladd, 1972: 27, pl. 6, Fig. 13; late Miocene.
†*Vicarya* sp. Ladd, 1972; Ladd, 1972: 26, pl. 6, Fig. 11; early Miocene.

Family MODULIDAE

Modulus tectum (Gmelin, 1791); [Kay, 1979: 113, Fig. 43A].

Family DIALIDAE

Cerithidium asperulata (A. Adams, 1860); Ladd, 1972: 29, pl. 7, Fig. 6; as *Obtortio dancei*; early Miocene.
Diala flammea (Pease, 1867); Ladd, 1972: pl. 7, Figs. 8–12; as *Diala ludens* Melvill and Standen, 1897; early Miocene; Holocene.
†*D. stricta* Habe, 1960; Ladd, 1972: 30, pl. 7, Fig. 13; early Miocene.
Finella failingi Ladd, 1972; Ladd, 1972: 28–29, Figs. 4, 5; as *Obtortio;* early Miocene.
F. pupoides A. Adams, 1860; Ladd, 1972: 30, pl. 7, Fig. 14; as *Obtortio pyrrhacme;* Melvill and Standen, 1895; early Miocene.
F. sulcifera (A. Adams, 1862); Ladd, 1972: 30, pl. 7, Fig. 14; as *Diala;* Holocene.
†*Finella* sp. A. Ladd, 1972; Ladd, 1972: 29, pl. 7, Fig. 7; as *Obtortio;* early Miocene.
Scalioa arenosa A. Adams, 1862; Fig. 2E.
S. bella A. Adams, 1860; [Kay, 1979: 117, Fig. 44I].
S. caledonica Crosse, 1870; Fig. 2F.
S. glareosa A. Adams, 1862; Fig. 2G.

Family LITIOPIDAE

Styliferina goniochila (A. Adams, 1860); [Kay, 1979: 118, Fig. 44H]. [Placement of this species follows Ponder (1985)].

Family CERITHIOPSIDAE

†*Ataxocerithium eniwetokensis* Ladd, 1972; Ladd, 1972: 32–33, pl. 4, Fig. 18; pl. 8, Fig. 1; Holocene.
Cerithiopsis sp. cf. *C. arga* Kay, 1979; [Kay, 1979: 126, Fig. 46A].
Cerithiopsis sp. A.; Fig. 2Q.
Cerithiopsis sp. B.; Fig. 2R.
Joculator granata Kay, 1979; [Kay, 1979: 127, Fig. 46C].
†*Joculator sp.* cf. *J. ovata* (Laseron, 1956); Ladd, 1972: 44, pl. 11, Fig. 12; early Miocene; Holocene.
J. semipicta (Gould, 1861); Ladd, 1972: 43, pl. 11, Figs. 5, 6; late Miocene; Holocene.
J. sumangi Ladd, 1972; Ladd, 1972: 44, pl. 11, Figs. 7–11; late Miocene.
J. tribulationis (Hedley, 1909); Ladd, 1972: 43, pl. 11, Fig. 14; late Miocene; Holocene.
J. turrigera (Watson, 1886); [Kay, 1979: 128, Figs. 46, D, E].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family CERITHIOPSIDAE (cont'd)
J. uveanum (Melvill and Standen, 1896); [Kay, 1979: 128, Fig. 46H].
†*Seila waluensis* Ladd, 1972; Ladd, 1972: 44, pl. 11, Fig. 13; late Miocene.
Family EULIMIDAE
Balcis acicula (Gould, 1849); Lamberson, 1978; Fig. 3B.
B. bryani (Pilsbry, 1917); [Kay, 1979: 161, Fig. 56I].
B. solida (Sowerby, 1865); [Kay, 1979: 162, Fig. 56K].
B. thaanumi (Pilsbry, 1917); [Kay, 1979: 164, Fig. 56M].
†*Balcis* sp. A. Ladd, 1982; Ladd, 1982: 55, pl. 41, Figs. 14, 15; as *Eulima;* early Miocene.
Hemileisotracum sp., Fig. 3C.
Leiostraca metcalfei (A. Adams, 1853); [Kay, 1979: 165, Fig. 56Q].
Mucronalia nitidula Pease, 1861; [Kay, 1979: 165, Fig. 56T].
Pyramidelloides suta (Pilsbry, 1918); [Kay, 1979: 84, Fig. 29G].
Stylapex sp., Fig. 3A.
Stylifer linckiae Sarasin and Sarasin, 1887; [Kay, 1979: 167, Fig. 57E].
Thyca crystallina (Gould, 1846); [Kay, 1979: 167, Fig. 56U].
Family STROMBIDAE
Lambis chiragra (Linnaeus, 1758); Abbott, 1961: 172, pl. 121, Figs. 10–12; Berg, 1974.
L. crocata (Link, 1807); [Abbott, 1961: 157, pl. 121, Fig. 8].
L. lambis (Linnaeus, 1758); Abbott, 1961: 154, pl. 12, Fig. 4; Berg, 1974.
L. scorpius (Linnaeus, 1758); Berg, 1974; [Abbott, 1961: 164, pl. 121, Fig. 5].
L. truncata (Humphrey, 1786); Abbott, 1961: 157, pl. 121: 9; Berg, 1974.
Strombus dentatus Linnaeus, 1758; Abbott, 1960: 85, pl. 14: 23; Berg, 1974.
S. erythrinus Dillwyn, 1817; Abbott, 1960: 81, pl. 20, Figs. 1–5.
S. fragilis (Röding, 1798); [Abbott, 1960: 82, pl. 14, Fig. 30].
S. gibberulus Linnaeus, 1758; Abbott, 1960: 143, pl. 14, Fig. 20; Berg, 1974; Ladd, 1972: 62, pl. 19, Fig. 9, pl. 20, Figs. 1–3; Holocene.
S. haemastoma Sowerby, 1842; Abbott, 1960: 117, pl. 17, Figs. 11, 12; Berg, 1974.
S. lentiginosus Linnaeus, 1758; Abbott, 1960, pl. 17, Figs. 11, 12.
S. luhuanus Linnaeus, 1758; Abbott, 1960: 136, pl. 14, Fig. 15; Berg, 1974; Gillary, 1974; Gillary and Gillary, 1979.
S. maculatus Sowerby, 1842; Abbott, 1960: 77, pl. 20, Figs. 24, 25.
†*S. micklei* Ladd, 1972; Ladd, 1972: 60–61, pl. 18, Figs. 5–8; late Miocene.
S. microurceus (Kira, 1959); [Abbott, 1960: 71, pl. 20: 24, 25].
S. mutabilis Swainson, 1821; Abbott, 1960: 74, pl. 20: 15, 16; Berg, 1974; Ladd, 1972: 58–59, pl. 15, Figs. 10–15; Holocene.
S. sinuatus Lightfoot, 1786; [Abbott, 1960: 60, pl. 17, Fig. 8].
S. taurus Reeve, 1857; Cernohorsky, 1972: 73, pl. 17, Fig. 5.
S. variabilis Swainson, 1820; [Abbott, 1960: 103, pl. 14, Figs. 21, 22].
S. wilsoni Abbott, 1967; [Abbott, 1967: 455, pl. 328, Figs. 1–3].
†*Strombus* sp. C.; Ladd, 1972: 61, pl. 18, Figs. 10, 11; late Miocene.
Terebellum terebellum (Linnaeus, 1758); Jung and Abbott, 1967: 453, pl. 321.
Family VANIKORIDAE
Vanikoro cancellata (Lamarck, 1822); Ladd, 1972: 52, pl. 13, Figs. 6–8; early Miocene, Holocene.
V. queriniana (Recluz, 1843); Ladd, 1972: 52, pl. 13, Figs. 9, 10; early Miocene; Holocene.
V. helicoidea (le Guillou, 1842); [Cernohorsky, 1972: 86, pl. 22, Fig. 1].
†*V.* cf. *V. kanakarum* Pilsbry, 1921; Ladd, 1972: 52, pl. 13, Fig. 11; Holocene.
Family HIPPONICIDAE
†*Hipponix foliaceus* Quoy and Gaimard, 1835; Ladd, 1972: 53, pl. 13, Figs. 15–21; Miocene.
†*H. revellei* Ladd, 1972; Ladd, 1972: 54, pl. 14, Figs. 1–18; early Miocene; Pliocene.
Sabia conica (Schumacher, 1817); Ladd, 1972: 54, pl. 13, Figs. 22–27; early Miocene; Holocene; [Kay, 1979: 179, Figs. 62F–H].
Family CAPULIDAE
Cheilea equestris (Linnaeus, 1758); Ladd, 1972: 52, pl. 13, Fig. 12; Miocene.
Crepidula aculeata (Gmelin, 1791); Found on pilings only; [Kay, 1979: 181, Figs. 63G, H].
Capulus danieli (Crosse, 1858); [Cernohorsky, 1972: 88, pl. 22, Fig. 5].
†*Capulus* sp. A.; Ladd, 1972: 55, pl. 14, Fig. 21; late Miocene.
†*Capulus* sp. B.; Ladd, 1972: 55, pl. 14, Fig.22; late Miocene.
Family XENOPHORIDAE
Xenophora cerea (Reeve, 1845); Ponder, 1983a: 23–25, Fig. 23.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family LAMELLARIIDAE
Lamellaria cf. *L. berghi* Deshayes, 1863; Fig. 3D.
Family ERATOIDAE
Proterato gemma (Bavay, 1917); [Cate, 1977: 353, Fig. 23].
P. stalagmia Cate, 1975; [Cate, 1977: 347, Fig. 11].
Family TRIVIIDAE
Trivia hordacea Kiener, 1845; [Kay, 1979: 187, Fig. 65B].
T. oryza (Lamarck, 1810); Ladd, 1977: 17, pl. 1, Figs. 10–12; Miocene and younger beds.
Family CYPRAEIDAE
Cypraea annulus Linnaeus, 1758; Ingram, 1947; [Burgess, 1970: 341, pl. 41A].
C. arabica Linnaeus, 1758; Ladd, 1977: 19, pl. 2, Figs. 1, 2; Holocene; [Burgess, 1970: 215, pl. 18A].
C. argus Linnaeus, 1758; [Burgess, 1970: 253, pl. 28 B–C].
C. asellus Linnaeus, 1758; [Burgess, 1970: 118, pl. 8H].
C. aurantium Gmelin, 1791; [Burgess, 1970: 118, pl. 8H].
C. beckii Gaskoin, 1836; [Burgess, 1970: 277, pl. 30L].
C. bistrinotata (Schilder and Schilder, 1937); [Burgess, 1970: 271, pl. 30C].
C. caputserpentis Linnaeus, 1758; Ingram, 1947; [Burgess, 1970: 177, pl. 12F].
C. carneola Linnaeus, 1758; Ingram, 1947; [Burgess, 1970: 201, pl. 32D].
C. catholicorum (Schilder and Schilder, 1938); [Burgess, 1970: pl. 13A].
C. caurica Linnaeus, 1758; [Burgess, 1970: 292, pl. 32D].
C. childreni Gray, 1825; Ladd, 1977: 22, pl. 3, Figs. 11–13; Holocene; [Burgess, 1970: 262, pl. 29G].
C. chinensis Gmelin, 1791; [Burgess, 1970: 79, pl. 5H].
C. cicercula Linnaeus, 1758; [Burgess, 1970: 266, pl. 30A].
C. clandestina Linnaeus, 1767; [Burgess, 1970: 93, pl. 7C].
C. cribraria Linnaeus, 1758; [Burgess, 1970: 189, pl. 136K].
C. depressa Gray, 1824; Ingram, 1947; as *Cypraea intermedia*; [Burgess, 1970: 217, pl. 18E].
C. dillwyni (Schilder, 1922); [Burgess, 1970: 273, pl. 30H].
C. eglantina Duclos, 1833; [Burgess, 1970: 218, pl. 19A].
C. erosa Linnaeus, 1758; [Burgess, 1970: 175, pl. 12 A–D].
C. fimbriata Gmelin, 1791; [Burgess, 1970: 139, pl. 9I].
C. globulus Linnaeus, 1758; [Burgess, 1970: 272, pl. 30D].
C. goodalli Sowerby, 1832; [Burgess, 1970: 103, pl. 7aC].
C. helvola Linnaeus, 1758; Ladd, 1977: 23, pl. 5, Figs. 1–3; late Miocene; [Burgess, 1970: 154, pl. 10G].
C. hirundo Linnaeus, 1758; [Burgess, 1970: 286, pl. 31F].
C. humphreysii Gray, 1825; [Cernohorsky, 1967: 92, pl. 17: 92].
C. isabella Linnaeus, 1758; Ingram, 1947; [Burgess, 1970: 41, pl. 2B].
†*C.* cf. *C. kamai* (Beets, 1941); Ladd, 1977: 25, pl. 5, Figs. 13–15; early Miocene.
C. labrolineata Gaskoin, 1849; [Burgess, 1970: 143, pl. 9aF].
C. leviathan Schilder and Schilder, 1938; [Burgess, 1970: 202, pl. 15, Fig. E, E_1].
C. limacina Lamarck, 1810; [Cernohorsky, 1967, pl. 13, Fig. 69].
C. lynx Linnaeus, 1758; [Burgess, 1970: 241, pl. 24C].
C. maculifera (Schilder, 1932); [Burgess, 1970: 217, pl. 18D].
C. mappa Linnaeus, 1758; [Burgess, 1970: 248, pl. 26 A, C–D].
C. margarita (Schilder and Schilder, 1938); [Cernohorsky, 1967: 72, pl. 11: 52].
C. mariae (Schilder, 1927); [Burgess, 1970: 274, pl. 30I].
C. martini Schepman, 1907; [Burgess, 1970: 60, pl. 4D].
C. mauritiana Linnaeus, 1758; [Burgess, 1970: 247, pl. 25B].
C. microdon Gray, 1828; [Burgess, 1970: 130, pl. 9D–E].
C. minoridens Melville, 1901; [Burgess, 1970: 132, pl. 9F].
C. moneta Linnaeus, 1758; Ingram, 1947; Menge, 1973; Renaud, 1977; [Burgess, 1970: 343, pl. 41B–H].
C. nucleus Linnaeus, 1758; [Burgess, 1970: 261, pl. 29H].
C. onyx Linnaeus, 1758; [Burgess, 1970: pl. 6A].
C. poraria Linnaeus 1758; Ingram, 1947; [Burgess, 1970: 152, pl. 10B].
C. punctata Linnaeus, 1771; [Burgess, 1970: 104, pl. 7aE].
C. schilderorum (Iredale, 1939); [Burgess, 1970: 190, pl. 14A].
C. scurra Gmelin, 1791; [Burgess, 1970: 225, pl. 19D].
C. staphylaea Linnaeus, 1758; [Burgess, 1970: 259, pl. 29E].
C. stolida Linnaeus, 1758; [Burgess, 1970: 290, pl. 31E].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family CYPRAEIDAE (cont'd)
C. talpa Linnaeus, 1758; [Burgess, 1970: 199, pl. 14F].
C. teres Gmelin, 1791; [Burgess, 1970: 109, pl. 8B].
C. testudinaria Linnaeus, 1758; [Burgess, 1970: 249, pl. 27A].
C. tigris Linnaeus, 1758; [Burgess, 1970: 229, pl. 22A].
C. ursellus Gmelin, 1791; [Burgess, 1970: 287, pl. 31].
C. ventriculus Lamarck, 1810; Ingram, 1947; [Burgess, 1970: 194, pl. 14D].
C. vitellus Linnaeus, 1758; [Burgess, 1970: 206, pl. 17A].
Family OVULIDAE
Calpurnus lacteus (Lamarck, 1810); [Cernohorsky, 1967: 107, pl. 21, Fig. 121].
C. verrucosus (Linnaeus, 1758); [Cernohorsky, 1967: 107, pl. 21, Fig. 122].
Pedicularia pacifica Pease, 1865; Ladd, 1977: 25, pl. 6, Figs. 5–7; Holocene.
Phenacovolva brunneiterma Cate, 1969; [Cernohorsky, 1972: 91, pl. 23: 5].
Primovula margarita (Sowerby, 1828); [Cernohorsky, 1972: 90, pl. 23, Fig. 7].
Family ATLANTIDAE
†*Atlanta peronii* Leseur, 1817; Ladd, 1977: 26; Holocene; [Ladd, 1977: 26, pl. 6, Figs. 14–20].
Family NATICIDAE
†*Ampullina berauensis* (Beets, 1941); Ladd, 1977: 27, pl. 7, Figs. 5–7; early Miocene.
Eunaticina papilla (Gmelin, 1791); [Cernohorsky, 1972: 102, pl. 27, Fig. 5].
Natica bougei Sowerby, 1908; [Cernohorsky, 1972: 98, pl. 25, Fig. 2].
N. qualteriana Recluz, 1844; Ladd, 1977: 30, pl. 9, Figs 3–10; as *Naticarius marochiensis* (Gmelin, 1791); Miocene; Holocene; [Cernohorsky, 1972: 95, pl. 24, Fig. 9].
N. onca (Roding, 1798); [Cernohorsky, 1972: 98, pl. 25, Fig. 6].
N. violacea Sowerby, 1825; [Cernohorsky, 1972: 96, pl. 25, Fig. 6].
Neverita cf. *N. petiveriana* Recluz, 1855; Fig. 3H, 3I.
Neverita sp.; Fig. 3F, 3G.
Polinices albumen (Linnaeus, 1758); [Cernohorsky, 1972: 99, pl. 26, Fig. 2].
P. aurantius (Röding, 1798); [Cernohorsky, 1972: 99, pl. 25, Fig. 12].
P. flemingiana (Recluz, 1844); [Cernohorsky, 1972: 98, pl. 25, Fig. 11].
P. melanostomus (Gmelin, 1791); [Cernohorsky, 1972: 101, pl. 26, Fig. 8].
P. tumidus (Swainson, 1840); Ladd, 1977: 28, pl. 8, Fig. 3; as *P. mamilla* (Linnaeus, 1758); late Miocene.
†*Sinum* sp. A.; Ladd, 1977: 30, pl. 9, Figs. 1, 2; Holocene.
Family CASSIDIDAE
Casmaria erinaceus (Linnaeus, 1758); [Abbott, 1968: 190, pl. 14, Figs. 8, 10–12].
C. ponderosa (Gmelin, 1791); [Abbott, 1968: 195, pl. 14, Figs. 1, 2].
Cassis cornuta (Linnaeus, 1758); [Abbott, 1968: 47, pl. 3, Figs. 1–4].
Phalium bisulcatum (Schubert and Wagner, 1829); [Abbott, 1968: 126, pl. 8, Fig. 13].
Family CYMATIIDAE
Charonia tritonis (Linnaeus, 1767); [Kay, 1979: 215, Fig. 77F].
Cymatium aquatile (Reeve, 1844); [Kay, 1979: 220, Fig. 77A].
C. clandestinum (Lamarck, 1816); [Kay, 1979: 220, Fig. 79A].
C. flaveola (Röding, 1798); [Hinton, 1978: 30, Fig. 7].
C. gemmatum (Reeve, 1844); [Kay, 1979: 222, Fig. 79C].
C. hepaticum (Linnaeus, 1758); [Cernohorsky, 1967: 48, pl. 4, Fig. 14].
C. intermedium (Pease, 1869); [Kay, 1979: 220, Fig. 77C].
C. lotorium (Linnaeus, 1758); [Cernohorsky, 1967: 48, pl. 4, Fig. 14].
C. muricinum (Röding, 1798); [Kay, 1979: 217, Fig. 77E].
C. nicobaricum (Röding, 1798); Houbrick, 1974; [Kay, 1979: 216, Fig. 77D].
C. pileare (Linnaeus, 1758); [Kay, 1979: 221, Fig. 77B].
C. pyrum (Linnaeus, 1758); [Kay, 1979: 218, Fig. 78B].
C. rubeculum (Linnaeus, 1758); [Cernohorsky, 1967: 52, pl. 4, Fig. 13].
C. vespaceum (Lamarck, 1822); [Kay, 1979: 223, Fig. 79E].
Distorsio anus (Linnaeus, 1758); [Kay, 1979: 223, Fig. 79K].
D. pusilla Pease, 1861; Ladd, 1977: 35, pl. 11, Figs. 12, 13; Holocene.
Gyrineum roseum (Reeve, 1844); [Cernohorsky, 1972: 117, pl. 32, Fig. 3].
[The occurrence of *Cymatium* cf. *C. caudatum* (Gmelin, 1791) cited by Ekdale et al. (1979) has not been confirmed].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family BURSIDAE
Bursa bufonia (Gmelin, 1791); Demond, 1957: 308; Kohn and Leviten, 1976; [Cernohorsky, 1967: 42, pl. 2, Fig. 5].
B. cruentata (Sowerby, 1841); [Kay, 1979: 227, Fig. 80B].
B. granularis (Röding, 1798); [Kay, 1979: 227, Fig. 80A].
B. rhodostoma (Sowerby, 1841); [Kay, 1979: 229, Fig. 80C–D].
B. rosa (Perry, 1811); [Kay, 1979: 229, Fig. 80E–F].
B. rubeta (Linnaeus, 1758); [Cernohorsky, 1972: 118, pl. 1, Fig. 5].
Tutufa bubo (Linnaeus, 1758); [Cernohorsky, 1972: 42, pl. 1, Fig. 1].
Family TONNIDAE
Malea pomum (Linnaeus, 1758); [Kay, 1979: 231, Fig. 81A].
Tonna perdix (Linnaeus, 1758); [Kay, 1979: 233, Fig. 81D].
‡Order HETEROGASTROPODA
Family ARCHITECTONICIDAE
†*Architectonica corwini* Ladd, 1972; Ladd, 1972: 18, pl. 2, Figs. 14–18; Miocene.
†*Climacopoma?* sp. A.; Ladd, 1972: 18, pl. 2, Figs. 8–10; early Miocene.
Heliacus infundibuliformis (Gmelin, 1791); [Cernohorsky, 1978: 165, pl. 58, Fig. 7].
H. variegatus (Gmelin, 1791); Ladd, 1972: 19, pl. 3, Figs. 1–3; late Miocene.
Philippia oxytropis A. Adams, 1855; [Kay, 1979: 100, Fig. 36A].
P. radiata (Roding, 1798); Ladd, 1972: 19, pl. 2, Figs. 19–21; late Miocene.
Family TRIPHORIDAE
[The arrangement follows that of Marshall (1983)].
†*Bouchetriphora otsuensis* (Yokoyama, 1920); Ladd, 1972: 45, pl. 11, Fig. 15; as *Triphora;* early Miocene.
B. pallida (Pease, 1871); Ladd, 1972: 45, pl. 11, Fig. 14; as *Triphora;* Holocene; [Kay, 1979: 148, Fig. 51L; as *Triphora*].
B. quadrimaculata (Hervier, 1897); Fig. 2J.
Euthymella elegans (Hinds, 1843); Ladd, 1972: 50, pl. 13, Fig. 2; as *Viriola;* Holocene; [Cernohorsky, 1978: 173, pl. 61, Fig. 7].
E. pagoda (Hinds, 1843); Ladd, 1972: 50, pl. 12, Fig. 21; as *Viriola;* Holocene.
E. cf. *E. regalis* (Jousseaume, 1884); Fig. 2M.
Inella cf. *I. aemulans* (Hinds, 1843); [Kay, 1979: 133, Fig. 48B].
I. japonica Kuroda and Kosuge, 1963; Fig. 2H.
I. cf. *I. lanceolata* Kosuge, 1962; [Kosuge, 1962: 120, pl. 8, Fig. 16].
†*I. maharatai* Beets, 1941; Ladd, 1972: 46, pl. 12, Fig. 1; early Miocene; late Miocene.
I. pyramidalis (Adams and Reeve, 1850); Ladd, 1972: 45, pl. 11, Figs. 16, 17; as *Triphora (Inella)*; Miocene.
Iniforis albogranosa Kosuge, 1961; Ladd, 1972: 47, pl. 12, Figs. 3–5; as *Triphora (Iniforis);* Holocene; [Kosuge, 1961: 313, pl. 19, Fig. 7].
I. formosulus (Hervier, 1897); [Cernhorsky, 1978: 170, pl. 60, Fig. 4].
I. ikukoae (Kosuge, 1963); [Kosuge, 1963; 258, pl. 18, Fig. 1].
I. lifuana (Hervier, 1897); [Kosuge, 1961: pl. 19, Fig. 5].
I. ofuensis (Baker and Spicer, 1935); Ladd, 1972: 47, pl. 12, Figs. 8–12; Holocene.
†*Mastonia intermissa* (Laseron, 1958); Ladd, 1972: 49, pl. 12, Figs. 17, 18; late Miocene.
M. rubra (Hinds, 1843); [Cernohorsky, 1978: 170, pl. 60, Fig. 6].
†*M. squamosa* (Kosuge, 1962); Ladd, 1972: 48, pl. 12, Fig. 16; Holocene.
M. ustulata (Hervier, 1897); Fig. 2N.
Mastoniaeformis clavata (Pease, 1871); [Kay, 1979: 133, Fig. 48B; as *Iniforis aemulans* Hinds].
M. concors (Hinds, 1843); [Kay, 1979: 133, Fig. 48D].
Mesophora cnodax (Jousseaume, 1884); Fig. 20.
M. granosa (Pease, 1871); [Marshall, 1983: 45, Figs. 19E–G].
Metaxia cf. *M. albicephala* Kay, 1979; [Kay, 1979: 130, Fig. 48M].
Metaxia sp.; Fig. 2P.
Nanophora cf. *N. atratus* (Kosuge, 1962); [Kosuge, 1962: 83, pl. 9, Fig. 5].
†*N. cingulifera* (Pease, 1861); Ladd, 1972: 48, pl. 12, Fig. 13; as *Triphora (Mastonia);* Holocene.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

‡The ordinal taxon "Heterogastropoda" is utilized here as a convenience only. Kosuge (1966) proposed the suborder Heterogastropoda to accommodate the Triphoridae, Mathildidae, Architectonicidae, and Epitoniidae, which he regarded as distinct from the Taenioglossa and Steonglossa. Haszpruner (1984, 1985) separates the Architectonicidae and Pyramidellidae as the Allogastropoda, distinct from the Architaenioglossa (the Valvatacea, Cyclophoracea, and Viviparacea); the Neotaenioglossa (rissoids, cerithiids, hipponicids, strombids, cypraeids, naticids, and tonnids); the Heteroglossa (cerithiopsids, triphorids, epitoniids and eulimids); and the Stenoglossa (the Neogastropods, including muricids, cancellarids, and the Conacea).

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TABLE 1 (cont'd)

Family TRIPHORIDAE (cont'd)
N. cf. *N. leucomys* (Hervier, 1897); Fig. 2I.
N. triticea (Pease, 1861); [Kay, 1979: 150, Fig. 51E].
Nanophora sp.; Fig. 2H.
Tetraphora hervieri (Kosuge, 1962); [Cernohorsky, 1978: 172, pl. 60, Fig. 14].
Triphora granulata (Adams and Reeve, 1850); [Cernohorsky, 1978: 169, pl. 59, Fig. 10].
T. taeniolata (Hervier, 1897); [Cernohorsky, 1978: 172, pl. 61, Fig. 1; as *Inella (Cautotriphora) monovitta* Laseron, 1958].
Viriola abbotti (Baker and Spicer, 1935); [Kay, 1979: 139, Fig. 50E].
V. bayani Jousseaume, 1884; [Kay, 1979: 139, Fig. 50J].
V. cancellata (Hinds, 1843); Ladd, 1972: 50, pl. 13, Fig. 1; late Miocene; [Kay, 1979: 140, Fig. 50D].
V. cf. *V. corrugata* (Hinds, 1843); [Cernohorsky, 1978: 173, pl. 61, Fig. 6; as *Viriola interfilata* (Gould)].
V. incisa (Pease, 1861); Ladd, 1972: 50, pl. 15, Fig. 22; Holocene.
V. intergranosa (Hervier, 1897); [Cernohorsky, 1978: 123, pl. 61, Fig. 8].
Family EPITONIIDAE
Epitonium alatum (Sowerby, 1844); [Kay, 1979: 153, Fig. 54C].
E. auritum (Sowerby, 1844); Fig. 3E.
E. irregularis (Sowerby, 1844); [Cernohorsky, 1972: 197, pl. 56, Fig. 8].
E. paumotensis (Pease, 1868); [Kay, 1979: 156, Fig. 54A].
E. perplexum (Deshayes, 1863); Ladd, 1972: 51, pl. 13, Fig. 3; Holocene; [Kay, 1979: 156, Fig. 54B].
E. symmetrica (Pease, 1868).
E. revolutum (Hedley, 1899); [Kay, 1979: 156, Fig. 54F].
E. cf. *E. vestalis* (Hinds, 1844); [Cernohorsky, 1978: 168, pl. 59, Fig. 7].
E. umbilicatum (Pease, 1869); [Kay, 1979: 157, Fig. 54K].
Opalia bicarinata (Sowerby, 1844); [Cernohorsky, 1978: 168, pl. 59, Fig. 9; as *Nodiscala*].
Family JANTHINIDAE
Janthina globosa Swainson, 1822; [Kay, 1979: 158, Fig. 55A, D].
J. janthina (Linnaeus, 1758); [Kay, 1979: 158, Fig. 55B].
Order NEOGASTROPODA
Family MURICIDAE
Aspella producta (Pease, 1861); [Kay, 1979: 235, Figs. 83C, D].
Attiliosa caledonicus (Jousseaume, 1881); [Vokes and D'Attilio, 1982: 70, Fig. 5].
Chicoreus brunneus (Link, 1807); [Cernohorsky, 1967: 120, pl. 25, Fig. 148].
C. microphyllus (Lamarck, 1816); [Radwin and D'Attilio, 1976: 39, pl. 4, Fig. 7].
C. ramosus (Linnaeus, 1758); [Cernohorsky, 1967: 122, pl. 25, Fig. 152].
Favartia guamensis Emerson and D'Attilio, 1979; [Emerson and D'Attilio, 1979, 4, Figs. 11, 12].
Homalocantha anatomica (Perry, 1811); [Radwin and D'Attilio, 1976, pl. 9, Fig. 5].
Marchia bipinnata (Reeve, 1845); [Radwin and D'Attilio, 1976: pl. 9, Fig. 1].
M. laqueata (Sowerby, 1841); [Radwin and D'Attilio, 1976: 58, pl. 9, Fig. 12].
M. martinetana (Röding, 1798); [Radwin and D'Attilio, 1976: pl. 27, Fig. 3].
M. triptera (Born, 1778); [Radwin and D'Attilio, 1976: pl. 9, Fig. 12].
Naguetia trigonula (Lamarck, 1816); [Radwin and D'Attilio, 1976, pl. 15, Fig. 12].
N. triquetra (Born, 1778); [Radwin and D'Attilio, 1976, pl. 15, Fig. 11].
Phyllocoma convoluta (Broderip, 1833); [Cernohorsky, 1967, pl. 24, Fig. 14].
Phyllonotus laciniatus (Sowerby, 1841); [Radwin and D'Attilio, 1976, pl. 6, Fig. 3].
†*Pterynotus* sp.; Ladd, 1977: 39, pl. 14, Fig. 3; Holocene.
Family THAIDIDAE
Cronia fiscella (Gmelin, 1791); Ladd, 1977: 40, pl. 14, Fig. 8; late Miocene; [Cernohorsky, 1972: 128, pl. 36, Fig. 8; as *Morula margariticola* (Broderip, 1832)].
Drupa arachnoides (Lamarck, 1822); Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; [Emerson and Cernohorsky, 1973: pl. 2, Fig. 6; as *Drupa ricinus ricinus*].
D. clathrata (Lamarck, 1816); Bernstein, 1974; Emerson and Cernohorsky, 1973: 33, pl. 2, Figs. 16–18.
D. elegans (Broderip and Sowerby, 1829); Bernstein, 1974; Emerson and Cernohorsky, 1973: 25, pl. 2, Fig. 12.
D. grossularia Röding, 1798; Emerson and Cernohorsky, 1973: 37, pl. 2, Figs. 23, 24; Kohn, 1980a.
D. morum Röding, 1798; Emerson and Cernohorsky, 1973: 17, pl. 2, Figs. 1–3; Bernstein, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980.
D. ricina (Linnaeus, 1758); Emerson and Cernohorsky, 1973: 22, pl. 2, Figs. 7,8; Bernstein, 1974, Leviten, 1974; Kohn and Leviten, 1976; Kohn 1980a; Leviten and Kohn, 1980.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family THAIDIDAE (cont'd)

D. rubusidaeus Röding, 1798; Emerson and Cernohorsky, 1973: 29, pl. 2, Figs. 13–15.
Drupella elata (Blainville, 1832); Kohn, 1980a; as *Drupella cornus* (Roding, 1798); [Kay, 1979: 244, Fig. 87A].
D. fenestrata (Blainville, 1832); [Cernohorsky, 1978: 68, pl. 19, Fig. 10].
D. fragum (Blainville, 1832); [Moyer et al., 1982: Fig. 1].
D. rugosa (Born, 1778); Ladd, 1982: 44, pl. 11, Figs. 12, 13; as *D. concatenata* (Lamarck, 1822); Holocene; [Cernohorsky, 1972: 126, pl. 35, Fig. 5].
Drupella sp., [Kay, 1979: 244, Fig. 87B; as *Drupella ochrostoma* (Blainville, 1832)].
Maculotriton eximius (Reeve, 1844); [Cernohorsky, 1978: 71, pl. 20, Fig. 10].
M. sculptile (Reeve, 1844); [Cernohorsky, 1972: 130, pl. 36, Fig. 12].
M. serriale (Deshayes, 1824); Leviten, 1974; as *M. bracteatus* (Hinds, 1844); Kohn and Leviten, 1976; Kohn, 1980a; [Cernohorsky, 1972: 129, pl. 36, Fig. 11].
Morula anaxeres (Kiener, 1836); [Cernohorsky, 1972: 126, pl. 35, Fig. 10].
M. funiculata (Reeve, 1846); Ladd, 1977: 40; as *Drupa (Drupella)* cf. *D. monilifera* (Pease, 1860); Holocene; [Kay, 1979; 247, Fig. 83I].
M. granulata (Duclos, 1832); Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Ladd, 1977: 40, pl. 14, Fig. 7; Holocene; Kohn, 1980a; as *Morula fiscella*; Leviten and Kohn, 1980; [Cernohorsky, 1972: 127, pl. 36, Fig. 2].
M. nodicostata (Pease, 1868); [Cernohorsky, 1972: 127, pl. 36, Fig. 6].
M. spinosa (H. and A. Adams, 1853); [Cernohorsky, 1978: 128, pl. 36, Fig. 6].
M. squamosa (Pease, 1868); Figs. 3J, 3K.
M. uva (Röding, 1798); Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Kay, 1979: 249, Fig. 87F].
Muricodrupa funiculus (Wood, 1828); Kohn and Leviten, 1976; [Kay, 1979: 238, Fig. 83I].
Nassa serta (Bruguière, 1789); [Cernohorsky, 1967: 135, pl. 29, Fig. 193].
Thais aculeata (Deshayes, 1844); [Cernohorsky, 1967: 130, pl. 28, Fig. 172; as *Thais hippocastanum* (Linnaeus, 1758)].
T. armigera (Link, 1807); Menge, 1973; Bernstein, 1974; Leviten and Kohn, 1980; [Kay, 1979: 251, Fig. 88G].
T. intermedia (Kiener, 1836); Bernstein, 1974; [Kay, 1979: 251, Fig. 88H].
T. tuberosa (Röding, 1798); Leviten, 1974; Kohn and Leviten, 1976; Leviten and Kohn, 1980; Kohn, 1980a; [Cernohorsky, 1967; 130, pl. 28, Fig. 174].
Vexilla lineata A. Adams, 1853; [Kay, 1979: 252, Fig. 88E].
V. vexillum (Gmelin, 1791); [Kay, 1979: 252, Fig. 88D].
[The record of *Purpura aperta* (Blainville, 1832) cited by Kay (1979) has not been confirmed].

Family CORALLIOPHILIDAE

Coralliophila costularis (Lamarck, 1816); [Cernohorsky, 1978: 73, pl. 21, Fig. 5].
C. d'orbignyana (Petit, 1851); [Kay, 1979: 255, Fig. 90A].
C. erosa (Roding, 1798); [Cernohorsky, 1972: 131, pl. 37, Fig. 6].
†*C. macneili* Ladd, 1977; Ladd, 1977: 41–42, pl. 14, Figs. 12, 13; late Miocene.
C. violacea (Kiener, 1836); [Kay, 1979: 256, Fig. 90C].
†*Coralliophila (Coralliophila)* sp.; Ladd, 1977: 41, pl. 14, Fig. 11; Holocene.
†*Coralliophila (Fusomurex)* sp. A.; Ladd, 1977: 42, pl. 15, Fig. 3; late Miocene.
†*Coralliophila (Fusomurex)* sp. B.; Ladd, 1977: 42, pl. 15, Fig. 4; early Miocene.
Latiaxis inflata (Dunker, 1847); Ladd, 1977: 43, pl. 15, Fig. 5; late Miocene.
Quoyula monodonta (Blainville, 1832); Ladd, 1977: 43–44, pl. 15, Fig. 7; Holocene; [Kay, 1979: 258, Fig. 90G; as *Quoyula madreporarum* Sowerby].
Rapa rapa (Linnaeus, 1758); [Cernohorsky, 1972: 130, pl. 37, Fig. 4].

Family BUCCINIDAE

Caducifer truncata (Hinds, 1844); [Cernohorsky, 1972: 141, pl. 30, Fig. 4].
Cantharus eximius Reeve, 1846; [Cernohorsky, 1978: 76, pl. 22, Fig. 11].
C. farinosus (Gould, 1850); [Kay, 1979: 261, Fig. 92D].
C. pulcher (Reeve, 1846); [Cernohorsky, 1972: 142, pl. 38, Fig. 8].
C. undosus (Linnaeus, 1758); Leviten, 1974; Kohn, 1980a; [Cernohorsky, 1972: 141, pl. 38, Fig. 5].
C. wagneri (Anton, 1839); [Cernohorsky, 1972: 142, pl. 39, Fig. 1].
Clivipollia fragaria (Wood, 1828); [Kay, 1979: 263, Fig. 92E].
Engina egregia (Reeve, 1844); [Cernohorsky, 1972: 143, pl. 39, Fig. 4].
E. lineata (Reeve, 1846); [Cernohorsky, 1972: 143, pl. 39, Fig. 4].
E. mendicaria (Linnaeus, 1758); [Cernohorsky, 1972: 144, pl. 38, Fig. 9].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family BUCCINIDAE (cont'd)
E. zonalis (Lamarck, 1822); [Salisbury, 1983a: 7].
Prodotia ignea (Gmelin, 1791); [Kay, 1979: 264, Fig. 92I].
P. iostoma (Gray, 1834); [Kay, 1979: 264, Fig. 92J].
Family COLUMBELLIDAE
Aesopus spiculum (Duclos, 1846); [Cernohorsky, 1972: 138, pl. 41, Fig. 9].
Anachis miser (Sowerby, 1844); [Kay, 1979: 266, Fig. 94F].
Columbella cf. *C. moleculina* Duclos, 1835; Fig. 3N.
†*C. pardalina* Lamarck, 1822; Ladd, 1977: 44, pl. 15, Fig. 11; late Miocene.
Euplica amirantium (Smith, 1884); Fig. 3M.
E. deshayesii (Crosse, 1859); [Cernohorsky, 1972: 134, pl. 40, Fig. 6].
E. cf. *E. liocyma* Pilsbry, 1904; Fig. 3Q.
E. cf. *E. minuta* Gould, 1860; Fig. 3R.
E. obesula Hervier, 1899; Fig. 3W.
E. turturina (Lamarck, 1822); Ladd, 1977: 44, pl. 15, Figs. 12, 13; Quaternary.
E. varians (Sowerby, 1832); Bernstein, 1974; Ladd, 1977: 45, pl. 15, Fig. 14; Holocene.
†*Lavesopus eniwetokensis* Ladd, 1977; Ladd, 1977: 45, pl. 16, Fig. 1; Holocene.
Mitrella fusiformis (Pease, 1869); [Kay, 1979: 268, Fig. 94H–I].
M. cf. *M. albina* (Kiener, 1841); Fig. 3P.
M. ligula (Duclos, 1840); [Cernohorsky, 1972: 135, pl. 41, Fig. 1].
†*M. sagitta* (Gaskoin, 1851); Ladd, 1977: 47, pl. 16, Fig. 11; early Miocene to Holocene.
Pyrene flava (Bruguière, 1789); [Cernohorsky, 1972: 132, pl. 40, Fig. 2].
P. cf. *P. livescens* (Reeve, 1859); Fig. 30.
P. obtusa (Sowerby, 1832); Ladd, 1977: 47, pl. 16, Fig. 10; Holocene; Fig. 3L.
P. ocellata (Link, 1807); [Cernohorsky, 1972: 132, pl. 40, Fig. 3].
P. punctata (Bruguière, 1789); Fig. 3V.
P. splendidula (Sowerby, 1874); [Habe, 1964: 89, pl. 28, Fig. 30].
P. testudinaria (Link, 1807); [Cernohorsky, 1972: 133, pl. 40, Fig. 4].
Seminella cf. *S. dautzenbergi* (Hervier, 1897); Fig. 3T.
S. divaricata (Pilsbry, 1904); Fig. 3S.
†*S. smithi* (Angas, 1877); Ladd, 1977: 47, pl. 16, Fig. 9 as *Anachis*; late Miocene.
S. subphilodicia (Hervier, 1899); Fig. 3U.
Zafra troglodytes (Souverbie, 1866); [Cernohorsky, 1972: 138, pl. 41, Fig. 8].
Zafrona pusilla (Pease, 1860); Ladd, 1977: 45, pl. 16, Fig. 2; as *Zafrona lifuana* (Hervier, 1899); Holocene.
Family COLUBRARIIDAE
Colubraria antiquata (Hinds, 1844); [Cernohorsky, 1972: 121, pl. 37, Fig. 2].
C. cf. *C. cumingi* (Dohrn, 1861); [Hirase, 1951: pl. 105, Fig. 1].
C. muricata (Lightfoot, 1786); [Kay, 1979: 271, Fig. 92L].
C. nitidula (Sowerby, 1833); [Cernohorsky, 1972: 121, pl. 37, Fig. 1].
C. tortuosa (Reeve, 1844); [Kay, 1979: 272, Fig. 92M].
Family MELONGENIDAE
†*Pugilina swartzi* Ladd, 1977; Ladd, 1977: 51, pl. 17, Figs. 6, 8; early Miocene.
Family NASSARIIDAE
Nassarius comptus (A. Adams, 1852); [Cernohorsky, 1978: 87, pl. 27, Fig. 4].
N. concinnus (Powys, 1835); [Cernohorsky, 1978: 88, pl. 27, Fig. 9].
†*N. eniwetokensis* Ladd, 1977; Ladd, 1977: 52, pl. 17, Figs. 14, 15; late Miocene.
N. gaudiosus (Hinds, 1844); Kohn, 1980a; [Cernohorsky, 1978: 86, pl. 27, Fig. 2].
N. glans (Linnaeus, 1758); [Cernohorsky, 1972: 151, pl. 45, Fig. 1].
N. graniferus (Kiener, 1834); [Cernohorsky, 1972: 146, pl. 42, Fig. 5].
†*N. marshallensis* Ladd, 1977; Ladd, 1977: 55, pl. 18, Figs. 6, 7; Miocene.
N. papillosus (Linnaeus, 1758); [Kay, 1979: 275, Fig. 95A].
N. pauperus (Gould, 1850); [Cernohorsky, 1972: 152, pl. 44, Fig. 8].
†*N. tiarula* (Kiener, 1841); Ladd, 1977: 52, pl. 17, Fig. 9; pl. 21, Fig. 9; Holocene.
Family FASCIOLARIIDAE
Dolicholatirus lancea (Gmelin, 1791); [Cernohorsky, 1972: 161, pl. 46, Fig. 7].
Fasciolaria filamentosa (Röding, 1798); [Cernohorsky, 1972: 153, pl. 45, Fig. 3].
Fusinus undatus (Gmelin, 1791); [Cernohorsky, 1972: 162, pl. 48, Fig. 2].
Latirus craticulatus (Linnaeus, 1758); [Cernohorsky, 1972: 156, pl. 46, Fig. 5].
L. maculatus (Reeve, 1847); [Cernohorsky, 1978: 92, pl. 29, Fig. 1].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family FASCIOLARIIDAE (cont'd)
L. nodatus (Gmelin, 1791); [Kay, 1979: 278, Fig. 96H].
L. noumeensis (Crosse, 1870); [Cernohorsky, 1978: 92, pl. 29, Fig. 3].
L. polygonus (Gmelin, 1791); Leviten, 1974; as *L. barclayi* (Reeve, 1847); [Cernohorsky, 1972: 154, pl. 45, Fig. 7].
Peristernia chlorostoma (Sowerby, 1825); Ladd, 1977: 56, pl. 18, Fig. 12; Holocene.
†*P. eniwetokensis* Ladd, 1977; Ladd, 1977: 57, pl. 18, Figs. 14, 15; Miocene.
P. funiculata (Tapparone-Canefri, 1882); [Cernohorsky, 1978: 142, pl. 29, Fig. 4].
P. incarnata (Kiener, 1840); [Cernohorsky, 1972: 161, pl. 47, Fig. 5].
P. nassatula (Lamarck, 1822); Ladd, 1977: 56, pl. 18, Fig. 10; early Miocene.
Family VASIDAE
Vasum ceramicum (Linnaeus, 1758); [Abbott, 1959: pl. 1, Fig. 1].
V. turbinellum (Linnaeus 1758); Leviten, 1974; Kohn and Leviten, 1976; as *V. cornigerum* (Lamarck, 1822); Kohn, 1980a; [Abbott, 1959: pl. 1, Figs. 2, 3].
Family OLIVIDAE
Belloliva simplex (Pease, 1867); Ladd, 1977: 58, pl. 18, Fig. 19; early Miocene; Holocene.
Oliva annulata (Gmelin, 1791); [Cernohorsky, 1967: pl. 46, Fig. 334].
O. carneola (Gmelin, 1791); [Cernohorsky, 1967: pl. 46, Fig. 337].
O. miniacea (Röding, 1798); [Cernohorsky, 1967: pl. 47, Fig. 340].
O. panniculata Montfort, 1810; [Zeigler and Porreca, 1969: 76, pl. 10, Fig. 19].
O. paxillus Reeve, 1850; [Cernohorsky, 1967: 192, pl. 48, Fig. 345].
Family HARPIDAE
†*Eocithara*? sp. B.; Rehder, 1973: 231; Ladd, 1977: 67; late Miocene.
Harpa amouretta Röding, 1798; Rehder, 1973: 240, pl. 189, Figs. 6–11.
H. gracilis Broderip and Sowerby, 1829; [Rehder, 1973, pl. 189, Figs. 3–5].
H. harpa (Linnaeus, 1758); Rehder, 1973: 237, pl. 187: Figs. 7–10.
Family MARGINELLIDAE
Granulina cf. *G. vitrea* Laseron, 1957; Fig. 4A.
Haloginella micros (Bavay, 1922); Fig. 4E.
H. cf. *H. keppelense* Laseron, 1957; Fig. 4F.
Kogomea hervieri (Bavay, 1922); Fig. 4G.
K. ovata Habe, 1951; Fig. 4B.
Kogomea sp.; Fig. 4C.
†*Marginella ringicula* Sowerby, 1900; Ladd, 1982: 59, pl. 37, Figs. 11, 12; Miocene.
Persicula cf. *P. pacifica* (Pease, 1868); [Cernohosky, 1972: pl. 48, Fig. 7].
Tringinella sp.; Fig. 4D.
Volvarina cf. *V. avena* (Kiener, 1834); Ladd, 1982: 59, pl. 37, Figs. 11, 12); Miocene.
V. fusiformis (Hinds, 1844); [Kay, 1979: Fig. 99B].
V. cf. *V. volunta* (Laseron, 1957); [Laseron, 1957: 305, Fig. 83].
Family MITRIDAE
Cancilla carnicolor (Reeve, 1844); [Cernohorsky, 1978: 104, pl. 33, Fig. 7].
C. filaris (Linnaeus, 1758); [Cernohorsky, 1967, pl. 36, Fig. 241].
C. fulgetrum (Reeve, 1844); [Cernohorsky, 1967: pl. 30, Fig. 188; as *M. boissaci* Montrouzier, 1858].
C. praestantissima (Röding, 1798); [Cernohorsky, 1967: pl. 37, Fig. 250].
Imbricaria conovula (Quoy and Gaimard, 1833); [Cernohorsky, 1978: 105, pl. 34, Fig. 5].
I. conularis (Lamarck, 1811); [Cernohorsky, 1967: 160, pl. 37, Fig. 254].
I. olivaeformis (Swainson, 1821); [Cernohorsky, 1967: 160, pl. 37, Fig. 255].
I. punctata (Swainson, 1821); Kohn and Leviten, 1976; [Cernohorsky, 1967: 160, pl. 37, Fig. 256].
I. vanikorensis (Quoy and Gaimard, 1833); [Cernohorsky, 1976: 160, pl. 37, Fig. 257].
Mitra acuminata Swainson, 1824; Cernohorsky, 1976: 494, [pl. 258, Figs. 26, 27].
M. aurora Dohrn, 1861; [Cernohorsky, 1976: 441, pl. 257, Figs. 21, 22].
M. avenacea Reeve, 1845; [Cernohorsky, 1976: 411, pl. 351].
M. cardinalis (Gmelin, 1791); Cernohorsky, 1976: 312, pl. 253, Figs. 5, 6.
M. chrysalis Reeve, 1844; Cernohorsky, 1976: 402, pl. 256, Figs. 16, 17.
M. chrysostoma Broderip, 1836; [Cernohorsky, 1976: pl. 256, Figs. 5, 6].
M. coarctata Reeve, 1844; [Cernohorsky, 1976: pl. 256, Fig. 8].
M. coffea Schubert and Wagner, 1829; [Cernohorsky, 1976: 320, pl. 255, Figs. 3, 4].
M. columbelliformis Kiener, 1838; [Cernohorsky, 1976: 491, pl. 258, Figs. 23–25].
M. contracta Swainson, 1820; [Cernohorsky, 1976: 393, pl. 256, Fig. 7].
M. coronata Lamarck, 1811; [Cernohorsky, 1976: 437, pl. 257, Figs. 16–18].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family MITRIDAE (cont'd)

M. cucumerina Lamarck, 1811; Bernstein, 1974; Kohn and Leviten, 1976; Kohn, 1980a; [Cernohorsky, 1976: 400, pl. 256, Figs. 13–15].
M. edentula Swainson, 1823; [Cernohorsky, 1976: pl. 257, Figs. 35, 36].
M. eremitarum (Röding, 1798; [Cernohorsky, 1976: 324, pl. 255, Figs. 7, 8].
M. fastigium Reeve, 1845; Bernstein, 1974; as *Mitra brunnea* Pease, 1868; [Cernohorsky, 1976: 494, pl. 258, Figs. 28, 29].
M. ferruginea Lamarck, 1811; [Cernohorsky, 1976: 397, pl. 256, Figs. 9, 10].
M. fraga Quoy and Gaimard, 1833; Ladd, 1977: 60, pl. 19, Fig. 9; Holocene; [Cernohorsky, 1976: 404, pl. 256, Figs. 18, 19].
M. fulvescens Broderip, 1836; [Cernohorsky, 1976: 431, pl. 257, Figs. 10, 11].
M. imperialis Röding, 1798; Cernohorsky, 1976: 321, pl. 255, Figs. 15, 16.
M. incompta (Solander in Lightfoot, 1786); [Cernohorsky, 1976: 322, pl. 253, Fig. 11].
M. litterata Lamarck, 1811; Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; as *Strigatella*; Kohn, 1980a; as *Strigatella*; Leviten and Kohn, 1980; [Cernohorsky, 1976: 482, pl. 258, Figs. 9–11].
M. luctuosa A. Adams, 1853; [Cernohorsky, 1976: 443, pl. 257, Figs. 23, 24].
M. mitra (Linnaeus, 1758); [Cernohorsky, 1976: 307, pl. 253, Fig. 1].
M. nivea (Broderip, 1836); [Cernohorsky, 1976: 335, pl. 291].
M. papalis (Linnaeus, 1758); [Cernohosky, 1976: 308, pl. 253, Fig. 3].
M. paupercula (Linnaeus, 1758); Leviten and Kohn, 1980; [Cernohorsky, 1976: 477, pl. 258, Figs. 1–3].
M. peculiaris Reeve, 1845; [Cernohorsky, 1976: 424, pl. 452].
M. petrosa Sowerby, 1874; [Cernohorsky, 1976: pl. 292, Fig. 13; "albino form of *M. ustulata*"].
M. pyramis (Wood, 1828); [Cernohorsky, 1976: 424, pl. 371].
M. rubritincta Reeve, 1844; [Cernohorsky, 1976: 399, pl. 256, Figs. 11, 12].
M. scutulata (Gmelin, 1791); [Cernohorsky, 1976: 488, pl. 258, Figs. 17–20].
M. stictica (Link, 1807); [Cernohorsky, 1976: 309, pl. 253, Figs. 3, 4].
M. tabanula Lamarck, 1811; [Cernohorsky, 1976: 408, pl. 256, Fig. 22].
M. ticaonica Reeve, 1844; [Cernohorsky, 1976: 429, pl. 257, Figs. 4, 5].
†*M. turgida* Reeve, 1845; Ladd, 1977: 60, pl. 19, Figs. 10, 11; late Miocene.
M. typha Reeve, 1845; [Cernohorsky, 1976: 499, pl. 450].
M. ustulata Reeve, 1844; [Cernohorsky, 1976: 337, pl. 292].
M. vultuosa Reeve, 1845; [Cernohorsky, 1976: 442, pl. 391, Fig. 5].
Neocancilla clathrus (Gmelin, 1791); [Cernohorsky, 1967: 154, pl. 35, Fig. 238].
N. papilio (Link, 1807); [Cernohorsky, 1967: 154, pl. 32, Fig. 210].
Pterygia crenulata (Gmelin, 1791); [Cernohorsky, 1967: 161, pl. 38, Fig. 259].
P. dactylus (Linnaeus, 1767); [Cernohorsky, 1967: 162, pl. 38, Fig. 260].
P. fenestrata (Lamarck, 1811); [Cernohorsky, 1967: 162, pl. 38, Fig. 261].
P. nucea (Gmelin, 1791); [Cernohorsky, 1967: 162, pl. 38, Fig. 262].
Scabricola casta (Gmelin, 1791); [Cernohorsky, 1967: 160, pl. 37, Fig. 258].
S. caerulea (Reeve, 1844); [Cernohorsky, 1972: 173, pl. 51, Fig. 6].
S. desetangsii (Kiener, 1838); [Cernohorsky, 1967: 161, pl. 37, Fig. 251; as *Swainsonia suffecta* (Dautzenberg and Bouge, 1923)].
S. variegata (Gmelin, 1791); [Cernohorsky, 1978: 101, pl. 32, Fig. 4].
Subcancilla interlirata (Reeve, 1844); [Cernohorsky, 1978: 105, pl. 34, Fig. 3].
S. verrucosa (Reeve, 1845); [Cernohorsky, 1967: 158, pl. 36, Fig. 249; as *Cancilla*].

Family COSTELLARIIDAE

Vexillum acupictum (Reeve, 1844); [Cernohorsky, 1967: 164, pl. 38, Fig. 256].
V. amabilis (Reeve, 1845); [Cernohorsky, 1967: 90, pl. 44, Fig. 320].
†*V. approximatum* (Pease, 1860); Ladd, 1977: 66, pl. 20, Fig. 19; early Miocene.
V. bernhardina (Röding, 1798); [Cernohorsky, 1967: 182, pl. 44, Fig. 322].
V. cadaverosum (Reeve, 1844); [Cernohorsky, 1967: 166, pl. 39, Fig. 269].
V. cancellarioides (Anton, 1839); Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Leviten and Kohn, 1980; as *Pusia nodosa* (Swainson, 1840); Kohn, 1980a; as *Pusia cancellarioides* (Anton, 1839); [Kay, 1979: 325, Fig. 109B].
V. catenatum (Broderip, 1836); [Cernohorsky, 1978: 116, pl. 40, Fig. 4].
†*V. cernohorskyi* Ladd, 1977; Ladd, 1977: 63, pl. 20, Figs. 6, 7; late Miocene.
V. corbiculum (Sowerby, 1870); [Cernohorsky, 1978: 112, pl. 37, Fig. 8].
V. coronatum (Helbling, 1779); [Cernohorsky, 1967: 166, pl. 39, Fig. 27].
V. costatum (Gmelin, 1791); [Cernohorsky, 1967: 167, pl. 39, Fig. 273].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family COSTELLARIIDAE (cont'd)

V. crocatum (Lamarck, 1811); [Cernohorsky, 1967: 167, pl. 39, Fig. 273].
V. deshayesi (Reeve, 1844); Ladd, 1977: 63, pl. 20, Fig. 8; late Miocene.
V. echinatum (A. Adams, 1853); [Cernohorsky, 1967: 168, pl. 40, Fig. 280].
V. emiliae (Garrett, 1880); [Kay, 1979: 327, pl. 109F].
V. exasperatum (Gmelin, 1791); [Cernohorsky, 1967: 168, pl. 40, Fig. 281].
†*V. exquisitum* (Garrett, 1872); Ladd, 1977: 66, pl. 21, Fig. 1; Holocene.
V. festum (Reeve, 1845); Ladd, 1977: 64, pl. 20, Fig. 10; Miocene.
V. filistriatum (Sowerby, 1874); [Cernohorsky, 1978: 110, pl. 36, Fig. 7].
V. fortiplicatum (Pease, 1868); [Cernohorsky, 1972: 176, pl. 52, Fig. 6].
†*V.* cf. *V. gembacanum* (Martin, 1884); Ladd, 1977: 65, pl. 20, Fig. 14; Miocene.
V. goubini (Hervier, 1898); [Cernohorsky, 1981: 101, pl. 3, Fig. 9].
V. granosum (Gmelin, 1791); [Cernohorsky, 1967: 170, pl. 40, Fig. 286].
V. gruneri (Reeve, 1844); [Cernohorsky 1967: 171, pl. 41, Fig. 287].
V. humilis (Hervier, 1897); [Cernohorsky, 1981: 96, pl. 1, Fig. 4].
V. infaustum (Reeve, 1845); [Cernohorsky, 1967: 183, pl. 45, Fig. 326].
V. interruptum (Anton, 1839); [Cernohorsky, 1978: 112, pl. 37, Fig. 10].
V. interstriatum (Sowerby, 1870); [Kay, 1979: 320, Fig. 108P].
V. lautum (Reeve, 1845); [Cernohorsky, 1972: 177, pl. 52, Fig. 10].
V. leucozonias (Deshayes, 1834); Ladd, 1977: 64, pl. 29, Fig. 11; Holocene.
V. luculentum (Reeve, 1845); [Cernohorsky, 1967: 172, pl. 41, Fig. 29].
V. mica (Reeve, 1845); [Cernohorsky, 1967: 172, pl. 41, Fig. 292].
V. michaui (Crosse and Fischer, 1864); [Cernohorsky, 1967: 171, pl. 41, Fig. 288; as *V. intertaeniatum* (Sowerby, 1874)].
V. microzonias (Lamarck, 1811); [Cernohorsky, 1967: 183, pl. 45, Fig. 328].
V. millecostatum (Broderip, 1836); [Cernohorsky, 1967: pl. 41, Fig. 321; as *Pusia adamsoni* (Reeve, 1845)].
V. modestum (Reeve, 1845); [Kay, 1979: 322, Fig. 108H].
V. moelleri (Kuster, 1840); [Cernohorsky, 1972: 178, pl. 51, Fig. 9].
V. obeliscus (Reeve, 1844); [Cernohorsky, 1967: 174, pl. 41, Fig. 296].
V. obtusispinosum (Sowerby, 1874); [Cernohorsky, 1967: 174, pl. 42, Fig. 297].
V. pacificum (Reeve, 1845); Ekdale et al. 1979: as *V. speciosum* (Reeve, 1844); [Cernohorsky, 1967: 174, pl. 42, Fig. 298].
V. pagodula (Hervier, 1897); [Cernohorsky, 1981: 95, pl. 1, Fig. 3].
V. patriarchalis (Gmelin, 1791); [Cernohorsky, 1967: 184, pl. 45, Fig. 329].
V. polygonum (Gmelin, 1791); [Cernohorsky, 1978: 108, pl. 36, Fig. 3].
V. roseum (Broderip, 1836); Ladd, 1977: 65, pl. 20, Fig. 15; Pleistocene.
V. rubrum (Broderip, 1836); [Kay, 1979: 331, Fig. 110E].
V. sanguisugum (Linnaeus, 1758); [Cernohorsky, 1967: 176, pl. 43, Fig. 206].
V. speciosum (Reeve, 1844); Ekdale et al., 1979; [Cernohorsky, 1972: 177, pl. 52, Fig. 9].
V. suavis (Souverbie, 1875); [Cernohorsky, 1978: 116, pl. 40, Fig. 3].
V tuberosum (Reeve, 1845); [Cernohorsky, 1967: 186, pl. 45, Fig. 333].
V. turben (Reeve, 1844); [Cernohorsky, 1978: 117, pl. 39, Fig. 8].
V. turrigerum (Reeve, 1845); [Cernohorsky, 1972: 175, pl. 52, Fig. 4].
V. tusum (Reeve, 1845); [Cernohorsky, 1972: 178, pl. 52, Fig. 11].
V. unifascialis (Lamarck, 1811); [Cernohorsky, 1967: 180, pl. 44, Fig. 316].
V. vulpecula (Linnaeus, 1758); [Cernohorsky, 1967: 180, pl. 44, Fig. 317].
V. zelotypum (Reeve, 1845); [Cernohorsky, 1972: 177, pl. 52, Fig. 8].

Family TURRIDAE

Anacithara nanisca (Hervier, 1897); Fig. 4I.
A. notabilis (E. A. Smith, 1888); Fig. 4J.
A. stricta Hedley, 1922; [Fig. 4H].
Carinapex minutissima (Garrett, 1873); [Kay, 1979: 344, Fig. 1150].
Clavus bilineatus (Reeve, 1845); Fig. 4L.
C. canicularis (Röding, 1798); [Cernohorsky, 1972: 185, pl. 53, Fig. 13].
C. laetus (Hinds, 1843); [Cernohorsky, 1978: 153, pl. 55, Fig. 1].
C. lamberti (Montrouzier, 1860); [Cernohorsky, 1978: 153, pl. 55, Fig. 2].
C. nodulosa (Pease, 1860); [Kay, 1965: 80, pl. 14, Figs. 9, 10].
C. opalus (Reeve, 1845); [Cernohorsky, 1978: 152, pl. 54, Fig. 11].
C. pica (Reeve, 1843); [Cernohorsky, 1978: 152, pl. 54, Fig. 9].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family TURRIDAE (cont'd)

C. unizonalis (Lamarck, 1822); [Cernohorsky, 1972: 186, pl. 53, Fig. 14].
C. viduus (Reeve, 1845); [Cernohorsky, 1978: 159, pl. 54, Fig. 7].
Clavus sp. A.; Fig. 4M.
Clavus sp. B.; Fig. 4K.
Daphnella aureola (Reeve, 1843); [Cernohorsky, 1978: 159, pl. 57, Fig. 1].
D. flammea (Hinds, 1843); [Cernohorsky, 1978: 158, pl. 56, Fig. 12].
D. cf. *D. granata* Hedley, 1922; [Hedley, 1922: 328, pl. 58, Fig. 162].
D. olyra (Reeve, 1845); [Cernohorsky, 1978: 159, pl. 57, Fig. 3].
D. rissoides (Reeve, 1843); [Powell, 1966: 124, pl. 19, Fig. 18].
Etrema alphonsianum (Hervier, 1896); [Hedley, 1922: pl. 47, Fig. 71].
E. crassilabrum (Reeve, 1843); [Cernohorsky, 1978: 156, pl. 56, Fig. 5].
E. cf. *E. polydesma* Hedley, 1922; [Hedley, 1922: 282, pl. 47, Fig. 83].
E. scalarina (Deshayes, 1863); [Deshayes, 1863: 109, pl. 12, Figs. 12–14]
E. trigonostomum (Hervier, 1896); Fig. 4R.
Eucithara angiostoma (Pease, 1868); [Kay, 1979: 352, Fig. 116B].
E. celebensis (Hinds, 1843); [Cernohorsky, 1972: 189, pl. 54, Fig. 7].
E. cithara (Gould, 1849); Fig. 4N.
E. debilis (Pease, 1868); Fig. 4P.
†*E. marshallensis* (Ladd, 1982); Ladd, 1982: 68, pl. 22, Figs. 15–19; Miocene.
E. reticulata (Reeve, 1846); [Cernohorsky, 1972: 186, pl. 54, Fig. 3].
E. cf. *E. stricta* Hedley, 1922; [Hedley, 1922: 304, pl. 51, Fig. 123].
E. stromboides (Reeve, 1846); [Cernohorsky, 1972: 186, pl. 54, Fig. 1].
E. vexillum (Reeve, 1846); [Hirase, 1951: pl. 115, Fig. 18].
Eucithara sp.; Fig. 4P.
Eucyclotoma tricarinata (Kiener, 1840); [Cernohorsky, 1978: 160, pl. 57, Fig. 8].
Iredalea pygmaea (Dunker, 1860); [Cernohorsky, 1972: 186, pl. 55, Fig. 4].
Kermia cf. *K. bifasciata* (Pease, 1860); [Kay, 1979: 360, Fig. 118F].
K. canistra (Hedley, 1922); [Cernohorsky, 1978: 162, pl. 57, Fig. 10].
K. cf. *K. concinna* (Hedley, 1922); Fig. 4S.
K. daedalea (Garrett, 1873); [Kay, 1979: 361, Fig. 118I].
K. edychroa (Hervier, 1896); Fig. 4U.
K. cf. *K. granicostata* (Reeve, 1846); Fig. 4Q.
K. maculosa (Pease, 1862); [Cernohorsky, 1978: 161, pl. 57, Fig. 11; as *Kermia barnardi* Brazier, 1876].
Lienardia apiculata (Montrouzier, 1864); [Kay, 1979: 353, Fig. 116L].
L. crassicostata (Pease, 1860); [Kay, 1979: 354, Fig. 116F].
L. cf. *L. falsaria* Hedley, 1922; [Cernohorsky, 1978: 156, pl. 56, Fig. 3].
L. goubini (Hervier, 1896); Fig. 4V.
L. idiomorpha (Hervier, 1897); Fig. 4W.
L. roseotincta (Montrouzier, 1872); [Cernohorsky, 1978: 156, pl. 56, Fig. 4].
L. rubida (Hinds, 1844); [Cernohorsky, 1972: 189, pl. 54, Fig. 9].
Lophiotoma acuta (Perry, 1811); [Powell, 1964: 303, pl. 180, Figs. 1, 2].
L. albina (Lamarck, 1822); [Powell, 1964: 306, pl. 180, Figs. 11, 12].
†*L. eniwetokensis* Ladd, 1982; Ladd, 1982: 62, pl. 19, Figs. 2, 3; early Miocene.
Lovellona atramentosa (Reeve, 1849); [Kay, 1979: 348, Fig. 115A].
Macteola interrupta (Reeve, 1845); [Cernohorsky, 1978: 157, pl. 56, Fig. 9].
M. segesta (Chenu, 1850); [Kay, 1979: 355, Fig. 116M].
Macteola sp.; not figured.
Microdaphne morrisoni Rehder, 1980; [Rehder, 1980: 88, pl. 11, Figs. 5, 6].
Mitrolumna stepheni (Melville and Standen, 1897); [Cernohorsky, 1978: 163, pl. 58, Fig. 5].
M. metula (Hinds, 1843); [Cernohorsky, 1978: 162, pl. 58, Fig. 2; as *Mitromorpha lachryma* (Reeve, 1845)].
Nodotoma harucoa (Bartsch, 1941); [Johnson, 1964: pl. 5, Fig. 4; as *Clathurella lacunosa* Gould, 1860].
Philbertia nexa (Reeve, 1845); [Cernohorsky, 1978: 162, pl. 58, Fig. 1].
P. cf. *P. crassilabrum* (Reeve, 1843); Fig. 4T.
P. rufolirata (Hervier, 1896); [Hervier, 1896: 99, pl. 2, Fig. 5].
P. tincta (Reeve, 1846); [Cernhorsky, 1978: 162, pl. 57, Fig. 15].
Tritonoturris cumingii (Powys, 1835); [Kay, 1979: 363, Fig. 118Q].
T. robillardi (H. Adams, 1869); [Powell, 1966: pl. 20, Fig. 23].
Turridrupa albofasciata (Smith, 1877); [Powell, 1967: 416, pl. 303, Figs. 3, 4].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family TURRIDAE (cont'd)
T. astricta (Reeve, 1843); [Powell, 1967: 417, pl. 305, Fig. 4].
Turridrupa bijubata (Reeve, 1843); [Powell, 1967: 418, pl. 303, Figs. 1, 2].
T. cerithina (Anton, 1839); [Powell, 1967: 420, pl. 305, Fig. 1].
T. diffusa (Powell, 1967); Powell, 1967: 422, pl. 305, Fig. 5.
T. jubata (Hinds, 1843); [Powell, 1967: 423, pl. 301, Fig. 3].
T. weaveri Powell, 1967; Powell, 1967: 423, pl. 303, Fig. 5
Turris acuta (Perry, 1811); [Powell, 1964: 303, pl. 180].
T. albina (Lamarck, 1822); [Powell, 1964: 306, pl. 180, Figs. 11, 12].
T. cryptorraphe (Sowerby, 1825); [Powell, 1964: 335, pl. 181, Figs. 14, 15].
T. spectabilis (Reeve, 1843); Powell, 1964: 336, pl. 181, Figs. 16, 17.
Xenuroturris cingulifera (Lamarck, 1822); [Powell, 1964: 322, pl. 175, Fig. 12].
X. kingae Powell, 1964; [Powell, 1964: 325, pl. 252, Fig. 6].
Family CONIDAE
Conus ammiralis Linnaeus, 1758; [Cernohorsky, 1978: 124, pl. 3, Fig. 2].
C. arenatus Hwass in Bruguière, 1792; [Cernohorsky, 1978: 131, pl. 43, Fig. 4].
C. aulicus Linnaeus, 1758; [Cernohorsky, 1978: 122, pl. 1, Fig. 5].
C. aureus Hwass in Bruguière, 1792; [Cernohorsky, 1978: 121, pl. 41, Fig. 1].
C. auricomus Hwass in Bruguière, 1792; [Cernohorsky, 1978: 123, pl. 1, Fig. 9].
C. aurisiacus Linnaeus, 1758; [Cernohorsky, 1967: 217, pl. 55, Fig. 412].
C. boeticus Reeve, 1849; [Cernohorsky, 1967: pl. 56, Fig. 415].
C. bullatus Linnaeus, 1758; [Cernohorsky, 1972: pl. 55, Fig. 8].
C. capitaneus Linnaeus, 1758; [Cernohorsky, 1978: 127, pl. 5, Fig. 1].
C. catus Hwass in Bruguière, 1792; Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Kay, 1979: 370, Fig. 121H].
C. chaldaeus (Roding, 1798); Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Kay, 1979: 370, Fig. 121I].
C. circumactus Iredale, 1929; [Kay, 1979: 370, Fig. 121J].
C. circumcisus Born, 1778; [Cernohorsky, 1978: 141, pl. 49, Fig. 1].
C. coelinae Crosse, 1858; [Cernohorsky, 1978: 130, pl. 43, Fig. 8].
C. consors Sowerby, 1833; Kohn, 1980a; [Walls, n.d.: 241].
C. coronatus Gmelin, 1791; Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Cernohorsky, 1978: 133, pl. 44, Fig. 6].
C. crocatus Lamarck, 1810; [Cernohorsky, 1978: 122, pl. 1, Fig. 7].
C. cylindraceus Broderip and Sowerby, 1830; [Cernohorsky, 1978: 143, pl. 50, Fig. 2].
C. distans Hwass in Bruguière, 1792; [Cernohorsky, 1978: 126, pl. 3, Fig. 7].
C. ebraeus Linnaeus, 1758; Menge, 1973; Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Kay, 1979: 371, Fig. 121K].
C. eburneus Hwass in Bruguière, 1792; Demond, 1957: 327; Ladd, 1982: 73, pl. 26, Fig. 5; early Miocene; Kohn, 1980a; Kohn, 1980b.
C. episcopus Hwass in Bruguière, 1792; [Hinton, 1978: pl. 69, Fig. 5].
C. flavidus Lamarck, 1810; Bernstein, 1974; Kohn and Leviten, 1976; Levitten and Kohn, 1980; [Kay, 1979: 373, Fig. 122E].
C. floccatus Sowerby, 1839; [Cernohorsky, 1972: 192, pl. 55, Fig. 6].
C. frigidus Reeve, 1848; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Cernohorsky, 1967: 220, pl. 56, Fig. 419].
C. generalis Linnaeus, 1767; [Cernohorsky, 1978: 124, pl. 3, Fig. 3].
C. geographus Linnaeus, 1758; [Cernohorsky, 1978: 137, pl. 7, Fig. 4].
C. glans Hwass in Bruguière, 1792; [Cernohorsky, 1967: 222, pl. 56, Fig. 421].
C. imperialis Linnaeus, 1758; [Kay, 1979: 373, Fig. 122J].
C. legatus Lamarck, 1810; [Hinton, 1978: pl. 69, Fig. 10].
C. leopardus (Roding, 1798); Kohn, 1980a; Kohn, 1980b; [Kay, 1979: 374, Fig. 122I].
C. litoglyphus Hwass in Bruguière, 1792; [Kay, 1979: 374, Fig. 122B].
C. litteratus Linnaeus, 1758; Kohn, 1980a; Kohn, 1980b; [Cernohorsky, 1978: 129, pl. 5, Fig. 9].
C. lividus Hwass in Bruguière, 1792; Kohn, 1980a; Kohn, 1980b; [Kay, 1979: 374, Fig. 122B].
C. luteus Sowerby, 1833; [Hinton, 1972: pl. 40, Fig. 11].
C. magnificus Reeve, 1843; [Cernohorsky, 1978: 123, pl. 41, Fig. 2].
C. magus Linnaeus, 1758; [Cernohorsky, 1978: 138, pl. 47, Fig. 2].
C. marmoreus Linnaeus, 1758; Kohn, 1980a; Kohn, 1980b; [Cernohorsky, 1978: 125, pl. 42, Fig. 1].
C. miles Linnaeus, 1758; [Kay, 1979: 375, Fig. 122H].

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TABLE 1 (cont'd)

Family CONIDAE (cont'd)

C. miliaris Hwass in Bruguière, 1792; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Cernohorsky, 1978: 132, pl. 44, Fig. 4].
C. moreleti Crosse, 1858; [Kay, 1979: 375, Fig. 122F].
C. musicus Hwass in Bruguière, 1792; [Cernohorsky, 1967: 224, pl. 57, Fig. 424].
C. mustelinus Hwass in Bruguière, 1792; [Cernohorsky, 1978: 127, pl. 5, Fig. 2].
C. nussatella Linnaeus, 1758; [Kay, 1979: 376, Fig. 122D].
C. obscurus Sowerby, 1833; [Kay, 1979: 376, Fig. 122C].
C. omaria Hwass in Bruguière, 1792; [Cernohorsky, 1978: 123, pl. 1, Fig. 8].
C. pertusus Hwass in Bruguière, 1792; [Kay, 1979: 378, Fig. 123C].
C. pulicarius Hwass in Bruguière, 1792; Kohn, 1980a; Kohn, 1980b; [Kay, 1979: 378, Fig. 123C].
C. quercinus Solander in Lightfoot, 1786; [Kay, 1979: 379, Fig. 123J].
C. rattus Hwass in Bruguière, 1792; Bernstein, 1974; Kohn, 1980a; Leviten and Kohn, 1980; [Kay, 1979: 379, Fig. 123E].
C. retifer Menke, 1829; Leviten and Kohn, 1980; [Cernohorsky, 1978: 122, pl. 1, Fig. 4].
C. sanguinolentus Quoy and Gaimard, 1834; [Cernohorsky, 1967: 226, pl. 58, Fig. 434].
C. scabriusculus Dillwyn, 1817; [Cernohorsky, 1967: 226, pl. 58, Fig. 435].
C. sponsalis Hwass in Bruguière, 1792; Bernstein, 1974; Leviten, 1974; Kohn and Leviten, 1976; Kohn, 1980a; Leviten and Kohn, 1980; [Kay, 1979: 380, Fig. 123G].
C. striatus Linnaeus, 1758; [Kay, 1979: 380, Fig. 123I].
C. sugillatus Reeve, 1844; Kohn, 1980a; Kohn, 1980b; [Cernohorsky, 1967: 228, pl. 59, Fig. 437].
C. tenuistriatus Sowerby, 1858; [Cernohorsky, 1967: 230, pl. 59, Fig. 438].
C. terebra Born, 1778; [Cernohorsky, 1978: 140, pl. 48, Fig. 7].
C. tessulatus Born, 1778; [Cernohorsky, 1978: 125, pl. 3, Fig. 5].
C. textile Linnaeus, 1758; [Cernohorsky, 1978: 121, pl. 1, Fig. 2].
C. tulipa Linnaeus, 1758; [Cernohorsky, 1978: 137, pl. 7, Fig. 5].
C. varius Linnaeus, 1758; [Cernohorsky, 1978: 135, pl. 7, Fig. 3].
C. vexillum Gmelin, 1791; [Kay, 1979: 381, Fig. 12a].
C. virgo Linnaeus, 1758; [Cernohorsky, 1978: 131, pl. 43, Fig. 6].
C. vitulinus Hwass in Bruguière, 1792; [Kay, 1979: 382, Fig. 123K].

Family TEREBRIDAE

Hastula lanceata (Linnaeus, 1758); [Cernohorsky, 1967: 210, pl. 54, Fig. 403].
H. penicillata (Hinds, 1844); [Cernohorsky, 1967: 212, pl. 54, Fig. 406].
H. solida (Deshayes, 1857); Miller, 1966; as *Terebra*; [Cernohorsky, 1967: 212, pl. 54, Fig. 408].
H. strigilata (Linnaeus, 1758); [Cernohorsky, 1967: 212, pl. 54, Fig. 409].
Terebra affinis Gray, 1834; Miller, 1966; Ladd, 1982: 82, pl. 30, Figs. 4, 5; Quaternary.
T. amoena Deshayes, 1859; [Cernohorsky, 1967: 196, pl. 49, Fig. 350].
T. areolata (Link, 1807); [Cernohosky,1967: 196, pl. 49, Fig. 354].
T. argus Hinds, 1844; Miller, 1966; [Cernohorsky, 1967: 196, pl. 49, Fig. 354].
T. babylonia Lamarck, 1822; Miller, 1966; [Cernohorsky, 1967: 198, pl. 49, Fig. 355].
T. cerithina Lamarck, 1822; [Cernohorsky, 1967: 198, pl. 49, Fig. 356].
T. chlorata Lamarck, 1822; [Cernohorsky, 1967: 198, pl. 49, Fig. 357].
T. cingulifera Lamarck, 1822; Miller, 1966; [Cernohorsky, 1967: 198, pl. 49, Fig. 358].
T. columellaris Hinds, 1844; [Cernohorsky, 1967: 198, pl. 49, Fig. 359].
T. conspersa Hinds, 1844; [Cernohorsky, 1967: 198, pl. 49, Fig. 360].
T. crenulata (Linnaeus, 1758); Miller, 1966; [Cernohorsky, 1967: 199, pl. 50, Fig. 361].
T. dimidiata (Linnaeus, 1758); Miller, 1966; [Cernohorsky, 1967: 199, pl. 50, Fig. 362].
T. felina (Dillwyn, 1817); Miller, 1966; as *Terebra tigrina* Gmelin, 1791; [Cernohorsky, 1967: 199, pl. 50, Fig. 364].
T. fenestrata Hinds, 1844; [Cernohorsky, 1967: 200, pl. 50, Fig. 365].
T. funiculata Hinds, 1844; [Cernohorsky, 1967: 200, pl. 50, Fig. 369].
T guttata (Roding, 1798); Miller, 1966; [Cernohorsky, 1967: 202, pl. 50, Fig. 372].
T. kilburni Burch, 1965; [Cernohorsky, 1967: 202, pl. 50, Fig. 372].
T. maculata (Linnaeus, 1758); Miller, 1966; [Cernohorsky, 1967: 204, pl. 51, Fig. 376].
T. nebulosa Sowerby, 1825; Miller, 1966; [Cernohorsky, 1967: 204, pl. 51, Fig. 380].
T. paucistriata (E. A. Smith, 1873); [Cernohorsky, 1967: 205, pl. 51, Fig. 383].
T. pertusa (Born, 1798); [Cernohorsky, 1967: 205, pl. 52, Fig. 384].
T quoygaimardi Cernohorsky and Bratcher, 1976; [Cernohorsky, 1978: 146, pl. 52, Fig. 3].
T subulata (Linnaeus, 1767); Miller, 1966; [Cernohorsky, 1967: 205, pl. 52, Fig. 385].
T. textilis Hinds, 1844; [Cernohorsky, 1967: 206, pl. 52, Fig. 391].
T. undulata Gray, 1834; [Cernohorsky, 1967: 208, pl. 52, Fig. 391].

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TABLE 1 (cont'd)

Family TEREBRIDAE (cont'd)
†*Terebra (Strioterebra)* sp. A. Ladd, 1982; Ladd, 1982: 82, pl. 30, Fig. 3; late Miocene.
†*Terebra (Oxymeris)* sp. B. Ladd, 1982; Ladd, 1982: 84, pl. 30, Fig. 14; late Miocene.
Terenolla pygmaea (Hinds, 1844); [Cernohorsky, 1978: 150, pl. 53, Fig. 5].
[The records of *T. cancellata* Quoy and Gaimard, 1832, *T. laevigata* Gray, 1834, and *T. picta* Hinds, 1844, cited by Miller (1966) have not been confirmed.]
Subclass OPISTHOBRANCHIA
Order ENTOMOTAENIATA
Family PYRAMIDELLIDAE
Chemnitzia cf. *C. gabrieli* (Hedley, 1909); Fig. 5A.
Chrysalida alveata (A. Adams, 1861); Fig. 5E.
Contraxiala obliqua Laseron, 1956; [Ponder, 1985: 108, Fig. 75A–B].
Costabieta horrida (Garrett, 1873); [Cernohorsky, 1978: 48, Figs. 13, 14; as *Rissoina*].
Evalea debilis (Pease, 1868); [Pease, 1868: 292, pl. 24, Fig. 2].
E. densestriata (Garrett, 1873); Fig. 5B.
E. peasei (Dautzenberg and Bouge, 1933); [Kay, 1979: 407, Fig. 132A].
Herviera gliriella (Melvill and Standen, 1896); [Kay, 1979: 407, Fig. 132C].
Miralda gemmifera (Dautzenberg and Fischer, 1906); [Dautzenberg and Fischer, 1906: 195, pl. 6, Fig. 2].
Odostomia exilis (Garrett, 1873); Fig. 5C.
O. gulicki Pilsbry, 1918; [Kay, 1979: 411, Fig. 132J].
O. oxia Watson, 1886; [Kay, 1979: 41, Fig. 132I].
Otopleura mitralis (A. Adams, 1855); [Cernohorsky, 1972: 201, pl. 57, Fig. 6].
O. nodicincta (A. Adams, 1855); [Cernohorsky, 1972: 201, pl. 57, Fig. 5].
Pyramidella pusilla A. Adams, 1854; [Dall and Bartsch, 1906: 324–325, pl. 24, Fig. 6].
P. sulcata (A. Adams, 1855); [Cernohorsky, 1972: 200, pl. 57, Fig. 2].
Pyrgulina cf. *P. densecostata* (Garrett, 1873); Fig. 5D.
P. oodes (Watson, 1886); [Kay, 1979: 414, Fig. 132N].
Syrnola lutea (Garrett, 1873).
S. polita (Pease, 1868).
Turbonilla cf. *T. infantula* Dall and Bartsch, 1906; [Dall and Bartsch, 1906: 338, pl. 20, Fig. 2].
T. lirata (A. Adams, 1855); [Kay, 1979: 414, Fig. 133F].
T. orthoplicatulata Nomura, 1936; [Nomura, 1936: 74, pl. 12, Figs. 101a, 101b].
T. pseudomala Nomura, 1938; [Nomura, 1938: 29, pl. 4, Figs. 33a, 33b].
T. cf. *T. tenuissima* Hedley, 1909; [Hedley, 1909: 450, pl. 42, Fig. 78].
Order SOLEOLIFERA
Family ONCHIDIIDAE
Onchidiella evelinae Marcus and Burch, 1965; Marcus and Burch, 1965: 253, Figs. 36–39.
Peronia personii (Cuvier, 1804); Marcus, 1965: 264.
Order CEPHALASPIDEA
Family ACTAEONIDAE
Pupa alveola (Souverbie, 1863); [Cernohorsky, 1972: 204, pl. 58, Fig. 3].
P. sulcata (Gmelin, 1791); [Cernohorsky, 1972: 203, pl. 58, Fig. 2].
Pupa sp.; Fig. 5H.
[The record of *Acteon variegatus* (Bruguière, 1789) cited by Ekdale et al. (1979) has not been confirmed.]
Family RINGICULIDAE
Ringicula cf. *R. dolearis* Gould, 1860; Fig. 5F.
Family AMPLUSTRIDAE
Hydatina amplustre (Linnaeus, 1758); Johnson and Boucher, 1983: 254; [Bertsch and Johnson, 1981: 16].
H. physis (Linnaeus, 1758); Johnson and Boucher, 1983: 254; [Bertsch and Johnson, 1981: 16].
Micromelo guamensis (Quoy and Gaimard, 1825); Johnson and Boucher, 1983: 255; [Bertsch and Johnson, 1981: 17].
Family SMARAGDINELLIDAE
Phanerophthalmus smaragdinus (Ruppell and Leuckart, 1828); Marcus and Burch, 1965: 238; as *Lathophthalmus smaragdinus* (Ruppell and Leuckart, 1828); [Kay, 1979: 422, Fig. 136B].
Smaragdinella calyculata (Broderip and Sowerby, 1829); Marcus and Burch, 1965: 236–238, Fig. 1; [Kay, 1979: 423, Fig. 136D].
Family BULLIDAE
Bulla vernicosa Gould, 1859; Johnson and Boucher, 1983: 255; [Kay, 1979: 423, Fig. 137E].
Cylichnatys angusta (Gould, 1859); Fig. 5M.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family ATYIDAE
Atys cylindricus (Helbling, 1779); [Cernohorsky, 1972: 208, pl. 59, Fig. 3].
A. debilis Pease, 1860; [Kay, 1979: 424, Fig. 137C].
A. cf. *A. kuhnsi* Pilsbry, 1917; [Kay, 1979: 425, Fig. 137B].
A. naucum (Linnaeus, 1758); [Cernohorsky, 1972: 208, pl. 59, Fig. 2].
Haminoea crocata Pease, 1860; [Kay, 1979: 426, Fig. 137F].
H. curta (A. Adams, 1850); [Kay, 1979: 427, Fig. 137I].
H. cymbalum (Quoy and Gaimard, 1835); Marcus and Burch, 1965: 243; as *Lamprohaminoea cymbalum* (Quoy and Gaimard, 1835); [Bertsch and Johnson, 1981: 18].
H. galba Pease, 1861; [Kay, 1979: 427, Fig. 137G].
H. cf. *H. japonica* Pilsbry, 1895; Fig. 5G.
H. linda Marcus and Burch, 1965; Marcus and Burch, 1965: 241, Figs. 12–16; [Johnson, 1982: 89].
H. musetta Marcus and Burch, 1965; Marcus and Burch, 1965: 239, Fig. 6.
Family RETUSIDAE
Coleophysis minima (Yamakawa, 1911); Fig. 5L.
Family AGLAJIDAE
Chelidonura hirundinina (Quoy and Gaimard, 1833); [Kay, 1979: 429, Fig. 138E].
C. inornata Baba, 1949; Johnson and Boucher, 1983: 255; [Johnson, 1982: 88].
Odontoglaja guamensis Rudman, 1978a; [Rudman, 1978a: 90, Fig. 1].
Philinopsis gardineri Eliot, 1903; Johnson and Boucher, 1983: 255; [Bergh, 1905: pl. 3, Fig. 6].
Family GASTROPTERIDAE
Gastropteron brunneomarginatum Carlson and Hoff, 1974; [Carlson and Hoff, 1974: 347, pl. X, Fig. 1].
Family SCAPHANDRIDAE
Acteocina cf. *A. hawaiensis* Pilsbry, 1921; [Kay, 1979: 431, Fig. 137M].
A. sandwicensis Pease, 1860; [Kay, 1979: 431, Fig. 137N].
Adamnestia japonica (A. Adams, 1862); Fig. 5I.
Nakamigawaia spiralis Kuroda and Habe, 1961; Fig. 5J.
Order ANASPIDEA
Family APLYSIIDAE
Aplysia dactylomela Rang, 1828; [Kay, 1979: 437, Fig. 131A].
A. parvula Guilding in Morch, 1863; Johnson and Boucher, 1983: 255; [Kay, 1979: 439, Fig. 131C].
A. pulmonica Gould, 1852; Marcus, 1965: 266.
Dolabella auricularia (Lightfoot, 1786); Johnson and Boucher, 1983: 256; [Kay, 1979: 440, Fig. 140D].
Dolabrifera dolabrifera (Rang, 1828); Marcus and Burch, 1965: 244; [Bertsch and Johnson, 1981: 24].
Stylocheilus longicaudus (Quoy and Gaimard, 1824); Marcus and Burch, 1965: 244; Johnson and Boucher, 1983: 256; [Kay, 1979: 440, Fig. 141B].
Order SACOGLOSSA
Family PLAKOBRANCHIDAE
Elysia bayeri Marcus, 1965; Johnson and Boucher, 1983: 257; [Carlson and Hoff, 1978: 91, Fig. 4].
E. marginata (Pease, 1871); Johnson and Boucher, 1983: 257; [Carlson and Hoff, 1978: 102, Fig. 14].
E. halimedae MacNae, 1954; Johnson and Boucher, 1983: 257; [Carlson and Hoff, 1978: 99, Fig. 12].
E. livida Baba, 1955; Johnson and Boucher, 1983: 257; [Carlson and Hoff, 1978: 100, Fig. 13].
E. mercieri (Pruvot-Fol, 1930); [Carlson and Hoff, 1978: Fig. 15].
E. obtusa Baba, 1938; Johnson and Boucher, 1983: 257; [Baba, 1949: 131, pl. 9, Figs. 28, 29].
E. ratna Marcus, 1965; Johnson and Boucher, 1983: 258; [Carlson and Hoff, 1978: 107, Fig. 18].
E. vatae Risbec, 1928; Johnson and Boucher, 1983: 258; [Carlson and Hoff, 1978: 108, Fig. 19].
Plakobranchus ocellatus van Hasselt, 1824; Johnson and Boucher, 1983: 256; [Bertsch and Johnson, 1981: 20–21].
Family HERMAEIDAE
Stiliger smaragdinus Baba, 1949; Johnson and Boucher, 1983: 256; [Baba, 1949: 129, pl. 7, Fig. 22].
Family CALYPHYLLIDAE
Cyerce elegans Bergh, 1888; [Kay, 1979: 455].
Order NOTASPIDEA
Family PLEUROBRANCHIDAE
Berthellina citrina (Ruppell and Leuckart, 1828); Willan, 1984: 37–40, Figs. 33–36; [Bertsch and Johnson, 1981: 26–27].
Berthella pellucida (Pease, 1860); Willan, 1984: 40–43, Figs. 6, 7, 17, 18, 29, 37–39, 44.
B. martensi (Pilsbry, 1896); Willan, 1984: 43–45, 51, 52, Figs. 8–12, 21–28, 30–32, 40–42, 44.
Pleurohedra haraldi Marcus and Marcus, 1970; Willan, 1984: 38–40, Figs. 1–5, 13–26, 19, 20.

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TABLE 1 (cont'd)

Order NUDIBRANCHIA
Family DORIDIDAE
Doriopsis pecten (Collingwood, 1881); Young, 1967: 161; [Bertsch and Johnson, 1981: 34–35].
D. viridis Pease, 1861; Young, 1967: 160, Fig. 1.
Family KENTRODORIDIDAE
Jorunna alisonae Marcus, 1976; Young, 1967: 168; as *Jorunna tomentosa* (Cuvier, 1804).
J. funebris (Kelaart, 1858); Johnson and Boucher, 1983: 260; [Marcus, 1976: 26, Figs. 20a, 20b].
Family DISCODORIDIDAE
Carminodoris nodulosa (Angas, 1864); [Bertsch and Johnson, 1981: 39].
Discodoris fragilis (Alder and Hancock, 1864); Johnson and Boucher, 1983: 261; [Bertsch and Johnson, 1981: 40].
Family ROSTANGIDAE
Rostanga lutescens (Bergh, 1905); Johnson and Bertsch, 1985: 405–410, Fig. 1.
Family TRIPPIDAE
Trippa echinata (Pease, 1860); [Kay and Young, 1969: 189–190].
T. intecta (Kelaart, 1858); [Willan and Coleman, 1984: 34, Fig. 98].
Family HALGERDIDAE
Halgerda elegans Bergh, 1905; [Bergh, 1905: pl. 2, Fig. 4a].
H. wasinensis Eliot, 1904; Johnson and Boucher, 1983: 262; [Rudman, 1978b: 60, Fig. 1].
Sclerodoris paliensis Bertsch and Johnson, 1982; Johnson and Boucher, 1983: 262; [Bertsch and Johnson, 1981: 45].
S. tuberculata Eliot, 1904; [Rudman, 1978b: 72, pl. 1].
Family PLATYDORIDIDAE
Platydoris cruenta (Quoy and Gaimard, 1832); Johnson and Boucher, 1983: 259; [Risbec, 1928: 75, pl. 2, Fig. 7].
P. scabra (Cuvier, 1904); Johnson and Boucher, 1983: 260; [Edmunds, 1971: 354, Fig. 7].
Family CADLINIDAE
Cadlinella ornatissima (Risbec, 1928); Johnson and Boucher, 1983: 276; [Baba, 1949: 145, pl. 19, Fig. 71].
Family CHROMODORIDIDAE
Chromodoris cf. *C. albonotata* Bergh, 1874; [Bertsch and Johnson, 1981: 52].
C. albopunctatus (Garrett, 1879); Johnson and Boucher, 1983: 263; [Bertsch and Johnson, 1981: 58; as C. cf. *C. imperialis* (Pease, 1860)].
C. albopustulosa (Pease, 1860); Young, 1967: 168; [Bertsch and Johnson, 1981: 53].
C. aspera (Gould, 1852); Young, 1967: 168; as *Chromodoris lilacina* (Gould, 1852); Johnson and Boucher, 1983: 266; as *C. inornata* Pease, 1871; [Bertsch and Johnson, 1981: 54; as *C. lilacina*].
C. briqua Marcus and Burch, 1965; Marcus and Burch, 1965: 145–250, Figs. 22–24.
C. colemani Rudman, 1982; [Rudman, 1982: 215, Fig. 176].
C. decora (Pease, 1860); Johnson and Boucher, 1983: 264; [Bertsch and Johnson, 1981: 55].
C. elisabethina Bergh, 1877; Johnson and Boucher, 1983: 265; [Johnson, 1982: 92].
C. fidelis (Kelaart, 1858); Marcus and Burch, 1965: 245; Johnson and Boucher, 1983: 265; Rudman, 1985: 276; [Rudman, 1985: 276, Fig. 12E].
C. galactos Rudman and Johnson, 1985; Rudman, 1985: 286–289, Figs. 12G, 26B, 27A, 28.
C. geometrica Risbec, 1928; Young, 1967: 166; Johnson and Boucher, 1983: 265; [Risbec, 1928: 148, pl. 6, Fig. 10].
C. marginata (Pease, 1860); Johnson and Boucher, 1983: 267; [Kay, 1979: 467, Fig. 150D].
C. verrieri (Crosse, 1875); [Rudman, 1985: 262, Fig. 12, 13A, 14, 15A].
C. vibrata (Pease, 1860); [Bertsch and Johnson, 1981: 56-57].
Durvilledoris lemniscata (Quoy and Gaimard, 1832); Johnson and Boucher, 1983: 273; as *Thorunna clitonata* (Bergh, 1905); [Rudman, 1984: 231].
Glossodoris atromarginata (Cuvier, 1804); Johnson and Boucher, 1983: 263; as *Casella atromarginata*; [Baba, 1949: 145, pl. 19, Fig. 71].
G. youngbleuthi (Kay and Young, 1969); [Bertsch and Johnson, 1981: 68–71; as *Chromolaichma youngbleuthi*].
Hypselodoris bullockii (Collingwood, 1881); [Willan and Coleman, 1984: 26, Fig. 67].
H. decorata (Risbec, 1928); Johnson and Boucher, 1983: 270; [Risbec, 1928: 151, pl. 7, Fig. 4].
H. infucata (Ruppell and Leuckart, 1828); Johnson and Boucher, 1983: 271; [Bertsch and Johnson, 1981: 62–63].
H. kayae Young, 1967; Young, 1967: 164, Fig. 8.
H. maculosa (Pease, 1871); [Pease, 1871: 16].
H. mouaci (Risbec, 1930); Marcus and Burch, 1965; as *H. hilaris*; Johnson and Boucher, 1983: 272; [Risbec, 1930: 278, pl. 1, Fig. 2].
Miamira sinuata (van Hasselt, 1824); [Bertsch and Johnson, 1981: 67].
Noumea decussata Risbec, 1928; Johnson and Boucher, 1983: 273; as *Thorunna decussata*; [Risbec, 1928: 167, pl. 8, Fig. 6].
N. flava (Eliot, 1904); [Eliot, 1904: 399, pl. 24, Figs. 8, 9].

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TABLE 1 (cont'd)

Family CHROMODORIDIDAE (cont'd)

- *N. norba* Marcus and Marcus, 1970; Johnson and Boucher, 1983: 275; as *Thorunna norba*; [Marcus and Marcus, 1970: 161, Fig. 19].
- *N. pusilla* (Bergh, 1874); [Bergh, 1874: pl. 1, Fig. 18].
- *Risbecia imperialis* (Pease, 1860); [Bertsch and Johnson, 1981: 50–51; as *Chromodoris godeffroyana* (Bergh, 1879)].
- *R. tryoni* (Garrett, 1873); Johnson and Boucher, 1983: 268; [Garrett, 1873: 232, pl. 4].
- *Thorunna australis* (Risbec, 1928); Johnson and Boucher, 1983: 270; as *Hypeselodoris australis*; [Johnson, 1982: 92; as *Hypselodoris australis*].
- *T. daniellae* (Kay and Young, 1969); [Kay and Young, 1969: 207, Fig. 48].
- *T. furtiva* Bergh, 1874; [Rudman, 1984: 277].
- *T. purpuropedis* Rudman and Johnson, 1985; Rudman, 1985: 289–291, Figs. 12H, 27, 29, 30.

Family HEXABRANCHIDAE

- *Hexabranchus sanguineus* (Ruppell and Leuckart, 1828); Marcus, 1965: 271; as *H. marginatus* (Quoy and Gaimard, 1832); Johnson and Boucher, 1983: 259; [Bertsch and Johnson, 1981: cover].

Family DENDRODORIDIDAE

- *Dendrodoris coronata* Kay and Young, 1969; Johnson and Boucher, 1983: 276; [Kay and Young, 1969: 218, Fig. 70].
- *D. elongata* Baba, 1936; Johnson and Boucher, 1983: 276; [Baba, 1949: 156, pl. 28, Fig. 104].
- *D. erubescens* (Bergh, 1905); Marcus and Burch, 1965: 250.
- *D. nigra* (Stimpson, 1855); Marcus and Burch, 1965: 250; Young, 1967: 168; Johnson and Boucher, 1983: 277; [Bertsch and Johnson, 1981: 72].
- *D. rubra* (Kelaart, 1858); [Orr, 1981: 39].
- *D. tuberculosa* (Quoy and Gaimard, 1932); [Kay and Young, 1969: 219, Fig. 72].

Family PHYLLIDIIDAE

- *Phyllidia pustulosa* Cuvier, 1804; Johnson and Boucher, 1983: 282; [Bertsch and Johnson, 1981: 74–75].
- *P. varicosa* Lamarck, 1801; Johnson and Boucher, 1983: 282; [Bertsch and Johnson, 1981: 74–75].

Family GYMNODORIDIDAE

- *Gymnodoris ceylonica* (Kelaart, 1858); Johnson and Boucher, 1983: 277; [Risbec, 1928: 182, pl. 7, Fig. 11].
- *G. citrina* (Bergh, 1877); Marcus and Burch, 1965: 245; as *Gymnodoris bicolor* (Alder and Hancock, 1864); Young, 1967: 169; Johnson and Boucher, 1983: 278; [Baba, 1949: 40, pl. 11, Figs. 37, 38].
- *G. okinawae* Baba, 1936; Johnson and Boucher, 1983: 278; [Bertsch and Johnson, 1981: 79].
- *G. plebeia* (Bergh, 1877); Johnson and Boucher, 1983: 279; [Kay and Young, 1969: 224, Fig. 76].
- *G. striata* (Eliot, 1908); Johnson and Boucher, 1983: 279; [Johnson, 1982: 93; as *Analogium striatum*].
- *Nembrotha cristata* Bergh, 1877; [Willan and Coleman, 1984: 12, Fig. 9].
- *Roboastra gracilis* (Bergh, 1877); [Baba, 1949: 136, pl. 13, Fig. 45].

Family TRIOPHIDAE

- *Plocamopherus ceylonicus* (Kelaart, 1858); Johnson and Boucher, 1983: 281; [Thompson, 1975: 509, pl. 1a].

Family NOTODORIDIDAE

- *Aegires citrinus* Prúvot-Fol, 1930; [Risbec, 1953: 60].
- *A. punctilucens* (d'Orbigny, 1837); [Baba, 1974: Fig. 1].
- *A. villosus* Farran, 1905; Johnson and Boucher, 1983: 281; [Edmunds, 1971: 379, Fig. 18].

Family GONIODORIDIDAE

- *Goniodoridiella savignyi* Prúvot-Fol, 1933; Johnson and Boucher, 1983: 282; [Baba, 1960: 301, pl. 8].
- *Goniodoris joubini* Risbec, 1928; Johnson and Boucher, 1983: 282; [Risbec, 1928: 175, pl. 5, Fig. 2].

Family DORIDOMORPHIDAE

- *Doridomorpha gardineri* Eliot, 1906; [Rudman, 1982: Fig. 28a].

Family VAYSSIEREIDAE

- *Okadaia elegans* Baba, 1930; Young, 1967: 171; 1969.

Family EMBLETONIIDAE

- *Embletonia gracilis* Risbec, 1928; [Gosliner and Griffiths, 1981: 142–148].

Family ARMINIDAE

- *Dermatobranchus fortunata* (Bergh, 1888); Johnson and Boucher, 1983: 282; [Bergh, 1888: 353, pl. 10].

Family BORNELLIDAE

- *Bornella anguilla* Johnson, 1985; Johnson, 1985: 17–26; [Willan and Coleman, 1984: 50, Fig. 162].
- *B. stellifer* (Adams and Reeve in Adams, 1848); Johnson and Boucher, 1983: 282; as *Bornella adamsii* Gray, 1850; [Willan and Coleman, 1984: 50, Fig. 161; as *Bornella adamsii* Gray, 1850.]

Family MARIANINIDAE

- *Marianina rosea* (Prúvot-Fol, 1930); Johnson and Boucher, 1983: 283; [Carlson and Hoff, 1973: 172; as *Aranucus bifidus* Odhner, 1936)].

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TABLE 1 (cont'd)

Family CUTHONIDAE
Phestilla lugubris (Bergh, 1870); Johnson and Boucher, 1983: 284; [Bertsch and Johnson, 1981: 90–91; as *Phestilla sibogae* Bergh, 1905].
Family CORYPHELLIDAE
Flabellina alisonae Gosliner, 1980; Gosliner, 1980: 40; Johnson and Boucher, 1983: 283; [Bertsch and Johnson, 1981: 88].
Family GLAUCIDAE
Glaucus atlanticus Forster, 1777; Johnson and Boucher, 1983: 285; [Bertsch and Johnson, 1981: 100].
Family AEOLIDIIDAE
Baeolidia nodosa (Haefelfinger and Stamm, 1959); [Gosliner, 1980: 66–69].
Cerberilla affinis Bergh, 1888; [McDonald and Nybakken, 1975: 380–381].
Favorinus japonicus Baba, 1949; Johnson and Boucher, 1983: 283; [Bertsch and Johnson, 1981: 96–97].
F. mirabilis Baba, 1955; [Baba, 1955: 53, pl. 17, Fig. 46].
Herviella claror Burn, 1963; Marcus and Burch, 1965: 251; Figs. 28–30; Young, 1967: 172.
H. mietta Marcus and Burch, 1965; Marcus and Burch, 1965: 251; Young, 1967: 171.
Phidiana bourailli (Risbec, 1928); Johnson and Boucher, 1983: 285; [Rudman, 1980: 146, Fig. 1B].
P. indica (Bergh, 1896); Johnson and Boucher, 1983: 285; [Bertsch and Johnson, 1981: 95; as *Caloria militaris* (Alder and Hancock, 1864)].
Phyllodesmium hyalinum Ehrenberg, 1831; Johnson and Boucher, 1983: 284; [Rudman, 1981: 22, Fig. 8].
Pteraeolidia ianthina (Angas, 1864); Johnson and Boucher, 1983: 284–285; [Bertsch and Johnson, 1981: 98–99].
Spurilla major (Eliot, 1903); Johnson and Boucher, 1983: 285; [Bertsch and Johnson, 1981: 89].
Subclass PULMONATA
Order BASOMMATOPHORA
Family MELAMPIDAE
Melampus flavus (Gmelin, 1791); [Cernohorsky, 1972: 213, pl. 61, Fig. 1].
Family SIPHONARIIDAE
Siphonaria guamensis (Quoy and Gaimard, 1833); Marcus and Burch, 1965: 256; [Hubendick, 1946: 41, pl. 6, Figs. 30–32].
S. normalis (Gould, 1846); Menge, 1973; Leviten, 1974; [Cernohorsky, 1972: 210, pl. 60, Fig. 2].
Order ORTHURETHRA
Family ACHATINELLIDAE
Lamellidea pusilla (Gould, 1847).
Family PUPILLIDAE
Gastrocopta pediculus (Shuttleworth, 1852); Reigle, 1964: 128.
G. servilis (Gould, 1843).
Order SIGMURETHRA
Family SUBULINIDAE
Subulina octona (Bruguière, 1792).
Lamellaxis gracilis (Hutton, 1834); Reigle, 1964: 128.
Suborder AULACOPODA
Family CHAROPIDAE
†*Vatusila eniwetokensis* (Ladd, 1958); Ladd, 1958: 190, pl. 30, Figs. 9–12; Miocene g; as *Ptychodon*; Solem, 1982: 195, Figs. 85e–f.
Class BIVALVIA
Family ARCIDAE
Anadara antiquata (Linnaeus, 1758); [Cernohorsky, 1972: 215, pl. 61, Fig. 3].
Arca avellana Lamarck, 1819; [Kilburn, 1983: 514, Figs. 2, 3].
A. ventricosa Lamarck, 1819; [Kay, 1979: 500, Figs. 161C–D].
Barbatia amygdalumtostum (Röding, 1798); [Kira, 1962: 122, pl. 43, Fig. 14; as *Barbatia bicolorata* (Dillwyn)].
B. decussata (Sowerby, 1833); [Kay, 1979: 500, Figs. 162G–H].
B. divaricata (Sowerby, 1833); [Kay, 1979: 501, Figs. 161E–G].
B. nuttingi Dall, Bartsch, and Rehder, 1938; [Kay, 1979: 503, Figs. 162I–J].
B. tenella (Reeve, 1844); [Kay, 1979: 504, Figs. 162C–D].
B. cf. *B. wendti* (Lamy, 1907); Fig. 6A.
Family GLYCYMERIDIDAE
Glycymeris reevei (Mayer, 1868); Fig. 6B.
Family MYTILIDAE
Botula silicula (Lamarck, 1819); [Kay, 1979: 509; Figs. 164E–F].
Lithophaga zittelliana Dunker, 1860; Fig. 6E.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family MYTILIDAE (cont'd)
Mytilus edulis Linnaeus, 1758; on floating plastic fishing floats; [Abbott, 1954: pl. 35, Fig. M].
Modiolus auriculatus Krauss, 1848; [Salvat and Rives, 1975: 367, Fig. 404].
M. philippinarum (Hanley, 1843); [Kira, 1962: 126, pl. 46, Fig. 18].
M. vagina (Lamarck, 1819); Fig. 6C.
Septifer bryanae (Pilsbry, 1929); [Kay, 1979: 512, Fig. 164P].
Family PINNIDAE
Atrina vexillum (Born, 1778); [Rosewater, 1961: pls. 156, 157].
Pinna muricata Linnaeus, 1758; Rosewater, 1961: 191, pl. 141].
Streptopinna saccata (Linnaeus, 1758); Rosewater, 1961: 22, pl. 169.
Family PTERIIDAE
Electroma electrina (Reeve, 1857); Fig. 6D.
Pinctada margaritfera (Linnaeus, 1758); [Kay, 1979: 516, Figs. 166D–E].
Pteria penguin (Röding, 1798); [Cernohorsky, 1978: 177, pl. 62, Fig. 1].
Family ISOGNOMONIDAE
Isognomon dentifera Krauss, 1848; [Salvat and Rives, 1975: 370, Fig. 415; as *I. pectinata* (Reeve, 1858)].
I. incisum (Conrad, 1837); [Kay, 1979: 520, Figs. 167C–D (not E–F)].
I. legumen (Gmelin, 1791); [Kay, 1979: 520, Figs. 167G–H].
I. perna (Linnaeus, 1758); [Kay, 1979: 521, Figs. 167C–D].
Melina ephippium (Linnaeus, 1758); [Cernohorsky, 1978: 178, pl. 63, Fig. 2].
Family MALLEIDAE
Malleus regula (Forsskål, 1775); [Kay, 1979: 521, Figs. 167I–K].
Family PECTINIDAE
Chlamys coruscans (Hinds, 1845); Waller, 1972: 231, pl. 1, Figs. 1–7, 12].
C. wilhelmini Bavay, 1904; Waller, 1972: 236, pl. 2, Figs. 30–33, 36–37; as *C. marshallensis* Waller, 1972.
Comptopallium vexillum (Reeve, 1853); Waller, 1972: 243, pl. 4, Figs. 64–75.
†*Excellichlamys spectabilis* (Reeve, 1853); Waller, 1972: 249; Holocene; [Waller, 1972: 246, pl. 5, Figs. 85–92].
Gloripallium pallium (Linnaeus, 1758); Waller, 1972: 239, pl. 3, Figs. 45–56.
Juxtamusium coudeini (Bavay, 1902); Waller, 1972: 250, Figs. 111–127; as *Juxtamusium maldviensis* (E. A. Smith, 1903).
Mirapecten mirificus (Reeve, 1853); [Kay, 1979: 526, Figs. 169A–B].
Pedum spondyloideum (Gmelin, 1791); Waller, 1972: 254, pl. 8, Figs. 136–143.
Family SPONDYLIDAE
Spondylus hystrix Bolten in Röding, 1798; [Kay, 1979: 530, Figs. 176G–H; and see *S. nicobaricus* Schreiberg, 1795 in Cernohorsky, 1978: 180, pl. 63, Fig. 4].
S. linguaefelis Sowerby, 1874; [Kay, 1979: 531, Figs. 171D–E].
S. squamosus Schreiber, 1793; [Hirase, 1951: pl. 15, Fig. 2].
S. tenebrosus Reeve, 1856; [Kay, 1979: 532, Figs. 171A–C].
S. cf. *S. varians* Sowerby, 1829; [Cernohorsky, 1978: 180, pl. 64, Fig. 3].
Family PLICATULIDAE
Plicatula simplex Gould, 1861; [Johnson, 1964: 149, pl. 25, Fig. 4].
Family LIMIDAE
Lima annulata Lamarck, 1819; [Cernohorsky, 1972: 220, pl. 62, Fig. 2].
L. concentrica Sowerby, 1888; [Cernohorsky, 1978: 181, pl. 65, Fig. 1].
L. fragilis (Gmelin, 1791); [Kay, 1979: 534, Figs. 172A–B].
L. lima vulgaris (Link, 1807); [Cernohorsky, 1972: 219, pl. 61, Fig. 5].
Family OSTREIDAE
Ostrea cf. *O. hanleyana* Sowerby, 1871; [Kay, 1979: 537, Figs. 173D–E].
O. cf. *O. sandvicensis* Sowerby, 1871; [Kay, 1979: 539, Figs. 173A–B].
Family CHAMIDAE
Chama broderipii Reeve, 1846; [Reeve, 1846: *Chama* No. 2].
C. iostoma Conrad, 1837; [Cernohorsky, 1978: 183, pl. 65, Fig. 5].
C. lazarus Linnaeus, 1758; [Cernohorsky, 1978: 183, pl. 65, Fig. 3].
C. pacifica Broderip, 1835; Fig. 6M.
Family LUCINIDAE
Codakia punctata (Linnaeus, 1758); [Cernohorsky, 1972: 221, pl. 62, Fig. 6].
Ctena bella (Conrad, 1837); [Kay, 1979: 543, Figs. 176A–B].
Lucina edentula (Linnaeus, 1758); [Kay, 1979: 543, Figs. 177A–B].
L. cf. *L. erythraea* Issel, 1869; [Bouchet and Danrigal, 1982: Fig. 20].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family LUCINIDAE (cont'd)
L. cf. *L. lorisi* Viader, 1937; Fig. 6K.
Family FIMBRIIDAE
Fimbria fimbriata (Linnaeus, 1758); Nicol, 1950: 83, Figs. 1, 2, 4, 6, 7.
Family LASAEIDAE
Nesobornia bartschi Chavan, 1969; [Kay, 1979: 549, Fig. 179G].
Family GALEOMMATIDAE
Scintilla hiloa Dall, Bartsch and Rehder, 1938; [Kay, 1979: 550, Fig. 179I].
Family SPORTELLIDAE
Hitia cf. *H. ovalis* Dall, Bartsch, and Rehder, 1938; [Kay, 1979: 552, Figs. 179E, F].
Family CARDIIDAE
Acrosterigma orbita (Broderip and Sowerby, 1838); [Kay, 1979: 556, Figs. 180F–G; as *Trachycardium*].
Corculum cardissa (Linnaeus, 1758); [Cernohorsky, 1972: 225, pl. 65, Fig. 2].
Discors lyratum (Sowerby, 1841); [Cernohorsky, 1972: 225, pl. 63, Fig. 2].
Fragum fragum (Linnaeus, 1758); [Cernohorsky, 1972: 223, pl. 63, Fig. 5].
F. loochooanum Kira, 1959; [Kira, 1962: 154, pl. 55, Fig. 13].
Laevicardium biradiatum (Bruguière, 1789); [Cernohorsky, 1972: 224, pl. 63, Fig. 6].
L. pulcherrima Sakurai and Habe, 1966; Fig. 6H.
Microfragum festivum (Deshayes, 1855); [Kira, 1962: 154, pl. 55, Fig. 10].
Family MACTRIDAE
Mactra sulcataria Reeve 1854; [Hirase, 1951: pl. 50, Fig. 7].
Family MESODESMATIDAE
Atactodea glabrata (Gmelin, 1791); [Kira, 1962: 166, pl. 58, Fig. 33; as *Actactodea striata* (Gmelin).
Ervilia (Spondervillia) bisculpta (Gould, 1861); [Kay, 1979: 558, Figs. 181E–F (not Figs. 181C–D)].
Spondervillia cf. *S. simplex* Laseron, 1953; Fig. 6J.
Family TELLINIDAE
Macoma dispar (Conrad, 1837); [Kay, 1979: 559, Figs. 182I–J].
M. obliquilineata (Conrad, 1837); [Kay, 1979: 559, Figs. 182 G–H].
M. obliquaria (Deshayes, 1854); Fig. 6L.
Pinquitellina robusta (Hanley, 1844); [Kay, 1979: 561, Figs. 182C–D].
Tellina crucigera Lamarck, 1818; [Kay, 1979: 564, Figs. 183A–B].
T. gargadia Linnaeus, 1758; [Afshar, 1969: 40, pl. 11, Figs. 6–10].
T. cf. *T. inflata* Gmelin, 1791; Fig. 6I.
T. cf. *T. ovalis* Sowerby, 1825; Fig. 6G.
T. linguaefelis Linnaeus, 1758; [Cernohorsky, 1972: 229, pl. 65, Fig. 4].
T. palatam Iredale, 1929; [Kay, 1979: 563, Figs. 182E–F].
T. perna (Spengler, 1798); [Kay, 1979: 563, Figs. 183E–F].
T. pudica Hanley, 1844; Fig. 6F.
T. scobinata Linnaeus, 1758; [Cernohorsky, 1972: 229, pl. 65, Fig. 5].
T. staurella (Lamarck, 1818); [Cernohorsky, 1972: 228, pl. 7, Fig. 4].
T. semen Hanley, 1844; [Boss, 1969: 136, pl. 15, Figs. 1–4].
T. substruncata Hanley, 1845; [Habe, 1964: 201, pl. 62, Fig. 8].
T. virgata Linnaeus, 1758; [Cernohorsky, 1972: 228, pl. 7, Fig. 5].
Family PSAMMOBIIDAE
Asaphis violascens (Forsskål, 1775); [Cernohorsky, 1972: 231, pl. 66, Fig. 7].
Gari maculosa (Lamarck, 1818); [Cernohorsky, 1972: 231, pl. 66, Fig. 3].
G. squamosa (Lamarck, 1818); [Cernohorsky, 1972: 231, pl. 66, Fig. 4].
Family SEMELIDAE
Semele australis (Sowerby, 1833); [Kay, 1979: 566, Figs. 183M–N].
Semelangulus crebrimaculatus Sowerby, 1867; [Kay, 1979: 565, Figs. 183J–K].
S. cf. *S. tokubei* Habe, 1961; [Habe, 1964: 119, pl. 61, Fig. 19].
Family TRAPEZIIDAE
Trapezium bicarinatum (Schumacher, 1817); [Cernohorsky, 1972: 232, pl. 68, Fig. 4].
T. oblongum (Linnaeus, 1758); [Kay, 1979: 566, Figs. 184E–F].
Family TRIDACNIDAE
Hippopus hippopus (Linnaeus, 1758); Rosewater, 1965: 361, pl. 267, Figs. 1, 3; Fankboner and Renaud, 1971.
†*Tridacna crocea* Lamarck, 1819; Rosewater, 1965: 393; Pleistocene?; [Rosewater, 1965: 392, pl. 292].
T. gigas (Linnaeus, 1758); Rosewater, 1965: 369, pl. 267, Fig. 2.
T. maxima (Roding, 1798); Rosewater, 1965: 384, pl. 267, Figs. 9–12.
T. squamosa Lamarck, 1819; Rosewater 1965: 380, pl. 267, Figs. 4–7.

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

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TABLE 1 (cont'd)

Family GLOSSIDAE
Meiocardia tetragona (Adams and Reeve, 1848); [Kira, 1962: 148, pl. 53, Fig. 24].
Family VENERIDAE
Dosinia cf. *D. miticula* Viader, 1937; Fig. 6N.
Gafrarium pectinatum (Linnaeus, 1758); [Cernohorsky, 1972: 234, pl. 67, Fig. 1].
G. tumidum (Roding, 1798); [Cernohorsky, 1972: 234, pl. 67, Fig. 2].
Glycodonta marica (Linnaeus, 1758); [Cernohorsky, 1972: 237, pl. 67, Fig. 5].
Lioconcha castrensis (Linnaeus, 1758); [Cernohorsky, 1972: 235, pl. 5, Fig. 7].
L. ornata (Dillwyn, 1817); [Cernohorsky, 1972: 236, pl. 67, Fig. 6].
Periglypta puerpera (Linnaeus, 1771); [Cernohorsky, 1972: 233, pl. 66, Fig. 5].
P. reticulata (Linnaeus, 1758); [Cernohorsky, 1972: 233, pl. 66, Fig. 6].
Pitar pellucidus (Lamarck, 1818); [Cernohorsky, 1972: 236, pl. 68, Fig. 2].
Venus toreuma Gould, 1850; [Kay, 1979: 570, Fig. 184L].
Family GASTROCHAENIDAE
Gastrochaena cuneiformis Spengler, 1783; [Kay, 1979: 570, Fig. 185A].
Family PHOLADIDAE
Martesia striata (Linnaeus, 1758); [Kay, 1979: 573, Fig. 185C].
Class POLYPLACOPHORA
Order CHITONID
Family ACANTHOCHITONIDAE
Cryptoplax elioti Pilsbry, 1901.
Family CHITONIDAE
†*Luculina russelli* Ladd, 1966; Ladd, 1966: 23, pl. 1, Figs. 13–15; probably Pliocene.
Family ISCHNOCHITONIDAE
Ischnochiton sp.
Family SCHIZOCHITONIDAE
†*Schizochiton marshallensis* Ladd, 1966; Ladd, 1966: 22, pl. 1, Figs. 4–9; early Miocene.
Family LEPIDOPLEURIDAE
Leptochiton acuminatus (Thiele, 1909).
Class CEPHALOPODA
Order OCTOPODA
Family OCTOPODIDAE
Octopus cyanea Gray, 1849; [Kay, 1979: 589, Figs. 194B–E].
Order TEUTHOIDEA
Family OMMASTREPHIDAE
Hyaloteuthis pelagica (Bosc, 1802); Voss, 1954: 365.
Subclass NAUTILOIDEA
Family NAUTILIDAE
Nautilus macromphalus Sowerby, 1849; Shells occasionally washed up on windward beaches; [Cernohorsky, 1972: 240, pl. 7, Fig. 8].
N. pompilius Linnaeus, 1758; Shells occasionally washed up on windward beaches; [Cernohorsky, 1972: 240, pl. 7, Fig. 7].

†Species not now living at Enewetak; horizons recorded by Ladd (1966, 1972, 1977, 1982).

1959); Cassididae (Abbott, 1968); Mitridae (Cernohorsky, 1976); *Drupa* (Emerson and Cernohorsky, 1973); *Rhinoclavis* (Houbrick, 1978); *Clypeomorus* (Houbrick, 1985); Harpidae (Rehder, 1973); *Gabrielona* (Robertson, 1973); Pinnidae (Rosewater, 1961); Tridacnidae (Rosewater, 1965); and Littorinidae (Rosewater, 1970). Collections of opisthobranchs made by J. B. Burch and W. Heard were described by Marcus and Burch (1965) and Marcus (1965). Young (1967, 1969) reported on his own collection of opisthobranchs, and Johnson and Boucher (1983) recorded 76 species from collections they made at Enewetak. Enewetak pectinids were discussed by Waller (1972). A paper by Ingram (1947) and a manuscript by Ingram and Morrison (MS, USNM) discuss the cowries of the Marshall Islands and include records from Enewetak.

Most studies of Enewetak mollusks have been ecologically oriented. As early as 1956, Kohn made collections and observations on the gastropod genus *Conus*, and his work on *Conus* (and that of his students) continues (Kohn, 1967, 1971, 1980a, 1980b; Kohn and Leviten, 1976; Leviten and Kohn, 1980; Leviten, 1974). Ecological studies on other groups include those on the Tridacnidae (Stasek, 1963a, 1963b; Fankboner, 1971a, 1971b, 1972; Leviten and Osenberg, 1979); Terebridae (Miller, 1966); *Nerita* (Stokes, 1966); Muricidae (Menge, 1974; Bernstein, 1974); *Cypraea moneta* (Renaud, 1977); Strombidae

(Berg, 1974); Vermetidae (Hopper, 1975, 1978); *Morula* (Sinclair, 1975); *Stylocheilus* (Sarver, 1978); *Phestilla* (Switzer, 1971); *Siphonaria* (Menge, 1973); and soft bottom communities (Ekdale et al., 1979).

Enewetak has also been the site of research on the genetic variability and the physiology of the Tridacnidae (Valentine and Ayala, 1974; Ayala et al., 1973; Valentine et al., 1973; Fankboner, 1971a, 1971b, 1974), of physiological studies of the Strombidae (Gillary, 1974; Gillary and Gillary, 1979), and of studies of growth and mortality rates in marine snails (Turk, 1979a, 1979b).

MODERN MOLLUSCAN FAUNA

Nonmarine Mollusks

The nonmarine molluscan fauna, comprised of eight species, conforms to the description of C. M. Cooke, Jr. (in Harry, 1966) of a typical atoll land snail fauna: ". . . very restricted. . . made up mostly of species that are accidentally distributed by man." Thus, of the eight species we record, five (both *Gastrocopta*, both Subulinidae, and *Lamellidea pusilla*) are probably adventive and widely distributed among the islands of the Pacific as a result of the activities of man (see Christensen and Kirch, 1981; Harry, 1966; and Solem, 1964 for discussion of Pacific basin land snails and their dispersal by humans). The remaining three nonmarine molluscan species are strandline species: *Melampus flavus* and *Truncatella guernii* are widely distributed on Pacific islands; *Assiminea nitida marshallensis* is endemic to the Marshall Islands, according to Abbott (1958). The list of Enewetak nonmarine mollusks is similar to that compiled for neighboring Rongelap in the Marshall Islands (Reigle, 1964). Of the 11 species recorded from Rongelap, three of the five adventive species also occur at Enewetak, and the two atolls also share two of the strandline species.

Marine Mollusks

At least three factors affect the records of the presence or absence of marine mollusks at Enewetak and, indeed, on any atoll. The three factors are the collecting effort, kinds of habitat available, and the chance occurrence or recruitment of young to the island.

Given 40 years of collection activity and the numerous collectors who have visited Enewetak, the approximately 1000 species of marine mollusks that are recorded as occurring at Enewetak today are probably fairly representative of the molluscan fauna that occurs between the intertidal zone and depths of about 30 m. In terms of numbers of species, the Enewetak molluscan fauna is about ⅗ that of the island of Okinawa, 2500 miles northwest; just slightly larger than that recorded for the Hawaiian Islands, 2000 miles northeast; and two and a half to three times larger than those reported for two Pacific atolls, Fanning and Funafuti (Table 2).

The fauna is dominated by gastropods, and the gastropod:bivalve ratio of 90:10 is the highest of all Pacific faunas for which there are records (Table 2). The gastropod record includes 947 species in 109 families. Neogastropods comprise 44% of the gastropod species, mesogastropods (including Heterogastropoda), 32%; euthyneurans, 17%; and archaeogastropods, about 8% of the mollusks.

TABLE 2

Characteristics of Pacific Island Marine Molluscan Faunas

Taxonomic Group	Enewetak		Okinawa*		Hawaii†		Funafuti‡		Fanning¶	
	No.	%	No.	%	No.	%	No.	%	No.	%
Archaeogastropods	76	8	179	13	50	6	35	11	16	5
Mesogastropods	323	32	472	34	292	35	154	48	149	51
Neogastropods	421	44	611	44	344	40	106	33	98	33
Euthyneura	174	17	149	8	171	20	34	8	32	10
Total	994		1411		857		329		295	
Gastropods										
Bivalves	115		426		141		80		52	
Cephalopods	4		n.a		5		3			
Polyplacophora	3		16		4		1		1	
Total mollusk species	1116		1853		1007		413		348	
Gastropod:Bivalve Ratio	90:10		77:23		86:14		80:20		85:15	

*Kuroda (1960). ‡Hedley (1899).
†Kay (1979). ¶Kay and Switzer (1974).

The families with the greatest number of species are the Turridae (78), Conidae (65), Mitridae (58), Cypraeidae (55), and the Costellariidae (51).

The bivalve record includes 30 families and 115 species. Among the bivalves, 51% of the species are infaunal, 41% are epifaunal byssate forms, and 6% are free-living species. The family Tellinidae has the largest number of species (17), followed by the Veneridae (10), Arcidae (9), and Cardiidae (8).

Composition

There are some noticeable anomalies in the composition of the Enewetak fauna in that several well-known Indo-West Pacific mollusks are conspicuous by their absence. We do not record the turbinid *Leptothyra picta*, the neritid *Smaragdia*, the rissoid *Merelina pisinna*, the vermetid *Dendropoma maxima*, the mesogastropod limpet *Hipponix*, the thaid *Vexilla*, the buccinid *Cantharus fumosus*, or the heterogastropod *Architectonica*. Several species such as *Gyrineum gyrineum* and *Morum denisoni* which are recorded from Kwajalein are absent at Enewetak.

Some of the absences are explicable. If a habitat is absent, then the species occurring in that habitat are also absent. Thus *Smaragdia* associated with sea grass beds and gastropods associated with volcanic substrates such as *Hipponix* and the muricid *Vexilla* (Vermeij et al., 1984) are not expected to occur at Enewetak. Other more subtle ecological restrictions have been suggested by Waller (1972) who has shown that several species of Enewetak Pectinidae are extremely restricted in their habitats. These species include *Comptopallium vexillum* which lives in association with terrigenous sediments and marine grasses around elevated islands and is found only as juveniles in the deeper portions of the lagoon of the atoll; and *Juxtamusium maldivense*, which also lives in the deeper portions of the lagoon, in association with abundant *Halimeda* on which it may depend for attachment and concealment.

The absence of gastropods such as the reef-associated *Leptothyra picta*, *Merelina pisinna*, *Dendropoma maxima*, and *Architectonica* is not easily explained and, for the present, is attributed to chance as has been suggested for certain aspects of the marine fauna of the Line Islands (Kay, 1971), the Hawaiian Islands (Kay, 1979, 1980), the northern Marianas (Vermeij et al., 1984), and among the islands of the Indian Ocean (Taylor, 1971).

Biogeography

With one exception, the subspecies *Assiminea nitida marshallensis* Abbott, 1958, all the Recent mollusks identified to species have been recorded elsewhere in the Indo-West Pacific. As Waller (1972) has noted, the significance of the latter observation lies in the demonstration that, for Pacific island mollusks, miles of open water without strong current systems have not resulted in much differentiation.

The marine mollusks of Enewetak are clearly of Indo-West Pacific derivation, and many species have ranges which span the Indo-West Pacific from the Hawaiian Islands on the east to the coast of east Africa on the west. A component of this fauna is restricted to the Pacific Plate (*sensu* Springer, 1982): 14 of the 56 cowries and five of the 19 strombids are Pacific Plate endemics.

Four species require special mention. Shells of two species of *Nautilus* and specimens of *Mytilus edulis* are reported from windward beaches, but there is no evidence that either *Nautilus* or *Mytilus* lives at Enewetak. One species, *Trochus niloticus*, was introduced by the Japanese about 1935, and these mollusks are very common.

FOSSIL MOLLUSKS

Fossil Record

The Enewetak molluscan fossil record was documented by Ladd (1966, 1972, 1977, 1982) who described and/or recorded 274 species primarily from two drill cores on the atoll. Ladd dealt only with chitons and gastropods and, unfortunately, was unable to complete his study of the Enewetak fossil material. Of the gastropods recorded by Ladd (1966 et seq.), archaeogastropods comprise 25%; mesogastropods (including Heterogastropoda), 56%; and neogastropods, 17% of the fossil record.

Although relatively numerous in terms of species, the Enewetak fossil record is far from complete. Apart from the euthyneurans, bivalves, cephalopods, and scaphopods which have not been considered, the neogastropods are underrepresented, and there are biases in other respects. There are proportionately more lagoonal forms such as rissoids and cerithiids than there are seaward reef flat species such as cones and muricids. High intertidal littorinids and neritids are not well represented. Four of the six fossil neritids are subtidal forms and only one littorinid *(Tectarius)* is recorded. Still another bias is in size—82% of the measurements for shell sizes are less than 10 mm in greatest dimension and the largest fossil shell is only 34 mm in length. Despite these deficiencies, the fossil record, together with the current checklist, allows at least three conclusions:

1. Species composition at Enewetak has changed with time.
2. Many species were widely distributed in the Pacific in the Miocene.
3. Previously wide species ranges have become restricted with time.

Geological Record

The Enewetak geological record comprises a Tertiary sequence extending back into the Eocene and a Quaternary surface limestone section. Ladd (1966) recognized six subdivisions of the Tertiary, the late Eocene (Tertiary b) to the Pliocene (Tertiary h), based on the system developed for the East Indies by van der Vlerk and Umbgrove (1927)

Fig. 1 a, *Diodora foveolata*, length 10 mm; b–c, *Emarginula concinna*, length 6.75 mm; d, *E. nigromaculata*, length 10 mm; e, *Calliostoma* sp., height 8 mm; f–g, *Orbitestella* sp., diameter 1.5 mm; h–i, *Teinostoma* sp., diameter 1.5 mm; j, *Astele engebienesis*, height 3 mm; k, *Rufodardanula* sp., height 1.5 mm; l, *Alvania crystallina*, height 3 mm; m, *Brookula* sp., height 1.25 mm; n–o, *Puperita bensoni*, height 6 mm; p, *Sansonia andamanica*, height 2 mm; q, *Marelepetopoma* sp., height 1.5 mm; r, *Microliotia dautzenbergi*, diameter 1.5 mm.

Fig. 2 a, *Planaxis zonatus*, height 7 mm; b, *Caecum* cf. *C. folini*, length 2.5 mm; c, *Turritella* sp. A., height 18 mm; d, *Turritella* sp. B., height 17 mm; e, *Scaliola arenosa*, height 3 mm; f, *S. caledonica*, height 2 mm; g, *S. glareosa*, height 3 mm; h, *Inella japonica*, height 3 mm; i, *Nanophora* cf. *N. leucomys*, height 2.5 mm; j, *Bouchetriphora quadrimaculata*, height 3 mm; k, *Vermicularia* sp., height 10 mm; l, *Cerithium claviforme*, height 25 mm; m, *Metaxia* sp., height 3 mm; n, *Cerithiopsis* sp. A., height 4 mm; o, *Cerithiopsis* sp. B., height 4 mm; p, *Euthymella regalis*, height 8 mm; q, *Mastonia ustulata*, height 3 mm; r, *Mesophora cnodax*, height 5 mm; s, *Nanophora* sp., height 3 mm.

Fig. 3 a, *Stylapex* sp., height 3.5 mm; b, *Balcis acicula*, height 8 mm; c, *Hemileiostracum* sp., height 2 mm; d, *Lamellaria* sp., length 8 mm; e, *Epitonium auritum*, height 19 mm; f–g, *Neverita* sp., height 5 mm; h–i, *Morula squamosa*, height 22 mm; j–k, *Neverita* cf. *N. petiveriana*, height 4.5 mm; l, *Pyrene obtusa*, height 12 mm; m, *Euplica amirantium*, height 4 mm; n, *Columbella* cf. *C. moleculina*, height 13 mm; o, *Pyrene* cf. *P. livescens*, height 10 mm; p, *P. albina*, height 12 mm; q, *Euplica* cf. *E. liocyma*, height 6.5 mm; r, *E.* cf. *E. minuta*, height 6 mm; s, *Seminella divaricata*, height 4 mm; t, *S. dautzenbergi*, height 4 mm; u, *S. subphilodicia*, height 4 mm; v, *Pyrene punctata*, height 13 mm; w, *P. obesula*, height 4 mm.

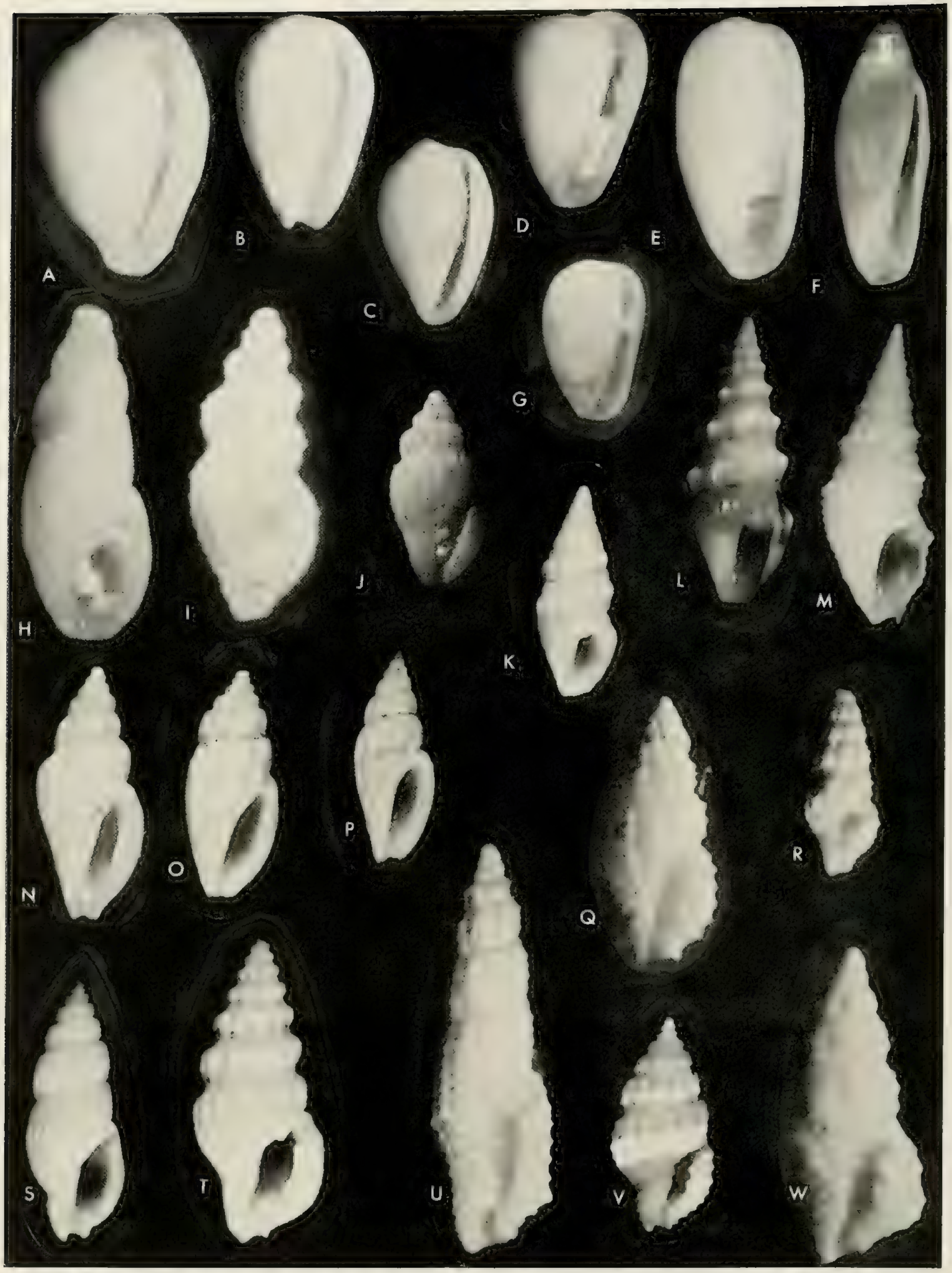

Fig. 4 a, *Granulina vitrea*, height 3 mm; b, *Kogomea ovata*, height 4 mm; c, *Kogomea* sp. A., height 1.5 mm; d, *Tringinella* sp., height 1.5 mm; e, *Haloginella micros*, height 3 mm; f, *H. keppelensis*, height 7 mm; g, *Kogomea hervieri*, height 1.5 mm; h, *Anacithara stricta*, height 3 mm; i, *A. nanisca*, height 3 mm; j, *A. notabilis*, height 3 mm; k, *Clavus* sp. B., height 7 mm; l, *C. bilineata*, height 10 mm; m, *Clavus* sp. A. n. *Eucithara cithara*, height 12 mm; o, *E. daedalea*, height 6 mm; p, *E.* sp., height 15 mm; q, *Kermia* cf. *K. granicostata*, height 6 mm; r, *Etrema trigonostoma*, height 2 mm; s, *Kermia concinna*, height 10 mm; t, *Philbertia crassilabrum*, height 12 mm; u, *Kermia edychroa*, height 4.5 mm; v, *Lienardia goubini*, height 5 mm; w, *Kermia idiomorpha*, height 3 mm.

Fig. 5 a, ***Chemnitzia gabrieli***, **height 5.25 mm; b,** ***Chrysalida alveata***, **height 4 mm; c,** ***Evalea densestriata***, **height 12 mm; d,** ***Pyrgulina densecostata***, **height 2.5 mm; e,** ***Chrysalida alveata***, **4 mm; f,** ***Ringicula doleari***, **height 1.75 mm; g,** ***Haloa japonica***, **height 5 mm; h,** ***Pupa*** **sp. 8 mm; i,** ***Nakagamigawaia spiralis***, **height 4 mm; j,** ***Adamnestia japonica***, **height 8 mm; k,** ***Eocylichna soyae***, **height 10 mm; l,** ***Coleophysis minima***, **height 3 mm; m,** ***Cylichnatys angustata***, **height 5 mm.**

and Leupold and van der Vlerk (1931). Mollusks are rare and poorly represented in limestones of late Eocene age (Tertiary b) that form the near-basement pavement and include only poorly preserved valves of *Pecten* and *Arca*, minute turbinids, molds of small gastropods, and one identifiable mollusk, a species of *Turritella* related to a living species also reported from the upper Tertiary of Indonesia (Ladd, 1966). In what is questionably considered early Oligocene, three shells of *Rissoina ailinana* Ladd, 1966 and nine specimens of the naticid *Ampullina berauensis* described from the Miocene of East Borneo (Ladd, 1966) are represented. Above the early limestones are 610 m (2000 ft) of fossil reef of Miocene age which contain the bulk of the Enewetak fossil record, about 170 species. The post-Miocene sections consist of more than 183 m (600 ft) of consolidated limestone and about 9 m (30 ft) of unconsolidated sediments (Ladd, 1966) from which 105 species are reported.

Paleoecology

Reef-associated limestones that underlie Enewetak do not record slow, continuous subsidence but rather periods

Fig. 6 a, *Barbatia wendti*, length 6 mm; b, *Glycymeris reevei*, length 15 mm; c, *Modiolus vagina*, length 45 mm; d, *Electroma electrina*, length 10 mm; e, *Lithophaga zitelleliana*, length 40 mm; f, *Tellina pudica*, length 6 mm; g, *T. ovata*, length 37 mm; h, *Laevicardium pulcherrimum*, length 18 mm; i, *Tellina inflata*, length 17 mm; j, *Spondervilia simplex*, length 2.75 mm; k, *Tellina* sp., length 5 mm; l, *Macoma obliquaria*, length 6 mm; m, *Chama* sp., length 20 mm; n, *Dosinia miticula*, length, 10 mm.

when the atoll stood above the sea as a high island. Leopold's (1969) report of spores and pollen indicates a richer and more varied flora on Enewetak in the Miocene than now occurs. The record of a high island fossil land shell, *Vatusila* (Ladd, 1958 as *Pytochodon*; Solem, 1982), is evidence of conditions quite different from those today. Leopold (1969) also demonstrated conclusively from analysis of pollen grains that mangroves occurred at Enewetak through the Miocene. The limestone sections ". . . are all reef associated. Many of the fossiliferous beds, especially those rich in mollusks, appear to have been deposited in lagoons, but other environments—reef wall, open shoal, and off-reef deposits—are also found" (Ladd, 1966).

Miocene Record

The Miocene record, the richest and most diverse of the fossil records, includes 170 species, 26% archaeogastropods, 58% mesogastropods (including heterogastropods), and 17% neogastropods, representing 90 genera and 42 families of mollusks.

The Miocene fauna is very different from that found at Enewetak today. The archaeogastropods are represented by eight families; today there are 13 families. Turbinids, trochids, and neritids comprise 71% of the Miocene species record; trochids, fissurellids, stomatellids, and turbinids represent 68% of the present archaeogastropod fauna. Among the mesogastropods, the rissoids (29 species) are the most numerous family comprising 30% of the record; the cerithiids (15 species), 19%; and vitrinellids and dialids (12 species) about 13% of the record. Today the cypraeids, cerithiids, rissoids, stombids, vitrinellids, and cymatids dominate the mesogastropods.

Some of the differences between the Miocene and modern faunas undoubtedly reflect biases in the fossil record as such. Other differences indicate the presence of habitats such as sea grass beds, mangrove swamps, brackish water lagoons, and high island shorelines which are not now present on the atoll. Thus four genera present in the Miocene record are extinct on Enewetak today but are found elsewhere in the Indo-West Pacific in environments which do not presently occur at Enewetak. The neritid *Smaragdia* (three species in the Miocene record) is associated with sea grass beds at Kwajalein, Marshall Islands, in the Caroline Islands, and as far east as the Hawaiian Islands (Kay, 1979). The sessile limpet-like mesogastropod *Hipponix* (two species in the Miocene record) is found on the volcanic shores of the Hawaiian Islands, on Guam, and in the northern Mariana Islands (Vermeij et al., 1984). The cerithiids *Terebralia* and *Potamides* (five species in the Miocene record) occur in mangrove associations in the Philippines and elsewhere in the Indo-Malayan archipelago. In all, 12 species or 7% of the Miocene fauna recorded by Ladd (1966, et seq.) are associated with habitats not now represented at Enewetak.

Other extinctions may represent range restrictions for reasons other than habitat change. *Nerita insculpta*, *Tectarius*, *Protobarleeia*, *Pugilina*, and *Eocithara* are not recorded after the Miocene. *Nerita insculpta* is now found in Indonesia and the Northern Marianas but apparently not on islands to the east. Only one species of *Tectarius*, *T. grandinatus*, now occurs on the Pacific Plate, and it is restricted to southeast Polynesia (Rosewater, 1970). *Protobarleeia myersi* now survives in Fiji and Australia (Ponder, 1983b). Although the Melongenidae do occur in the Indo-West Pacific, no species of *Pugilina* is known from the Pacific Plate.

Still other extinctions are even more puzzling. A number of species recorded from the Miocene of Enewetak survive on other Pacific islands, including Kwajalein. Among the species are *Leptothyra laeta*, *L. candida*, *L. verruca*, *Merelina pisinna*, *Rissoina concinna*, *R. supracostata*, *Mitra turgida*, and *Vexillum approximatum*.

Post-Miocene Record

The post-Miocene record consists of 105 species of mollusks: 23% archaeogastropods, 61% mesogastropods, and 16% neogastropods. Most of these mollusks are extant. Twenty-three or 22% are extinct at Enewetak today, although some survive elsewhere in the Indo-West Pacific, among them *Synaptocochlea rosacea*, *Leptothyra picta*, and *Nannophora cingulifera*.

Faunal Relations

The closest tie in the fossil record between Enewetak and another locale is with Bikini. About 34% of the species found in the drill holes at Enewetak were also found in drill holes at Bikini. Apart from the Bikini relationship, the strongest tie for which there is a published record is with Fiji with 13% of the Enewetak Miocene species shared. The record is less strong with Guam and Saipan (4% of the Miocene record) and Java (3%).

Several possibly far-flung relationships were cited by Ladd (1966). Among them he notes that *Haplocochlias* (one species in the Miocene) is recognized as a western American genus, and the turbinid *Cynisca* (one species in the Miocene) is known only from South Africa. Neither of these relationships has been subsequently confirmed. However, the shells of *Sansonia kenneyi*, described from the Miocene of Enewetak, are indistinguishable from Miocene shells from Italy and Pliocene shells from France (Le Renard, personal communication).

Species Survival

Ladd (1966) pointed out early that many living mollusks in the Marshall Islands have been there since late Tertiary time. More recently Stanley (1979) and Stanley et al. (1980) commented on the "great stability of the Indo-West Pacific fauna" and suggest that species have tended to survive for unusually long periods in the region. The Enewetak fossil record together with the modern record provides strong evidence for the generalization: 62 species from the Miocene record are identified as living today at Enewetak. They represent 35% of that record.

From the Holocene record, 65% survive today on Enewetak.

Of the 140 extinct species listed by Ladd (1966, et seq.), 84% became extinct in the Miocene, 14.8% in the Holocene. The Enewetak record may be contrasted with that reported by Newman (1986) who calculated from Ladd (1982: Table 4) that of 126 extinctions since the Eocene, 56 or 44.4% became extinct in the Pleistocene and only five (3.5%) of the extant species survived from the Miocene. This last figure is too low for Enewetak and may be peculiar to the fossil record of Fiji and the New Hebrides (Vanuatu).

There is no single pattern of extinction and survival such as Wells (1982) found for the Midway corals, where at the end of the Miocene there was complete replacement of the Miocene genera. At Enewetak, the Turbinidae and Rissoidae show a pattern in which equal numbers of species have been extinct since the Miocene, occur both in the Miocene and today, and appear only in the modern record. The trochid, neritid, and littorinid records, in contrast, are almost entirely modern.

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Chapter 15

Insects and Allies (Arthropoda) of Enewetak Atoll

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INTRODUCTION

Insects and related terrestrial arthropods of Enewetak Atoll remain inadequately investigated. Woodbury (1962) included an inventory of arthropods known from the atoll in which he indicated that ectoparasites were taken from 10 species of birds; altogether he reported 45 species or subspecies authentically recorded from the atoll. The present list increases the number of arthropods to 191 species (or subspecies) and must still be considered preliminary, as records are lacking for many expected groups. Before this list can be completed, further collections and their study are required, especially of the soil fauna, ectoparasites and nidicoles of reptiles, birds, and rodents, and the forms associated with humans and human habitations. A checklist of Enewetak insects and related arthropods is provided in Table 1.

Investigations

Enewetak Atoll appears to have received little or no attention from investigators of insects and other terrestrial arthropods until the beginning of American occupation in 1944. Published records and dated specimens from earlier times are either given without exact localities or refer to other parts of the Marshall Islands. The relative isolation of the atoll probably accounted for the inattention. Even during the period of the Japanese Mandate, when insects were collected elsewhere in the Marshalls and generally throughout Micronesia, nothing was specifically included from Enewetak. The entomological activities of the Japanese during that period are best summarized in a long series of papers reporting on results of Teiso Esaki's Micronesian Expeditions of 1936–1940 (cf. Esaki et al., 1955). Entomological field work on Enewetak by Americans began in 1944 and continued through the postwar years to the present. Surveys conducted by or with the support of the military, the U. S. Commercial Company, and the Pacific Science Board (PSB) gave considerable impetus to establishing the series *Insects of Micronesia* in 1954. This series has become the most important source for reporting on the Micronesian fauna. The earliest account treating Enewetak insects is apparently Townes (1946), a mimeographed report for the U. S. Commercial Company, which contains records of about 20 species. The first such account published in a serial is apparently Van Zwaluwenburg (1948) in which an elaterid beetle is reported. Titles containing records of Enewetak insects and allies are cited in the bibliography.

Visits to Enewetak Atoll by entomologists and others providing records of insects and related groups from the atoll are outlined in Table 2. So far as is known, all of these visits follow the period of Japanese occupation. Spellings of the islets or motus are those currently used by the Marshallese, and they may vary from names previously used in gazetteers or in Bryan (1971).

For a time, an insect collection assembled by L. D. Tuthill was kept at the Mid-Pacific Research Laboratory (MPRL) at Enewetak. Those specimens eventually went to Bishop Museum for inclusion in studies reported in *Insects of Micronesia*. This collection, along with those conducted under the auspices of the PSB, are to be ultimately deposited in collections of participating PSB institutions: California Academy of Sciences in San Francisco, Field Museum of Natural History in Chicago, Museum of Comparative Zoology at Harvard University in Cambridge, and National Museum of Natural History in Washington, as well as Bishop Museum in Honolulu.

Environment

Enewetak Atoll is an isolated outlier on the northwestern extremity of the Ralik Chain in the drier, northern portion of the Marshall Islands. Vegetation is accordingly poorer there than on the wetter, southern atolls of both the Ralik and Ratak Chains (cf. Hathaway, 1953; St. John, 1960). A drier climate and a less diverse flora would offer fewer niches for insects; thus one would

TABLE 1

Checklist of Enewetak Insects and Related Arthropods

Class ARACHNIDA
Order SCORPIONIDA
Family ISCHNURIDAE
Hormurus australasiae Fabricius, 1775: Townes, 1946.
Order PSEUDOSCORPIONIDA
Family ATEMNIDAE
Oratemnus samoanus whartoni Chamberlin, 1947: Beier, 1957.
Family CHERNETIDAE
Haplochernes insulanus Beier, 1957: Beier, 1957.
Family CHTHONIIDAE
Lechytia sakagamii Morikawa, 1952: Beier, 1957.
Order ARANEAE
Family ARANEIDAE
*_Araneus theis_ (Walckenaer, 1841).
Family CLUBIONIDAE
*_Chiracanthium diversum_ Koch, 1873.
Family DIPLURIDAE
Masteria hirsuta Koch, 1873: Roewer, 1963.
Family EUSPARASSIDAE
*_Heteropoda venatoria_ (Linnaeus, 1767).
Family LINYPHIIDAE
*_Erigone_ sp.
Family OONOPIDAE
Opopaea foveolata Roewer, 1963: Roewer, 1963.
*_Opopaea lena_ Suman, 1965.
Family PHOLCIDAE
*_Smeringopus elongatus_ (Vinson, 1863).
Family SALTICIDAE
*_Flacillula minuta_ (Berland, 1929).
*_Vitia albipalpis_ Marples, 1957.
Family SCYTODIDAE
Scytodes striatipes (Koch, 1873): Roewer, 1963.
Family THERIDIIDAE
Latrodectus geometricus (Koch, 1841): Townes, 1946.
Order ACARI
Suborder GAMASIDA
Family DERMANYSSIDAE
*_Ornithonyssus_ sp.
Suborder IXODIDA
Family ARGASIDAE
Ornithodoros capensis Neumann, 1901: Bushman, Parker and Johnson, 1963.
Suborder ACTINEDIDA
Family ERYTHRAEIDAE
Balaustium sp.
Belaustuim sp.: Townes, 1946.
Class DIPLOPODA (MYRIAPODA in part)
Order PROTEROSPERMOPHORA
Family STRONGYLOSOMIDAE
*_Oxidus gracilis_ (Koch, 1847).
Class INSECTA
Order THYSANURA
Family LEPISMATIDAE
Not identified: Townes, 1946.
Order COLLEMBOLA
Family ENTOMOBRYIDAE
*_Seira bipunctata_ (Packard, 1873).
Family ISOTOMIDAE
*_Isotomurus tricuspis_ Börner, 1906?

*New Enewetak record.

(This table continued on next page.)

TABLE 1 (cont'd)

Order ODONATA
- Family LIBELLULIDAE
  - *Pantala flavescens* (Fabricius, 1798): Jackson, 1968.
  - **Tramea lacerata* Hagen, 1861.

Order BLATTODEA
- Family BLATTELLIDAE
  - **Blattella lituricollis* (Walker, 1868).
  - **Lupparia notulata* (Stål, 1860).
- Family BLATTIDAE
  - **Melanozosteria soror* (Brunner, 1865).
  - **Neostylopyga rhombifolia* (Stoll, 1813).
  - **Periplaneta americana* (Linnaeus, 1758).
  - **Periplaneta australasiae* (Fabricius, 1775).
- Family PYCNOSCELIDAE
  - **Pycnoscelis surinamensis* (Linnaeus, 1767).

Order ORTHOPTERA
- Family ACRIDIDAE
  - *Aiolopus thalassinus tamulus* (Fabricius, 1798).
    - *Aiolopus tamulus* (Fabricius, 1798): Townes, 1946.
- Family GRYLLIDAE
  - **Ornebius bimaculatus* (Shiraki, 1930).
  - *Gryllodes sigillatus* (Walker, 1869): Townes, 1946.
  - **Speonemobius* sp. prob. *tigrinus* (Saussure, 1877).
- Family TETTIGONIIDAE
  - *Phisis pallida* (Walker, 1869): Townes, 1946.

Order DERMAPTERA
- Family CARCINOPHORIDAE
  - *Euborellia annulipes* (Lucas, 1847): Brindle, 1972.
- Family CHELISOCHIDAE
  - *Chelisoches morio* (Fabricius, 1775): Townes, 1946.
- Family LABIDURIDAE
  - *Labidura riparia* (Pallas, 1773): Townes, 1946; Brindle, 1972.

Order PSOCOPTERA
- Family CAECILIIDAE
  - *Caecilius casarum* Badonnel, 1931: Thornton et al., 1972.
- Family ECTOPSOCIDAE
  - *Ectopsocus maindroni* Badonnel, 1935: Thornton et al., 1972.
- Family LEPIDOPSOCIDAE
  - *Cyptophania marginata* Thornton, Lee and Chui, 1972: Thornton et al., 1972.
- Family PSOCIDAE
  - *Ptycta angulata* Thornton, Lee and Chui, 1972: Thornton et al., 1972.

Order MALLOPHAGA
- Family MENOPONIDAE
  - * *Actornithophilus bicolor* (Piaget, 1880).
  - *Actornithophilus ceruleus* (Timmermann, 1954): Woodbury, 1962.
  - * *Actornithophilus incisus* (Piaget, 1880).
  - * *Actornithophilus ochraceus* (Nitzsch, 1818).
  - * *Austromenopon atrofulvum* (Piaget, 1880).
  - * *Colpocephalum angulaticeps* Piaget, 1880.
- Family PHILOPTERIDAE
  - * *Halipeurus mirabilis* Thompson, 1940.
  - * *Pectinopygus gracilicornis* (Piaget, 1880).
  - * *Quadraceps birostris* (Giebel, 1874).
  - * *Quadraceps hopkinsi* Timmermann, 1952.
  - * *Quadraceps separatus* (Kellogg and Kuwana, 1902).
  - * *Saemundssonia albemarlensis* (Kellogg and Kuwana, 1902).
  - * *Saemundssonia puellula* Timmermann, 1965.
  - * *Saemundssonia remota* Timmermann, 1951.
  - * *Saemundssonia snyderi* (Kellogg and Paine, 1910).
  - * *Trabeculus hexakon* (Waterston, 1914).

*New Enewetak record.

(This table continued on next page.)

TABLE 1 (cont'd)

Order THYSANOPTERA
  Family PHLAEOTHRIPIDAE
    * *Haplothrips gowdeyi* (Franklin, 1908).
Order HETEROPTERA
  Family ANTHOCORIDAE
    Physopleurella mundula (White, 1877): Herring, 1967.
  Family COREIDAE
    Liorhyssus hyalinus (Fabricius, 1794): Gross, 1963.
  Family CYDNIDAE
    Geotomus pygmaeus (Dallas, 1851): Ruckes, 1963.
  Family GERRIDAE
    Halobates micans (Eschscholtz, 1822): Cheng, 1981.
    Hermatobates sp.: Cheng, 1977.
  Family LYGAEIDAE
    **Germalus* sp.
    Nysius picipes Usinger, 1937: Usinger, 1949, 1951; Barber, 1958.
    Nysius pulchellus Stål, 1859: Usinger, 1949, 1951; Barber, 1958.
    Pachybrachius nigriceps (Dallas, 1852): Barber, 1958.
  Family MIRIDAE
    Campylomma eniwetok Schuh, 1984: Schuh, 1984.
    Campylomma marshallensis Usinger, 1952: Schuh, 1984.
    Trigonotylus dohertyi (Distant, 1904): Carvalho, 1956.
  Family NABIDAE
    Nabis capsiformis Germar, 1839: Gross, 1963.
  Family PENTATOMIDAE
    Oechalia schellenbergii (Guerin-Méneville, 1831): Ruckes, 1963.
      Oechalia consocialis (Boisduval): Usinger, 1952.
    Platynopus melacanthus (Boisduval, 1835): Ruckes, 1963.
Order HOMOPTERA
  Family APHIDIDAE
    Aphis gossypii Glover, 1855: Essig, 1956.
    Aphis craccivora Koch, 1854.
      Aphis medicaginis Koch, 1854: Essig, 1956.
  Family CICADELLIDAE
    Balclutha incisa (Matsumura, 1902): Linnavouri, 1975.
    Balclutha saltuella (Kirschbaum, 1868): Linnavouri, 1975.
    Exitianus fusconervosus (Motschulsky, 1863).
      Exitianus capicola Stål, 1855: Linnavouri, 1960 (in part).
    Exitianus plebeius (Kirkaldy, 1906): Linnavouri, 1960.
      Exitianus capicola Stål, 1855: Linnavouri, 1960 (in part).
    Orosius argentatus (Evans, 1940): Linnavouri, 1975.
      Nesaloha cantonis Oman, 1943: Oman, 1943.
      Orosius cantonis (Oman, 1943): Ghauri, 1966.
    Recilia affinis (Osborn, 1934): Linnavouri, 1975.
    Recilia hopponis (Matsumura, 1914): Linnavouri, 1975.
  Superfamily COCCOIDEA
    Ceroplastes cirripediformis Comstock, 1881: Beardsley, 1966.
    Coccus hesperidum Linnaeus, 1758: Beardsley, 1966.
    Icerya purchasi Maskell, 1878: Beardsley, 1966.
    Lepidosaphes esakii Takahashi, 1939: Beardsley, 1966.
    Phenacoccus solani Ferris, 1918: Beardsley, 1966.
    Pseudococcus microadonidum Beardsley, 1966: Beardsley, 1966.
    Saissetia coffeae (Walker, 1852): Beardsley, 1966.
  Family DELPHACIDAE
    Sogatella kolophon (Kirkaldy, 1907): Fennah, 1971.
  Family DERBIDAE
    Lamenia caliginea charon Fennah, 1956: Fennah, 1956, 1971.
Order COLEOPTERA
  Family ANTHICIDAE
    Anthicus vexator Werner, 1965: Werner, 1965.

*New Enewetak record.

(This table continued on next page.)

TABLE 1 (cont'd)

Family CARABIDAE
Egadroma smaragdula (Fabricius, 1798): Darlington, 1970.
Family CERAMBYCIDAE
Prosoplus atlanticus atlanticus Breuning, 1938: Gressitt, 1956.
Family CHRYSOMELIDAE
**Aphthona bicolorata* Jacoby, 1904.
Family COCCINELLIDAE
Coelophora inaequalis (Fabricius, 1775): Chapin, 1965 [including variety *novemmaculata* (Fabricius, 1781): Chapin, 1965].
Harmonia arcuata (Fabricius, 1787): Chapin, 1965.
Nephus roepkei (Fluiter, 1938): Chapin, 1965.
**Scymnus nigrosuturalis* Kamiya, 1961.
Family DERMESTIDAE
Dermestes ater De Geer, 1774: Beal, 1961.
Family ELATERIDAE
Conoderus pallipes Eschscholtz, 1829: Van Zwaluwenburg, 1948, 1957.
Simodactylus fasciolatus Fairmaire, 1863: Van Zwaluwenburg, 1957.
Family MYCETOPHAGIDAE
Typhaea stercorea Linnaeus, 1758: Michitaka Chûjô, 1970.
Family NITIDULIDAE
Carpophilus davidsoni Dobson, 1952: Gillogly, 1962.
Carpophilus hemipterus (Linnaeus, 1758): Gillogly, 1962.
Carpophilus marginellus Motschulsky, 1858: Gillogly, 1962.
Carpophilus mutilatus Erichson; 1843: Gillogly, 1962.
Carpophilus pilosellus Motschulsky, 1858: Gillogly, 1962.
Urophorus humeralis (Fabricius, 1798): Gillogly, 1962.
Family OEDEMERIDAE
**Eobia kanack* (Fairmaire, 1849).
**Eobia matsumurai* Kono, 1937.
**Eobia trukana* Kono, 1937.
**Eobia* new species, Macnamara and Arnett, in preparation.
**Pselaphanca apicata* (Fairmaire, 1881).
*New genus and species, Macnamara and Arnett, in preparation.
Family PROPALTICIDAE
Propalticus insularis John, 1960, 1971.
Family SCOLYTIDAE
Cryphalomorphus nubilus Wood, 1960: Wood, 1960.
Hypothenemus eruditus Westwood, 1836: Wood, 1960.
Family TENEBRIONIDAE
Gebieniella carinata (Eschscholtz, 1831): Kulzer, 1957.
**Gonocephalum adpressiforme* Kaszab, 1951.
Order NEUROPTERA
Family CHRYSOPIDAE
Chrysopa ramburi Schneider, 1851: Adams, 1959.
Order LEPIDOPTERA
Family ARCTIIDAE
Utetheisa pulchelloides Hampson, 1907: Townes, 1946.
Family HESPERIIDAE
Badamia exclamationis (Fabricius, 1775): Townes, 1946.
Family NOCTUIDAE
Spodoptera exempta (Walker, 1856).
Laphygma exempta (Walker, 1856): Townes, 1946.
Spodoptera litura (Fabricius, 1775).
Prodenia litura (Fabricius, 1775): Townes, 1946.
Family NYMPHALIDAE
Hypolimnas bolina (Linnaeus, 1764): Townes, 1946.
Precis villida (Fabricius, 1787): Townes, 1946.
Precis villida bismarckiana (Hagen): Clark, 1951.

*New Enewetak record.

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TABLE 1 (cont'd)

Family SPHINGIDAE
- **Agrius convolvuli* (Linnaeus, 1758): Riotte, in preparation.
- *Cephonodes armatus* Rothschild and Jordan, 1903: Townes, 1946.
- **Cephonodes picus* (Cramer, 1777): Riotte, in preparation.
- *Gnathothlibus erotus* (Cramer, 1777).
  - *Chromis erotus* (Cramer, 1777): Townes, 1946.

Family TORTRICIDAE
- *Adoxophyes fasciculana* (Walker, 1866): Clarke, 1976.

Order DIPTERA

Family AGROMYZIDAE
- *Ophiomyia cornuta* (de Meijere, 1910): Spencer, 1963.
- *Pseudonapomyza spicata* (Malloch, 1914): Spencer, 1963.

Family CALLIPHORIDAE
- *Chrysomya megacephala* (Fabricius, 1784): James, 1962.
- *Phaenicia cuprina* (Wiedemann, 1930): James, 1962.

Family CANACEIDAE
- *Nocticanace marshallensis* Wirth, 1951: Wirth, 1951.

Family CERATOPOGONIDAE
- *Dasyhelea esakii* Tokunaga, 1940: Tokunaga and Murachi, 1959.
- *Dasyhelea flavescens* Tokunaga and Murachi, 1959: Tokunaga and Murachi, 1959.
- *Dasyhelea flavibasalis* Tokunaga, 1940: Tokunaga and Murachi, 1959.
- *Dasyhelea peliliouensis* Tokunaga, 1940: Tokunaga and Murachi, 1959.
- *Forcipomyia tuthilli* Tokunaga, 1959: Tokunaga and Murachi, 1959.

Family CHIRONOMIDAE
- *Clunio tuthilli*:Tokunaga, 1964.
- *Pontomyia natans* Edwards, 1926: Cheng and Hashimoto, 1978.
- **Tanytarsus halophilae* Edwards, 1926.
- **Telmatogeton pusillum* Edwards, 1935.
- *Thalassomya maritima* Wirth, 1947: Tokunaga, 1964.

Family CHLOROPIDAE
- **Cadrema pallida* (Loew, 1866).
- *"*Gaurax*" *bicoloripes* (Malloch, 1932).

Family EPHYDRIDAE
- **Allotrichoma alium* Cresson, 1929.
- **Discocerina mera* Cresson, 1939.
- **Hecamede persimilis* Hendel, 1913.
- **Hostis guamensis* Cresson, 1945.
- **Placopsidella cynocephala* Kertész, 1901.

Family HIPPOBOSCIDAE
- **Olfersia spinifera* (Leach, 1817).

Family MILICHIIDAE
- **Desmometopa varipalpis* Malloch, 1927.
- **Milichiella lacteipennis* (Loew, 1866).

Family MUSCIDAE
- *Atherigona flavipalpis* Malloch, 1928: Snyder, 1965.
- *Atherigona (Acritochaeta) orientalis* Schiner, 1868.
  - *Atherigona excisa* (Thompson, 1868): Snyder, 1965.
- *Musca (Musca) domestica* Linnaeus, 1758: Snyder, 1965.

Family PHORIDAE
- *Diploneura (Dohrniphora) cornuta* (Bigot, 1857): Beyer, 1967.
- *Megaselia (Megaselia) scalaris* (Loew, 1866): Beyer, 1967.

Family SARCOPHAGIDAE
- *Boettcherisca karnyi* (Hardy, 1927): Souza Lopes, 1958.
- *Parasarcophaga (Liosarcophaga) misera* (Walker, 1849): Souza Lopes, 1958.
- *Phytosarcophaga gressitti* (Hall and Bohart, 1948): Souza Lopes, 1958.

Family SCATOPSIDAE
- **Holoplagia guamensis* (Johannsen, 1946) or near?

Family SCIARIDAE
- *Bradysia tritici* (Coquillett, 1895): Steffan, 1969.

*New Enewetak record.

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TABLE 1 (cont'd)

Family SCIARIDAE (cont'd)
Corynoptera latistylata (Hardy, 1956): Steffan, 1969.
Plastosciara latipons Hardy, 1956: Steffan, 1969.
Family STRATIOMYIDAE
Brachycara ventralis Thomson, 1869: James, 1962.
Family SYRPHIDAE
Ishiodon scutellaris (Fabricius, 1805): Shiraki, 1963.
Family TIPULIDAE
Limonia (Dicranomyia) pectinunguis Tokunaga, 1940: Alexander, 1972.
Order HYMENOPTERA
Family ANTHOPHORIDAE
**Xylocopa sonorina* Smith, 1879.
Family BRACONIDAE
Zele sp.: Townes, 1946.
Family EULOPHIDAE
Hemiptarsenus semialbiclavus (Girault, 1916): Yoshimoto and Ishii, 1965.
Family EVANIIDAE
**Szepligetella sericea* (Cameron, 1883).
Family FORMICIDAE
Monomorium pharaonis (Linnaeus, 1758): Townes, 1946.
Family ICHNEUMONIDAE
Echthromorpha agrestoria insidiator (Smith, 1863): Townes, 1958.
Family MEGACHILIDAE
Megachile diligens hedleyi Rainbow, 1897: Krombein, 1950.
Megachile (Eutricharaea) fullawayi Cockerell, 1914: Krombein, 1950.
Family SPHECIDAE
**Chalybion bengalense* (Dahlbom, 1845).
Pison punctifrons Shuckard, 1838: Krombein, 1949.
Solierella peckhami (Ashmead, 1897).
Solierella rohweri (Bridwell, 1920): Krombein, 1949.
**Tachysphex bengalensis* Cameron, 1889.
Family VESPIDAE
**Odynerus* sp.
Pachodynerus nasidens (Latreille, 1812): Townes, 1946.
**Polistes fuscatus aurifer* (Saussure, 1853).
**Ropalidia marginata* (Lepeletier, 1836).

*New Enewetak record.

expect fewer indigenous insect species on Enewetak than on, for instance, Arno Atoll. However, the introduction of exotic plant and insect species on Enewetak complicates the picture.

The most notable aspect concerning the environment at Enewetak is obviously the man-made alterations and disturbances over many parts of the atoll. These had extreme impacts on the indigenous biota and tended to become more severe as the sequence of human occupation progressed on the atoll. The advent of Micronesians and the development of a native culture were followed by colonization and by trade with non-Micronesian elements. Thus, at least certain islets were affected by the changes associated with the earlier phases of human occupation, including the establishment of copra plantations. The later periods included construction of military bases and air fields, warfare, cleanup operations following warfare, and testing of nuclear devices and associated activities. The devastation by warfare that occurred on certain islets during World War II was subsequently magnified by applications of insecticides (Townes, 1946) and cleanup operations in which entire islets were cleared by bulldozing. One of the early programs of the U. S. military was to establish vegetative growth on the bare sand to hold it down (Bryan, 1944; personal communication).

The postwar testing of nuclear devices accounted for further and sometimes complete devastation of certain islets. Some sites were also bulldozed following tests. All these postwar activities and the traffic of personnel and materials, mainly through Hawaii, facilitated the importation of exotic plants and insects. Many species of plants were intentionally introduced or reintroduced to Enewetak from nursery stock via Kwajalein (Fosberg, 1959). Over 50 species of exotic plants were reported for Enewetak during that period (St. John, 1960) marking a dramatic increase of exotics over previous periods when, for example, only 24 exotics were estimated for a lusher part of the Marshall Islands (Arno) in 1850 (Hathaway, 1953). The plants in some measure may serve as an indication of the numbers of insects and related groups that were also introduced to

TABLE 2

Collectors of Insects and Related Groups on Enewetak Atoll

Name	Month/Year	Islets
Allen, R.	Aug. 1945	Enewetak, Runit
Bohart, R.	Jan. 1945	Enewetak?
Bryan, E. H., Jr.	Aug. 1944	Enewetak, Enjebi, Japtan, Medren
	Feb. 1975	Alembel, Ananij, Bijile, Enewetak, Enjebi, Ikuren, Japtan, Lojwa, Medren, Runit
Bushman, J. B.	Mar.–May 1962	Aej, Enewetak, Enjebi, Inedral, Japtan, Jinimi, Medren, Mijikadrek, Ribewon
Cheng, L.	Sept. 1975	Enewetak, Ikuren, Japtan, Medren
Dybas, H. S.	Nov.–Oct. 1944	Enewetak, Japtan
Edgar, S. A.	Nov.–Oct. 1944	Enewetak, Japtan
Fosberg, F. R.	May 1946	Japtan
	May 1951	Enjebi
Hagen, E.	Nov. 1944	Enewetak, Japtan
Jackson, W. B.	1964–67 (summers)	Enjebi, Runit
Knudsen, J. W.	Apr. 1965	Enewetak
	Aug. 1967	?
Lamberson, P.	?	Enjebi
Morrison, J.	Apr.–June 1946	Biken, Ikuren, Kidrinen, Louj, Lujor, Mut
Oakley, R. G.	May 1946	Aomon, Enjebi, Japtan (and others with Townes?)
Ōshiro, Y.	Dec. 1950–Jan. 1951	Bokombako, Elugelab, Enjebi
Parker, D.	Mar.–Apr. 1962	Aej
Reish, D. J.	July 1956	Enewetak
Townes, H. K.	May 1946	Aomon, Enewetak, Enjebi, Ikuren, Japtan
Tuthill, L. D.	Aug.–Sept. 1956	Ananij, Ikuren, Japtan, Medren
	Jan.–Feb. 1957	Japtan, Medren
	July 1957	"Nan"
	Sept. 1957	Medren
	Aug. 1958	Japtan
Wheeler, M. R.	Aug.–Sept. 1955	Enjebi, Ikuren, Japtan, Medren
Young, F. N.	May 1945	Medren

Enewetak during the same periods. Hence, the indigenous (including endemic) biota of Enewetak—the species that represent the true unadulterated character of the atoll—probably suffered profoundly through both physical impacts on the environment and biological impacts, including competition for space and resources from adventive forms.

In view of the disturbances to Enewetak Atoll, it seems relevant to note the times and places where species were collected or observed, thereby providing a summary of the first four decades of entomological records for the atoll. This information is provided in the section on Collection Records.

Fauna

Townes (1946) estimated that a large dry atoll like Enewetak might have 500 species of insects. This estimate could be somewhat high. The indigenous insect fauna of Enewetak would be expected to be less than that of Arno Atoll. The fauna of Arno was also estimated at around 500 species (Usinger and LaRivers, 1953), and at least 296 species have already been recorded for that atoll (Gressitt, 1954). Cole (1949, 1951) listed 56 species of insects collected from Bikini Atoll in 1947. Bikini lies in the same zone as Enewetak and would be expected to support a nearly identical fauna. Cole's survey was the only one conducted for Bikini and, unfortunately, it occurred after applications of DDT on the islets and after the first atomic bomb tests there. These perturbations must have had severe effects on the fauna and on Cole's results. Cole's lists were admittedly incomplete; however, 35 species listed by him, including 12 species of ants, have not yet been reported for Enewetak. Most of these 35 species probably also occur or have occurred on Enewetak.

We expect that, when fully studied, the arthropod fauna of Enewetak Atoll will comprise 350 to 400 species. This estimate takes into consideration that the 191 taxa reported herein do not include many groups that are expected to occur in cryptic habitats, such as soil and decaying plant materials and those associated with vertebrates.

In comparing the fauna of Enewetak Atoll with the total number of species reported for the Marshall Islands, we find about 32% (191 of 592) represented on Enewetak (Table 3). Many of the exotic species carried to Kwajalein and Enewetak in recent years are, of course, reflected in this percentage, which would be lower if only the truly indigenous and endemic elements were considered. We estimate that around 43% (82 of 191) of the species presently listed for Enewetak could be adventive elements. The extent of transfer into neighboring atolls by these adventives is not known.

The percentage of species endemic to the Marshalls is certainly not high at 4% (25 of 592); we expect this figure to increase somewhat after future collections from cryptic habitats are studied. These endemics are listed in Table 4. The proportion of species endemic to Enewetak Atoll is very low at 1½% (3 of 191); this percentage, too, is expected to increase following future studies. Of the 25 species endemic to the Marshalls, 52% (13) are restricted to the western or Ralik Chain, 24% (6) are restricted to the eastern or Radak Chain, and 24% (6) are found on both chains (Table 5). Present records indicate that 64% (16 of 25) of these endemics are restricted to single atolls; they represent only 2½% (16 of 592) of the total Marshall Islands' fauna.

A rather low proportion, 9½% (57 of 592), of the Marshall Islands fauna is restricted to the central and eastern Carolines–Marshalls–Gilberts sector of the Pacific (Table 6). This includes the most characteristic species to be expected on atolls; they are listed in Table 7. About half (31 of 57) are strictly limited to atolls and low islands, and these include the taxa endemic to the Marshalls. The others (26 of 57) also occur on high islands proximal to

TABLE 3

Numbers of Insects and Allies Reported for the Marshall Islands and Numbers for Enewetak Atoll Only, Including Counts of Endemic Taxa

Group	Marshall Islands	Enewetak Atoll	Endemic to Marshalls	Endemic to Enewetak
Arachnida	42	19	2	
Myriapoda	4	1		
Insecta:				
Thysanura	1	1		
Collembola*	2	2		
Odonata	7	2		
Blattodea*	9	7		
Mantodea	1			
Phasmatodea	1			
Orthoptera	10	5		
Isoptera	6			
Dermaptera	7	3		
Embioptera	1			
Psocoptera	16	4		
Mallophaga	22	16		
Anoplura	3			
Thysanoptera	2	1		
Heteroptera	30	15	2	1
Homoptera	65	18	1	
Coleoptera	116	29	9	
Neuroptera	2	1		
Lepidoptera	40	11		
Diptera	142	40	10	2
Siphonaptera	1			
Hymenoptera	62	16	1	
Totals	592	191	25	3

*Group is poorly surveyed, with Enewetak records accounting for most or all Marshall Island records.

TABLE 4

Taxa Endemic to the Marshall Islands

Arachnida

Pseudoscorpionida
Garypus ornatus Beier—Garypidae (Bikini)
Xenolpium oceanicum latum Beier—Olpiidae (Lae, Ujae, Utirik)

Insecta

Heteroptera
Riptortus saileri Usinger—Coreidae (Kwajalein)
Campylomma eniwetok Schuh—Miridae (Enewetak)

Homoptera
Ugyops kinbergi magas Fennah—Delphacidae (Ailinglapalap, Jaluit)

Coleoptera
Ceresium robustum Gressitt—Cerambycidae (Arno)
Ceresium unicolor marshallum Gressitt—Cerambycidae (Majuro)
Oopsis marshallensis Gressitt—Cerambycidae (various atolls)
Prosoplus hibisci Gressitt—Cerambycidae (Majuro, Utirik)
Prosoplus major Gressitt—Cerambycidae (Arno)
Melanoxanthus lariversi Van Zwaluwenburg—Elateridae (Arno)
Simodactylus marshallensis Ōhira—Elateridae (Kwajalein)
Chariotheca costata Kulzer—Tenebrionidae (Arno, Ailinglapalap)
Tagalus angustus Kulzer—Tenebrionidae (Arno)

Diptera
Nocticanace marshallensis Wirth—Canaceidae
Dasyhelea nigristigmata Tokunaga and Murachi—Ceratopogonidae (Ailinglapalap)
Dasyhelea sp. No. 1 Tokunaga and Murachi—Ceratopogonidae (Arno)
Forcipomyia tuthilli Tokunaga—Ceratopogonidae (Enewetak)
Clunio tuthilli Tokunaga—Chironomidae (Enewetak)
Cricotopus sp. No. 1 Tokunaga—Chironomidae (Kwajalein)
Plastosciara jaluitensis Steffan—Sciaridae (Jaluit)
Scythropochroa trispinosa Steffan—Sciaridae (Kwajalein)
Limonia beardsleyi Alexander—Tipulidae (Namu, Namorik)
Limonia sentifera Alexander—Tipulidae (Namu, Arno)

Hymenoptera
Cirrospiloideus fullawayi Yoshimoto and Ishii—Eulophidae (Ebon)

TABLE 5

Distribution of Insects and Allies Endemic to the Marshall Islands

Group	Ralik Chain (Western)	Ratak Chain (Eastern)	Both chains	Single atoll
Arachnida	1		1	1
Heteroptera	2			2
Homoptera			1	
Coleoptera	1	5	3	5
Diptera	8	1	1	7
Hymenoptera	1			1
Totals	13	6	6	16

atolls where they are indigenous in the central and eastern Carolines (Yap, Truk, Ponape, Kosrae). None of the Marshalls or Gilberts are correspondingly close to a high island. The high islands of the Carolines are centers of endemism with relatively rich faunas and may have been sources for many of the forms now strictly limited to atolls. Thus, the presence of isolated high islands in the vicinity of atolls may have considerable influence on the nature of an atoll fauna.

Factors influencing an atoll fauna would include the above, as well as the degree of isolation of the atoll, land area, climate, frequency of typhoons, effects of wind and sea currents, and presence of migratory birds. Finally, human activities have considerable bearing on the nature of an atoll fauna; these affect faunal composition through environmental alteration and allow increased opportunities for establishment of adventive species. Direct air and shipping routes between the Marshalls and Hawaii have obviously permitted movements of species between the two island groups within the past 40 years (Table 8). Of the adventive elements on Enewetak that also occur in Hawaii, we note that they represent around 28% (54 of 191) of the atoll's fauna. Furthermore, when considering the Enewetak adventives alone, we see that a higher proportion, 66%, also occurs in Hawaii (54 of 82). Hawaii, as an example of a center of commerce in the Pacific, has witnessed a marked increase of established adventives over recent decades (cf. Beardsley, 1962, 1979), and that is due largely to increased air traffic.

Gressitt (1954) stated that atolls and low islands in the Carolines, Marshalls, and Gilberts have relatively poor but uniform faunas. This appears so within the Marshalls, at least at the generic level and frequently at the species level, when the adventive forms established on Kwajalein and Enewetak Atolls are discounted.

Zoogeography

The geographical affinities of major groups represented in the Marshall Islands, or otherwise in Micronesia, are only partly ascertained at this time. Many groups are not yet studied to the point where they can be analyzed definitively. This is also true for the faunas of adjacent regions; all have influences on the Micronesian fauna through past or present movements of species.

In the following discussion, the general geographical distributions are given for all species reported for the Marshall Islands to classify the potential inventory and sources of the species for Enewetak Atoll. The numbers of species counted for the Marshalls and Enewetak are provided at the beginning of most of the following sections. Also, most major groups occurring in Micronesia are summarized to give some perspective to the Marshall Islands fauna; this includes, when known, the number of species or subspecies reported for Micronesia and the percentage

TABLE 6

Distribution of Marshalls' Fauna Restricted to the Carolines (Central and Eastern*)–Marshalls–Gilberts Sector of the Pacific Ocean

Group†	Atolls: Marshalls only	Atolls: Of island groups within sector	Atolls and high islands within sector
Arachnida			
Pseudoscorpionida	2	1	1
Opiliones			1
Insecta			
Psocoptera			2
Heteroptera			
Coreidae	1		
Lygaeidae		1	
Miridae	1	1	
Homoptera			
Cixiidae			2
Pseudococcidae			2
Delphacidae	1		1
Derbidae			1
Coleoptera			
Cerambycidae	5		3
Chrysomelidae			1
Coccinellidae		1	
Elateridae	2		
Oedemeridae		1	
Scolytidae			1
Tenebrionidae	2		1
Lepidoptera			
Noctuidae			1
Diptera			
Canaceidae	1		
Ceratopogonidae	3		2
Chironomidae	2		1
Culicidae			1
Drosophilidae			1
Platystomatidae			1
Sciaridae	2		
Stratiomyidae			1
Tipulidae	2		
Hymenoptera			
Cynipoidea			1
Eucharidae		1	
Eulophidae	1		1
Totals	25	6	26

*Central and Eastern Carolines = all atolls and high islands E of Palau; this division is the Federated States of Micronesia.

†Table 4 lists taxa in column 1, Table 7 lists taxa in columns 2 and 3.

TABLE 7

Taxa Reported for the Marshalls and Restricted to the Central and Eastern Carolines (Excluding Palau)–Marshalls–Gilberts Sector of the Pacific Ocean

Arachnida

Pseudoscorpionida
- *Lechytia sakagamii* Morikawa (CA, M + Marcus)
- *Nesidiochernes maculatus* Beier (K, M)

Opiliones
- *Zalmoxis solitaria* (Roewer) (P,M)

Insecta

Psocoptera
- *Ectopsocus villosus* Thornton and Wong (T, P, K, M)
- *Heterocaecilius campanula* Lee and Thornton (P, CA, M, G)

Hemiptera
- *Nysius picipes* Usinger—Lygaeidae (M, G + Wake)
- *Campylomma marshallensis* Usinger—Miridae (M, G + Kanton)

Homoptera
- *Myndus apicalis* (Metcalf)—Cixiidae (CA, T, P, K, M)
- *Myndus praecanus* Fennah—Cixiidae (P, M)
- *Pseudococcus marshallensis* Beardsley—Pseudococcidae (K, M)
- *Pseudococcus microadonidum* Beardsley—Pseudococcidae (T, P, M, G)
- *Ugyops superciliata* Fennah—Delphacidae (CA, P, K, M)
- *Flaccia dione* Fennah—Derbidae (CA, K, M)

Coleoptera
- *Paremeopedus minimus* (Blair)—Cerambycidae (CA, T, P, M)
- *Prosoplus a. atlanticus* Breuning—Cerambycidae (P, M)
- *Prosoplus xyalopus* (Karsch)—Cerambycidae (Y, CA, M, G)
- *Brontispa chalybeipennis* (Zacher)—Chrysomelidae (P, K, M)
- *Scymnus uncinus* Chapin—Coccinellidae (M, G)
- *Eobia* new species Macnamara and Arnett—Oedemeridae (M, G + Ocean)
- *Cryphalomorphus nubilus* Wood—Scolytidae (CA, K, M)
- *Uloma lariversi* Kulzer—Tenebrionidae (K, M)

Lepidoptera
- *Nagia hieratica* Hampson—Noctuidae (Y, P, M, G)

Diptera
- *Dasyhelea flavibasalis* Tokunaga—Ceratopogonidae (P?, M)
- *Dasyhelea pallivittae* Tokunaga—Ceratopogonidae (K, M)
- *Smittia yapensis* Tokunaga—Chironomidae (Y, T, CA, M)
- *Aedes marshallensis* Stone and Bohart—Culicidae (CA, K, M, G)
- *Microdrosophila errator* Wheeler and Takada—Drosophilidae (P, K, M)
- *Scholastes carolinensis* Enderlein—Platystomatidae (P, M)
- *Cephalochrysa rugulosa* James—Stratiomyidae (P, K, M)

Hymenoptera
- *Pseudeucoila gressitti* Yoshimoto—Cynipoidea (T, M)
- *Parachalcura maculata* Watanabe—Eucharidae (CA, M)
- *Hemiptarsenus carolinensis* Yoshimoto and Ishii—Eulophidae (Y, CA, M, G)

*CA, Caroline Atolls; G, Gilberts; K, Kosrae; M, Marshalls; P, Ponape; T, Truk; Y, Yap.

TABLE 8
Proportions of Indigenous and Adventive Species for Groups Represented on Enewetak Atoll

Group	Total species reported	Indigenous, including endemic	Adventive	Also found in Hawaii
Arachnida	19	10	9	6
Myriapoda	1		1	1
Insecta:				
Thysanura	1		1	
Collembola	2		2	
Odonata	2	1	1	2
Blattodea	7		7	7
Orthoptera	5		5	2
Dermaptera	3		3	3
Psocoptera	4	2	2	2
Mallophaga	16	16		13
Thysanoptera	1		1	1
Heteroptera	15	11	4	6
Homoptera	18	7	11	8
Coleoptera	29	18	11	10
Neuroptera	1	1		
Lepidoptera	11	8	3	2
Diptera	40	30	10	23
Hymenoptera	16	5	11	9
Totals	191	109	82	95*

*Forty-one are indigenous to Enewetak; 54 are adventive.

of those endemic to Micronesia. These figures will certainly change as studies continue on this and adjacent faunas.

ARACHNIDA

The Micronesian arachnid fauna is partially studied, though the spiders and mites remain incompletely surveyed. The Amblypygi just enter the Micronesian area at Palau, with one Papuan–Malayan species reported, *Charon grayi* Gervais (Takashima, 1950).

Scorpionida

Marshalls 2, Enewetak 1—The *Hormurus* we list for Enewetak is widely distributed in the Pacific and also occurs from China to Australia. The tropicopolitan *Isometrus maculatus* (DeGeer) is reported for the Marshalls, Gilberts, Palau; it is commonly found in dwellings but is not yet reported for Enewetak. Micronesian fauna, studied by Chapin (1957), comprises three species. A second *Hormurus* of mainly Australian–Melanesian distribution reaches Palau.

Pseudoscorpionida

Marshalls 10, Enewetak 3—Seven of the 10 pseudoscorpions reported for the Marshalls are restricted to Micronesia. Two of these are endemic to the Marshalls but are not reported for Enewetak; they are *Garypus ornatus* Beier (Bikini) and *Xenolpium oceanicum latum* (Beier) (Lae, Ujae, Utirik). The *Lechytia* we list for Enewetak is restricted to atolls or low islands, including the Carolines (Ulithi) and Marcus Island. *Nesidiochernes maculatus* Beier is restricted to the eastern Carolines (Kosrae) and Marshalls and is not yet reported for Enewetak. Three species are either widespread in Micronesia or at least recorded from distant localities. One of these is the *Haplochernes* we list for Enewetak. The three extra Micronesian taxa comprise *Oratemnus samoanus whartoni* Chamberlin reported for Enewetak, western Carolines, and Okinawa; the nominate *O. s. samoanus* Beier of mainly Polynesian distribution; and a species of *Geogarypus* also occurring on Taiwan. Micronesian fauna, studied by Beier (1957), comprises 45 species or subspecies of which all are confined to the Pacific basin.

Opiliones

Marshalls 1, Enewetak 0—Only one species, *Zalmoxis solitaria* (Roewer), is recorded for the Marshalls; its distribution is restricted to the eastern Carolines (Ponape) and Marshalls (Jaluit). Micronesian fauna, studied by Goodnight and Goodnight (1957), comprises six endemic species in five genera. One genus, *Parasamoa*, is endemic to Ponape and is related to a Samoan genus and also to another in the Seychelles; the remaining four genera have representatives in the Malayan subregion.

Araneae

Marshalls 19, Enewetak 12—Spiders reported for the Marshalls are widespread (9 species), distributed in the Malayan subregion and Pacific (3), confined to Oceania (5), or undetermined (2). Of the species we list for Enewetak, the *Araneus, Chiracanthium, Flacillula, Heteropoda, Latrodectus, Smeringopus,* and *Vitia* are widespread; the *Masteria*, two *Opopaea*, and *Scytodes* are confined to Oceania; and the *Erigone* is of unknown distribution, as it is unidentified. At least five of the 12 spiders reported for Enewetak also occur in Hawaii, a probable avenue for the introduction of some of the adventive species. Roewer (1963) treated seven families of Micronesian spiders totaling 13 species, 10 of which are restricted to Micronesia; eight of the species we treat for Enewetak are not included in Roewer's treatment.

Acari

Many additional records are expected for the Marshalls; suborders are treated below.

Gamasida (Mesostigmata): Marshalls 4, Enewetak 1—*Laelaps echidnina* Berlese and *L. nuttalli* Hirst are reported for the Marshalls but not Enewetak; both are associated with *Rattus* and are cosmopolitan or nearly so. The *Ornithonyssus* we list for Enewetak is not identified, but the only species thus far reported for Micronesia is the cosmopolitan *O. bacoti* (Hirst), a species associated with rodents, particularly rats. These mites are among the seven parasitic Mesostigmata reported for Micronesia by Wilson (1967). *Glyptholaspis asperrima* (Berlese) is one of five macrochelids reported for Micronesia by Krantz (1967); it is described from Java and reported for Palau and the Marshalls (Arno); some of the specimens are from a palm log (Palau).

Ixodida (Metastigmata): Marshalls 2, Enewetak 1—The ticks, reviewed by Kohls (1957), now comprise at least six species in Micronesia. Kohls reported *Rhipicephalus sanguineus* (Latreille) for the Marianas and Gilberts; earlier, Schnee (1904) reported it for the Marshalls (Jaluit). This cosmopolitan tick is associated mainly with the dog. The *Ornithodoros* we list for Enewetak is from collections from two species of noddies and their nests and possibly from three additional species of sea birds from Enewetak (Bushman, Parker, and Johnson, 1963). This tick is widespread on oceanic islands of both hemispheres, including Hawaii.

Actinedida (Prostigmata): Marshalls 4, Enewetak 1—*Balaustium* and *Calorema* are not identified further; the former is reported for Enewetak and the latter for Kwajalein. Two species of *Tetranychus* are reported for Kwajalein by Sugerman (1972a, 1979): *T. cinnabarinus* (Boisduval) is known from North America and India, and *T. tumidus* Banks is reported for the United States, Puerto Rico, and Guam.

Oribatida: Records are lacking for the Marshalls, though the group is certainly expected there. Micronesian oribatids are beginning to be reported upon by Sengbusch (1982a, b), who described two lohmnanniids endemic to the Carolines (Yap, Ponape) belonging to an ancient group of Gondwanan origin.

MYRIAPODA

The Micronesian myriapod fauna is poorly sampled, with only chilopods and diplopods reported for the Marshalls. Pauropods are reported only from Palau and Guam (Remy, 1957). Symphylans apparently remain unreported for Micronesia, though they may be expected on remote islands. *Hanseniella orientalis* (Hansen), for example, is an Indo-Australian species that also reaches Samoa and the Marquesas (Adamson, 1932; Silvestri, 1939). Four other species are reported for Hawaii (Scheller, 1961).

Chilopoda

Marshalls 1, Enewetak 0—The only centipede definitely reported for the Marshalls is *Scolopendra morsitans* Linnaeus, a widespread species reported for Jaluit (Schnee, 1904). Townes (1946) stated that *Scolopendra* occurs on practically every island and is moderately common, but Enewetak was not specifically indicated.

Diplopoda

Marshalls 3, Enewetak 1—Two unidentified millipedes representing *Polyxenus* and *Trigonoiulus* are reported for the Marshalls. *Oxidus gracilis* (Koch), recently collected from Enewetak, occurs throughout the Pacific; it is common in Hawaii and is easily transported in soil through commerce (Williams, 1931).

INSECTA

Apterygota

Only two orders (Thysanura and Collembola) of these primitive, wingless insects have been reported for Enewetak to date. Although only a few species have been reported, further records can be expected, possibly including proturans and diplurans.

Thysanura

Marshalls 1, Enewetak 1—At least one species of Lepismatidae is reported for the Marshalls, questionably identified as *Lepisma saccharina* Linnaeus (Schnee, 1904). Townes (1946) observed a lepismatid on Enewetak, but it was not identified.

Collembola

Marshalls 2, Enewetak 2—The *Isotomurus* and *Seira* we list for Enewetak were recently collected and appear to be the first records of the order for the Marshalls. Uchida (1944) studied earlier collections from Micronesia (Marianas and Carolines), with more than half of the 13 species treated appearing to be endemic. Mari Mutt (1979) added another endemic species to the Carolines fauna (Ponape).

Pterygota

These are insects that have attained flight, including those that have secondarily lost the capability. The bulk of the insects belong to this group, and they are discussed below either at the ordinal or familial level.

Odonata

Marshalls 7, Enewetak 2—Only one damselfly (Zygoptera), *Ischnura aurora* (Brauer), reaches the Marshalls but not Enewetak; it has Oriental affinities. Six dragonflies (Anisoptera) reach the Marshalls, and two are recorded for Enewetak. Of the latter, the *Pantala* we list for Enewetak is tropicopolitan and widespread in the Pacific, including Hawaii. The *Tramea* we list is a sight record by E. H. Bryan, Jr.; it is a North American species that reached Hawaii late last century and was likely transported from Hawaii to Enewetak. The four other anisopterans reaching the Marshalls are widespread in Micronesia and beyond, with three found in Australia or on continental islands bordering the western Pacific, and one ranging from Africa through Asia and Australia. The Micronesian fauna, studied by Asahina (1940) and reviewed by Lieftinck (1962), comprises 48 species or subspecies, with endemism about 52%. The monotypic genus *Pacificothemis* is endemic to the eastern Carolines (Ponape).

Blattodea

Marshalls 9, Enewetak 7—All the cockroaches reported for the Marshalls are widespread in the Pacific and either include at least the Oriental region (4 species) or occur around the world (5). The Micronesian fauna has not been surveyed, but seven species from Enewetak are present in Bishop Museum. Of these, the *Blattella*, *Lupparia*, and *Melanozosteria* we list are Oriental; the *Neostylopyga* and *Pycnoscelis* are Oriental now spread through the tropics; and both *Periplaneta* are African, with one species now tropicopolitan *(australasiae)* and one now cosmopolitan *(americana)*. All seven reported for Enewetak include Hawaii in their distributions. Two additional species reported for the Marshalls are the cosmopolitan *Blattella germanica* (Linnaeus) and the Oriental *Melanozosteria nitida* (Brunner).

Mantodea

Marshalls 1, Enewetak 0—Only one Melanesian mantid, *Orthodera burmeisteri* Wood-Mason, reaches the Marshalls but it is not reported for Enewetak. Beier (1972) reviewed the Micronesian fauna, which comprises five species. The only mantid endemic to Micronesia is from Palau, and it has Philippine affinities.

Phasmatodea

Marshalls 1, Enewetak 0—Only one species, *Megacrania batesi* Kirby, is reported for the Marshalls but not Enewetak; it is distributed through Melanesia, Indonesia, and the Philippines. The Pacific walkingsticks were generally surveyed by Nakata (1961). At least nine species are reported for Micronesia, including four endemic to the Carolines and one to the Marianas, but the group there remains poorly collected.

Orthoptera

Marshalls 10, Enewetak 5—The species reaching the Marshalls are circumtropical (1), widespread in the Old World (1), Oriental (3), Indo-Australian (2), or restricted to Oceania (3). Although the Micronesian fauna has not been surveyed, five species are known from Enewetak, either reported earlier (Townes, 1946; Sugerman, 1972a) or present in Bishop Museum. Of the five we list for Enewetak, the *Aiolopus* is an acridid of Indo-Australian distribution; the *Phisis* is a tettigoniid also found in Polynesia (Samoa, Tahiti); and there are three gryllids: the *Gryllodes* is circumtropical, the *Ornebius* is Oriental, and the *Speonemobius* is Oceanian. The *Gryllodes* and *Ornebius* reported for Enewetak are also found in Hawaii. The following are reported for the Marshalls but are not definitely recorded for Enewetak—Acrididae: *Locusta danica* (Linnaeus), *L. migratoria manilensis* (Mayne), *Oxya hyla intricata* (Stål); Gryllacrididae: *Gryllacris* sp. near *aurantiaca* Brunner von Wattenwyl; and Tettigoniidae: *Phaneroptera furcifera* Stål

Isoptera

Marshalls 6, Enewetak 0—Three of the termites known from the Marshalls are identified: *Kalotermes repandus* Hill is restricted to Oceania, *Coptotermes formosanus* Shiraki is an Oriental species spread into the Pacific and elsewhere, and *Cryptotermes brevis* (Walker) is tropicopolitan (Cole, 1951; Sugerman, 1972a, 1972b). The last two are also reported for Hawaii. The three unidentified termites appear to represent *Glyptotermes*, *Nasutitermes*, and *Prorhinotermes*. The Micronesian fauna has not been monographed.

Dermaptera

Marshalls 7, Enewetak 3—All of the earwigs reported for the Marshalls are cosmopolitan species. All but one of the seven are reported for Kwajalein. Three of the seven comprise the total earwig fauna for the Caroline atolls, and the greater number in the Marshalls, particularly Kwajalein, is likely a result of heavier international traffic. At least four of the seven also occur in Hawaii, including the three that we list for Enewetak. Micronesian fauna, treated by Brindle (1972), comprises 24 species, with endemism about 46%.

Embioptera

Marshalls 1, Enewetak 0—*Oligotoma (Aposthonia) micronesiae* Ross, described from the Marianas, is also reported for the Marshalls (Jaluit) and Gilberts (Butaritari). It and a related species found in the Carolines and Polynesia, *O. (A.) oceanica* Ross, along with an undescribed member of the subgenus from Ponape, all possibly have Philippines affinities. Micronesian fauna, reviewed by Ross (1955), comprises five species of which two appear to be endemic to Micronesia. Two Oriental species that have spread to other tropical areas also reach Micronesia.

Psocoptera

Marshalls 16, Enewetak 4—All of these species range beyond the Marshalls, with seven of the 16 restricted to Micronesia, two extending only to Hawaii, three restricted to Oceania, one also in the Oriental region, and three widespread. Of the four psocids reported for Enewetak, one is confined to Micronesia, one to Oceania, and two are widespread. Only the *Caecilius* and *Ectopsocus* of the four we list are also reported for Hawaii. Micronesian fauna, reviewed by Thornton et al. (1972), comprises 90 species. Endemism in the fauna is about 44%, with 19 endemic species in the Marianas, 19 more in the Carolines, and two in the Bonins. The number of endemics is diminished in the eastern part of the Carolines, with three on Ponape and one on Kosrae. Psocids are fairly well represented on Caroline atolls, with one of the nine species there endemic; five of the nine also occur in the Marshalls.

Mallophaga

Marshalls 22, Enewetak 16—Collections from 11 avian species were made on Enewetak (Elbel, personal communication), and at least 16 species of chewing lice are now known from the atoll. These are mainly from collections made by J. B. Bushman and coworkers, subsequently studied by R. E. Elbel et al. Amerson and Emerson (1971) reported most of the same species for the central South Pacific. Earlier, Woodbury (1962) reported *Actornithophilus ceruleus* (Timmerman) for Enewetak. Six additional chewing lice recorded for the Marshalls, but not Enewetak, are included in the National Museum of Natural History collection: *Actornithophilus limosae* Kellogg, *A. umbrinus* Burmeister, *Eidmanniella albescens* Piaget, *Menopon gallinae* Linnaeus, *Trinoton querquedulae* (Linnaeus), and *Pectinopygus sulae* (Rudow). Mallophaga are coincident with their avian hosts, and all of the host species sampled on Enewetak range beyond the Marshalls, with most being widespread over parts of the Pacific. Thirteen of the 16 species listed for Enewetak are also reported for Hawaii.

Anoplura

Marshalls 3, Enewetak 0—Two lice reported for the Marshalls are cosmopolitan and associated with man: *Pediculus humanis* (Linnaeus) and *Pthirus pubis* (Linnaeus). Another species, *Hoplopleura pacifica* Ewing, is associated with *Rattus* and is widespread in the Pacific; it is also reported for the Malayan subregion, Madagascar, Caribbean, and southeastern United States. Micronesian fauna comprises six species which are mostly widespread and coincident with their hosts; they are mostly associated with man or domestic animals (Ferris, 1959; Wilson, 1972).

Thysanoptera

Marshalls 2, Enewetak 1—These species are either cosmopolitan, the *Haplothrips* we list for Enewetak, or Oriental, *Taeniothrips vitticornis* (Karny); the latter is reported for Kwajalein by Sugerman (1972a). Both are also reported for Hawaii. Micronesian fauna remains incompletely surveyed. Kurosawa (1940) treated 14 species based largely on T. Esaki's collections; at that time no thrips were reported for the Marshalls.

Heteroptera

Many of the larger families represented in Micronesia have been studied. Among the groups remaining to be reported upon are the aquatic and semiaquatic families occurring in fresh water; however, they are probably largely absent on isolated atolls. Families treated for Micronesia but lacking records for the Marshalls include Acanthosomidae (Ruckes, 1963), Enicocephalidae (Usinger and Wygodzinsky, 1960), Neididae (Gross, 1963), Plataspidae (Ruckes, 1963), Saldidae (Drake, 1961), and Tingidae (Drake, 1956). As with this and most of the following insect orders, each family represented in the Marshalls is reviewed, and when there is a relevant treatise for the group, the author is cited.

Anthocoridae (Herring, 1967): Marshalls 3, Enewetak 1—These are species of Pacific or Ethiopian–New World distribution, with one restricted to Micronesia. All three are widespread in Micronesia. The *Physopleurella* we list for Enewetak also occurs in Hawaii. Micronesian fauna comprises 20 species, with about 70% endemism.

Aradidae (Matsuda and Usinger, 1957): Marshalls 1, Enewetak 0—*Chiastoplonia pygmaea* China, described from Samoa, is also reported for Marshalls and Carolines. Three species including the one reported for the Marshalls also occur on Caroline atolls; all three are widespread in Micronesia. Micronesian fauna comprises 40 species, with endemism about 93%.

Cimicidae (Usinger and Ferris, 1960): Marshalls 1, Enewetak 0—The bed bug, *Cimex hemipterus* (Fabricius), is a tropicopolitan species generally distributed in Micronesia. It is reported for the Marshalls but not for Enewetak.

Coreidae (Gross and Schaffner, 1963): Marshalls 3, Enewetak 1—These are species either endemic or of Melanesian or cosmopolitan distribution. The endemic species, *Riptortus saileri* Usinger, is known only from Kwajalein. The Melanesian species, *Leptocoris isolata* (Distant), occurs throughout the Marshalls but is not reported elsewhere in Micronesia. Micronesian fauna comprises 15 species, with about 13% endemism.

Cydnidae (Ruckes, 1963): Marshalls 1, Enewetak 1—*Geotomus pygmaeus* (Dallas) is a species of Malayan–Oceanian distribution, including Hawaii. Only one other species, from Guam, is reported for Micronesia.

Gerridae (Cheng, 1977): Marshalls 2, Enewetak 2—Two marine species were recently collected from Enewetak. *Halobates micans* (Eschscholtz) is commonly found on the open ocean; it is circumtropical in distribution and is the only member of the genus also occurring in the Atlantic. The *Hermatobates* remains unidentified; it is apparently undescribed and of limited distribution in the Pacific.

Lygaeidae (Barber, 1958): Marshalls 7, Enewetak 4—These species are restricted to Micronesia (3), or are of Malayan–Melanesian (2), Indo-Australian–Pacific (1), or Oriental–Pacific (1) distribution. *Nysius picipes* Usinger, one of the species reported for Enewetak, is restricted to atolls and low islands. The *Pachybrachius* is the only species of four we list for Enewetak that is also reported for Hawaii; it is mainly of Indo-Australian–Pacific distribution. Micronesian fauna comprises 43 species, with endemism about 40%.

Miridae (Carvalho, 1956; Schuh, 1984): Marshalls 7, Enewetak 3—These species are tropicopolitan (1), mainly of Old World distribution (1), Oriental–Pacific (2), Australia–Pacific (1), or limited to Oceania (2). Of the Enewetak species, *Campylomma eniwetok* Schuh is notable because it is one of only three insects thus far reported as endemic to the atoll (the other Enewetak endemics are midges: Ceratopogonidae and Chironomidae). *Campylomma marshallensis* Usinger is restricted to the Marshalls and Gilberts, plus one record for Kanton, Phoenix Islands; the *Trigonostylus* we list is tropicopolitan. Micronesian fauna comprises 89 species, with endemism about 81%. Four species are restricted to atolls; all are in *Campylomma*: the two mentioned above, plus *C. ulithiensis* Carvalho (Ulithi) and *C. wakeana* Schuh (Wake).

Nabidae (Gross, 1963): Marshalls 1, Enewetak 1—*Nabis capsiformis* Germar is a cosmopolitan species. Micronesian fauna comprises four species of which one is endemic to the Carolines (Palau, Ponape).

Pentatomidae (Ruckes, 1963): Marshalls 2, Enewetak 2—The *Platynopus* we list for Enewetak is restricted to Melanesia and Micronesia, and the *Oechalia* we list is of Australian–Pacific distribution. Micronesian fauna comprises 33 species, with endemism about 55%. All of these species include high islands in their distributions.

Reduviidae (Wygodzinsky and Usinger, 1960): Marshalls 1, Enewetak 0—The only species recorded from isolated atolls is the one reaching the Marshalls, *Ploiaria insolida* (B. White), which is Philippines–Pacific in distribution. Micronesian fauna comprises 30 species, with endemism about 67%.

Veliidae: Marshalls 1, Enewetak 0—*Halovelia maritima* Bergroth is marine and mainly of Australian–Indonesian distribution; it is also reported for Bikini (Cole, 1951).

Homoptera

This is the only large insect order reasonably stuc ied in its entirety for Micronesia. Some of the families are well represented on Micronesian islands and have a high proportion of endemic taxa. The following families were treated for Micronesia but representatives are not reported for the Marshalls: Aleyrodidae (Takahashi, 1956), Cercopidae (Synave, 1957), Cicadidae (Esaki and Miyamoto, 1975), and Membracidae (Kato, 1960).

Aphididae (Essig, 1956): Marshalls 4, Enewetak 2—All are widespread or cosmopolitan species also reported for Hawaii. An additional aphid reported for the Marshalls is *Hysteroneura setariae* (Thomas) (Sugerman, 1972a). Micronesian fauna comprises 16 species, mostly widespread; endemics include one species and one subspecies of Malayan or Oriental affinities.

Cicadellidae (Linnavuori, 1960, 1975): Marshalls 10, Enewetak 7—The species we list for Enewetak are widespread in both hemispheres (1), of New World–Pacific distribution (1), Oriental–Pacific (3), Australia–Pacific (1), or limited to Oceania (1). At least one is reported for Hawaii: *Recilia affinis* (Osborn). *Balclutha lucida* (Butler) is reported for Arno and Ebon but not Enewetak; it is of New World–Pacific distribution. Two undetermined cicadellids are reported for Kwajalein by Sugerman (1972a, 1979): *Empoasca*, a genus well represented in the Pacific and *Carneocephala*, a New World genus not included in Linnavuori's treatment. Micronesian fauna comprises 87 species, with endemism about 66%.

Cixiidae (Fennah, 1956, 1971): Marshalls 2, Enewetak 0—Both *Myndus apicalis* (Metcalf) and *M. praecanus* Fennah are endemic to the central eastern Carolines and Marshalls. Micronesian fauna comprises 29 species, all endemic.

Coccoidea (Beardsley, 1966, 1975): Marshalls 36, Enewetak 7—These are mostly species of widespread distribution of which 25 also occur in Hawaii. Seven species are restricted to Micronesia; of these, five are widespread in Micronesia and two are endemic to the eastern Carolines and Marshalls. Many of these scale insects are common on cultivated plants and have become widely distributed. All of the species reported for Enewetak also occur on Kwajalein, and five of the seven also occur in Hawaii. Micronesian fauna comprises 150 species, with endemism about 23%.

Delphacidae (Fennah, 1956, 1971): Marshalls 9, Enewetak 1—These species are restricted to Micronesia (2), Micronesia plus Hawaii (1), or mainly to Oceania plus continents and continental islands bordering the western Pacific (6). The *Sogatella* we list for Enewetak is reported for Australia, Philippines, and Micronesia. Of the restricted taxa, *Ugyops kinbergi mayas* Fennah is endemic to the Marshalls and occurs on both island chains and *U. superciliatus* Fennah is limited to the eastern Carolines and Marshalls. Micronesian fauna comprises 63 species with endemism about 44%. Three species are endemic to atolls elsewhere: the Gilberts, Wake, and Ocean Island, a raised atoll.

Derbidae (Fennah, 1956, 1971): Marshalls 3, Enewetak 1—Species or subspecies restricted to Micronesia of which the *Lamenia* we list for Enewetak is endemic to the Marshalls; *Flaccia dione* Fennah is limited to Caroline atolls, Kosrae, and Marshalls; and *Swezeyia zephrus* Fennah occurs through much of Micronesia. *Lamenia* and *Swezeyia* possibly have Philippine affinities, while *Flaccia* has ties to Melanesia (Fiji). Micronesian fauna comprises 56 species, with endemism about 95%. Derbids are well represented on Caroline atolls, with 20 species of which four are endemic to atolls; another species is endemic to the Gilberts.

Psyllidae (Tuthill, 1964): Marshalls 1, Enewetak 0—*Mesohomotoma hibisci* (Froggatt) ranges from Australia and continental islands bordering the western Pacific to Oceania where it is widespread; it is reported for Kwajalein (Sugerman, 1972a). Micronesian fauna comprises 22 species, with endemism about 68%. Two additional psyllids besides *M. hibisci* occur on Caroline atolls but are not reported for the Marshalls.

Coleoptera

Most of the large families of beetles have been surveyed. The outstanding exception is the Curculionidae or weevils, a family well represented on Pacific islands, with only the Guam components of the Micronesian fauna adequately studied. A few species are reported for the Marshalls but not Enewetak. Families monographed for Micronesia, but not yet reported for the Marshalls, include the Cantharidae (Wittmer, 1958), Cryptophagidae (Michitaka Chûjô, 1970), Cybocephalidae (Endrödy-Younga, 1971), Endomychidae (Strohecker, 1958), Lampyridae (Wittmer, 1958), Malachiidae (Wittmer, 1958, 1970), Platypodidae (Wood, 1960), Prionoceridae (Wittmer, 1958), Rhysodidae (Bell and Bell, 1981), and Scaphidiidae (Löbl, 1981).

Anobiidae (Ford, 1958): Marshalls 1, Enewetak 0—*Lasioderma serricorne* (Fabricius), the cigarette beetle, is reported for Kwajalein; it is a cosmopolitan species. Micronesian fauna comprises nine species, with endemism about 67%.

Anthicidae (Werner, 1965): Marshalls 3, Enewetak 1—All are species of *Anthicus* and are confined to the Pacific Basin. *Anthicus vexator* Werner, reported for Enewetak, occurs on Caroline atolls and the Marshalls and Gilberts. It is also reported for the Phoenix Islands and Hawaii. *Anthicus insularis* Werner is restricted to Micronesia and *A. oceanicus* LaFerté is widely distributed in Micronesia, extending to Polynesia, Ryukyus, and possibly into the Indian Ocean. Micronesian fauna comprises nine species, with endemism about 44%.

Anthribidae: Marshalls 1, Enewetak 0—*Araecerus* sp. is reported for Kwajalein (Sugerman, 1972a) and is probably one of several species widespread in the Pacific. The genus is mainly Oriental–Pacific in distribution.

Bostrychidae (Michio Chûjô, 1958): Marshalls 1, Enewetak 0—*Dinoderus bifoveolatus* (Wollaston), widely distributed in warmer regions, is reported for Kwajalein. Micronesian fauna comprises 10 species, with none endemic; most are widespread.

Carabidae and Cicindelidae (Darlington, 1970): Marshalls 5, Enewetak 1—These species are of Oriental–Pacific distribution (1) or Indo-Australian–Pacific (1), of Neotropical affinities (2), or possibly restricted to Oceania (1). The *Egadroma* we list for Enewetak belongs to the second category. Two species were not treated by Darlington; they are *Callida insularis* Boheman and *Selenophorus* sp.; both were reported for Jaluit by Schnee (1904). Micronesian fauna comprises 49 species, with endemism about 27%, representing 11 different stocks, most resulting in only a single endemic species. Curiously, one cicindelid, *Therates labiatus* (Fabricius), ranging from Melanesia to the Philippines, also occurs on Nukoro, one of the Caroline atolls, but nowhere else in Micronesia.

Cerambycidae (Gressitt, 1956): Marshalls 12, Enewetak 1—These species are mostly restricted to Micronesia and have Oceanian–Malayan affinities; close relatives may extend to the Indian Ocean, but they are generally absent on continental Asia. Of these, five are endemic to the Marshalls: two *Ceresium* are restricted to single atolls, *C. unicolor marshallum* Gressitt (Majuro) and *C. robustum* Gressitt (Arno); *Prosoplus major* Gressitt and *P. hibisci* Gressitt are from various atolls, also in the eastern chain (Ratak); and *Oopsis marshallensis* Gressitt is the most widespread of the endemics, occurring on both island chains. The *Prosoplus* we list for Enewetak occurs in the eastern Carolines (Ponape) and Marshalls. Only *Sybra alternans* (Wiedemann) ranges beyond Micronesia; it is also reported for Indonesia, Philippines, and Hawaii. Micronesian fauna comprises 105 species, with about 87% restricted to Micronesia, including 7% endemic to atolls or low islands. Correspondence of species occurring on the different Micronesian atoll groups is fairly low, with three of 12 species from Caroline atolls also present in the Marshalls and one of the four species from the Gilberts likewise found in the Marshalls. Most of the atoll species in the Carolines also occur on adjacent high islands; however, *Sciadella atollorum* Gressitt is restricted to atolls. One of the four Gilberts species, *Sybra catalana* Gressitt, is endemic there.

Chrysomelidae (Gressitt, 1955): Marshalls 3, Enewetak 1—These species are either confined to Oceania and their affinities are Melanesian–Malayan (2) or they are Oriental–Pacific in distribution (1). *Aphthona bicolorata* Jacoby is associated with euphorbiaceous plants and is fairly common in parts of Oceania, including Enewetak. *Brontispa chalybeipennis* (Zacher) is associated with the coconut palm and had a rather restricted range, within the eastern Carolines (Ponape, Kosrae) and the Marshalls before it reached Hawaii. *Pagria signata* (Motschulsky) belongs to the second category. Micronesian fauna comprises about 38 species, with endemism about 66%. None of the species is restricted to atolls.

Cleridae: Marshalls 1, Enewetak 0—One cosmopolitan species, *Necrobia rufipes* DeGeer, the red-legged ham beetle, is reported for Jaluit (Schnee, 1904).

Coccinellidae (Chapin, 1965): Marshalls 8, Enewetak 4—These species either are found on continents, Asia and/or Australia (4), or are confined to the Pacific Basin, with two restricted to Micronesia and two also found on subcontinental islands of the western Pacific. One of the restricted species, *Scymnus uncinus* Chapin, is limited to the Marshalls and Gilberts. One additional species, from India, was released in the Marshalls (Majuro, Uliga) and Guam but was not recovered. Micronesian fauna comprises 48 species, with endemism about 46%.

Cucujidae: Marshalls 1, Enewetak 0—The cosmopolitan *Oryzaephilus surinamensis* (Linnaeus), the saw-toothed grain beetle, is reported for Kwajalein (Sugerman, 1972a).

Curculionidae (Zimmerman, 1942, 1948, 1964): Marshalls 6, Enewetak 0—These species are possibly cosmopolitan (*Sitophilus* sp.), of Indonesian–Pacific affinities (*Oxydema* sp.), restricted to Oceania (3), or undetermined (1). Of the restricted species, *Sphenophorus sulcipes* Karsch is described from the Marshalls; *Platysimus insularis* (Boheman) is reported for Polynesia, Fiji, the Marshalls and Gilberts; and *Trigonops hirsuta* Zimmerman, described from Guam, is reported for Kwajalein. Weevils of Guam and the Marianas have received attention by Zimmerman (1942, 1948).

Dermestidae (Beal, 1961): Marshalls 3, Enewetak 1—All of the species reported for the Marshalls are also found in Hawaii, and none is restricted to the Pacific. The *Dermestes* we list for Enewetak is cosmopolitan and widespread in Micronesia. *Orphinus terminale* (Sharp) is of Malayan–Pacific distribution and *Trogoderma anthrenoides* (Sharp) is a Neotropical species that has been established in Hawaii and has also reached Saipan and Kwajalein. Micronesian fauna comprises 12 species, mostly widespread; only one species, *Orphinus nesioticus* Beal, from Guam, is endemic.

Elateridae (Van Zwaluwenburg, 1948, 1957; Ôhira, 1971): Marshalls 11, Enewetak 2—All identified species are of Oceanian distribution. The two species we list for Enewetak are either reported for New Britain, eastern Carolines, and Marshalls *(Simodactylus)* or range through Micronesia and Polynesia *(Conoderus)*. Two other species are endemic to the Marshalls and are restricted to single atolls: *Melanoxanthus lariversi* Van Zwaluwenburg from Arno and *Simodactylus marshallensis* Ôhira from Kwajalein. Two unidentified elaterids, *Ampedus* sp. and *Anchastus* sp., are reported for Kwajalein (Sugerman, 1972a, 1979). Micronesian fauna comprises 70 species, with endemism about 71%.

Histeridae: Marshalls 1, Enewetak 0—*Platysoma* sp. is reported for Jaluit (Schnee, 1904). The genus is well represented in the Indo-Malayan area, but some species occur in the New World.

Hydrophilidae: Marshalls 1, Enewetak 0—At least one species, *Dactylosternum abdominale* (Fabricius), is reported for the Marshalls (Sugerman, 1972a); it is possibly the same as one or both of the *Cyclonotum* spp. reported by Schnee (1904) for Jaluit. The species is widely distributed in the New World and is established in Hawaii.

Mycetophagidae (Michitaka Chûjô, 1970): Marshalls 2, Enewetak 1—The *Typhaea* we list for Enewetak is a cosmopolitan species. *Litargus vestitus* Sharp, reported for Arno and Jaluit, is an Oceanian species found throughout Micronesia and parts of Polynesia. Both species are reported for Hawaii. Micronesian fauna comprises three species, with none endemic.

Nitidulidae (Gillogly, 1962): Marshalls 14, Enewetak 6—These are mostly widespread species, but one is restricted to Micronesia and Polynesia; six are cosmopolitan; three are found on various continents; one is also from Australia; two are also from New Guinea; and one occurs in Polynesia, Philippines, and Sri Lanka. Micronesian fauna comprises 39 species, with endemism about 33%. None is restricted to atolls; correspondence of species among different atoll groups is fairly high with six of eight of the Caroline atolls species and seven of the nine Gilberts species also found in the Marshalls.

Oedemeridae (Macnamara and Arnett, in preparation): Marshalls 8, Enewetak 6—These species are more or less of Malayan–Oriental distribution. Of these, only one is rather restricted, occurring only in the Marshalls, Gilberts, and Ocean Island. The remaining seven tend to be widespread in Micronesia and include some that also occur on Melanesian and Polynesian islands. Micronesian fauna comprises 19 species, with most restricted to Micronesia.

Propalticidae (John, 1960, 1971): Marshalls 1, Enewetak 1—*Propalticus insularis* John is restricted to Micronesia. Micronesian fauna comprises eight species, with endemism 63%.

Scarabaeidae (Cartwright and Gordon, 1971): Marshalls 6, Enewetak 0—These species are of the subfamily Aphodiinae and are either restricted to Micronesia (2); nearly restricted, occurring also in Samoa (1); found in the Malayan and/or Melanesian subregions (2); or have a general Old World distribution (1). Micronesian fauna comprises 27 species (10 are aphodiines), with endemism about 37%. Of the endemic species, four are aphodiines, four are melolonthines, one is a ruteline, and one is a dynastine. None is restricted to atolls. Both species occurring on Caroline atolls (aphodiines) also occur in the Marshalls. One of the two Gilberts species, also an aphodiine, occurs in the Marshalls. The other species, a dynastine, *Papuana huebneri* (Fairmaire), is the only Micronesian record for that Melanesian group.

Scolytidae (Wood, 1960): Marshalls 9, Enewetak 2—Of these species, only one is endemic to a more or less restricted area, Kosrae and the Marshalls including Enewetak; one species reaches Hawaii; one is Malayan; two are cosmopolitan; and the rest tend to be widespread in Micronesia and also occur in warmer regions bordering the western Pacific. Micronesian fauna comprises 53 species, with endemism about 28%.

Staphylinidae: Marshalls 2, Enewetak 0—Two rove beetles are reported for Kwajalein by Sugerman (1972a): *Lispinus impressicollis* Motschulsky, ranging throughout the Old World tropics and extending into the Indian and Pacific Oceans, and a species questionably placed in *Medon*, a widespread genus with many species.

Tenebrionidae (Kulzer, 1957): Marshalls 16, Enewetak 2—Of these species, two are endemic to the Marshalls; one also occurs on Kosrae, eastern Carolines; three are more widespread in Micronesia; three are Oceanian; two are Malayan–Pacific and comprise the *Gebieniella* and *Gonocephalum* that we list for Enewetak; one is Oriental; and four are cosmopolitan. Of the species endemic to the Marshalls, *Tagalus angustus* Kulzer is restricted to Arno and *Chariotheca costata* Kulzer is restricted to Arno and Ailinglapalap. Micronesian fauna comprises 92 species, with about 62% restricted to Micronesia, including 4% endemic to atolls and low islands. Correspondence of species between atoll groups is fairly low, with four of 13 Caroline atolls species and one of the three Gilberts species also occurring in the Marshalls. One of the Caroline atolls species, *Bradymerus faraulepensis* Kulzer, is endemic to a single atoll (Faraulep).

Strepsiptera

Micronesian fauna unstudied.

Neuroptera

Only the Chrysopidae has been reported for the Marshalls. Two other families treated for Micronesia are still unreported for the Marshalls: Hemerobiidae (Carpenter, 1961) and Myrmeleontidae (Adams, 1959).

Chrysopidae (Adams, 1959): Marshalls 2, Enewetak 1—Both species are widespread in Micronesia and are also of Australian–Malayan distribution. *Chrysopa ramburi* Schneider, reported for Enewetak, is the senior synonym of *C. jaluitana* Kempny (1904). *Chrysopa basalis* Walker is also reported for the Marshalls (Ailinglapalap).

Trichoptera

The Micronesian fauna is largely unsurveyed, although a few species are known to occur in the Marianas and Carolines, including remote Kosrae (Gressitt, 1954).

Lepidoptera

The Micronesian fauna is poorly studied, except the Sphingidae and certain microlepidopteran families. Three families that have been treated for Micronesia, but have not been found as yet in the Marshalls, are Agonoxenidae (Clarke, 1984), Chlidanotidae (Clarke, 1976), and Oecophoridae (Clarke, 1984).

Arctiidae: Marshalls 2, Enewetak 1—The *Utetheisa* we list for Enewetak ranges through much of Micronesia and the South Pacific (Schnee, 1904). An undetermined lithossine is reported for Kwajalein (Sugerman, 1972a).

Cosmopterygidae: Marshalls 1, Enewetak 0—An undetermined *Trissodorus* is reported for the Marshalls but without mention of Enewetak (Townes, 1946). This species might be *T. honorariella* (Walshingham), a *Pandanus* leaf perforator recorded from Sri Lanka and the Pacific, including Hawaii.

Danaidae: Marshalls 1, Enewetak 0—*Danaus plexippus* (Linnaeus) is reported for the Marshalls (Jaluit) by Seitz (1904); it is also reported by Townes (1946) but without specific locality. This is a widespread North American species, also occurring in Hawaii and elsewhere in the Pacific, including Australia.

Gelechiidae: Marshalls 1, Enewetak 0—*Stoeberhinus testaceus* Butler, of Indonesian–Pacific distribution, including Hawaii, is reported for Kwajalein (Sugerman, 1972a).

Geometridae: Marshalls 1, Enewetak 0—An undetermined *Thalassodes* is reported for Jaluit by Seitz (1904). A number of species occur in the South Pacific.

Hesperiidae: Marshalls 1, Enewetak 1—The *Badamia* we list for Enewetak (Townes, 1946) is widely distributed in the Pacific, including Hawaii (as a recent introduction); it also occurs in the Oriental and Australian regions.

Lycaenidae: Marshalls 1, Enewetak 0—The *Lampides* reported by Sugerman (1979) is probably *L. boeticus* (Linnaeus), a blue butterfly distributed throughout the Old World and Pacific, including Hawaii.

Noctuidae (Fukushima, 1947, in part): Marshalls 13, Enewetak 2—These species are mostly widespread: *Anticarsia irrorata* (Fabricius), *Mocis frugalis* (Fabricius), *Nagia linteola* (Guenée), *Plusia chalcites* (Esper), *Spodoptera exempta* (Walker), *S. litura* (Fabricius), and *S. mauritia* (Boisduval) occur through warmer regions of the Old World and extend into the Pacific; *Achaea janata* Linnaeus, *Anua coronata* (Fabricius), *Bocana manifestalis* Walker, *Calogramma festiva* (Donovan), and *Platysenta illecta* (Walker) are Oriental or Indo-Australian–Pacific; and *Nagia hieratica* Hampson is restricted to Micronesia. The last is described from material taken in the Marshalls and Gilberts and is also reported for the Carolines (Yap, Ponape). Of the two *Spodoptera* we list for Enewetak, one *(exempta)* is common in Hawaii.

Nymphalidae: Marshalls 2, Enewetak 2—These butterflies are Indo-Australian–Pacific *(Hypolimnas)* or Australian–Pacific *(Precis)* in distribution. The former, *H. bolina*, exhibits much variation, and specimens from the Marshalls have received the subspecific or infrasubspecific names: *inconstans*, *jaluita*, or *pallescens*. Clark (1951) treated the butterflies of the Marshalls.

Olethreutidae (Clarke, 1976): Marshalls 3, Enewetak 0—These species are either Oriental extending into the Pacific and Indian Oceans (2) or are restricted to Micronesia (1). *Heleana p. physalodes* (Meyrick) and *Stratherotis leucaspis* (Meyrick) belong to the first category. The restricted species, *Icelita monela* Clarke, is reported for the southern Marianas, Marshalls, and Gilberts. Micronesian fauna comprises 58 species, with endemism about 55%.

Pyralidae: Marshalls 7, Enewetak 0—These are mostly widespread species: *Marasmia trapezalis* Guenée occurs throughout the world; *Hymenia recurvalis* (Fabricius), *Nacoleia diemenalis* Guenée, and *Syngamia floridalis* (Zeller) are of Old World–Pacific distribution; *Herpetogramma licarsisalis* (Walker) is Oriental; *Piletocera signiferalis* (Wallengren) ranges from Australia to Polynesia (Marquesas); and one is undetermined *(Diaphania)*. The last is a large world-distributed genus of warmer regions. All of these species are reported for Kwajalein by Sugerman (1972a, 1979). The *Hymenia* appears to be the only one of the above that is also reported for Hawaii.

Sphingidae (Riotte, in preparation): Marshalls 4, Enewetak 4—We list all of these species for Enewetak; they are either restricted to Oceania (1) or also occur on continental islands or continents bordering the western Pacific (3). The restricted one is *Cephonodes armatus* R. and J. Micronesian fauna comprises 18 species, with none endemic. All seem to have Old World affinities and many tend to be widespread in the Eastern Hemisphere. Although these insects are large-bodied, they are highly vagile and are able to reach oceanic islands far from continents; this may help to explain the apparent absence of endemic forms in Micronesia.

Tineidae: Marshalls 2, Enewetak 0—*Decadarchis simulans* (Butler) and *Opogona omoscopa* (Meyrick) range from Africa to Australia and into the Pacific, including Hawaii. Both are based on single records for the Marshalls and are tentatively identified (Sugerman, 1972a, 1979).

Tortricidae (Clarke, 1976): Marshalls 1, Enewetak 1—*Adoxophyes faciculana* (Walker) mainly ranges through the Malayan and Melanesian subregions, with the only records for Micronesia being from Kosrae and Enewetak. Micronesian fauna comprises seven species, with endemism about 86%.

Diptera

While many of the families represented in Micronesia have been surveyed, a few remain incompletely studied at this time; these include the Asilidae, Cecidomyiidae, Dolichopodidae, Tachinidae, and various acalyptrate families. Families monographed for Micronesia, but not represented in the Marshalls, include the Asteiidae (Sabrosky, 1957), Bibionidae (Hardy, 1956), Clusiidae (Steyskal and Sasakawa, 1966), Coelopidae (Hardy, 1957), Empididae (Quate, 1960), Mycetophilidae (Colless, 1966), Micropezidae (Aczel, 1959), Nycteribiidae (Theodor, 1966), Pipunculidae (Hardy, 1956), Scenopinidae (Hardy, 1958), Simuliidae (Stone, 1964), Streblidae (Maa, 1966), and Tabanidae (Stone, 1960).

Agromyzidae (Spencer, 1963): Marshalls 2, Enewetak 2—Species either ranging from Melanesia through Indonesia to islands in the Indian Ocean *(Ophiomyia)* or restricted to the Pacific, Australia, and Taiwan *(Pseudonapomyza)*. Both species are widely distributed in Micronesia. Micronesian fauna comprises 19 species, with endemism about 32%. Both species reported for the Marshalls also occur in the Gilberts and Caroline atolls; however, the Caroline atolls have three additional species not recorded for the Marshalls; no additional species are recorded for the Gilberts.

Asilidae: Marshalls 2, Enewetak 0—Two unidentified species representing two genera (*Clinopogon* and *Stenopogon*) are reported for the Marshalls (Cole, 1951; Sugerman, 1972a, 1972b). Both genera are represented in the Oriental region.

Calliphoridae (James, 1962): Marshalls 6, Enewetak 2—These are mostly species of broad distribution, being circumtropical (1), Holarctic and reaching many other areas (1), Indo-Australian (2), ranging from Africa to the Pacific (1), or Malayan–Pacific (1). The two species reported for Enewetak are circumtropical [*Phaenicia cuprina* (Wiedemann)] or Indo-Australian [*Chrysomya megacephala* (Fabricius)]. All of the above are widespread in Micronesia except the Holarctic *Phaenicia sericata* (Meigen). Micronesian fauna comprises 11 species, with endemism low at around 9% (one endemic species occurs in the Bonins). The nonendemic fauna is at least partly coincident with man in the Pacific. Over half of the Micronesian fauna is represented in the Marshalls. All three species reported on Caroline atolls and three of the four species reported for the Gilberts also occur in the Marshalls.

Canaceidae (Wirth, 1951): Marshalls 2, Enewetak 1—These are either endemic to the Marshalls (*Nocticanace marshallensis* Wirth) or restricted to the Marshalls and eastern Carolines (Kusaie) (*Procanace townesi* Wirth). The latter is not yet reported for Enewetak. Micronesian fauna comprises two species, with endemism 100%.

Ceratopogonidae (Tokunaga and Murachi, 1959): Marshalls 23, Enewetak 5—These species are mostly confined to Micronesia (19), including three endemic to the Marshalls; four also occur on continental islands bordering Asia. Of the three endemics, *Forcipomyia tuthilli* Tokunaga is one of three of the only known insects restricted to Enewetak Atoll at this time; *Dasyhelea nigristigmata* Tokunaga and Murachi is restricted to Ailinglapalap and *Dasyhelea* sp. No. 1 T. and M. is restricted to Arno. Two species are limited to the eastern Carolines (Ponape or Kosrae) and the Marshalls: *Dasyhelea flavibasalis* Tokunaga and *D. pallivittae* Tokunaga. Micronesian fauna comprises 147 species, with endemism about 90%. Ten of the 16 species reported from Caroline atolls also occur in the Marshalls, as do five of the nine Gilberts species, showing that there is a fair correspondence of these midges on Micronesian atolls.

Chironomidae (Tokunaga, 1964): Marshalls 16, Enewetak 5—These species are mostly confined to Micronesia, including two endemic to the Marshalls. Eight occur beyond Micronesia and mostly range no farther than the Malayan subregion, Japan, or Polynesia. Of the Marshall Island endemics, *Clunio tuthilli* Tokunaga is restricted to Enewetak, and *Cricotopus* sp. No. 1 Tokunaga is restricted to Kwajalein. *Clunio tuthilli* is notable because, thus far, it is one of only three known insects restricted to Enewetak. Micronesian fauna comprises 100 species, with endemism about 79%. Some species are marine.

Chloropidae: Marshalls 3, Enewetak 2—Two species from Enewetak are among the Micronesian specimens under study by C. W. Sabrosky; both are presumably widespread, including Hawaii. Another chloropid, *Eutropha noctilux* (Walker), is reported for Kwajalein (Sugerman, 1972a).

Culicidae (Bohart, 1956): Marshalls 4, Enewetak 0—These are mostly widespread through the tropics or subtropics (2), of Australian–Malayan plus Melanesian distribution (1), or restricted to the eastern Carolines (Kosrae), Marshalls, and Gilberts (1). The last mentioned is *Aedes marshallensis* Stone and Bohart. Micronesian fauna comprises 47 species, with endemism about 64%. The fauna of the Caroline atolls possesses 10 species, of which only three are reported for the Marshalls; the two species reported for the Gilberts also occur in the Marshalls.

Dolichopodidae: Marshalls 5, Enewetak 0—*Chrysosoma complicatum* Becker and *C. fraternum* Van Duzee are apparently restricted to Pacific islands, with the latter described from Hawaii, while *C. leucopogon* (Wiedemann) ranges from Africa through Asia into the Pacific. *Campsicnemus* and *Cymatopus* are each represented by an unidentified species from the Marshalls. The former genus contains numerous endemics in Hawaii. These species are variously listed by Cole (1951) and Sugerman (1972a, 1972b, 1979).

Drosophilidae (Wheeler and Takada, 1964): Marshalls 5, Enewetak 0—These species are cosmopolitan or tropicopolitan (2), Old World tropics (1), Australian–Malayan–Pacific (1), or restricted to Micronesia (1). The restricted species is endemic to the eastern Carolines (Ponape, Kosrae) and the Marshalls. Micronesian fauna comprises 70 species, with endemism about 59%. About 43% of all Micronesian species are restricted to single island groups. Only one species is endemic to atolls (Kapingamarangi, eastern Carolines). Of the species recorded from Caroline atolls, only two of the eight also occur in the Marshalls, but both of the two Gilberts species occur in the Marshalls.

Ephydridae: Marshalls 5, Enewetak 5—Five species from Enewetak are among the Micronesian specimens under study by Wirth. These species are fairly widespread in the Pacific, and all occur at least on continental islands of the western Pacific, including two also found in Australia and one ranging west to India and the Seychelles.

Hippoboscidae (Maa, 1966): Marshalls 3, Enewetak 1—All are ectoparasites of birds; two are pantropical and one, *Ornithoica pusilla* (Schiner), is restricted to the Marshalls (Arno) and Polynesia (Tokelaus, Tuamotus). *Olfersia spinifera* (Leach) has been recorded from Enewetak and also leeward Hawaiian islands. Micronesian fauna, six species, comprises two species parasitic on marine birds, two generally parasitic on migratory land birds, and two generally parasitic on breeding land birds. The dispersal of hippoboscids is apparently keyed to the migration routes of hosts. Maa mentioned two routes, through Siberia to New Zealand via the Marianas and through the Philippines into the Carolines via Palau. The second is the more important for hippoboscids. The fauna has Oriental affinities.

Lauxaniidae: Marshalls 2, Enewetak 0—Two unidentified species are reported for the Marshalls representing *Homoneura* and possibly *Prosopomyia* (Cole, 1951; Sugerman, 1972a, 1972b, 1979). The former has many species in the Oriental region; the latter is Palearctic.

Lonchaeidae: Marshalls 3, Enewetak 0—*Lamprolonchaea aurea* (Macquart) is reported for Bikini (Cole, 1951) and *L. metatarsata* (Kertész) is reported for Kwajalein (Sugerman, 1979). The former is of Mediterranean origin, and the latter is of Malayan–Pacific distribution. An undetermined *Lonchaea* is also reported for Kwajalein.

Milichiidae: Marshalls 3, Enewetak 2—The two species we list for Enewetak are virtually cosmopolitan. A third species, *Desmometopa singaporensis* Kertész, reported for Kwajalein (Sugerman, 1979), is Oriental–Pacific in distribution.

Muscidae (Snyder, 1965): Marshalls 8, Enewetak 3—These are either widespread or cosmopolitan species (4), those more or less restricted to the Pacific and continents and islands bordering the western Pacific (3), or undetermined (1). The Enewetak muscids all belong to the first category. An undetermined *Lispe* from Kwajalein, listed by Sugerman (1979), is tentatively assigned to the last category. Micronesian fauna comprises 84 species, with endemism about 63%. Only one species, *Atherigona tobi* Snyder, is restricted to atolls or low islands. Seven Marshalls muscids occur on Caroline atolls, which have 16 species reported. All three of the Gilberts species also occur in the Marshalls.

Neriidae (Aczel, 1959): Marshalls 1, Enewetak 0—*Telostylinus longicoxa* (Thomson) is widespread in Micronesia. Micronesian fauna comprises four species, with endemism 100%; three are of limited distribution in Micronesia, being endemic to Palau, Yap, or Palau and western Caroline atolls.

Otitidae: Marshalls 1, Enewetak 0—*Pseudeuxesta prima* (Osten Sacken), reported for Kwajalein (Sugerman, 1972a), is Indonesian–Pacific in distribution, including Hawaii.

Phoridae (Beyer, 1967): Marshalls 4, Enewetak 2—These species are either restricted to Micronesia (2) or nearly cosmopolitan (both Enewetak records). One of the restricted species occurs only in the eastern Carolines (Ponape, Kosrae) and the Marshalls. Micronesian fauna comprises 25 species, with endemism about 64%. Most of the extra-Micronesian species are either widespread or Malayan–Pacific in distribution, but two species range no farther than Hawaii.

Platystomatidae: Marshalls 2, Enewetak 0—*Scholastes carolinensis* Enderlein, reported for Kwajalein and Lib, is possibly restricted to the Carolines and Marshalls, while *Plagiostenopterina aenea* (Wiedemann), reported for Kwajalein, is Indo-Australian (Sugerman, 1972a, 1972b).

Psychodidae (Quate, 1959): Marshalls 2, Enewetak 0—These are species also reaching Melanesia or Polynesia (Hawaii). Micronesian fauna comprises 34 species, with about 71% endemism.

Sarcophagidae (de Souza Lopes, 1958, 1963): Marshalls 5, Enewetak 3—These are species widespread in Micronesia and that also occur in Hawaii (1), Malayan subregion (2), or continents and islands bordering the western Pacific basin (1) or are species of nearly worldwide distribution (1). Micronesian fauna comprises 14 species, with about 36% endemism. Correspondence of species on atolls is fairly uniform, with four of five species reported for the Gilberts also occurring in the Marshalls.

Scatopsidae (Hardy, 1956): Marshalls 2, Enewetak 1—The Enewetak record is new, a specimen questionably determined as *Holoplagia guamensis* (Johannsen) by W. W. Wirth. *Holoplagia guamensis* is otherwise distributed in the Marianas (Guam) and Carolines, including atolls, and also Hawaii, the only non-Micronesian locality. The other species reaching the Marshalls, but not Enewetak, is *Swammerdamella albimana* Edwards; it also occurs in Fiji and Samoa. Micronesian fauna comprises six species of which one is endemic to the Carolines, three are Micronesian–Hawaiian, one also occurs in Melanesia–Polynesia, and one is cosmopolitan.

Sciaridae (Steffan, 1969): Marshalls 7, Enewetak 3—Two of these species are endemic to the Marshalls, two are not widely distributed in Micronesia but also occur in Hawaii, two also occur in the Oriental region, and one is nearly cosmopolitan. Of the endemics, *Scythropochroa trispinosa* Steffan is restricted to Kwajalein and *Plastosciara jaluitensis* Steffan is restricted to Jaluit. Micronesian fauna comprises 22 species, with endemism about 77%, but some species may have broader distribution than presently indicated. The fauna apparently has Oriental and possibly Papuan affinities.

Sphaeroceridae (Richards, 1963): Marshalls 4, Enewetak 0—These are species restricted to Micronesia (2), or otherwise occurring in the Malayan subregion (1), or cosmopolitan (1). Micronesian fauna comprises 21 species, with endemism about 38%. The single species reported for Caroline atolls, as well as the two species reported for the Gilberts, also occurs in the Marshalls.

Stratiomyidae (James, 1962): Marshalls 4, Enewetak 1—These are either island species restricted to Micronesia (1), those occurring also in Melanesia and islands of the Indian Ocean (2), or widespread species of the tropics and subtropics (1). The restricted species, *Cephalochrysa rugulosa* James, occurs in the eastern Carolines (Ponape, Kosrae) and the Marshalls. The widespread species, *Hermetia illucens* (Linnaeus), occurring in all warm regions, is of American origin. Micronesian fauna comprises 24 species, with endemism about 63%. The three species occurring on Caroline atolls and the two occurring in the Gilberts are also found in the Marshalls, making the atoll stratiomyid fauna fairly uniform.

Syrphidae (Shiraki, 1963): Marshalls 3, Enewetak 1—The *Ischiodon* we list for Enewetak is a widespread Indo-Australian species occurring all over Micronesia. Also reported for the Marshalls are *Syritta orientalis* Macquart, ranging through southern Asia into the Pacific, and *Eristalis calliphoroides* Shiraki, restricted to the Carolines and Marshalls. Micronesian fauna comprises 27 species, with endemism about 70%.

Tachinidae: Marshalls 2, Enewetak 0—The Nearctic *Lespesia archippivora* (Riley) probably reached Kwajalein via Hawaii. An unidentified *Exorista,* also reported for Kwajalein, belongs to a genus well represented in the Old World. Both species are reported by Sugerman (1972a).

Tephritidae (Hardy and Adachi, 1956): Marshalls 3, Enewetak 0—These species are circumtropical [*Dioxyna sororcula* (Wiedemann)], ranging from Africa through Asia into Australia and the Pacific (*Spathulina acroleuca* Schiner), or Malayan–Pacific in distribution (*Dacus frauenfeldi* Schiner). Of these, only *D. sororcula* is reported for Hawaii.

Tethinidae: Marshalls 1, Enewetak 0—*Dasyrhicnoessa insularis* (Aldrich), described from Hawaii, is reported for Lib Island (Sugerman, 1972b).

Tipulidae (Alexander, 1972): Marshalls 9, Enewetak 1—Excepting the circumtropical *Limonia umbrata* (de Meijere), all of these species are confined to the Pacific, with most restricted to Micronesia; two are endemic to the Marshalls. The most widely distributed of the preceding, *Styringomyia didyma* Grimshaw, ranging from New Guinea to the Tuamotus and northward in the Pacific, was described from Hawaii. The two endemic species are *Limonia beardsleyi* Alexander from Namu, Kili, and Namorik and *L. sentifera* Alexander from Namu and Arno. Micronesian fauna comprises 71 species, with endemism about 72%. One of the species from the Marshalls also occurs on Caroline atolls for which five species are reported, including two that are more or less endemic (one may also occur on Ponape). The three species reported for the Gilberts also occur in the Marshalls.

Siphonaptera

(Hopkins, 1961): Marshalls 1, Enewetak 0—Only *Ctenocephalides f. felis* (Bouche), the cat flea, is reported thus far for the Marshalls but not Enewetak. Micronesian fauna comprises six species that are mostly cosmopolitan species associated with man, domestic mammals (particularly Carnivora), and rats. One species, a bat flea, is found mainly in the Oriental region and reaches Japan and apparently Guam (a single record).

Hymenoptera

The Micronesian fauna is partly studied but remains poorly surveyed in general. Groups that are especially in need of study include the Braconidae, Formicidae, and many families of Chalcidoidea and Proctotrupoidea. Families essentially monographed for Micronesia but not reported for the Marshalls include Colletidae (Krombein, 1950), Encyrtidae (Yoshimoto and Ishii, 1965), Halictidae (Krombein, 1950), Mymaridae (Doutt, 1955), Scoliidae (Krombein, 1949, 1950), Stephanidae (Townes, 1958), and Trichogrammatidae (Doutt, 1955).

Anthophoridae (Krombein, 1950, in part): Marshalls 1, Enewetak 1— *Xylocopa sonorina* Smith is a carpenter bee of Oriental affinities introduced to Hawaii and elsewhere in the Pacific. Micronesian fauna comprises six species, including two of *Ceratina* endemic to the Marianas or Carolines.

Bethylidae: Marshalls 1, Enewetak 0—An unidentified *Scleroderma* is reported for Kwajalein (Sugerman, 1972a). The genus is widespread and occurs in Hawaii.

Braconidae: Marshalls 4, Enewetak 1—Four genera are known for the Marshalls, and all are single records with none of the species identified (Cole, 1951; Sugerman, 1972a, 1979; Townes, 1946). They are *Chelonus, Macrocentrus, Microplitis,* and *Zele*. Only the last is reported for Enewetak. All are widespread genera whose species parasitize Lepidoptera. *Chelonus* and *Macrocentrus* are known from Hawaii. Watanabe (1945) studied the Esaki collections from the Carolines and Marianas, including three endemic species of *Chelonus* and two of *Macrocentrus*.

Chalcidae: Marshalls 1, Enewetak 0—An unidentified species, possibly *Chalcis,* is reported for Jaluit (Schnee, 1904).

Cynipidae: Eucoilinae (Yoshimoto, 1962): Marshalls 3, Enewetak 0—These species, all in *Pseudeucoila,* are either restricted to Micronesia (2) or also occur in Samoa and Hawaii (1). Micronesian fauna comprises 13 species, with endemism about 77%. Two other species of *Pseudeucoila* reported for Caroline atolls are known from high islands in the Carolines and elsewhere but are not among those reported for the Marshalls.

Eucharidae (Watanabe, 1958): Marshalls 1, Enewetak 0—A single species, *Parachalcura maculata* Watanabe, is restricted to the Marshalls and Caroline atolls. Micronesian fauna comprises nine species, with all species endemic.

Eulophidae (Yoshimoto and Ishii, 1965): Marshalls 5, Enewetak 1—These are species either restricted to

Micronesia (4) or also occurring in Australia, Philippines, and Hawaii (1). The last is also reported for Enewetak. One of the restricted species, *Cirrospiloideus fullawayi* Y. and I., is reported only from Ebon. Micronesian fauna comprises 35 species, with endemism about 60%. Only three of the 11 species occurring on Caroline atolls and one of the two species occurring in the Gilberts are also present in the Marshalls, making the atoll eulophid fauna irregular.

Evaniidae (Townes, 1958): Marshalls 2, Enewetak 1—These species are either circumtropical [*Evania appendigaster* (Linnaeus)] or Malayan–Melanesian and extending farther into the Pacific, including Enewetak and Hawaii *(Szeptigetella)*. Micronesian fauna comprises three species, with none endemic.

Formicidae: Marshalls 22, Enewetak 1—Ants from Enewetak are poorly sampled, and the 13 species listed by Cole (1949) for Bikini should also occur there. The sole species we list for Enewetak, *Monomorium pharaonis* (Linnaeus), is cosmopolitan. Species reported for the Marshalls are widespread (11), Oriental (8), more or less restricted to the Pacific (2), or Australian (1). At least 13 of these ants also occur in Hawaii, being mainly "tramp species" that are widely distributed by commerce. Wilson and Taylor (1967) treated the Polynesian fauna, which includes many species of possible occurrence in Micronesia.

Ichneumonidae (Townes, 1958): Marshalls 2, Enewetak 1—The polytypic *Echthromorpha agrestoria* Swederus ranges from Africa through Asia into the Pacific and includes three subspecies endemic to Micronesia, plus a further subspecies *(insidiator)* of Indonesian–Melanesian distribution that is reported for Enewetak. The other species, *Trathala flavoorbitalis* (Cameron), is Oriental. Both species occur in Hawaii. Micronesian fauna comprises 33 species, with endemism probably less than 60%. Only 12% are reported for isolated atolls, but none occurs exclusively on atolls.

Megachilidae (Krombein, 1950): Marshalls 3, Enewetak 2—Two species of *Megachile* reported for Enewetak are either of Oceanian distribution *(hedleyi)* or possibly of Philippine origin and are now found throughout Micronesia and Hawaii *(fullawayi)*. A third species, *M. umbripennis* Smith, is Oriental and was not seen in Micronesia until after World War II; it is now reported for the Marianas and Marshalls and also occurs in Hawaii. Micronesian fauna comprises eight species, with endemism about 38%.

Scelionidae: Marshalls 2, Enewetak 0—Two unidentified species are reported for Kwajalein (Sugerman, 1979); they represent *Telenomus* and possibly *Caloteleia*.

Sphecidae (Krombein, 1949, 1950): Marshalls 11, Enewetak 4—The species from Enewetak are from continental areas, probably reaching Pacific islands, including Hawaii, through human activities. Species reported for the Marshalls are widespread in the Old World (2), Oriental region (3), New World (3), or limited to Pacific islands (3). Species in the last category all belong to *Pison*. Nine of 11 species reaching the Marshalls also occur in Hawaii, including the four reported for Enewetak. It is probable that at least some of the sphecids gained entry to the Marshalls via Hawaii. Micronesian fauna comprises 30 species, with endemism about 17%.

Vespidae (Krombein, 1949): Marshalls 4, Enewetak 4—The species of *Pachodynerus* and *Polistes* we list for Enewetak are from North America, introduced to Hawaii and Micronesia; the *Ropalidia* is Malayan. The distribution of *Odynerus* sp. is undetermined, but there are three endemic congeners described from the Marianas. Micronesian fauna comprises 12 species, with endemism about 58%.

COLLECTION RECORDS

Insects and Allies of Enewetak Atoll

Taxa are listed in the same order as given in the checklist (Table 1). Collection records reported are abbreviated and include, when known, the islet, month, year, and surname of collector. The specific islet was unclear in some cases, and these are listed as "?Islet" or by a descriptive phrase (see first entry). The name of the determiner is included when the particular specimens cited were previously unreported for Enewetak.

Class ARACHNIDA
Order SCORPIONIDA
Family ISCHNURIDAE
Hormurus australasiae Fabricius
"On every island visited": May 1946, Townes.

Order PSEUDOSCORPIONIDA
Family ATEMNIDAE
Oratemnus samoanus whartoni Chamberlin
Enewetak Islet: Nov. 1944, Dybas and Edgar. Japtan Islet: Oct.–Nov. 1944, Dybas.
Family CHERNETIDAE
Haplochernes insulanus Beier
Japtan Islet: Nov. 1944, Dybas.
Family CHTHONIIDAE
Lechytia sakagamii Morikawa
Enewetak Islet: Nov. 1944, Dybas. Japtan Islet: Nov. 1944, Dybas.

Order ARANEAE
Family ARANEIDAE
Araneus theis (Walckenaer)
Ikuren Islet: Sept. 1975, Cheng. Medren Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Family CLUBIONIDAE
Chiracanthium diversum Koch
Japtan Islet: Sept. 1975, Cheng. Medren Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Family DIPLURIDAE
Masteria hirsuta Koch
Enewetak ?Islet: June 1946, Morrison.
Family EUSPARASSIDAE
Heteropoda venatoria (Linnaeus)
Enewetak Islet: Sept. 1975, Cheng—det. by L. J. Pinter (determined from cast exoskeleton).

Family MICRYPHANTIDAE
Erigone sp.
Enewetak Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Family OONOPIDAE
Opopaea foveolata Roewer
Enewetak ?Islet: Nov. 1944, Dybas.
Opopaea lena Suman
Enewetak Islet: Sept. 1975, Cheng. Medren Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Family PHOLCIDAE
Smeringopus elongatus (Vinson)
Enewetak Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Family SALTICIDAE
Flacillula minuta (Berland)
Japtan Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Vitia albipalpis Marples
Enewetak Islet: Sept. 1975, Cheng—det. by L. J. Pinter.
Family SICARIIDAE
Scytodes striatipes (Koch)
Japtan Islet: Nov. 1944, Dybas; July 1946, Townes.
Family THERIDIIDAE
Latrodectus geometricus (Koch)
Enjebi Islet: Date?, Lamberson—det. by L. J. Pinter. ?Islet: May 1946, Townes.

Order ACARI
Family ARGASIDAE
Ornithodoros capensis Neumann
Aej, Ananij, Boken, Jinimi, Ribewon, and other Islets: Spring 1962, Bushman or coworkers—det. by D. E. Johnson.
Family DERMANYSSIDAE
Ornithonyssus sp.
?Islet: 1962, Bushman or coworkers—det. by N. Wilson.
Family ERYTHRAEIDAE
Balaustium sp.
?Islet: May 1946, Townes.

Class DIPLOPODA
Order PROTEROSPERMOPHORA
Family STRONGYLOSOMIDAE
Oxidus gracilis (Koch)
Enewetak Islet: Sept. 1975, Cheng—det. by F. G. Howarth.

Class INSECTA
Order THYSANURA
Family LEPISMATIDAE
Not identified
?Islet: May 1946, Townes.

Order COLLEMBOLA
Family ENTOMOBRYIDAE
Seira bipunctata (Packard)
Enewetak Islet: Sept. 1975, Cheng—det. by P. Bellinger.
Family ISOTOMIDAE
Isotomurus tricuspis Börner ?
?Islet: Sept. 1975, Cheng—det. by P. Bellinger.

Order ODONATA
Family LIBELLULIDAE
Pantala flavescens (Fabricius)
Enjebi Islet: Date?, Jackson.
Tramea lacerata Hagen
Medren Islet: Feb. 1975, Bryan—sight record by E. H. Bryan, Jr.

Order BLATTODEA
Family BLATTELLIDAE
Blattella lituricollis (Walker)
Enjebi Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug. 1956, Tuthill—det. by S. Asahina.
Lupparia notulata (Stål)
Bokombako Islet: Dec. 1950, Ôshiro. Japtan Islet: Jan. 1957, Tuthill; Feb. 1957, Tuthill—det. by S. Asahina.
Family BLATTIDAE
Melanozosteria soror (Brunner)
Ananij Islet: Aug. 1956, Tuthill. Bokombako Islet: Dec. 1950, Ôshiro—det. by S. Asahina. Enewetak Islet: Sept. 1975, Cheng—det. by G. M. Nishida.
Neostylopyga rhombifolia (Stoll)
Enewetak Islet: Sept. 1975, Cheng—det. by G. M. Nishida.
Periplaneta americana (Linnaeus)
Enewetak Islet: Sept. 1975, Cheng—det. by F. G. Howarth. Enjebi Islet: Jan. 1951, Ôshiro—det. by S. Asahina.
Periplaneta australasiae (Fabricius)
Enjebi Islet: May 1946, Oakley and Townes. Japtan Islet: Aug. 1956, Tuthill; Sept. 1956, Tuthill. Medren Islet: Aug. 1956, Tuthill.
Family PYCNOSCELIDAE
Pycnoscelis surinamensis (Linnaeus)
Ananij Islet: Aug. 1956, Tuthill. Elugelab Islet: Jan. 1951, Ôshiro Enewetak Islet: Nov. 1944, Dybas. Enjebi Islet: May 1946, Oakley. Japtan Islet: Aug. 1956, Tuthill; Jan. 1957, Tuthill—det. by S. Asahina. Medren Islet: Sept. 1975, Cheng—det. by F. G. Howarth.

Order ORTHOPTERA
Family ACRIDIDAE
Aiolopus thalassinus tamulus (Fabricius)
Aomon Islet: May 1946, Townes Enewetak Islet: May 1946, Townes; Sept. 1975, Cheng. Japtan Islet: May 1946, Townes; Sept. 1975, Cheng—det. by G. M. Nishida.
Family GRYLLIDAE
Ornebius bimaculatus (Shiraki)
Enewetak Islet: Sept. 1975, Cheng—det. by F. G. Howarth.
Gryllodes sigillatus (Walker)
Enewetak Islet: Sept. 1975, Cheng—det. by F. G. Howarth.
Speonemobius sp. prob. *tigrinus* (Saussure)
Japtan Islet: Sept. 1975, Cheng—det. by A. B. Gurney.
Family TETTIGONIIDAE
Phisis pallida (Walker)
"All islands or atolls visited": May 1946, Townes.

Order DERMAPTERA
Family CARCINOPHORIDAE
Euborellia annulipes (Lucas)
Enewetak Islet: Sept. 1975, Cheng—det. by G. M. Nishida. Enjebi Islet: May 1946, Townes and Oakley [published as 1949]: Nov. 1947, Dybas; Aug. 1956, Tuthill.
Family CHELISOCHIDAE
Chelisoches morio (Fabricius):
"on every island visited": May 1946, Townes.
Family LABIDURIDAE
Labidura riparia (Pallas).
Enewetak Islet: Sept. 1975, Cheng—det. by G. M. Nishida. Enjebi Islet: May 1946, Townes; Jan. 1951, Ôshiro. ?Islet: May 1946, Townes; Jan. 1951, Ôshiro.

Order PSOCOPTERA
Family CAECILIIDAE
Caecilius casarum Badonnel

Japtan Islet: Feb. 1957, Tuthill.
Family ECTOPSOCIDAE
Ectopsocus maindroni Badonnel
Enewetak Islet: Sept. 1975, Cheng—det. by I. W. B. Thornton. Japtan Islet: May 1946, Townes.
Family LEPIDOPSOCIDAE
Cyptophania marginata Thornton, Lee and Chui
Enewetak Islet: Nov. 1944, Dybas. ?Islet: Nov. 1944, Edgar.
Family PSOCIDAE
Ptycta angulata Thornton, Lee and Chui
Ikuren Islet: Aug. 1956, collector? Medren Islet: Sept. 1975, Cheng—det. by I. W. B. Thornton.

Order MALLOPHAGA
Family MENOPONIDAE
Actornithophilus bicolor (Piaget)
Medren Islet: May 1962, Bushman—det. by K. C. Emerson.
Actornithophilus ceruleus (Timmermann)
Aej Islet: Mar.–Apr. 1962, Parker and Bushman—det. by R. D. Price. ?Islet: 1962, Woodbury.
Actornithophilus incisus (Piaget)
Aej Islet: Mar.–Apr. 1962, Parker and Bushman—det. by K. C. Emerson. ?Islet: 1962, Parker and Bushman.
Actornithophilus ochraceus (Nitzsch)
Medren Islet: Apr. 1962, Parker and Bushman—det. by R. D. Price.
Austromenopon atrofulvum (Piaget)
Aej Islet: Mar.–Apr. 1962, Parker and Bushman—det. by R. D. Price. Enewetak Islet: Feb. 1962, Parker and Bushman; Mar. 1962, Parker and Bushman. ?Islet: 1962, Parker and Bushman—det. by R. D. Price.
Colpocephalum angulaticeps Piaget
Ribewon Islet: May 1962, Bushman—det. by R. D. Price. Medren Islet: May 1962, Bush—det. by R. D. Price.
Family PHILOPTERIDAE
Halipeurus mirabilis Thompson
Jinimi Islet: May 1962, Bushman—det. by T. Clay.
Pectinopygus gracilicornis (Piaget)
Ribewon Islet: May 1962, Bushman—det. by K. C. Emerson. Medren Islet: May 1962, Bushman—det. by K. C. Emerson.
Quadraceps birostris (Giebel).
Aej Islet: Mar. 1962, Parker and Bushman—det. by K. C. Emerson. Enewetak Islet: Feb.–Mar. 1962, Parker and Bushman—det. by R. E. Elbel.
Quadraceps hopkinsi Timmermann
Aej Islet: Mar.–Apr. 1962, Parker and Bushman—det. by R. E. Elbel.
Quadraceps separatus (Kellogg and Kuwana)
Aej Islet: Mar.–Apr. 1962, Parker and Bushman—det. by R. D. Price.
Quadraceps sp. [Not counted in totals.]
?Islet: 1962, Woodbury.
Saemundssonia albemarlensis (Kellogg and Kuwana)
Aej Islet: Mar. 1962, Parker and Bushman—det. by K. C. Emerson.
Saemundssonia puellula Timmermann
Jinimi Islet: May 1962, Bushman—det by R. E. Elbel.
Saemundssonia remota Timmermann
Aej Islet: Mar.–Apr. 1962, Parker and Bushman—det. by R. E. Elbel.
Saemundssonia snyderi (Kellogg and Paine)
Enewetak Islet: Mar. 1962, Parker and Bushman—det. by R. E. Elbel.

Trabeculus hexakon (Waterston)
Jinimi Islet: May 1962, Bushman—det. by T. Clay.

Order THYSANOPTERA
Family PHLAEOTHRIPIDAE
Haplothrips gowdeyi (Franklin)
Enewetak Islet: Sept. 1975, Cheng—det. by F. A. Bianchi.

Order HETEROPTERA
Family ANTHOCORIDAE
Physopleurella mundula (White)
Japtan Islet: Aug. 1956, Tuthill.
Family COREIDAE
Liorhyssus hyalinus (Fabricius)
Elugelab Islet: Jan. 1951, Ôshiro.
Family CYDNIDAE
Geotomus pygmaeus (Dallas)
?Islet: Aug. 1956, Tuthill.
Family GERRIDAE
Halobates micans (Eschscholtz)
Enewetak Islet: Sept. 1975, Cheng.
Hermatobates sp.
?Islet: 1977, Cheng.
Family LYGAEIDAE
Germalus sp.
Enewetak Islet: Sept. 1975, Cheng—det. by W.C. Gagné.
Nysius picipes Usinger
Aomon Islet: May 1946, Oakley and Townes. Enjebi Islet: May 1946, Oakley and Townes. Japtan Islet: May 1946, Oakley and Townes; date?, Townes.
Nysius pulchellus Stål
Ananij Islet: Aug. 1956, Tuthill. Enewetak Islet: Sept. 1975, Cheng—det. by W. C. Gagné. Enjebi Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug. 1956, Tuthill; Jan. 1957, Tuthill; Sept. 1975, Cheng. Medren Islet: Aug. 1956, Tuthill; Sept. 1975, Cheng. ?Islet: May 1946, Oakley; Dec. 1950, Ôshiro.
Pachybrachius nigriceps (Dallas)
Enewetak Islet: Sept. 1975, Cheng—det. by W. C. Gagné. Japtan Islet: Aug. 1956, Tuthill; Sept. 1956, Tuthill; Jan. 1957, Tuthill; Sept. 1975, Cheng—det. by W. C. Gagné.
Family MIRIDAE
Campylomma eniwetok Schuh
Japtan Islet: Feb. 1957, Tuthill.
Campylomma marshallensis Usinger
Enewetak Islet: Sept. 1975, Cheng. Japtan Islet: Sept. 1975, Cheng—det. by W.C. Gagné.
Trigonotylus dohertyi (Distant)
?Islet: May 1946, Townes.
Family NABIDAE
Nabis capsiformis Germar
Elugelab Islet: Jan. 1951, Ôshiro. Japtan Islet: May 1946, Townes; Aug. 1956, Tuthill; Jan.–Feb. 1957, Tuthill; Sept. 1975, Cheng—det. by W. C. Gagné.
Family PENTATOMIDAE
Oechalia schellenbergii (Guerin-Méneville)
Enjebi Islet: Dec. 1950, Ôshiro. ?Islet: Aug. 1945, Allen; May 1946, Townes.
Platynopus melacanthus (Boisduval)
Bokombako Islet: Dec. 1950, Ôshiro.

Order HOMOPTERA
Family APHIDIDAE
Aphis gossypii Glover
Enjebi Islet: May 1946, Oakley. Japtan Islet: May 1946,

Townes. ?Islet: Jan. 1945, R. Bohart; May 1946, Oakley.
Aphis craccivora Koch
Enjebi Islet: May 1951, Fosberg. Japtan Islet: May 1946, Oakley.
Family CICADELLIDAE
Balclutha incisa (Matsumura)
?Islet: Dec. 1950, Ôshiro.
Balclutha saltuella (Kirschbaum)
Japtan Islet: Aug. 1958, Tuthill.
Exitianus fusconervosus (Motschulsky)
Aomon Islet: May 1946, Townes. Elugelab Islet: Jan. 1951, Ôshiro. Ikuren Islet: May 1946, Townes.
Exitianus plebeius (Kirkaldy)
Ananij Islet: Aug. 1956, Tuthill. Aomon Islet: May 1946, Townes. Elugelab Islet: Jan. 1951, Ôshiro. Enewetak Islet: Sept. 1975, Cheng. Ikuren Islet; May 1946, Townes; Aug. 1956, Tuthill. Japtan Islet: Sept. 1975, Cheng. Medren Islet: Aug. 1956, Tuthill; Sept. 1975, Cheng—det. by W. C. Gagné.
Orosius argentatus (Evans)
Aomon Islet: May 1946, Townes. Enewetak Islet: May 1946, Townes. Japtan Islet: May 1946, Oakley; Aug. 1958, Tuthill.
Recilia affinis (Osborn)
Ikuren Islet: Aug. 1956, Tuthill.
Recilia hopponis (Matsumura)
Japtan Islet: Aug. 1958, Tuthill.
Superfamily COCCOIDEA
Ceroplastes cirripediformis Comstock
Medren Islet: Sept. 1957, Tuthill.
Coccus hesperidum Linnaeus
Enjebi Islet: May 1946, Oakley. Japtan Islet: May 1946, Townes.
Icerya purchasi Maskell
?"Nan" Islet: July 1957, Tuthill.
Lepidosaphes esakii Takahashi
Japtan Islet: May 1946, Townes.
Phenacoccus solani Ferris
Enjebi Islet: May 1946, Townes.
Pseudococcus microadonidum Beardsley
Enjebi Islet: May 1946, Townes.
Saissetia coffeae (Walker)
Medren Islet: Sept. 1957, Tuthill.
Family DELPHACIDAE
Sogatella kolophon (Kirkaldy)
Japtan Islet: Aug. 1956, Tuthill.
Family DERBIDAE
Lamenia caliginea charon Fennah
Ikuren Islet: Aug. 1956, Tuthill. Japtan Islet: May 1946, Townes [published as Mar.]; Aug. 1956, Tuthill. ?Islet: Nov. 1944, Edgar.

Order COLEOPTERA
Family ANTHICIDAE
Anthicus vexator Werner
Enewetak Islet: Nov. 1944, Dybas. Japtan Islet: Nov. 1944, Hagen; Sept. 1975, Cheng—det. by G. A. Samuelson.
Family CARABIDAE
Egadroma smaragdula (Fabricius)
Enewetak Islet: Sept. 1975, Cheng—det. by G. A. Samuelson. Enjebi Islet: Jan. 1951, Ôshiro.
Family CERAMBYCIDAE
Prosoplus atlanticus atlanticus Breuning
Elugelab Islet: Jan. 1951, Ôshiro.
Family CHRYSOMELIDAE
Aphthona bicolorata Jacoby. ?Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.
Family COCCINELLIDAE
Coelophora inaequalis
Enewetak Islet: Sept. 1975, Cheng—det. by G. A. Samuelson. Japtan Islet: August 1956, Tuthill. Medren Islet: Aug. 1956, Tuthill.
Harmonia arcuata (Fabricius)
Enewetak Islet: Aug. 1945, Allen. Japtan Islet: May 1946, Townes.
Nephus roepkei (Fluiter)
Enewetak Islet: Sept. 1975, Cheng—det. by G. A. Samuelson. Enjebi Islet: May 1946, Townes. Medren Islet: Aug. 1956, Tuthill.
Scymnus nigrosuturalis Kamiya
Japtan Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.
Family DERMESTIDAE
Dermestes ater De Geer
Japtan Islet: May 1946, Townes.
Family ELATERIDAE
Conoderus pallipes Eschscholtz
Enewetak Islet: May 1946, Oakley and Townes. Enjebi Islet: Dec. 1950, Ôshiro. Japtan Islet: Sept. 1975, Cheng—det. by G. A. Samuelson. ?Islet: May 1946, Oakley and Townes.
Simodactylus fasciolatus
Enjebi Islet: May, 1946, Oakley. Japtan Islet: May 1946, Townes; Sept. 1975, Cheng—det. by G. A. Samuelson. Runit Islet: Aug. 1945, Allen.
Family MYCETOPHAGIDAE
Typhaea stercorea Linnaeus
Enewetak Islet: Nov. 1944, Edgar.
Family NITIDULIDAE
Carpophilus davidsoni Dobson
Japtan Islet: May 1946, Fosberg; Sept. 1956, Tuthill.
Carpophilus hemipterus (Linnaeus)
Enewetak Islet: Nov. 1944, Dybas.
Carpophilus marginellus Motschulsky
Japtan Islet: May 1946, Fosberg.
Carpophilus mutilatus Erichson
Japtan Islet: Nov. 1944, Dybas.
Carpophilus pilosellus Motschulsky
Enewetak Islet: Nov. 1944, Dybas and Edgar.
Urophorus humeralis (Fabricius)
Elugelab Islet: Jan. 1951, Ôshiro. Enewetak Islet: Nov. 1944, Dybas. Japtan Islet: Nov. 1944, Dybas. May 1946, Oakley; May 1946, Fosberg; Sept. 1956, Tuthill.
Family OEDEMERIDAE
Eobia kanack (Fairmaire)
Japtan Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.
Eobia matsumurai Kono
Japtan Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.
Eobia trukana Kono
Japtan Islet: Aug.–Sept. 1956, Jan.–Feb. 1957, Tuthill. Enewetak Islet: May 1946, Townes.
Eobia new species
Japtan Islet: August 1956, Jan. 1957, Tuthill. ?Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.
Pselaphanca apicata (Fairmaire)
Japtan Islet: Aug.–Sept. 1956, Jan. 1957, Tuthill. Medren Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.
New genus and new species:
Japtan Islet: Aug.–Sept. 1956, Jan.–Feb. 1957, Tuthill.
Family PROPALTICIDAE
Propalticus insularis John
Japtan Islet: Nov. 1944, Dybas.

Family SCOLYTIDAE

Cryphalomorphus nubilus Wood

Ikuren Islet: May 1946, Townes.

Hypothenemus eruditus Westwood

Japtan Islet: Nov. 1944, Dybas.

Family TENEBRIONIDAE

Gebieniella carinata (Eschscholtz)

?Islet: Nov. 1944, Edgar.

Gonocephalum adpressiforme Kaszab

Enewetak Islet: Sept. 1975, Cheng—det. by G. A. Samuelson.

Order NEUROPTERA

Family CHRYSOPIDAE

Chrysopa ramburi Schneider

Aomon Islet: May 1946, Townes. Bokombako Islet: Dec. 1950, Ôshiro. Japtan Islet: May 1946, Townes.

Order LEPIDOPTERA

Family ARCTIIDAE

Utetheisa pulchelloides Hampson

"Occurs on every island visited": May 1946, Townes.

Family HESPERIIDAE

Badamia exclamationis (Fabricius)

?Islet: May 1946, Townes.

Family NOCTUIDAE

Spodoptera exempta (Walker)

?Islet: May 1946, Townes.

Spodoptera litura (Fabricius)

"Occurs on every island visited": May 1946, Townes.

Family NYMPHALIDAE

Hypolimnas bolina (Linnaeus)

"On every island visited": May 1946, Townes.

Precis villida (Fabricius)

Aomon Islet: May 1946, Townes. Enjebi Islet: May 1946, Townes. Medren Islet: May 1945, Young.

Family SPHINGIDAE

Agrius convolvuli (Linnaeus)

Enjebi Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug.–Sept. 1956, Tuthill. Medren Islet: Aug. 1956, Tuthill. ?Islet: Aug. 1967, Knudsen.

Cephonodes armatus Rothschild and Jordan

?Islet: May 1946, Townes.

Cephonodes picus (Cramer)

Enewetak Islet: May 1946, Townes and Oakley. Enjebi Islet: May 1946, Townes; May 1946, Townes and Oakley; Jan. 1951, Ôshiro.

Gnathothlibus erotus (Cramer): ?Islet: May 1946, Townes.

Family TORTRICIDAE

Adoxophyes fasciculana (Walker)

Elugelab Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug. 1956, Tuthill; Jan. 1957, Tuthill.

Order DIPTERA

Family AGROMYZIDAE

Ophiomyia cornuta (de Meijere)

Enewetak Islet: Sept. 1975, Cheng. Japtan Islet: May 1954, Townes [published as 1956]; Aug. 1956, Tuthill?; Jan–Feb. 1957, Tuthill; Sept. 1975, Cheng—det. by J. A. Tenorio. Medren Islet: Aug. 1955, Wheeler.

Pseudonapomyza spicata (Malloch)

?Islet: May 1946, Townes.

Family CALLIPHORIDAE

Chrysomya megacephala (Fabricius)

Bokombako Islet: Dec. 1950, Ôshiro. Enjebi Islet: Dec. 1950, Ôshiro.

Phaenicia cuprina (Wiedemann)

Enewetak Islet: May 1946, Townes; Jan. 1951, Ôshiro. Enjebi Islet: May 1946, Oakley.

Family CANACEIDAE

Nocticanace marshallensis Wirth

Aomon Islet: May 1946, Townes. Enewetak Islet: Sept. 1975, Cheng. Japtan Islet: May 1946, Townes; Sept. 1975, Cheng—det. by W. W. Wirth.

Family CERATOPOGONIDAE

Dasyhelea esakii Tokunaga

Japtan Islet: Aug–Sept. 1956, Tuthill; Jan.–Feb. 1957, Tuthill; Sept. 1975, Cheng—det. by W. W. Wirth.

Dasyhelea flavescens Tokunaga and Murachi

Enewetak ?Islet: Aug. 1956, Tuthill.

Dasyhelea flavibasalis Tokunaga

Japtan Islet: Aug. 1956, Tuthill.

Dasyhelea peliliouensis Tokunaga

Japtan Islet: Aug. 1956, Tuthill.

Forcipomyia (Forcipomyia) tuthilli Tokunaga

Japtan Islet: Aug. 1956, Tuthill.

Family CHIRONOMIDAE

Clunio tuthilli Tokunaga

Enewetak Islet: Sept. 1975, Cheng. Japtan Islet: Sept. 1956, Tuthill; Sept. 1975, Cheng—det. by W. W. Wirth. Medren Islet: Sept. 1956, Tuthill.

Pontomyia natans Edwards

11 30N 162 15E (lagoon): date?, Cheng?

Tanytarsus halophilae Edwards

Japtan Islet: Sept. 1975, Cheng—det. by W. W. Wirth.

Telmatogeton pusillum Edwards

Japtan Islet: Sept. 1975, Cheng—det. by W. W. Wirth.

Thalassomya maritima Wirth

Enewetak Islet: Sept. 1975, Cheng. Enjebi Islet: Dec. 1950, Ôshiro. Ikuren Islet: Sept. 1975, Cheng. Japtan Islet: Aug. 1956, Tuthill; Sept. 1975, Cheng—det. by W. W. Wirth.

Family CHLOROPIDAE

Cadrema pallida (Loew)

Enewetak ?Islet: Jan. 1951, Ôshiro. Enjebi Islet: Aug.–Sept., Wheeler. Ikuren Islet: Aug.–Sept., Wheeler. Japtan Islet: May 1946, Townes; Aug.–Sept. 1956, Tuthill; Jan.–Feb. 1957, Tuthill; Aug.–Sept., Wheeler—det. by C. Sabrosky.

"*Gaurax*" *bicoloripes* (Malloch)

Japtan Islet: Aug.–Sept. 1955, Wheeler; Aug. 1956, Tuthill; Jan. 1957, Tuthill—det. by C. Sabrosky (generic position uncertain, not *Oscinosoma*).

Family EPHYDRIDAE

Allotrichoma alium Cresson

Japtan Islet: Aug.–Sept. 1955, Wheeler—det. by W. W. Wirth.

Discocerina mera Cresson

Japtan Islet: Aug. 1956, Tuthill—det. by W. W. Wirth.

Hecamede persimilis Hendel

Japtan Islet: Aug.–Sept. 1955, Wheeler. Medren Islet: Aug.–Sept. 1955, Wheeler. ?Islet: Dec. 1950, Ôshiro—det. by W. W. Wirth.

Hostis guamensis Cresson

Japtan Islet: Aug. 1956, Tuthill; Sept. 1975, Cheng—det. by W. W. Wirth.

Placopsidella cynocephala Kertész

Enjebi Islet: Jan. 1951, Ôshiro—det. by W. W. Wirth. Ikuren Islet: Sept. 1975, Cheng. Japtan Islet: Sept. 1975, Cheng—det. by J. A. Tenorio. Medren Islet: Aug.–Sept. 1955, Wheeler—det. by W. W. Wirth; Sept. 1975, Cheng—det. by J. A. Tenorio.

Family HIPPOBOSCIDAE
Olfersia spinifera (Leach)
Ribewon Islet: May 1962, Bushman—det. by T. C. Maa.
Family MILICHIIDAE
Desmometopa varipalpis Malloch
Medren Islet: Aug.–Sept. 1955, Wheeler. ?Islet: Dec. 1944, Edgar; May 1946, Townes—det. by C. Sabrosky.
Milichiella lacteipennis (Loew)
Enewetak ?Islet: Dec. 1950, Ôshiro. Japtan Islet: Aug.–Sept. 1955, Wheeler—det. by C. Sabrosky.
Family MUSCIDAE
Atherigona flavipalpis Malloch
Elugelab Islet: Jan. 1951, Ôshiro. Enjebi Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug. 1956, Tuthill.
Atherigona (Acritochaeta) orientalis Schiner
Japtan Islet: Aug. 1956, Tuthill.
Musca (Musca) domestica Linnaeus
Ananij Islet: Aug. 1956, Tuthill. Ikuren Islet: Aug. 1956, Tuthill. Japtan Islet: Aug. 1956, Tuthill. Medren Islet: Aug. 1956, Tuthill. ?Islet: Dec. 1950, Ôshiro.
Family PHORIDAE
Diploneura (Dohrniphora) cornuta (Bigot)
Japtan Islet: Aug. 1956, Tuthill.
Megaselia (Megaselia) scalaris (Loew)
Japtan Islet: Aug. 1956, Tuthill.
Family SARCOPHAGIDAE
Boettcherisca karnyi (Hardy)
Japtan Islet: Nov. 1944, Edgar.
Parasarcophaga (Liosarcophaga) misera (Walker)
Enewetak Islet: Sept. 1975, Cheng—det. by J. A. Tenorio. Enjebi Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug. 1956, Tuthill.
Phytosarcophaga gressitti (Hall and Bohart)
?Islet: Jan. 1951, Ôshiro.
Family SCATOPSIDAE
Holoplagia guamensis (Johannsen) or near ?
Ikuren Islet: Sept. 1975, Cheng—det. by J. A. Tenorio.
Family SCIARIDAE
Bradysia tritici (Coquillett)
Japtan Islet: Aug. 1956, Tuthill.
Corynoptera latistylata (Hardy)
Japtan Islet: Aug. 1956, Tuthill.
Plastosciara latipons Hardy
Japtan Islet: Aug. 1956, Tuthill; Sept. 1956, Tuthill.
Family STRATIOMYIDAE
Brachycara ventralis Thomson
Japtan Islet: May 1946, Townes.
Family SYRPHIDAE
Ischiodon scutellaris (Fabricius)
Enewetak Islet: Nov. 1944, Dybas; May 1946, Oakley and Townes. Japtan Islet: Jan. 1957, Tuthill. ?Islet: Jan. 1951, Ôshiro; date?, Fosberg.
Family TIPULIDAE
Limonia (Dicranomyia) pectinunguis Tokunaga
Ananij Islet: Aug. 1956, Tuthill. Elugelab Islet: Jan. 1951, Ôshiro. Japtan Islet: Aug. 1956, Tuthill; Sept. 1975, Cheng—det. by F. G. Howarth.

Order HYMENOPTERA
Family ANTHOPHORIDAE
Xylocopa sonorina Smith
Enewetak Islet: Aug. 1944?, Bryan; Feb. 1975?, Bryan—sight records by E. H. Bryan, Jr.
Family BRACONIDAE
Zele sp.:
?Islet: May 1946, Townes.
Family EULOPHIDAE
Hemiptarsenus semialbiclavus (Girault)
?Islet: May 1946, Townes.
Family EVANIIDAE
Szeptigetella sericea (Cameron)
Medren Islet: Sept. 1975, Cheng—det. by G. Nakahashi.
Family FORMICIDAE
Monomorium pharaonis (Linnaeus)
Enjebi Islet: May 1946, Townes.
Family ICHNEUMONIDAE
Echthromorpha agrestoria insidiator (Smith)
Bokombako Islet: Dec. 1950, Ôshiro. Elugelab Islet: Jan. 1951, Ôshiro.
Family MEGACHILIDAE
Megachile diligens hedleyi Rainbow
Enjebi Islet: May 1946, Oakley; May 1946, Oakley and Townes. Japtan Islet: May 1946, Townes.
Megachile (Eutricharaea) fullawayi Cockerell
Enewetak Islet: Sept. 1975, Cheng—determined by G. Nakahashi. Enjebi Islet: May 1946, Oakley.
Family SPHECIDAE
Chalybion bengalense (Dahlbom)
Enewetak Islet: Sept. 1975, Cheng—det. by G. Nakahashi.
Pison punctifrons Shuckard
Japtan Islet: May 1946, Townes.
Solierella peckhami (Ashmead)
Enjebi Islet: May 1946, Townes and Oakley.
Tachysphex bengalensis Cameron
Japtan Islet: Sept. 1975, Cheng—det. by G. Nakahashi.
Family VESPIDAE
Odynerus sp.
Enewetak Islet: Sept. 1975, Cheng—det. by G. Nakahashi.
Pachodynerus nasidens (Latreille)
?Islet: May 1946, Townes.
Polistes fuscatus aurifer (Saussure)
Japtan Islet: Sept. 1975, Cheng—det. by G. Nakahashi.
Ropalidia marginata (Lepeletier)
Enewetak Islet: Sept. 1975, Cheng. Japtan Islet: Sept. 1975, Cheng—det. by G. Nakahashi.

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Chapter 16

Pycnogonida of Enewetak Atoll

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INTRODUCTION

The Pycnogonida (sea spider) fauna of the western and mid-Pacific island chains is almost unknown. Although generally benthic organisms, a few are considered planktonic and are associated with hosts in parasitic or commensal relationships. Most are known to feed on a wide variety of soft-bodied marine life with coelenterates reported as food more often in the literature than any other group. Pycnogonids should therefore be, and probably are, quite at home on the coral reefs of atolls and volcanic islands of these Pacific chains. The fact that there is only one paper (Child, 1982) on pycnogonids from the Marshall Islands, and particularly Enewetak Atoll, attests not only to the scarcity of pycnogonids but also to a lack of collections containing pycnogonids from the small and usually remote Pacific islands.

Pycnogonids are collected fortuitously during the course of benthic sampling for other marine organisms. They are almost impossible to see in their regular habitats because of their microscopic size and their cryptic coloration, which renders them almost invisible. Pycnogonids have been found in the laboratory during the microscopic examination of benthic samples, sometimes long after the collection was made, and it is usually impossible to return to the same collection locality for more samples. That large numbers are found in benthic samples demonstrates the careful collecting and sorting procedure during the field efforts.

The pycnogonids of the Marshall Islands and Enewetak Atoll predictably will not be as diverse or varied as the fauna of large islands or continental shores. The diversity of benthic habitats on coral atolls is reduced and almost totally excludes the muddy estuaries and weed-encrusted rocky shores of continental masses and large islands. Many groups of organisms are faunistically impoverished on coral atolls. Barnard (1965), in discussing predominantly benthic amphipods, states that "Micronesia primarily offers an epifaunal environment in the shallow sea, with scarce remnants of muddy coastal shelves fringing larger islands and continents. Hence the lack of [diverse] shallow sea bottoms, the diminution of environmental variability and the decrease of food from runoff should be limiting factors." This impoverishment would extend to those groups of pycnogonids preying on algal-attached sessile organisms. The lack of large expanses of foliose algae and sea grass beds on atolls, including Enewetak, limits the availability of many kinds of pycnogonid foods that use these plants as substrates.

The embryology of most pycnogonids, at least for those groups about which we know anything of their life habits, is not conducive to wide island arc dispersal. The eggs and young of many pycnogonids are carried by the male on their ovigers—appendages specifically modified for this purpose—and have no known planktonic dispersal. Their metamorphosis is directly from larva to adult, but in some recorded instances, the eggs are deposited in a host organism, such as a bivalve mollusk, where the young lead a parasitoid existence until they reach a free-living adult stage. Dispersal from island group to island group is problematical, and many pycnogonid species are thought to be endemics, some in quite restricted areas. Many of these endemics may be due to a lack of collecting in adjacent areas. I believe though, that when more is known about pycnogonid distribution, many of these species will remain recorded as endemics.

Only five pycnogonid species in four genera are known from Enewetak Atoll (Table 1). A sixth, *Nymphon micronesicum* (family Nymphonidae), is also known from Bikini (Child, 1982). This is a very small faunule when considering the great diversity of this class of arthropods in the oceans of the world. There are approximately 900 recognized species of pycnogonids in 76 genera and nine families (a very small faunule when the great diversity of this class of arthropods is considered), and we probably know about one-half or less than half of the world's species. The littoral shores of the world have not been sampled to any great extent, and with a few exceptions, it is in this environment that the greatest diversity, if not the greatest numbers, of pycnogonids live. Further collecting in littoral and sublittoral habitats on Enewetak Atoll and other

TABLE 1

Checklist of Pycnogonida of Enewetak Atoll

Phylum ARTHROPODA
  Class PYCNOGONIDA
    Order PANTOPODA
      Family AMMOTHEIDAE
        ***Ammothella stauromata* Child, 1982.
      Family CALLIPALLENIDAE
        ***Callipallene* sp. cf. *novaezelandiae* (Thomson, 1884).
      Family ENDEIDAE
        ***Endeis nodosa* Hilton, 1942.
      Family PHOXICHILIDIIDAE
        ***Anoplodactylus glandulifer* Stock, 1954.
        ***Anoplodactylus marshallensis* Child, 1982.

*New Enewetak and Micronesian record.

islands and atolls of Micronesia will undoubtedly add many species to the faunal checklist shown in Table 1. Collections of coral rubble from lagoon and outer reef habitats will probably yield additional new distributional records and new species. Scraping for fouling organisms on pier pilings, navigation buoys, and ship's hulls is another method for sampling common pycnogonid habitats and should increase our knowledge of that fauna. Pycnogonid habitats have hardly been touched on most of the oceanic islands of the Pacific.

COLLECTION DATA

Ammothella stauromata, *Anoplodactylus glandulifer*, and *Anoplodactylus marshallensis* were all collected by the author in 1969 from pier pilings on the north end of Enewetak Island (site name Fred). *Callipallene* sp. cf. *novaezelandiae* and *Endeis nodosa* were collected by the author in 1969 and by others in 1974 and 1975 from lagoon rubble and coral rocks in fairly shallow water. The *Callipallene* specimens were found in rubble on a lagoon coral knoll near Jinedrol Island (site name Alvin) and in coral rubble from Enewetak Island. *Endeis nodosa* came from coral rocks in the lagoon off Enewetak Island and from pier pilings on the lagoon side of Runit Island (site name Yvonne). No specimens have been reported from the rich outer reef habitats of Enewetak Atoll.

Ammothella stauromata and *Anoplodactylus marshallensis* are recently described species (Child, 1982) and are known only from Enewetak Atoll. *Anoplodactylus glandulifer* Stock, 1954, has the widest known distribution of the five species. It is known in widely scattered localities from the Red Sea and the east coast of Africa to Burma and Singapore and for the first time in the central Pacific islands at Enewetak. *Endeis nodosa* Hilton, 1942, has been known only from Hawaii, on Oahu Island, and the Enewetak specimens extend its known range considerably to the west. The *Callipallene* specimens show slight differences from Thomson's (1884) species *novaezelandiae*, but if they are in fact this species, the previously known southern hemisphere distribution of *C. novaezelandiae* (east coast of Africa to New Zealand) would be extended to the northern hemisphere at Enewetak. The record depths for all five species are shallow to littoral.

In general, the four genera have a worldwide distribution, predominantly in the tropics, but there are species of *Endeis*, *Anoplodactylus*, and *Callipallene* in deep sea habitats and even in cold Antarctic waters. *Anoplodactylus* is the largest genus represented in terms of species known with about 75 now recognized. It has several known representatives in most papers on the perimeter Pacific island groups, including Australia and New Zealand, and appears in the few reports that exist on western and mid-Pacific islands. There are close relations of the Enewetak species of *Anoplodactylus* in Japan and the Indian Ocean.

The specific food preferences of most pycnogonid species are unknown; so there can be no comparisons of habitat-food preference among the various species.

The genus *Ammothella*, with 28 known species, is tropical–temperate in distribution and has island representatives in scattered localities around some parts of the Pacific perimeter. *Callipallene*, with 28 known species, is one of many genera in a large family which seems to have an area of proliferation, at the generic level, in the Austral-Indonesian area (referring to the island arc from Australia and New Zealand through the Philippines). Of the 24 genera in the family Callipallenidae, 13 genera have representatives in this area. One genus *(Parapallene)* has the majority of its known species found in this area, and three genera (*Pycnopallene*, *Spasmopallene*, and *Stylopallene*) are endemic. Therefore, it would not be surprising at all to find a number of coral reef species of callipallenids at Enewetak and the Marshall Islands. The genus *Endeis*, with 17 reported species, has seven from the Austral-Indonesian region.

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Chapter 17

Stomatopod Crustacea of Enewetak Atoll

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INTRODUCTION

This study provides a checklist and discusses the biogeographic relationships of the 12 species of Stomatopoda (mantis shrimps) now known to occur on Enewetak Atoll. Five species are widely distributed throughout the Indo-West Pacific region, and three species have somewhat more restricted ranges in the Indo-West Pacific and Indian Ocean. Four species are endemic to the Central Pacific (two to Enewetak), and three taxa need further taxonomic investigation, which may demonstrate further endemism. Stomatopods from Enewetak are dwarfed in body size compared to their mainlaind relatives. Small size has strong consequences for life history and evolutionary patterns in stomatopods, and in particular is likely to generate endemism. We provide information on the color patterns of the stomatopods from Enewetak, showing which traits are the most reliable indicators of species identity for taxonomic and field research and which traits are most likely to be influenced by body size, sex, or habitat. Several anomalies in usually invariant color traits are found in stomatopods from Aomon Island, which was closer to sources of radiation from atomic testing than more southern islands in the atoll. We also summarize what is known about the habitat and fighting behavior of the coral-dwelling mantis shrimps from Enewetak. For each of the above topics, we identify or discuss all previous literature on the stomatopods of Enewetak.

CHECKLIST

The stomatopod Crustacea from Enewetak Atoll were first recorded by Manning (1971) and more recently by Manning and Reaka (1982); these studies included the description of three new species. Here we identify four species (*Gonodactylus ternatensis, Pseudosquilla ciliata, P. ornata,* and *Lysiosquilla maculata*) that have not been recorded previously from Enewetak, bringing to 12 the total number of species known from the atoll (Table 1). We also identify here all pertinent literature in which particular species of stomatopods from Enewetak have been discussed.

BIOGEOGRAPHIC COMPARISONS

Pseudosquilla ciliata is the only species of those found on Enewetak that also occurs in the Atlantic. Five of the species known from Enewetak (*G. chiragra, G. platysoma, P. ciliata, P. ornata,* and *L. maculata*) are widely distributed throughout the Indo-West Pacific region. All of these are relatively large species of stomatopods, and *Pseudosquilla* has a particularly long larval dispersal stage (Reaka, 1979a, 1980a; Reaka and Manning, 1987a).

Three species have somewhat more restricted distributions in the Western Pacific, Indo-Malayan, and Indian Ocean regions than the previously mentioned group. *Haptosquilla glyptocercus* occurs from Enewetak to Japan, northern Australia, and as far west as the Andaman Islands. *Gonodactylus smithii* is known from Oceania and the South China Sea and from Australia to the western Indian Ocean; however, populations from the western Indian Ocean and Red Sea may be referable to another species, *G. acutirostris* De Man. *Gonodactylus ternatensis* is known with certainty only from localities between Samoa and Indonesia.

Of the remaining species, *G. espinosus* and *G. incipiens* are known only from island localities in the Central Pacific, while *G. insularis* and *G. micronesica* apparently are endemic to Enewetak Atoll. These four species, as well as *H. glyptocercus* (which also has a relatively restricted distribution), are the smallest species that occur on Enewetak.

Figure 1 shows that the typical body sizes of populations of all of the coral-dwelling stomatopods from Enewetak are diminutive compared to those from many other geographic localities, particularly the Indo-West Pacific mainland areas. This fact is emphasized by comparing lineages of the same or closely related species in different regions. For example, individuals of *G. smithii* attain considerably smaller sizes in Enewetak than in Thailand or

TABLE 1

Checklist of Stomatopoda from Enewetak Atoll

Phylum CRUSTACEA
  Class MALACOSTRACA
    Order STOMATOPODA
      Family GONODACTYLIDAE
        Gonodactylus chiragra (Fabricius): Manning, 1971.
        Gonodactylus espinosus Borradaile: Manning, 1971.
        Gonodactylus incipiens Lanchester: Reaka, 1973; Dingle et al., 1973; Caldwell and Brunenmeister, 1975; Reaka, 1975a; Caldwell and Dingle, 1977; Reaka, 1979a.
          Gonodactylus viridis Serène: Caldwell and Dingle, 1972.
          Gonodactylus childi Manning: Manning, 1972.
        Gonodactylus insularis Manning and Reaka: Manning and Reaka, 1982
          Gonodactylus falcatus (Forskål): Manning, 1971; Caldwell and Dingle, 1972; Dingle et al., 1973; Reaka, 1973; Reaka, 1975a; Reaka, 1975b; Reaka, 1976; Reaka, 1979a; Manning and Reaka, 1982.
        Gonodactylus micronesica Manning: Manning, 1971; Dingle et al., 1973; Reaka, 1973.
        Gonodactylus platysoma Wood-Mason: Manning, 1971; Caldwell and Dingle, 1972; Reaka, 1973; Caldwell and Brunenmeister, 1975; Reaka, 1975a; Reaka, 1975b; Reaka, 1979a.
        Gonodactylus smithii Pocock: Manning, 1971; Caldwell and Dingle, 1972; Reaka, 1973; Dingle et al., 1973; Caldwell and Brunenmeister, 1975; Reaka, 1975a; Reaka, 1975b; Reaka, 1979a; Reaka, 1979b.
        **Gonodactylus ternatensis* De Man, 1902 (new record based on specimen in USNM collections).
      Family PROTOSQUILLIDAE
        Haptosquilla glyptocercus (Wood-Mason): Manning, 1971; Caldwell and Dingle, 1972; Dingle et al., 1973; Caldwell and Brunenmeister, 1975; Reaka, 1975a; Reaka, 1975b; Reaka, 1976; Caldwell and Dingle, 1977; Reaka, 1979a; Reaka, 1979b.
      Family PSEUDOSQUILLIDAE
        **Pseudosquilla ciliata* (Fabricius, 1787) (new record based on specimen in USNM collection).
        **Pseudosquilla ornata* Miers, 1880 (new record based on specimen in Rijksmuseum van Natuurlijke Historie, Leiden).
      Family LYSIOSQUILLIDAE
        **Lysiosquilla maculata* (Fabricius, 1793) (new record based on specimen determined by R. Kinzie for Mid-Pacific Marine Laboratory reference collection).

*New records for species at Enewetak.

Australia (and we suggest that this may be an endemic population). Individuals of *G. incipiens* from Enewetak are smaller than their cognates from Thailand *(G. viridis)* or Australia *(G. affinis)*. *Gonodactylus insularis* in Enewetak is a dwarf species compared to its close relatives in Thailand *(G. mutatus)*, Australia *(G. falcatus)*, and Hawaii *(G. aloha)*. These data cannot be accounted for by collecting techniques, sample sizes, or latitude and temperature. (See Reaka and Manning, 1987a, for further discussion). One lineage, that of *H. glyptocercus*, does not fit this pattern since it is not smaller in Enewetak than in Thailand.

We have discussed elsewhere reproductive and life history traits and their relationship to body size, dispersal ability, and evolutionary rates in stomatopods, including those from Enewetak (Reaka, 1975a, 1976, 1978, 1979a, 1979b, 1980a; Reaka and Manning, 1981, 1987a). Life history traits are scaled to body size within related lineages of stomatopods, and the life history patterns of species from Enewetak conform to these overall patterns. In particular, however, small body size and restricted dispersal ability generate rapid evolutionary changes and are likely to be associated with endemism. The tendency for dwarfism and endemism in the stomatopods from Enewetak provides another example of this trend.

COLOR PATTERNS

Despite their cryptic habits, stomatopods often are flamboyantly colored (Reaka, 1975b, 1980b, 1981; Reaka and Manning, 1981). Some of these color patterns vary dramatically among individuals of the population, while other traits are invariable in color. In another study on the coral-dwelling stomatopods of Enewetak (Reaka and Manning, 1987b), we provide the first quantitative analysis in any crustacean of the degree of color polymorphism in all morphological traits, and we test a series of hypotheses about the function of color patterns in stomatopods. Invariant and species-specific color traits can facilitate accurate identification of morphologically similar species in the field and also can be used to resolve taxonomic differences among sibling species (Manning, 1964, 1971; Manning and Reaka, 1979, 1981a, 1981b, 1982). Therefore, we provide here a summary of the traits that will be either the most useful or the most likely to lead one astray in field identifications of the common coral-dwelling stomatopods in Enewetak.

The meral spot (an often brightly colored oval indentation on the dorsomedial surface of each of the raptorial second maxillipeds) is one of the most reliable characteristics for identifying species (Table 2). The meral spot is

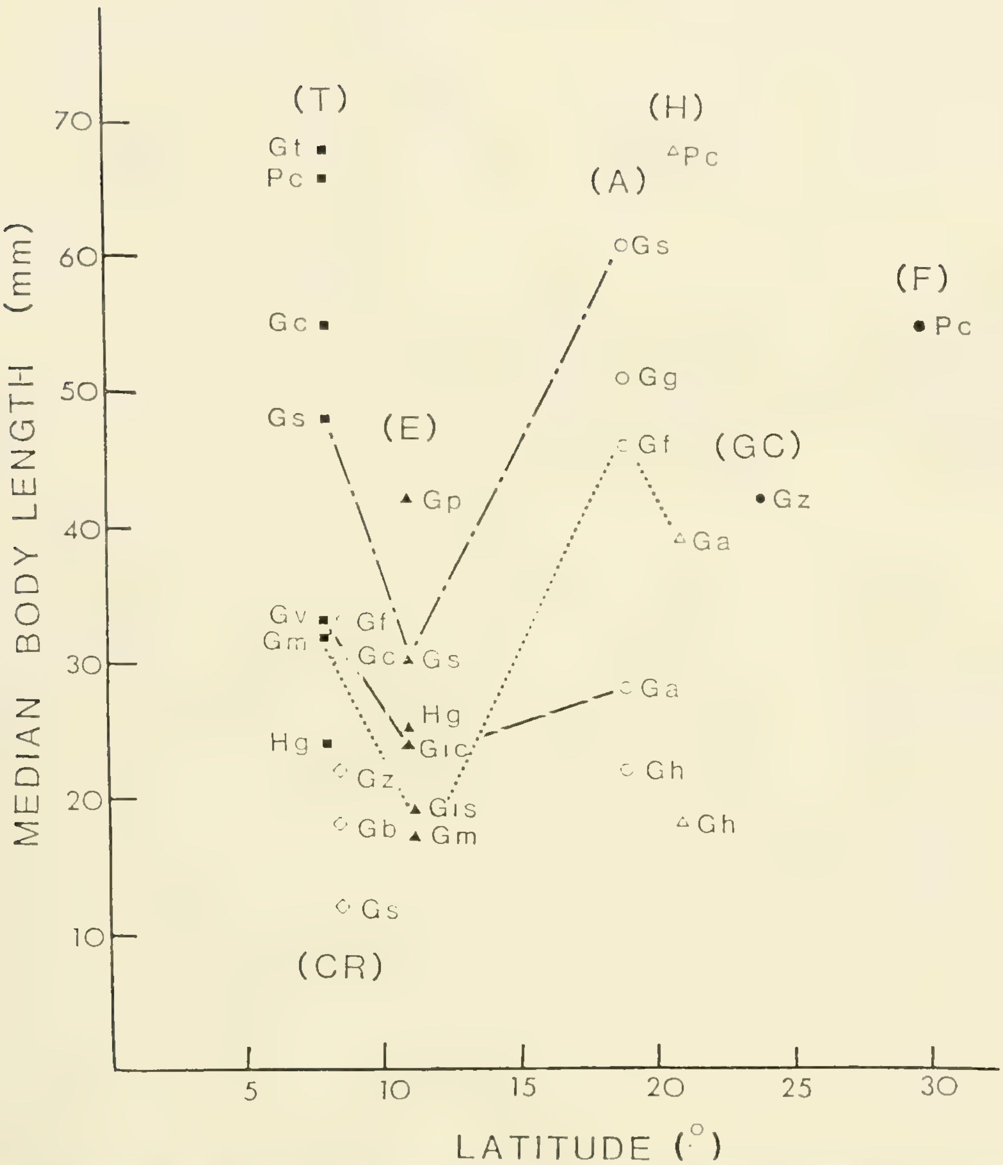

Fig. 1 Median body lengths of populations of stomatopods from different localities as a function of latitude. Body lengths are listed in descending order. Lines (discussed in text) connect conspecific or cognate populations that are especially pertinent to this discussion. [From Reaka and Manning, 1987b.]

■ Phuket, Thailand (T)
- Gt is *Gonodactylus ternatensis,*
- Pc is *Pseudosquilla ciliata,*
- Gc is *G. chiragra,*
- Gs is *G. smithii,*
- Gv is *G. viridis,*
- Gm is *G. mutatus,*
- Hg is *Haptosquilla glyptocercus*

○ Townsville, Australia (A)
- Gs is *G. smithii,*
- Gg is *G. graphurus,*
- Gf is *G. falcatus,*
- Ga is *G. affinis,*
- Gh is *G. hendersoni*

◇ Pacific Costa Rica (CR)
- Gf is *G. festae,*
- Gc is *G. costaricensis,*
- Gz is *G. zacae,*
- Gb is *G. bahiahondensis,*
- Gs is *G. stanschi*

△ Hawaii (H)
- Pc is *P. ciliata,*
- Ga is *G. aloha,*
- Gh is *G. hendersoni*

▲ Enewetak (E)
- Gp is *G. platysoma,*
- Gs is *G. smithii,*
- Hg is *H. glyptocercus,*
- Gic is *G. incipiens,*
- Gis is *G. insularis,*
- Gm is *G. micronesica,*

● Gulf of California (GC)
- Gz is *G. zacae*

● Florida (F)
- Pc is *P. ciliata*

TABLE 2

Color Traits Within Species*

Trait	*G. incipiens*	*G. insularis*	*G. micronesica*	*G. platysoma*	*G. smithii*	*H. glyptocercus*
Antennules	[Reddish in shallow habitats, yellowish in deeper habitats]	clear	RED	[Clear juv., red adults]	RED	MAROON†
Antennae	[Clear ♀, red or orange ♂; clear in small loose rubble, red and orange in large cemented rubble and microatolls]	clear, red	CLEAR	[Clear juv., red adults]	RED	WHITE†
Antennal scales	[Clear yellowish juv.; greenish adults]	[Greenish absent in juv.]	CLEAR	BASAL WHITE, DISTAL GREEN†	[Yellowish juv., greenish adults]	CLEAR
Meral spot on raptorial 2nd maxilliped	Whitish pink,† variations blue green to salmon	YELLOW, ANTERIOR RED INFUSION†	WHITE	WHITE	CARMIME RED, SURROUNDED BY BLACK AND WHITE CONCENTRIC RINGS†	CREAM†
Carpus of raptorial 2nd maxilliped			RED	RED		
Propodus of raptorial 2nd maxilliped	Dark spots† [Increase with depth, and in large cemented rubble and microatolls]		RED†		IRIDESCENT BLUE PURPLE WITH BRIGHT YELLOW BACKGROUND OUTLINE ON MERUS†	
Dactyl of raptorial 2nd maxilliped			RED†	BRIGHT BLUISH BLUE-GREEN†		
Other maxillipeds	[Yellowish ♀, greenish ♂; yellowish in shallow habitats and in small loose rubble, greenish in deeper habitats and in large cemented rubble and microatolls]	yellow	GREEN	green	[Yellowish ♀, greenish ♂]	brown
Walking legs	pink	pink	GREEN	GREEN	[Yellowish ♀, greenish ♂]	brown

8th thoracic segment				LATERAL "EYE-SPOT": RED ORANGE PATCH SURROUNDED BY DARK BLUE, RED, PALE BLUE, AND WHITE CONCENTRIC RINGS†		
6th abdominal and telson segments		4 PROMINENT BLACK SPOTS: 2 ON 6TH ABDOM. AND 2 ON ANTERIOR TELSON†	RED CARINAE ON 6TH ABDOM. AND TELSON†	LATERAL "EYE-SPOT" ON 6TH ABDOM.: YELLOW ORANGE PATCH SURROUNDED BY DARK BLUE, RED BROWN, AND WHITE CONCENTRIC RINGS†		
Basal segment and forked tip of uropod	[Clear juv., green adults; clear in shallow and in habitats with aggressive species, yellowish in deeper habitats and in those without aggressive species]	blue green	GREEN	ORANGE WITH LIGHT AND DARK BLUE SPOTS ON BASAL SEGMENT;† GREEN TIP	CARMINE RED SPOT ON BASAL SEGMENT;† blue green tip	brown
Uropodal endopod	[Clear in habitats with aggressive species, colored in habitats without aggressive species]	[Clear juv., red adults]	GREEN	GREEN	[Yellowish juv., other colors on adults]	clear, brown
Uropodal exopod	yellow green	RED†	GREEN	GREEN	[Yellowish juv., other colors on adults]	clear, brown
Body color	yellow green tan; medial dark hieroglyphic markings on thorax and abdomen	greenish	GREEN	olive brown	[Brownish ♀, greenish ♂]	[Brownish ♀, greenish ♂]
Speckling, mottling, transverse banding	[Speckling and mottling increase in larger individuals; banding increases in deeper habitats]		WHITE BAND ACROSS BOTH THORAX AND POSTERIOR ABDOMEN	WHITE BAND ACROSS THORAX; VERY HEAVY MOTTLING OVERALL	[Speckling increases in larger individuals, in deeper habitats, in habitats with aggressive species, and in large cemented rubble and microatolls] BANDING ABSENT†	dark hieroglyphic pattern on thorax and abdomen

*Upper case letters signify invariable traits; lower case letters in brackets are traits that vary in a statistically predictable ($p < 0.05$) way within species; lower case letters (no brackets) indicate most common colors of variable traits. Juv., juveniles or small individuals; shallow habitats are <0.5 m, deeper habitats 0.5 to 2.0 m.

†Unique colors that do not overlap those of any individuals in other species.

whitish pink in *G. incipiens*, yellow with an anterior red infusion in *G. insularis*, white in *G. micronesica* and *G. platysoma*, carmine red surrounded by a black-and-white ring in *G. smithii*, and cream colored in *H. glyptocercus*. Our analysis, however, shows that the color of the meral spot ranges from blue greenish to salmon among individuals classified as *G. incipiens*; morphological differences, especially in the structure of the telson, among members of this population also suggest that this taxon needs further investigation. Additionally, individuals in the Enewetak population of *G. smithii* have a carmine meral spot, whereas members of other populations of *G. smithii* bear a dark purplish red meral spot. This fact, in combination with the observations that *G. smithii* from Enewetak are diminutive in body size, produce smaller eggs relative to their body size, and invest a smaller proportion of their body volume in a brood of eggs than do other populations of *G. smithii* (Reaka, 1975a, 1979a; Reaka and Manning, 1987b), suggest that this population also is in need of taxonomic investigation and may represent an endemic species.

Several other invariant traits also are useful for species identifications, particularly when used in combination with the meral spots. *Haptosquilla glyptocercus* sports uniquely maroon antennules and white antennae among the species at Enewetak. The antennal scales of *G. platysoma* are white proximally but green distally. The propodus of the raptorial appendage in *G. smithii* is iridescent blue purple, set against a bright yellow background outline where it folds against the merus. Lateral dark spots characterize the propodus of the raptorial appendage in *G. incipiens* (although their number increases with depth and type of habitat). The propodus and dactyl of the raptorial maxilliped are uniquely red in *G. micronesica*. The dactyl of the raptorial appendage in *G. platysoma* is bright bluish blue-green. *Gonodactylus platysoma* also is remarkable for the colorful concentric "eye spots" on each side of the eighth thoracic and sixth abdominal segments. On the thorax this spot is composed of an outer white band, followed by a pale blue, red, dark blue, and finally an innermost red orange circlet of color. On the sixth abdominal segment, the "eye spot" is formed of an outer band of white, followed by red brown and dark blue rings and an innermost patch of yellow orange. The basal segment of each uropod in *G. platysoma* is orange with a light and dark blue spot. The basal segment of each uropod in *G. smithii* bears a brilliant red spot which is conspicuously exposed against dark green body coloration when the uropods are flared (particularly when the telson is coiled defensively in front of the body during a fight); these spots vanish when the uropods are tucked under the telson in a submissive posture. In addition, *G. insularis* is characterized by a lineage-specific set of four black spots—two on the sixth abdominal segment and two on the anterior telson. The uropodal exopods (and usually the endopods) are uniquely red in *G. insularis*, as are the dorsal carinae on the sixth abdominal segment and telson in *G. micronesica* (Table 2).

In contrast to the invariable and often unique traits discussed above, however, the color of most traits varies among individuals or with sex, developmental stage, or habitat in most species. When the range of variability among individuals is considered for all species (Reaka and Manning, 1987b), all of the major morphological traits can be ranked for relative variability of color, providing an indication of which traits are likely to be the most—or the least—reliable indicators of species identity in general. Except for the specific cases identified in Table 2 as being invariable, the uropodal exopods, antennules, antennae, uropodal endopods, and antennal scales, respectively, form a set of traits that are moderately variable in color. Similarly, when all species are considered (with invariable exceptions being noted in Table 2), the color of the maxillipeds, walking legs, and uropodal forked tips varies still more among individuals; body color is in general the most polymorphic of all traits. Descriptions of species and field identifications based upon the latter characters are most likely to be biased by small sample sizes.

Color patterns vary predictably with sex in some cases (Table 2). The color of the body, walking legs, and maxillipeds are more likely to be greenish in males but may shift toward other hues (especially brownish, yellowish) in females of some species (*G. smithii, G. incipiens, H. glyptocercus*). In *G. incipiens*, the antennae are more likely to be red or orange in males but clear in females.

The color pattern of certain traits also varies predictably with size or age in some species. The incidence of blue green or green coloration on the antennal scales or on the endopods, exopods, or forked tips of the uropods increases in larger individuals of several species (*G. incipiens, G. insularis, G. smithii*). The color of the uropodal endopod shifts toward red (matching the red of the invariant exopod) as individuals of *G. insularis* become larger. Also, the antennae and antennules of *G. platysoma* change from clear to red as individuals mature. White speckling on the body increases with size in *G. incipiens* and *G. smithii*.

Several color characteristics shift with habitat within species, where these shifts cannot be explained by the distributions of individuals of different sexes and sizes in different habitats. In *G. incipiens*, the frequency of white transverse banding on the body, dark spots on the propodus of the raptorial appendage, and yellow coloration on the antennules and distal fork of the uropods increases from shallow (0.5 m) to deeper (0.5 to 2.0 m) habitats. The degree of color polymorphism among individuals also increases with depth (antennal scales, maxillipeds, distal forks of the uropods) in *G. incipiens*. Additionally, the uropodal endopods in *G. incipiens* shift toward clear coloration in habitats that contain assemblages of aggressive species of stomatopods.

Color patterns also correlate with habitat and susceptibility to predation *among* species. Because they are highly vagile or occupy deep, reefward, or open exposed environments, *G. incipiens, G. platysoma*, and *G. micronesica* are likely to encounter considerable fish predation. On the other hand, *G. insularis*, *G. smithii*, and *H. glyptocercus* are less vagile, often occur in more protected and shoreward habitats, and undoubtedly suffer less predation than *G. incipiens*, *G. platysoma*, and *G. micronesica*. *Gonodactylus platysoma* and *G. incipiens* are the most heavily speckled and mottled species, and transverse banding is most developed in these two species and *G. micronesica*. Green is the predominant color in 17%, 47%, and 50%, respectively, of the traits of *G. incipiens*, *G. platysoma*, and *G. micronesica*. Green coloration is found on only 8%, 8%, and 0%, respectively, of the traits in *G. insularis*, *G. smithii*, and *H. glyptocercus* (see Reaka and Manning, 1987b, for details). Thus, we conclude that fish predation is likely to be a selective factor promoting drab greenish coloration and speckling and banding patterns that camouflage the individual against algae and the grainy calcareous substrate.

On the other hand, species with elaborate aggressive displays (see section on behavior) bear the most brightly colored structures; 62% and 58%, respectively, of the traits in *G. smithii* and *G. insularis*, but only 33%, 29%, and 20%, respectively, of those in nonagressive species (*G. incipiens*, *G. micronesica*, and *G. platysoma*, respectively) include predominantly red and yellow hues. (See Reaka and Manning, 1987b, for analysis.) *Haptosquilla glyptocercus* is one of the most uncolorful species, with only 9% of its traits (the antennules) bearing bright coloration; individuals of this species show extremely aggressive behavior but lack complex displays.

Similarly, bright colors are concentrated on anterior structures associated with threatening and attacking behavior (see Table 2 and quantified data in Reaka and Manning, 1987b). Red, maroon, or orangish antennules are found in *G. smithii*, *G. micronesica*, *G. platysoma*, *H. glyptocercus*, and *G. incipiens*, respectively. Red antennae are frequent in *G. insularis*, *G. smithii*, and *G. platysoma*. *Gonodactylus insularis* and *G. smithii* usually bear red or yellowish antennal scales. Maxillipeds often are yellowish in *G. incipiens*, *G. insularis*, and *G. smithii*. *Gonodactylus smithii* bears a red meral spot, and the carpus and propodus in *G. micronesica* and *G. platysoma* are red. Bright colors also characterize posterior structures used in defensive combat (red uropodal spots in *G. smithii*; red or yellow uropodal endopods and exopods in *G. insularis* and *G. smithii*, respectively; red telson carinae in *G. micronesica*).

Color polymorphism of the body is greatest in *G. smithii* and *G. insularis*; *G. insularis* and *G. incipiens* have the most color polymorphic appendages. Therefore, color polymorphism among individuals in the population is greatest either in species with elaborate aggressive communication (e.g., graded displays in *G. insularis*, *G. smithii*) or in species that occur in association with these species (*G. incipiens*). These observations suggest that color polymorphism may function for individual recognition of aggressive communication.

Several deviant color patterns, particularly in *G. platysoma*, were found on the northern island of Aomon, which was closer to sources of radiation from atomic testing than many of the southern islands in the atoll. Deviations in the red coloration of the anterior raptorial appendage, in the blue spots on the orange background of the basal segment of the uropod, and in the sequence of concentric colors on the lateral "eye spots" were observed in the population of *G. platysoma* collected from Aomon. Comparisons with other populations of this species collected from farther south on the atoll revealed that these deviations were not explained by body size, sex, or habitat.

BEHAVIOR

Stomatopods are highly visual, active predators that have some of the most complex behavior known in invertebrates (Caldwell and Dingle, 1975; Reaka, 1980b; Reaka and Manning, 1981). The gonodactylids and protosquillids on Enewetak (Table 1) inhabit preformed burrows in coral or calcareous substrate that cannot be enlarged; these species show the most intense and complex aggressive behavior. Members of the genus *Pseudosquilla* also show relatively elaborate behavior and strong aggression and occupy either holes in coral or excavations under coral. Lysiosquillids burrow in sand, can enlarge their burrows, have less elaborate behavior, and can grow to very large sizes (Caldwell and Dingle, 1975; Reaka, 1981; Reaka and Manning, 1981, 1987a).

The second maxilliped of stomatopods is enlarged into a raptorial appendage that is used to smash and stab competitors for burrows, predators, or hard-bodied prey. Intense, potentially lethal fighting behavior is observed among members of the same and different species in both the field and laboratory. Aggressive behaviors include strikes (a smashing blow with the hammer-like raptorial appendage or a stab with the open, needle-sharp dactyl); a variety of aggressive lunges and chases; and graded threat displays in which the raptorial appendages are lowered and spread, exposing the conspicuous meral spots. Defensive behaviors include coiling the armored telson in front of the body with the uropods spread wide. In coral-dwelling species this stance may effectively block the entrance of a burrow against an intruder. In addition, these mantis shrimps exhibit several retreat behaviors, including submissive postures in which the head and telson are lowered and their associated structures are tucked alongside or under the body.

The agonistic behavior of different species of coral-dwelling stomatopods in Enewetak has been addressed in several studies (Caldwell and Dingle, 1972, 1977; Reaka, 1973; Dingle, Highsmith, Evans, and Caldwell, 1973; Caldwell and Brunenmeister, 1975). We provide new data and synthesize all previous research on the aggressive behavior of these mantis shrimps in a comprehensive study elsewhere (Reaka and Manning, 1987b), but we provide a brief summary here.

Haptosquilla glyptocercus delivers the most strikes, but this relatively uncolorful species is exceptionally prone to retreat from opponents and is less likely to use threatening displays than *G. smithii* or *G. insularis*. Sporting a yellow meral spot and other bright coloration, *G. insularis* uses the highest number of threat displays in its interactions, strikes relatively often, and rarely retreats in a contest; consequently, this species can be classified as a very aggressive species. *Gonodactylus smithii* also is highly aggressive, striking but also retreating quite frequently. Members of this species perform some of the most expansive threat displays, thus exposing one of the most dramatic meral spots (carmine surrounded by black and white concentric circles) seen in any stomatopod. Interspecific tests indicate that *H. glyptocercus* dominates *G. insularis*, and that *G. insularis* wins contests with *G. smithii*. *Gonodactylus incipiens* and *G. platysoma* are characterized by low levels of fighting activity and subordinate social relationships to the other species in Enewetak.

HABITAT

Field work in 1972 allowed us to quantitatively analyze the distribution of shallow water stomatopods from several major types of habitat in Enewetak (Reaka, 1973; Reaka and Manning, 1987b). These habitats include:

1. Dead coral rubble
2. Soft rubble and vermetid rocks
3. The calcareous bases of "microatolls" (colonies of *Porites* in which the center has died and often was riddled with boring organisms)
4. Open reef benches of consolidated calcareous accretion (Table 3)

Dingle et al. (1973), Caldwell and Dingle (1975), and Caldwell and Brunenmeister (1975) provide additional information about the occurrence of stomatopods in particular habitats on Enewetak.

Coral rubble habitat is found on the reef platform as isolated heads, in small patch reefs, or along the reefward algal ridge on the east side of Enewetak. These habitats usually are ≤0.5 m deep and contain *G. incipiens*, *G. micronesica*, and *H. glyptocercus*. Stomatopods also are collected from coral rubble in somewhat deeper habitats (≤1 m deep) in the channel between Enewetak and the sandy islets on the northeast side of Enewetak, between these sandy islets and Japtan, and on the northeast side of Japtan. These rubble habitats contain *G. incipiens*, *G. micronesica*, *G. platysoma* (small), *G. smithii* (small), and *H. glyptocercus*. In addition to the above species, a population now classified as *G. insularis* (Manning and Reaka, 1982) was found in the rubble on the northeast flank of the sandy islets (Dingle et al., 1973; Reaka, 1980a). By the summer of 1972, however, the rubble had been partly buried by sand, and no *G. insularis* could be found. Our later analysis suggests some morphological differences between the population found in 1971 and *G. insularis* (Manning and Reaka, 1982), and the possibility remains that the former population represents an additional (possibly now extinct?) species in the closely related *G. falcatus* lineage. Of the species found in dead coral rubble, *G. incipiens* is the most common (45% of the 40 individuals collected), followed by *H. glyptocercus* (25%), small *G. smithii* (18%), *G. micronesica* (10%), and small *G. platysoma* (3%).

Stomatopods inhabit soft rubble and vermetid rocks on the shoreward and reefward sides (≤1.5 m deep) of the moat on the north side of Aomon. In 1972 *G. insularis* inhabited only the shoreward side of this moat (≤1 m deep). *Gonodactylus incipiens* and small *G. platysoma* and *G. smithii* also are found here; the distribution of small *G. smithii* extends into the somewhat deeper reefward areas of the moat. Of the stomatopods collected from the Aomon moat (N = 33), *G. insularis* is the most common (45%), followed by small *G. smithii* (27%), *G. incipiens* (15%), and small *G. platysoma* (12%).

Stomatopods also can be collected from the bases of the microatolls at depths of 0.5 to 2.0 m on the reef flat northeast of Enewetak. *Gonodactylus smithii* is abundant (72% of the 43 individuals quantified) and reaches large body sizes in this habitat. Although their numbers were not thoroughly quantified, our field notes indicate that *G. platysoma* also attains large sizes and is "abundant." The smaller species occurring in this habitat, *G. incipiens* and *H. glyptocercus*, also reach relatively large sizes but are less common (9% each of the quantified individuals; however, quantification was less systematic in this than in other habitats, and further sampling is needed). Caldwell and Dingle (1975) suggest that large individuals of *G. platysoma* occupy relatively open caverns under microatolls, while individuals of *G. smithii* and the smaller species inhabit borings further inside the center of the *Porites* colony. Despite their abundance, individuals of *G. smithii* are rarely observed away from their protective coral colony (Reaka, personal observation).

Individuals of two species, *G. platysoma* and *G. incipiens*, are commonly observed moving rapidly about on the open reef adjacent to the microatolls, particularly on low or incoming tides. As in the microatolls where they find refuge, the *G. incipiens* and *G. platysoma* observed on the open reef flat are relatively large in size. Our field notes indicate that individuals of *G. platysoma* are particularly abundant in this habitat. The shallow reef benches (≤0.5 m deep) on the east side of Enewetak and the east side of Japtan also yield stomatopods. These reef benches are scoured by wave action and frequently are exposed at low tides. Stomatopods *(G. incipiens, H. glyptocercus)* are collected from tubular holes in the solid reef substrate or as they dart about in the tide pools at low tide. *Gonodactylus incipiens* was the most common stomatopod in this habitat (7/9 or 78% of the quantified individuals), although further sampling is needed to assess the relative abundance of *H. glyptocercus*.

In 1972 a heavy rainfall during a mid-day low tide caused a massive reef kill in this shallow exposed habitat (Reaka, 1980a; Leviten and Kohn, 1980). Despite their high activity levels and probable high metabolic rates, stomatopods are remarkably tolerant of harsh physical conditions (low O_2, high temperatures, etc.; Reaka, personal observation). During this reef kill, mortality among the

TABLE 3

Distribution and Major Types of Habitat of Stomatopods
(E is east; N is north; NE is northeast)

Habitats and sites	*G. incipiens* No. females and males*	*G. incipiens* Body size, mm†	*G. insularis* No. females and males*	*G. insularis* Body size, mm†	*G. micronesica* No. females and males*	*G. micronesica* Body size, mm†	*G. platysoma* No. females and males*	*G. platysoma* Body size, mm†	*G. smithii* No. females and males*	*G. smithii* Body size, mm†	*H. glyptocercus* No. females and males*	*H. glyptocercus* Body size, mm†	Total No. individuals	Locally co-occurring species	Relative abundance of co-occurring species in major habitats (1–4)
1. Coral rubble															
Patch reefs and isolated heads on a reef platform E side of Enewetak (<0.5 m deep‡), often near shore	2♀, 1♂ [3]	15 to 19 (18)									1♀ [1]	17 (17)	[4]	*G. incipiens* *H. glyptocercus*	
Along algal ridge of reef crest, E side of Enewetak (<0.5 m deep)	3♀, 2♂ [5]	11 to 17 (16)			Present¶								[5+]	*G. incipiens* *G. micronesica*	45% *G. incipiens* 25% *H. glyptocercus*
In channel (~1 m deep) and on outer reef flat between Enewetak and sandy islets ("Sand Island") NE side of Enewetak	4♀§, 1♂ [5]	17 to 24 (22)			2♀ [3]	16 to 20 (18)	1♀, "relatively common"	16, "small"	2♀, 1♂ [5]	19 to 20 (19) "small"			[14+]	*G. incipiens* *G. micronesica* *G. platysoma* (small) *G. smithii* (small)	18% *G. smithii* (small) 10% *G. micronesica* 3+% *G. platysoma* (small)
On NE flank of Sand Island (between Enewetak and Japtan) (≤1 m deep)	2♀ [2]	28 to 34 (31)	Present in 1971**		1♀ [1]	22 (22)			2♀ [2]	"small"			[5+]	*G. incipiens* *G. micronesica* *G. smithii* (small) *G. insularis***	
On N side of Japtan (≤1 m deep)	1♀, 2♂ [3]	15 to 18 (17)									5♀, 4♂ [9]	15 to 27 (24)	[12]	*G. incipiens* *H. glyptocercus*	
2. Soft rubble and vermetid rocks															
Shoreward side of moat on N side of Aomon (≤1 m deep)	3♀ [5]	29 to 32 (30)	12♀, 3♂ [15]	8 to 33 (20)			1♀, 3♂ [4]	15 to 41 (28)	[7]	20, "small"			[31]	*G. incipiens* *G. insularis* *G. platysoma* (small) *G. smithii* (small)	45% *G. insularis* 27% *G. smithii* (small) 15% *G. incipiens* 12% *G. platysoma* (small)
Reefward side of moat on N side of Aomon (≤1.5 m deep)	Present¶								1♀ [2]	13, "small"			[2+]	*G. smithii* (small) *G. incipiens*	
3. Bases of microatolls															
Reef flat (0.5 to 2 m deep) NE side of Enewetak	1♀, 3♂ [4]	23 to 36 (33.5)					1♀, 3♂ "abundant"	50 to 60 (57)	13♀, 18♂ [31]	18 to 62 (31)	1♀, 1♂ [4]	20 to 34 (30)	[43+]	*G. incipiens* (large) *G. platysoma* (large) *G. smithii* (mod. large) *H. glyptocercus*	72% *G. smithii* (mod. large) 9% *G. platysoma* (large)†† 9% *G. incipiens* (large) 9% *H. glyptocercus*
4. Open reef flat															
Reef flat (0.5 to 2 m deep) near microatolls, large coral and other rubble, often considerable algae, NE side of Enewetak	3♀, 5♂ [9]	21 to 42 (33)					"abundant"	"large"					[9+]	*G. incipiens* (large) *G. platysoma* (large)	(Both common)
Holes in solid reef platform, often scoured, with little or no algae or in open tidepools in the same area (<0.5 m deep), E side of Enewetak and E side of Japtan	4♀, 3♂ [7]	18 to 31 (23)									2♀ [2]	24 to 26 (25)	[9]	*G. incipiens* *H. glyptocercus*	78% *G. incipiens* 22% *H. glyptocercus*
Total No. Individuals	[43+]		[15+]		[4+]		[9+]		[47]		[16]		[134+]		

*Number in brackets is total number collected. Totals sometimes exceed the sum of the sexes because sex was not recorded for some individuals.
†Number in parentheses is median body length.
‡At low tide.
§1♀ with eggs, 24 mm.
¶Field notes indicate that the species was observed, although individuals were not collected.
**Had been present in 1971, but not present in 1972.
††*G. platysoma* undoubtedly is far more abundant than indicated by this datum.

stomatopods was low compared to that in other crustaceans and gastropods (Reaka and Manning, 1987b).

Our field studies show that considerable microhabitat overlap, particularly for individuals of similar body sizes, occurs among the species of coral-dwelling stomatopods of Enewetak (Table 3). *Gonodactylus incipiens* is the most ubiquitous species, and *H. glyptocercus*, *G. smithii*, *G. platysoma*, *G. micronesica*, and *G. insularis*, respectively, occupy increasingly restricted habitats (number of sites and habitat type). Of the 10 sites sampled comprehensively in 1972, the most common co-occurring species assemblage includes *G. incipiens*, *G. smithii*, *G. platysoma*. Although not very common, *G. micronesica* occurs in this assemblage as well. When *G. insularis* is present, it also is a member of the *G. incipiens*, *G. smithii*, *G. platysoma* assemblage. Although *H. glyptocercus* frequents a wide range of habitat types, this species co-occurs most often with *G. incipiens* alone, thus forming a second major species association.

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Chapter 18

Cirripedia of Enewetak Atoll

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INTRODUCTION

Barnacle research at Enewetak Atoll, Marshall Islands, has been incidental to other marine studies. There have been just two published reports. Zullo et al. (1972) reported specimens of *Balanus amphitrite amphitrite* Darwin, 1854, and *Balanus eburneus* Gould, 1841, in the collections of the California Academy of Sciences. Tomlinson (1973) reported the acrothoracican barnacles *Lithoglyptes bicornis* Aurivillius, 1892 (as *Lithoglyptes spinatus* Tomlinson and Newman, 1960), *Lithoglyptes mitis* Tomlinson, 1969, and *Cryptophialus heterodontus* Tomlinson, 1969, from shells in the U. S. National Museum of Natural History's Division of Malacology. Both of the *Balanus* spp. are cosmopolitan in warm and temperate seas; they are commonly transported as fouling organisms and were introduced to Enewetak (W. A. Newman, personal communication). The acrothoracican barnacles reported by Tomlinson (1973) also have relatively wide distributional ranges, but these were established by natural means. However, because acrothoracicans lack planktotrophic larvae, their long-range dispersal mechanisms are not understood.

Nine species of barnacles are known from Enewetak Atoll, four of which are new records supplied by W. A. Newman. In comparing barnacle records from Enewetak Atoll and the other Marshall Islands (Henry, 1957; Tomlinson, 1969, 1973; Zullo et al., 1972; Newman and Tomlinson, 1974; and Grygier, 1981a) to species reported from the Caroline Islands (Hiro, 1937, 1938; Boschma, 1953, 1955; Henry, 1957; Newman, 1960a, 1972; Tomlinson, 1969, 1973; Ross and Newman, 1973; and Newman and Ross, 1976), there is a strong indication that more barnacles should occur at Enewetak Atoll than have been reported. The proximity of the Caroline Islands to the Marshall Islands suggests that many of the Caroline Island species, or closely related ones, may occur in the Marshall Islands and at Enewetak Atoll. However, it will take a directed effort to collect and identify the barnacle species, rather than the incidental collecting that has occurred previously, because tropical barnacles tend to be cryptic and sparsely distributed as compared to temperate forms (Newman, 1960b).

Because so few of the species that may occur at Enewetak Atoll have been reported, the included checklist (Table 1) also lists species that probably occur at Enewetak Atoll.

TABLE 1

Checklist of Shallow-Water Cirripedia Found, or Likely to Be Found, in the Waters Surrounding Enewetak Atoll*

Subphylum CRUSTACEA
  Class MAXILLOPODA
    Subclass CIRRIPEDIA
      Order ASCOTHORACICA
        Suborder SYNAGOGOIDIDA
          Family SYNAGOGIDAE
            †*Gorgonolaureus bikiniensis* Utinomi, 1962.
      Order THORACICA
        Suborder LEPADOMORPHA
          Family HETERALEPADIDAE
            †*Heteralepas hataii* Hiro, 1937.
            †*Heteralepas* spp.
            †*Paralepas palinuri* (Barnard, 1924).

*Systematic hierarchy taken from Bowman and Abele (1982).
†Species likely to be found at Enewetak Atoll.

(This table continued on next page.)

TABLE 1 (cont'd)

      - Family IBLIDAE
        - †*Ibla cumingi sibogae* Hoek, 1907.
      - Family LEPADIDAE
        - †*Conchoderma auritum* (Linnaeus, 1767).
        - †*Conchoderma virgatum* (Spengler, 1790).
        - ‡*Lepas anatifera* Linnaeus, 1758.
        - †*Lepas anatifera striata* de Graaf, 1952.
        - †*Lepas anserifera anserifera* Linnaeus, 1767.
        - †*Lepas hilli* (Leach, 1818).
      - Family MICROLEPADIDAE
        - †*Microlepas* spp.
      - Family POECILASMATIDAE
        - †*Octolasmis lowei* (Darwin, 1851).
        - †*Trilasmis fissum* (Darwin, 1851).
      - Family SCALPELLIDAE
        - †*Lithotrya nicobarica* Reinhardt, 1850.
  - Suborder BALANOMORPHA
    - Superfamily CHTHAMALOIDEA
      - Family CHTHAMALIDAE
        - Subfamily EURAPHIINAE
          - †*Euraphia hembeli* Conrad, 1837.
          - ‡*Euraphia intertexta* (Darwin, 1854).
    - Superfamily CORONULOIDEA
      - Family CORONULIDAE
        - Subfamily CHELONIBIINAE
          - †*Chelonibia caretta* (Spengler, 1790).
          - †*Chelonibia testudinaria* (Linnaeus, 1758).
        - Subfamily CORONULINAE
          - †*Coronula diadema* (Linnaeus, 1767).
        - Subfamily PLATYLEPADINAE
          - †*Platylepas decorata* Darwin, 1854.
          - †*Platylepas hexastylos* (Fabricius, 1798).
      - Family TETRACLITIDAE
        - Subfamily TETRACLITELLINAE
          - †*Tetraclitella divisa* (Nilsson-Cantell, 1921).
        - Subfamily TETRACLITINAE
          - ‡*Tesseropora pacifica* (Pilsbry, 1928).
    - Superfamily BALANOIDEA
      - Family ARCHAEOBALANIDAE
        - Subfamily ARCHAEOBALANINAE
          - †*Acasta* spp.
      - Family BALANIDAE
        - *Balanus amphitrite amphitrite* Darwin, 1854: Zullo et al., 1972.
        - *Balanus eburneus* Gould, 1841: Zullo et al., 1972.
        - †*Balanus trigonus* Darwin, 1854.
        - †*Megabalanus tintinnabulum* (Linnaeus, 1758).
      - Family PYRGOMATIDAE
        - Subfamily PYRGOMATINAE
          - †*Cantellius* spp.
          - †*Hiroa stubbingsi* Ross and Newman, 1973.
          - †*Nobia* spp.
          - ‡*Savignium crenatum* (Sowerby, 1823).
          - †*Savignium dentatum* (Darwin, 1854).
          - †*Savignium elongatum* (Hiro, 1931).
          - †*Savignium milleporum* (Darwin, 1854).
- Order ACROTHORACICA
  - Suborder PYGOPHORA
      - Family CRYPTOPHIALIDAE
        - †*Cryptophialus cordylacis* Tomlinson, 1969.
        - *Crytophialus heterodontus* Tomlinson, 1969; Tomlinson, 1973.
        - †*Cryptophialus rossi* Tomlinson, 1973.

†Species likely to be found at Enewetak Atoll.
‡New Enewetak Atoll records.

(This table continued on next page.)

TABLE 1 (cont'd)

Family LITHOGLYPTIDAE
- †*Balanodytes taiwanus* Utinomi, 1950.
- †*Kochlorine ulula* Tomlinson, 1973.
- †*Lithoglyptes bicornis* Aurivillius, 1892.
  - *Lithoglyptes spinatus* Tomlinson and Newman, 1960; Tomlinson, 1973.
  - *Lithoglyptes mitis* Tomlinson, 1969: Tomlinson, 1973.
- †*Lithoglyptes wilsoni* Tomlinson, 1969.
- †*Weltneria reticulata* Tomlinson, 1969.

Order RHIZOCEPHALA

Suborder KENTROGONIDA

Family SACCULINIDAE
- †*Sacculina actaeae* Guerin-Ganivet, 1911.
- †*Sacculina bipunctata* Kossmann, 1872.
- †*Sacculina carpiliae* Guerin-Ganivet, 1911.
- †*Sacculina inconstans* Boschma, 1952.
- †*Sacculina punctata* Boschma, 1934.
- ‡Sacculinid sp.

*Systematic hierarchy taken from Bowman and Abele (1982).
†Species likely to be found at Enewetak Atoll.
‡New Enewetak Atoll records.

ASCOTHORACICA

Ascothoracicans generally have been considered the most primitive barnacles, but there is argument to separate them as a subclass coordinate with the Cirripedia (Grygier, 1983). The bases for the argument are that the Ascothoracica have nauplii that lack "frontolateral horns; a relatively anamorphic rather than highly metamorphic development; an ascothoracid larva capable of feeding at all stages rather than a single cyprid stage lacking a complete gut and functional mouthparts; wholly prehensile first antennae rather than ones also provided with cement glands; and natatory thoracic limbs that show no indication of ever having been used as cirri. Furthermore, it has recently been shown that the ascothoracican sperm, the most generalized known for the Crustacea, is distinct from that of the remainder of the cirripeds" (Newman, 1982). Though the evidence is strong for the separation of the Ascothoracica from the Cirripedia, no consensus exists. It is included herein for this reason and because only one species has been reported from the Marshall Islands (Utinomi, 1962).

Ascothoracicans are ecto- and endoparasites of various anthozoans and echinoderms. Often highly modified for a parasitic existence, they show little resemblance to the "typical" thoracic barnacle. They lack calcareous plates, do not cement themselves to the substratum, and retain more characteristics of the free-living ancestors of the cirripeds than any other group of crustaceans.

Gorgonolaureus bikiniensis Utinomi, 1962, is the single ascothoracican reported from the Marshall Islands. Described as a new genus and species, it is known only from Bikini Atoll and is reported to be a parasite on the gorgonacean *Paracis squamata*. This shallow-water gorgonian has not been reported from Enewetak Atoll (Lang and Devaney, this volume). The only other described congeneric species is *Gorgonolaureus muzikae* Grygier, 1981, reported from deep water in Hawaii (Grygier, 1981b).

THORACICA

Thoracicans include the typical barnacles usually recognized by their form and the presence of calcareous plates. There are both free-living and symbiotic taxa, and they can be divided morphologically into pedunculate and sessile forms. The pedunculate barnacles (Lepadomorpha) are composed of a peduncle that attaches to the substratum and a capitulum that is usually surrounded by calcareous plates. The sessile barnacles (Verrucomorpha and Balanomorpha) lack the peduncle, and the aperture is guarded by an operculum formed by one or two pairs of calcareous plates.

Many thoracic barnacles have wide distributional ranges. This is due in part to the majority having planktonic larval stages (Newman and Tomlinson, 1974) and some, such as several oceanic lepadomorph species, naturally attaching to floating debris. In addition, some of the natural distributions have been greatly extended because certain species tend to "foul" ship bottoms and floating objects and can be carried great distances.

Six of the nine barnacle species reported from Enewetak Atoll are thoracicans. This high percentage is not unusual because thoracicans are generally larger than species in the other barnacle orders and have a more obvious "barnacle" appearance, thus making them more recognizable and liable to be collected. The other three species, belonging to the Acrothoracica, are small, burrow in calcium carbonate, and do not have the typical barnacle appearance. They were found because Tomlinson (1973) intentionally looked for their burrows in mollusk shells.

ACROTHORACICA

Acrothoracicans are small, nonparasitic naked barnacles that burrow primarily in calcareous substrata. These substrata include live coral, coral rock, and mollusk shells. Sexes are separate, and the burrows are created by the females. The dwarf males are short-lived, non-feeding organisms (Tomlinson, 1969) that are usually found near the attachment disc of the female.

Newman and Tomlinson (1974) presented an interesting question on the dispersal mechanisms of acrothoracican barnacles. The adults are poor dispersers because they are obligate inhabitants of calcium carbonate. Therefore, it is difficult to explain the distribution of species such as *Lithoglyptes bicornis* Aurivillius, 1892, which is found in the Caribbean Sea, the Red Sea, Australia, Japan, the Marshall Islands, and the Line Islands. The difficulty arises because the naupliar dispersal stages are usually passed in the egg, and the cyprids are non-feeding and weak swimmers (Newman and Tomlinson, 1974).

A single paper has been published reporting on acrothoracicans from Enewetak Atoll (Tomlinson, 1973). Not collected as barnacle material, the specimens were discovered in shells of the turbinid snail *Turbo argyrostomus* Linnaeus, 1758, housed at the U. S. National Museum of Natural History's Division of Malacology.

The three species of acrothoracican barnacles reported from Enewetak Atoll have relatively wide distributions considering their presumed limited powers of dispersal. *Cryptophialus heterodontus* Tomlinson, 1969, has a western Pacific distribution and is known from Australia, the Marshall Islands (Tomlinson, 1969), and Okinawa (Tomlinson, 1973). *Lithoglyptes mitis* Tomlinson, 1969, appears to have an insular distribution, having been collected at Fiji (Tomlinson, 1969), the Loyalty Islands, the Marshall Islands, New Caledonia, Ninafou Island (?Niuafou), and Samoa (Tomlinson, 1973). As mentioned, *Lithoglyptes bicornis* Aurivillius, 1892, has an unusually wide distribution for an acrothoracican barnacle. Over part of its range it is known by its synonyms *Lithoglyptes spinatus* Tomlinson and Newman, 1960, and *Lithoglyptes ampulla* Aurivillius, 1892 (Newman and Tomlinson, 1974).

Only a few species of acrothoracicans have been reported from the Marshall, Caroline, and Gilbert Islands (Tomlinson, 1969, 1973) that have not also been found at Enewetak Atoll. Due to the cryptic habitat of burrowing barnacles and the fact that they are seldom looked for, it is probable that these and/or other acrothoracicans occur at Enewetak Atoll.

RHIZOCEPHALA

Rhizocephalans are endoparasites of crustaceans, primarily decapods. The adults are highly modified and bear no resemblance to other cirripeds. However, they are classified with barnacles because their naupliar larvae have the characteristic frontolateral horns, and there is a typical cyprid larval stage.

There are no published accounts of rhizocephalans from Enewetak Atoll or the Marshall Islands. The only record is of a sacculinid found on a male specimen of *Galathea affinis* Ortmann, 1892, collected at Sta. No. JWK-412, Engebi Island, Enewetak Atoll, found on an *Acropora* sp. (Haig, personal communication). Apparently, no other rhizocephalans were found on the decapods collected at Enewetak Atoll (J. S. Garth and A. J. Bruce, personal communication). However, *Sacculina punctata* Boschma, 1934, and *Sacculina bipunctata* Kossmann, 1872, have been reported from the Caroline Islands. *Sacculina carpiliae* Guerin-Ganivet, 1911, *Sacculina inconstans* Boschma, 1952, and possibly *Sacculina actaeae* Guerin-Ganivet, 1911, have been reported from the Gilbert Islands (Boschma, 1953, 1955); and an undescribed species of *Lernaeodiscus* has been reported from Hawaii (Edmondson, 1946; Boschma, 1953). Although present records indicate that infection by rhizocephalans at Enewetak Atoll is of low incidence, some undoubtedly occurs. In general, little work has been done on rhizocephalans in recent years, probably because of the histological work necessary for taxonomic identification.

DISCUSSION

The most noticeable aspect of barnacle research at Enewetak Atoll, and the Marshall Islands in general, is the paucity of work that has been done. The more obvious noncommensal forms have been collected and identified, along with a few of the more cryptic species. However, in comparison to the Caroline Islands, the smaller commensal, burrowing, and parasitic forms have been largely missed. This is characteristic of studies in which barnacle research is incidental to other work being carried out.

Because the cirriped fauna of Enewetak Atoll is so poorly known, little can be said of its biogeography. Its fauna, however, is Indo-West Pacific in origin, with some elements of the circumtropical-temperate fauna. Enewetak Atoll is composed of low islands and is located on the Pacific Plate. For these reasons the fauna can be expected to be less diverse than at high islands, such as the Carolines, or islands such as Palau and the Philippines that are not on the Pacific Plate (Springer, 1982; W. A. Newman, personal communication). While some patchiness is to be expected, the low islands of the Marshalls would be expected to have few, if any, of Springer's (1982) Type 2 or 3 endemics. However, some care must be taken in interpreting barnacle endemicity and distributional ranges. Several of the taxa are so poorly known that distributional records often indicate where a certain amount of work has been done, not where the natural limits to distribution occur.

Many of the species reported from the Caroline Islands could occur at Enewetak Atoll. Most have reasonably wide western Pacific distributional ranges, and the proximity of the island groups makes this feasible. In addition, Springer (1982) suggests that the Caroline Islands may act as a conduit onto the Pacific Plate from the western Pacific. The species most likely to occur at Enewetak Atoll are the barnacle commensals of wide-ranging nectonic organisms such as marine mammals and reptiles. These commensals include *Conchoderma auritum* (Linnaeus, 1767), *Conchoderma virgatum* (Spengler, 1790), *Lepas hilli* (Leach, 1818), *Chelonibia caretta* (Spengler, 1790), *Coronula diadema* (Linnaeus, 1767), and *Platylepas hexastylos* (Fabricius, 1798). Another group, which is undoubtedly better represented at Enewetak Atoll than records indicate, includes the coral-inhabiting species in the balanid subfamily Pyrgomatinae.

Our knowledge of barnacles from Enewetak Atoll can be summarized as incomplete taxonomically. However, zoogeographically Enewetak Atoll is representative of the Indo-West Pacific faunal region with a close relationship to the western Pacific. A small but obvious component of the fauna is the cosmopolitan fouling community, which includes many of the familiar thoracic barnacles that are often so abundant in shallow water. The majority of species, however, display a more restricted distribution.

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Chapter 19

Nonplanktonic Copepoda of Enewetak Atoll

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The copepod fauna of Enewetak is based on studies carried out on symbiotic (commensal and parasitic) species as well as those found as part of the plankton community (Chapter 20, this volume). A checklist of copepod fauna is found in Table 1.

Copepods associated with marine invertebrates at Enewetak have been recorded since 1970 mainly through the efforts of A. J. Humes. Twenty-five of these copepods, their hosts, and references are given in Table 2. These include two harpactacoid, 19 poecilostomatoid (as cyclopoid), and four siphonostomatoid (as cyclopoid) forms. As a result of these publications, one new genus and 14 new species were reported from Enewetak; additional species remain to be described (Humes, personal communication).

Parasitic copepods from fishes include two poecilostomatoid (as cyclopoid) and 20 siphonostomatoid (as caligoid) species, three of which were new to science (Lewis, 1964; 1968). These copepods and their fish hosts

TABLE 1

Checklist of Nonplanktonic Copepoda of Enewetak Atoll

*Subclass COPEPODA
- Order HARPACTICOIDA
  - Family CANUELLIDAE
    - *Sunaristes dardani* Humes and Ho, 1969: Humes, 1971b.
  - Family TEGASTIDAE
    - *Tesgastes acroporanus* Humes, 1981: Humes, 1981.
- Order POECILOSTOMATOIDA
  - Family BOMOLOCHIDAE
    - *Nothobomolochus gibber* (Shiino, 1957): Lewis, 1968.
    - *Pseudotaeniacanthus* sp.: Lewis, 1968.
  - Family LICHOMOLGIDAE
    - *Acanthomolgus fissisetiger* (Humes and Ho, 1968): Humes 1973b.
    - *Anisomolgus insolens* (Humes and Ho, 1968): Humes, 1973b.
    - *Lichomolgus tridacnae* Humes, 1972: Humes, 1972b.
    - *Metaxymolgus aculeatus* (Humes and Ho, 1968): Humes, 1973b.
    - *Octopicola regalis* Humes, 1974: Humes, 1974.
    - *Paradoridicola adelphus* (Humes and Ho, 1968): Humes 1973b.
    - *Paramolgus eniwetokensis* Humes, 1973: Humes, 1973b.
    - *Paramolgus ostentus* Humes, 1973: Humes, 1973b.
    - *Schedomolgus lobophorus* Humes and Ho, 1968: Humes and Stock, 1973.
    - *Synstellicola acanthasteris* (Humes, 1970).
      - *Stellicola acanthasteris* Humes, 1970: Humes, 1970a. Synonomy based on Humes (1976).
  - Family MYICOLIDAE
    - *Anthessius alatus* Humes and Stock, 1965: Humes, 1972b.
    - *Anthessius amicalis* Humes and Stock, 1965: Humes, 1972b.
    - *Anthessius solidus* Humes and Stock, 1965: Humes, 1972b.
  - Family PSEUDANTHESSIDAE
    - *Pseudanthessius comanthi* Humes, 1972: Humes, 1972a.
    - *Senariellus tensus* Humes, 1977: Humes, 1977.
  - Family SABELLIPHILIDAE
    - *Scambicornus idoneus* (Humes and Cressey, 1961): Humes, 1980.
  - Family TAENIACANTHIDAE
    - *Clavisodalis heterocentroti* Humes, 1970: Humes, 1970b.
  - Family XARIFIDAE
    - *Xarifia breviramea* Humes and Dojiri, 1982: Humes and Dojiri, 1982.
    - *Xarifia sabiuraensis* Misaki, 1978: Humes and Dojiri, 1982.
- Order SIPHONOSTOMATOIDA
  - Family CALIGIDAE
    - *Anuretes serratus* Shiino, 1954: Lewis, 1968.
    - *Caligus alaihi* Lewis, 1968: Lewis, 1968.
    - *Caligus asymmetricus* Kabata, 1965: Lewis, 1968.
    - *Caligus bonito* Wilson, 1905: Lewis, 1968.
    - *Caligus*(?) *confusus* Pillai, 1961: Lewis, 1968.

*The higher classification used herein (to Family level) follows Bowman and Abele (1982).

(This table continued on next page.)

TABLE 1 (cont'd)

Family CALIGIDAE (cont'd)
Caligus coryphaenae Steenstrup and Lutken, 1861: Lewis, 1968.
Caligus kapuhili Lewis, 1967: Lewis, 1968.
Caligus laticaudus Shiino, 1960: Lewis, 1968.
Caligus ligatus Lewis, 1964: Lewis, 1968.
Caligus productus Dana, 1853: Lewis, 1968.
Caligus pseudokalumai Lewis, 1968: Lewis, 1968.
Dentigryps litus Lewis, 1964: Lewis, 1964; 1968.
Lepeophtheirus dissimulatus Wilson, 1905; Lewis, 1968.
Lepeophtheirus(?) *plectropomi* Nunes-Ruivo and Fourmanoir, 1956: Lewis, 1968.
Pseudanuretes pomacanthi Lewis, 1968: Lewis, 1968.
Pseudocaligus similis Lewis, 1968: Lewis, 1968.

Family DISSONIDAE
Dissonus heronensis Kabata, 1966: Lewis, 1968.
Dissonus similis Kabata, 1966: Lewis, 1968.
Family EURYPHORIDAE
Alebion gracilis Wilson, 1905: Lewis, 1968.
Family NANASPIDIDAE
Nanaspis manca Humes, 1973: Humes, 1973a; 1980.
Nanaspis pusilla Humes, 1973: Humes, 1973a; 1980.
Nanaspis spinifera Humes, 1973: Humes, 1973a; 1980.
Family PANDARIDAE
Pandarus cranchii Leach, 1819: Lewis, 1968.
Family STELLICOMITIDAE
Astroxynus culcitae Humes, 1971: Humes, 1971a.

TABLE 2

Invertebrate Host and Symbiotic Copepoda Recorded from Enewetak Atoll

Hosts	Copepod symbionts	References
	CNIDARIA	
Octocorallia (Soft corals)		
Alcyonacea		
Lobophytum pauciflorum	*Anisomolgus insolens*	Humes (1973b)
Lobophytum pauciflorum	*Paradoridicola adelphus*	Humes (1973b)
Lobophytum pauciflorum	*Paramolgus eniwetokensis*	Humes (1973b)
Lobophytum pauciflorum	*Paramolgus ostentus*	Humes (1973b)
Nephthea chabrolii	*Metaxymolgus aculeatus*	Humes (1973b)
Stolonifera		
Pachyclavularia violacea	*Acanthomolgus fissisetiger*	Humes (1973b)
Zoantharia		
Scleractinia (Stony corals)		
Acropora florida	*Schedomolgus lobophorus*	Humes and Stock (1973)
Acropora florida	*Tegastes acroporanus*	Humes (1981)
Acropora florida	*Xarifia breviramea*	Humes and Dojiri (1982)
Acropora florida	*Xarifia sabiuraensis*	Humes and Dojiri (1982)
	ARTHROPODA	
Crustacea		
Coenobitoidea (Hermit crabs)		
Dardanus guttatus	*Sunaristes dardani*	Humes (1971b)
Dardanus lagopodes	*Sunaristes dardani*	Humes (1971b)
Dardanus megistos	*Sunaristes dardani*	Humes (1971b)
Dardanus scutellatus	*Sunaristes dardani*	Humes (1971b)
	MOLLUSCA	
Bivalvia (Tridacnid clams)		
Hippopus hippopus	*Anthessius alatus*	Humes (1972b)
Hippopus hippopus	*Anthessius amicalis*	Humes (1972b)
Tridacna gigas	*Anthessius alatus*	Humes (1972b)
Tridacna gigas	*Lichomolgus tridacnae*	Humes (1972b)
Tridacna maxima	*Anthessius alatus*	Humes (1972b)
Tridacna squamosa	*Anthessius alatus*	Humes (1972b)
Tridacna squamosa	*Anthessius amicalis*	Humes (1972b)
Tridacna squamosa	*Anthessius solidus*	Humes (1972b)
Tridacna squamosa	*Lichomolgus tridacnae*	Humes (1972b)
Cephalopoda		
Octopus cyaneus	*Octopicola regalis*	Humes (1974)

(This table continued on next page.)

TABLE 2 (cont'd)

Hosts	Copepod symbionts	References
ECHINODERMATA		
Asteroidea (Sea stars)		
Acanthaster planci	*Synstellicola acanthasteris*	Humes (1970a)
Culcita novaeguineae	*Astroxynus culcitae*	Humes (1971a)
Crinoidea (Feather stars)		
Comanthus bennetti	*Pseuanthessius comanthi*	Humes (1972a)
Echinoidea (Sea urchins)		
Heterocentrotus trigonarius	*Clavisodalis heterocentroti*	Humes 1970b)
Echinothrix calamaris	*Senariellus tensus*	Humes (1977)
Holothuroidea (Sea cucumbers)		
Thelenota ananas	*Nanaspis manca*	Humes (1973a; 1980)
Thelenota ananas	*Nanaspis pusilla*	Humes (1973a; 1980)
Thelenota ananas	*Nanaspis spinifera*	Humes (1973a; 1980)
Holothuria atra	*Scambicornus idoneus*	Humes (1980)

are given in Table 3. Cressey and Cressey (1979) also reported three new species of parasitic copepods on synodontid lizard fishes from Bikini Atoll, northwest of Enewetak.

While no free-living nonplanktonic copepods have been reported from Enewetak, nearly 60 species were recorded from Ifaluk Atoll in the Caroline Islands (Vervoort, 1964). Many of these and others are likely to occur at Enewetak.

TABLE 3

Parasitic Copepods on Fish at Enewetak Atoll

Hosts	Parasitic copepod	References
CHORDATA		
*Pisces		
Elasmobranchii (Sharks)		
Carcharhinidae		
Carcharhinus amblyrhynchos (C. menisorrah)	*Alebion gracilis*	Lewis (1968)
Galeocerdo cuvier (C. cuvieri)	*Pandarus cranchii*	Lewis (1968)
Osteichthyes (Bony fishes)		
Belonidae		
Platybelone argalus platyura (Belone platyura)	*Nothobomolochus gibber*	Lewis (1968)
Holocentridae		
Neoniphon sammara (Holocentrus sammara)	*Caligus alaihi*	Lewis (1968)
Sargocentron spiniferum (Holocentrus spinifer)	*Caligus ligatus*	Lewis (1968)
Aulostomidae		
Aulostomus chinensis	*Dentigryps litus*	Lewis (1968)
Fistulariidae		
Fistularia commersonii (F. petimba)	*Pseudocaligus similis*	Lewis (1968)
Serranidae		
Epinephelus fuscoguttatus	*Lepeophtheirus plectropomi?*	Lewis (1968)
Epinephelus hoedtii (E. kohleri)	*Lepeophtheirus plectropomi?*	Lewis (1968)
Plectropomus sp. *(P. leopardus)*	*Dentigryps litus*	Lewis (1968)

*Systematic arrangement after Randall and Randall, this volume.

(This table continued on next page.)

TABLE 3 (cont'd)

Hosts	Parasitic copepod	References
Carangidae		
Caranyx melampygus	*Caligus confusus?*	Lewis (1968)
Caranyx melampygus?	*Caligus coryphaenae*	Lewis (1968)
Mullidae		
Parupeneus cyclostomus?	*Lepeophtheirus dissimulatus*	Lewis (1968)
Chaetodontidae		
Chaetodon auriga	*Caligus kapuhili*	Lewis (1968)
Chaetodon lunula	*Caligus kapuhili*	Lewis (1968)
Pomacanthidae		
Pomacanthus imperator	*Pseudanuretes pomacanthi*	Lewis (1968)
Acanthuridae		
Acanthurus nigricauda (*A. gahhm*)	*Pseudotaeniacanthus* sp.	Lewis (1968)
Acanthurus olivaceus	*Caligus laticaudus*	Lewis (1968)
Naso vlamingii	*Anuretes serratus*	Lewis (1968)
Scombridae		
Euthynnus affinis (*E. yaito*)	*Caligus coryphaenae*	Lewis (1968)
Grammatorcynus bilineatus	*Caligus asymmetricus*	Lewis (1968)
	Caligus coryphaenae	Lewis (1968)
Gymnosarda unicolor (*G. nuda*)	*Caligus pseudokalumai*	Cressey and Cressey (1980); Lewis (1968)
Katsuwonus pelamis	*Caligus coryphaenae*	Lewis (1968)
†*Sarda orientalis*	*Caligus asymmetricus*	Lewis (1968)
†*Sarda orientalis*	*Caligus bonito*	Lewis (1968)
†*Sarda orientalis*	*Caligus croyphaenae*	Lewis (1968)
†*Sarda orientalis*	*Caligus productus*	Lewis (1968)
Balistidae		
Balistoides viridescens	*Dentigryps litus*	Lewis (1964; 1968)
Balistoides viridescens	*Dissonus heronensis*	Lewis (1968)
Tetraodontidae		
Arothron meleagris	*Dissonus similis*	Lewis (1968)

†Considered misidentification of host (Bruce B. Collette, personal communication).

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Chapter 20

Lagoon Plankton of Enewetak Atoll

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INTRODUCTION

The zooplankton community of atoll lagoons is uniquely different from the zooplankton community in the ocean waters outside the atoll for at least two reasons. First, there is a greater abundance of zooplankton in the lagoon, no doubt reflecting the better food conditions provided by exported reef detritus and phytoplankton production (Gerber and Marshall, 1982). Second, the species composition of the lagoon zooplankton largely consists of species adapted to the restricted shallower conditions found therein. Earlier studies on the zooplankton of atoll lagoons were mostly concerned with determining abundance, either to evaluate their food potential to corals (e.g., Kramer, 1897; Russell, 1934; Motoda, 1938; Odum and Odum, 1955; Johannes et al., 1970; Johannes and Gerber, 1974) or in understanding the water exchange patterns between lagoons and the surrounding sea (e.g., Johnson, 1949, 1954; Gilmartin, 1958; Michel, 1969; Michel et al., 1971; Tranter and George, 1972). In these studies little attempt was made to identify the organisms to species. However, these works are important because they provide a basic understanding of the ecology of zooplankton in lagoon environments. For a more detailed discussion on the ecological role of zooplankton in atoll lagoons see Chapter 10 by Gerber and Marshall, Volume 1.

Studies on the species composition of lagoon zooplankton at Enewetak Lagoon and nearby atolls have for the most part focused on the holoplanktonic organisms, forms that are permanently planktonic all of their lives; these forms are the main attention of this chapter. Because information is lacking on the life history of many of the species mentioned, some meroplanktonic forms—organisms that are temporarily planktonic—are no doubt included in this checklist (Table 1). In the works discussed below, a variety of sampling methods have been used to collect the zooplankton, and each method has its inherent advantages and disadvantages. In a sense it is perhaps fortunate that no one method is best to sample the various types of zooplankton. One important aspect lacking in the data is adequate seasonal samplings to provide information on how species composition and abundance change over time. Whereas most of the lagoon plankton studies were based on samples collected over a few days in one season, the present author has sampled more extensively, during two winter periods and one summer period.

DINOPHYTA

Dinophyceae (Dinoflagellata)

Nineteen species of dinoflagellates were identified from plankton tows taken off the wide passage and/or deep entrance at Enewetak during the summer of 1956 (Hirshfield et al., 1957). Their species list and nomenclature were originally based on Lebour (1925) and Schiller (1937). They have been revised here using Parke and Dixon (1976). More recently, three additional planktonic species were recorded from Enewetak at a mid-lagoon and shallow station during two winters and one summer period (Gerber, 1981).

SARCODINA

Radiolaria

Fifty species (including 18 undetermined) of radiolarians were collected from plankton hauls made during the summer of 1956 (Hirshfield et al., 1957) (Table 1). Gilmartin (1958) and Gerber (1981) have recorded radiolarians in plankton samples from Enewetak Lagoon but have not attempted identification. Radiolarian fragments were recorded in the gut contents of calanoid copepods from Enewetak Lagoon (Gerber and Marshall, 1974). For radiolarian classification see Campbell and Moore (1954).

CILIOPHORA

Tintinnina

Nine species of tintinnids were recorded from plankton hauls taken in the wide passage and/or deep entrance at Enewetak during the summer of 1956 (Hirshfield et al., 1957). Four of the species from Enewetak were considered to be new and are not known to have been described. In February 1976, plankton tows in Enewetak

TABLE 1

Checklist of Plankton of Enewetak Atoll

Phylum DINOPHYTA (DINOFLAGELLATES)
  Class DINOPHYCEAE
    Order DINOPHYSIALES
      Family AMPHISOLENIACEAE
        Amphisolenia spp.: Hirshfield et al. 1957.
      Family DINOPHYSIACEAE
        Dinophysis rontundatum (Clap et Lach): Hirshfield et al. 1957.
        Dinophysis schuettii (Murray et Whitting): Hirshfield et al. 1957.
        Phalacroma (?) *perradictyum* Stein: Hirshfield et al. 1957.
      Family ORNITHOCERCIACEAE
        Ornithocercus splendidus Murray and Whitting: Hirshfield et al. 1957.
        Ornithocercus sp.
      Family CERATOCORYACEAE
        Ceratocorys horrida Stein: Hirshfield et al. 1957.
    Order PYROCYSTALES
      Family PYROCYSTACEAE
        Pyrocystis fusiformis Thompsen *ex* Murray: Gerber, 1981.
        Pyrocystis pseudonoctiluca Thompsen *ex* Murray: Gerber, 1981.
        Dissodinium lunula (Schutt) Taylor: Gerber, 1981.
    Order PERIDINIALES
      Family PERIDINIACEAE
        Protoperidinium divergens (Ehrenberg) Balach.
          Peridinium divergens (Ehrenberg): Hirshfield et al. 1957.
        Protoperidinium depressum (Bailey) Balach.
          Peridinium depressum (Bailey): Hirshfield et al. 1957.
        Protoperidinium globulum (Stein) Balach.
          Peridinium globulum (Stein): Hirshfield et al. 1957.
        Peridinium oceanicum (Vanhoffen) Balach.
          Peridinium oceanicum (Vanhoffen): Hirshfield et al. 1957.
      Family GONYAULACACEAE
        Gonyaulax birostris (Stein): Hirshfield et al. 1957.
      Family CERATIACEAE
        Ceratium candelabrum (Ehrenberg) Stern: Hirshfield et al. 1957.
        Ceratium furca (Ehrenberg) Clap. et Lachm.: Hirshfield et al. 1957.
        Ceratium gibberum Gourret: Hirshfield et al. 1957.
        Ceratium lineatum (Ehrenberg) Cleve: Hirshfield et al. 1957.
        Ceratium tripos (O. F. Muller) Nitzsch: Hirshfield et al. 1957.
        Ceratium tripos O. F. Muller var. B: Hirshfield et al. 1957.
Phylum SARCODINA
  Class ACTINOPODEA
    Order PORULOSIDA
      Suborder ACANTHARINA
        Acanthometron sp.: Hirshfield et al. (1957).
        Acantholonche sp. *A.*: Hirshfield et al. (1957).
        Acantholonche sp. *B*: Hirshfield et al. (1957).
        Acanthochiasma fusiformis Haeckel: Hirshfield et al. (1957).
        Acanthostaurus purpurascens Haeckel: Hirshfield et al. (1957).
        Aspidomma sp.: Hirshfield et al. (1957).
        Dodecapsis tricinata Haeckel: Hirshfield et al. (1957).
        Dorataspis sp.: Hirshfield et al. (1957).
        Hexalaspis heliodiscus Haeckel: Hirshfield et al. (1957).
        Hexacolpus infundibulum Haeckel: Hirshfield et al. (1957).
        Hexonaspis hastataz Haeckel: Hirshfield et al. (1957).
        Hystrichaspis dorsata Haeckel: Hirshfield et al. (1957).
        Phractaspis sp.: Hirshfield et al. (1957).
        Quadrilonche mesostauras Haeckel: Hirshfield et al. (1957).
        Tessarapelma concretuira Haeckel: Hirshfield et al. (1957).
        Tessarapelma concretuira Haeckel: Hirshfield et al. (1957).
        Zygostaurus sagitalis Haeckel: Hirshfield et al. (1957).
        Zygacantha sp.: Hirshfield et al. (1957).

(This table continued on next page.)

TABLE 1 (cont'd)

Suborder SPUMELLINA
- *Diplosphaera hexagonalis* Haeckel: Hirshfield et al. (1957).
- *Euchitonia lanceolata* Haeckel: Hirshfield et al. (1957).
- *E. muelleri* Haeckel: Hirshfield et al. (1957).
- *Flustrella semispiralis* Haeckel: Hirshfield et al. (1957).
- *Heliodiscus asteriscus* Haeckel: Hirshfield et al. (1957).
- *Hexalonche philosophica* Haeckel: Hirshfield et al. (1957).
- *Hexastylus phaenaxonia* Haeckel: Hirshfield et al. (1957).
- *Hymeniastrum euclidis* Haeckel: Hirshfield et al. (1957).
- *Monozonium alatum* Haeckel: Hirshfield et al. (1957).
- *Ommatospyris virginea* Haeckel: Hirshfield et al. (1957).
- *O. hexagonium* Haeckel: Hirshfield et al. (1957).
- *Panartus pluteus* Haeckel: Hirshfield et al. (1957).
- *Sphaerozoum* sp.: Hirshfield et al. (1957).
- *Spongaster tetras* Ehrenberg: Hirshfield et al. (1957).
- *Spongodiscus velella* Haeckel: Hirshfield et al. (1957).
- *Stylospongia* sp.: Hirshfield et al. (1957).
- *Tetrapyle* sp.: Hirshfield et al. (1957).

Order OSCULOSIDA

Suborder NASSELLINA
- *Adelocyrtis* sp.: Hirshfield et al. (1957).
- *Archiscenium* sp.: Hirshfield et al. (1957).
- *Callimitra agnesae* Haeckel: Hirshfield et al. (1957).
- *Corocalyptra elisabethae* Haeckel: Hirshfield et al. (1957).
- *Dictyocephalus* sp.: Hirshfield et al. (1957).
- *Dictyoceras* sp.: Hirshfield et al. (1957).
- *Eucyrtidium hexagonatum* Haeckel: Hirshfield et al. (1957).
- *Eucyrtidium* sp.: Hirshfield et al. (1957).
- *Lychnocanium pyriforme* Haeckel: Hirshfield et al. (1957).
- *Monostephus* sp.: Hirshfield et al. (1957).
- *Pterocanium tricolpum* Haeckel: Hirshfield et al. (1957).
- *Pterocorys campanula* Haeckel: Hirshfield et al. (1957).
- *Semantis* sp.: Hirshfield et al. (1957).
- *Theocorys* sp.: Hirshfield et al. (1957).
- *Tricylidium dictyospyris* Haeckel: Hirshfield et al. (1957).
- *Zygostephanium* sp.: Hirshfield et al. (1957).

Phylum CILIOPHORA

Class POLYHYMENOPHORA

Order OLIGOTRICHIDA

Suborder TINTINNINA

Family CODONELLIDAE
- *Tintinnopsis* sp.: Hirshfield et al. 1957.
- *Codonella cuspidata* Kofoid and Campbell: Gold and Morales (1977).
- *Codonaria oceanica (Brandt)* Kofoid and Campbell: Gold and Morales (1977).

Family CODONELLOPSIDAE
- *Codonellopsis americana* Kofoid and Campbell: Gold and Morales (1977).

Family CYTTAROCYCLIDAE
- *Farella azorica* (Cleve) Jorgensen: Hirshfield et al. 1957.

Family PTYCHOCYLIDAE
- *Epiplocyclis* sp.: Hirshfield et al. 1957.
- *Poroecus apicatus* Kofoid and Campbell: Gold and Morales (1977).
- *Poroecus apiculatus* (Cleve) Cleve: Gold and Morales (1977).
- *Poroecus curtus* Kofoid and Campbell: Gold and Morales (1977).

Family EPIPLOCYLIDAE
- *Epiplocylis labiosa* Kofoid and Campbell: Gold and Morales (1977).
- *Epiplocylis pacifica* Kofoid and Campbell: Gold and Morales (1977).

Family PETALOTRICHIDAE
- *Craterella torulata* Jorgensen: Gold and Morales (1977).
- *Petalotricha major* Jorgensen: Gold and Morales (1977).

Family RHABDONELLIDAE
- *Protorhabdonella simplex* (Cleve) Jorgensen: Gold and Morales (1977).
- *Protorhabdonella striatura* Kofoid and Campbell: Gold and Morales (1977).

(This table continued on next page.)

TABLE 1 (cont'd)

Family RHABDONELLIDAE (cont'd)
- *Rhabdonella amor* (Cleve) Brandt: Gold and Morales (1977).
- *Rhabdonella elegens* (Jorgensen) Kofoid and Campbell: Gold and Morales (1977).
- *Rhabdonella inflata* Kofoid and Campbell: Hirshfield et al. (1957).
- *Rhabdonella poculum* (Ostenfeld and Schmidt): Hirshfield et al. (1957).
- *Rhabdonellopsis apophysata* Cleve: Gold and Morales (1977).

Family XYSTONELLIDAE
- *Xystonella* sp.: Hirshfield et al. (1957).

Family UNDELLIDAE
- *Undella hemispherica* Laachmann: Gold and Morales (1977).
- *Proplectella biorbiculata* Hada: Gold and Morales (1977).
- *Proplectella perpusilla* Kofoid and Campbell: Gold and Morales (1977).

Family DICTYOCYSTIDAE
- *Dictyocysta occidentalis* Kofoid and Campbell: Gold and Morales (1977).

Family TINTINNIDAE
- *Amphorella brandti* Jorgensen: Gold and Morales (1977).
- *Canthariella brevis* Kofoid and Campbell: Hirshfield et al. (1957).
- *Dadayiella* (?) *ganymedes* Entz, Sr.: Hirshfield et al. (1957).
- *Steenstrupiella gracilis* (Jorgensen) Kofoid and Campbell: Gold and Morales (1977).
- *Steenstrupiella steenstrupii* (Claparede and Lachmann) Kofoid and Campbell: Gold and Morales (1977).
- *Tintinnus fraknoii* Daday: Gold and Morales (1977).
- *Tintinnus lususundae* var *tenuis* (Kofoid and Campbell) Hada: Gold and Morales (1977).
- *Tintinnus lususundae* var *turgescens*: Gold and Morales (1977).
- *Tintinnus* sp.: Hirshfield et al. (1957).

Phylum CNIDARIA
- Class HYDROZOA
  - Order SIPHONOPHORA
    - Suborder CALYCOPHORA
      - Family DIPHYIDAE
        - **Abylopsis eschscholtzii* Huxley: Sears, 1950.
        - *Abylopsis tetragona* Otto: Sears, 1950; Gerber, 1981.
        - **Agalma okeni* Eschscholtz: Sears, 1950.
        - *Bassia bassensis* Quoy and Gaimard: Sears, 1950; Gerber, 1981.
        - *Chelophyces contorta* Lens and Van Riemsdijk: Sears, 1950; Gerber, 1981; Alvariño (personal communication).
        - *Diphyes chamissonis* Huxley: Sears, 1950; Gerber, 1981.
        - *Diphyes dispar* Chamiso and Eysenhardt: Sears, 1950; Gerber, 1981.
        - **Lensia conoidea* Keferstein and Ehlers: Sears, 1950.
        - *Lensia subtillis* Chum: Gerber, 1981.
        - *Lensia subtiloides* Lens and Van Riemsdijk: Gerber, 1981.
    - Suborder PHYSOPHORIDA
      - Family PHYSALIIDAE
        - †*Physalia utriculus* (Gmelin, 1790)
  - Order HYDROIDA
    - Suborder LEPTOMEDUSAE (CALYPTOBLATINA)
      - Family AEQUOREIDAE
        - †*Aequorea* sp.
    - Suborder CHONDROPHORA
      - Family VELELLIDAE
        - †*Velella* sp.
      - Family PORPITIDAE
        - †*Porpita pacifica* Lesson, 1826.
- Class SCYPHOZOA
  - Order SEMAEOSTOMAE
    - Family ULMARIDAE
      - †*Aurelia* sp. of *A. labiata* Chamisso and Eysenhardi, 1820.
    - Family PELAGIDAE
      - †*Pelagia noctiluca* (Forsskål, 1775)

* Only recorded outside lagoon but in the immediate vicinity of Enewetak Atoll.
† These were identified in the ocean waters neighboring Bikini Atoll (Chiba et al., 1955).

(This table continued on next page.)

TABLE 1 (cont'd)

Order RHIZOSTOMAE
Suborder KOLPOPHORAE
Family MASTIGIIDAE
†*Mastigias ocellatus* (Modeer, 1791).
Family THYSANOSTOMATIDAE
Thysanostoma flagellatum (Haeckel): Arneson, 1980.
Phylum CTENOPHORA
Class TENTACULATA
Order LOBATA
Family MNEMIIDAE
Mnemiopais sp.: Gilmartin, 1958; Gerber, 1981.
Phylum MOLLUSCA
Class GASTROPODA
Order THECOSOMATA (PTEROPODA)
Family CAVOLINIDAE
Creseis acicula Rang: Gerber, 1981.
Creseis virgula Rang: Gilmartin, 1958.
Creseis sp.: Johnson, 1954.
Family LIMACINIDAE
Limacina sp.: Gerber, 1981.
Order MESOGASTROPODA (HETEROPODA)
Family ATLANTIDAE
Atlanta sp.: Gilmartin, 1958.
Phylum ARTHROPODA
Class CRUSTACEA
Subclass COPEPODA
Order CALANOIDA
Family CALANIDAE
Mesocalanus tenuicornis Dana: Mahnken, 1966; Gerber, 1981.
Calanus minor (Claus): Mahnken, 1966; Barnett, 1967; Gerber, 1981.
Canthocalanus pauper (Giesbrecht): Johnson, 1954; Barnett, 1967; Gerber, 1981.
Neocalanus gracilis (Dana): Gilmartin, 1958; Barnett, 1967.
Undinula vulgaris (Dana): Johnson, 1954; Gilmartin, 1958; Mahnken; 1966, Barnett, 1967; Hobson and Chess, 1978; Gerber, 1981.
Cosmocalanus darwini (Lubbock): Johnson, 1954; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
Family EUCALANIDAE
Eucalanus attenuatus (Dana): Johnson, 1954; Gerber, 1981.
Eucalanus monochus Giesbrecht: Gerber, 1981.
Mecynocera clausi Thomson: Barnett, 1967; Gerber, 1981.
Rhincalanus sp. Dana: Mahnken, 1966.
Family PARACALANIDAE
Paracalanus parvus (Claus): Barnett, 1967.
Acrocalanus gibber Giesbrecht: Gilmartin, 1958; Barnett, 1967; Gerber, 1981.
Acrocalanus gracilis Giesbrecht: Mahnken, 1966; Barnett, 1967; Gerber, 1981.
Acrocalanus longicornis Giesbrecht: Barnett, 1967; Gerber, 1981.
Acrocalanus monachus Giesbrecht: Mahnken, 1966; Barnett, 1967; Gerber, 1981.
Calocalanus pavo (Dana): Johnson, 1954; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
Calocalanus pavoninus Farran: Gerber, 1981.
Calocalanus plumulosus (Claus): Barnett, 1967; Gerber, 1981.
Calocalanus styliremus Giesbrecht: Barnett, 1967; Gerber, 1981.
Family CLAUSOCALANIDAE
Clausocalanus arcuicornis (Dana): Mahnken, 1966; Barnett, 1967; Gerber, 1981.
Clausocalanus farrani Sewell: Gerber, 1981.
Clausocalanus furcatus (Brady): Mahnken, 1966; Gerber, 1981.
Clausocalanus pergens Farran: Johnson, 1954; Barnett, 1967; Gerber, 1981.
Family EUCHAETIDAE
Euchaeta rimana (Bradford): Gerber, 1981.
Euchaeta marina (Prestandrea): Gilmartin, 1958; Mahnken, 1966; Hobson and Chess, 1978.

† These were identified in the ocean waters neighboring Bikini Atoll (Chiba et al., 1955).

(This table continued on next page.)

TABLE 1 (cont'd)

Family SCOLECITRICHIDAE
- *Scolecithricella dentate* (Giesbrecht): Barnett, 1967; Gerber, 1981.
- *Scolecithricella marginata* (Giesbrecht): Mahnken, 1966; Barnett, 1967.
- *Scolecithricella tenuisserata* (Giesbrecht): Barnett, 1967.
- *Scolecithrix danae* (Lubbock): Johnson, 1954; Gilmartin, 1958; Mahnken, 1966; Gerber, 1981.

Family TEMORIDAE
- *Temora discaudata* Giesbrecht: Mahnken, 1966; Gerber, 1981.

Family PSEUDODIAPTOMIDAE
- *Pseudodiaptomus cornutus* Nicholl: Barnett, 1967.

Family METRIDIIDAE
- *Metridia* sp. Boeck: Hobson and Chess, 1978.
- *Pleuromamma abdominalis* (Lubbock): Barnett, 1967.
- *Pleuromamma gracilis* (Claus): Barnett, 1967; Gerber, 1981.
- *Pleuromamma xiphias* (Giesbrecht): Hobson and Chess, 1978.

Family CENTROPAGIDAE
- *Centropages calaninus* (Dana): Gilmartin, 1958; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
- *Centropages elongatus* Giesbrecht: Johnson, 1954; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
- *Centropages gracilis* (Dana): Barnett, 1967; Gerber, 1981.
- *Centropages orsinii* Giesbrecht: Mahnken, 1966; Barnett, 1967; Gerber, 1981.

Family LUCICUTIIDAE
- *Lucicutia flavicornis* (Claus): Mahnken, 1966; Barnett, 1967; Gerber, 1981.
- *Lucicutia ovalis* Wolfenden: Gerber, 1981.

Family HETERORHABDIDAE
- *Heterorhabdus papilliger* (Claus): Barnett, 1967.

Family ARIETELLIDAE
- *Paramisophria* ? sp. Scott: Barnett, 1967.

Family PSEUDOCYCLOPIDAE
- *Pseudocyclops* sp. Brady: Barnett, 1967.

Family CANDACIIDAE
- *Candacia aethiopica* (Dana): Gilmartin, 1958; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
- *Candacia bispinosa* (Claus): Barnett, 1967; Gerber, 1981.
- *Candacia catula* (Giesbrecht): Barnett, 1967; Gerber, 1981.
- *Candacia discaudata* A. Scott: Barnett, 1967.
- *Paracandacia simplex* (Giesbrecht): Barnett, 1967.
- *Paracandacia truncata* (Dana): Mahnken, 1966; Barnett, 1967; Gerber, 1981.

Family PONTELLIDAE
- *Calanopia minor* A. Scott: Johnson, 1954; Barnett, 1967; Gerber, 1981.
- *Labidocera laevidentata* (Brady): Gilmartin, 1958; Barnett, 1967; Gerber, 1981.
- *Pontellina plumata* (Dana): Gilmartin, 1958; Gerber, 1981.
- *Pontellopsis* sp. G. Brady: Gilmartin, 1958.

Family ACARTIIDAE
- *Acartia fossae* Gurney: Gerber, 1981.
- *Acartia hamata* Mori: Johnson, 1954; Mahnken, 1966; Barnett, 1967.
- *Acartia negligens* Dana: Mahnken, 1966; Barnett 1967; Gerber, 1981.
- *Acartia spinicaudata* Giesbrecht: Barnett, 1967.

Family TORTANIDAE
- *Tortanus gracilis* (Brady): Johnson, 1954; Gilmartin, 1958; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
- *Tortanus murrayi* A. Scott: Johnson, 1954.

Order CYCLOPODA

Family OITHONIDAE
- *Oithona nana* (Claus): Barnett, 1967; Gerber, 1981.
- *Oithona plumifera* Baird: Johnson, 1954; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
- *Oithona pseudofrigida* (Giesbrecht): Barnett, 1967; Gerber, 1981.
- *Oithona rigida* Giesbrecht: Barnett, 1967; Gerber, 1981.
- *Oithona tenuis* Rosendorn: Barnett, 1967; Gerber, 1981.

Family CLAUSIDIIDAE
- *Saphirella tropica* Wolfenden: Gerber, 1981.

Family ONCAEIDAE
- *Oncaea media* Giesbrecht: Barnett, 1967; Gerber, 1981.
- *Oncaea venusta* Philippi: Johnson, 1954; Barnett, 1967; Gerber, 1981.
- *Lubbockia squillimana* Claus: Johnson, 1954; Gerber, 1981.

(This table continued on next page.)

TABLE 1 (cont'd)

- Family SAPPHIRINIDAE
  - *Sapphirina stellata* Giesbrecht: Johnson, 1954; Gerber, 1981.
  - *Sapphirina tropica* Wolfenden: Gerber, 1981.
  - *Copilia mirabilis* Dana: Johnson, 1954; Gilmartin, 1958; Mahnken, 1966; Barnett, 1967; Gerber, 1981.
  - *Copilia quadrata* Dana: Barnett, 1967.
- Family CORYCAEIDAE
  - *Corycaeus agilis* Dana: Mahnken, 1966; Barnett, 1967; Gerber, 1981.
  - *Corycaeus andrewsi* Farran: Mahnken, 1966.
  - *Corycaeus asiaticus* F. Dahl: Barnett, 1967; Gerber, 1981.
  - *Corycaeus catus* F. Dahl: Barnett, 1967; Gerber, 1981.
  - *Corycaeus crassiusculus* Dana: Mahnken, 1966; Barnett, 1967; Gerber, 1981.
  - *Corycaeus flaccus* Giesbrecht: Gerber, 1981.
  - *Corycaeus gracilis* Dana: Mahnken, 1966.
  - *Corycaeus latus* Dana: Gerber, 1981.
  - *Corycaeus lautus* Dana: Gerber, 1981.
  - *Corycaeus limbatus* Brady: Barnett, 1967; Gerber, 1981.
  - *Corycaeus longistylis* Dana: Barnett, 1967; Gerber, 1981.
  - *Corycaeus medius* Gurney: Barnett, 1967; Gerber, 1981.
  - *Corycaeus pumilus* M. Dahl: Mahnken, 1966.
  - *Corycaeus robustus* Giesbrecht: Mahnken, 1966; Barnett, 1967.
  - *Corycaeus speciosus* Dana: Mahnken, 1966; Barnett, 1967; Gerber, 1981.
  - *Corycaeus tenuis* Giesbrecht: Gerber, 1981.
  - *Corycaeus typicus* (Kroyer): Barnett, 1967; Gerber, 1981.
  - *Corycaeus vitreus* Dana: Mahnken, 1966; Barnett, 1967; Gerber, 1981.
  - *Farranula carinata* (Giesbrecht): Gerber, 1981.
    - *Corycaeus carinatus* Giesbrecht: Barnett, 1967.
  - *Farranula concinna* (Dana): Gerber, 1981.
    - *Corycaeus concinnus* Dana: Mahnken, 1966; Barnett, 1967.
  - *Farranula gibbula* (Giesbrecht): Gerber, 1981.
    - *Corycaeus gibbulus* Giesbrecht: Mahnken, 1966; Barnett, 1967.

Order HARPACTICOIDA
- Suborder OLIGOARTHRA
  - Family ECTINOSOMATIDAE
    - *Microsetella norvegica* (Boeck): Barnett, 1967.
    - *Microsetella rosea* (Dana): Barnett, 1967; Gerber, 1981.
  - Family CLYTEMNESTRIDAE
    - *Clytemnestra rostrata* Brady: Gerber, 1981.
    - *Clytemnestra scutellata* Dana: Gerber, 1981.
  - Family MACROSETELLIDAE
    - *Macrosetella gracilis* (Dana): Gilmartin, 1958; Barnett, 1967; Gerber, 1981.
  - Family LONGIPEDIIDAE
    - *Longipedia coronata* Claus: Gerber, 1981.
    - *Longipedia weberi* A. Scott: Gerber, 1981.
  - Family HARPACTICIDAE
    - *Harpacticus* spp. M. Edwards: Gerber, 1981.
  - Family PELTIDIIDAE
    - *Peltidium* spp. Philippi: Gerber, 1981.
  - Family TEGASTIDAE
    - *Tegestes* sp. Norman: Gerber, 1981.
  - Family THALESTRIDAE
    - *Eudactylopus andrewi* Sewell: Gerber, 1981.
    - *Eudactylopus anomala* Sewell: Gerber, 1981.
    - *Eudactylopus fasciatus* Sewell: Gerber, 1981.
    - *Dactylopoda* sp. G. O. Sars: Gerber, 1981.
  - Family DIOSACCIDAE
    - *Amphiascus coralicola* Sewell: Gerber, 1981.
    - *Amphiascopsis cinctus* (Claus): Gerber, 1981.
    - *Metamphiascopsis hirsutus* (Thompson and A. Scott): Gerber, 1981.
  - Family METIDAE
    - *Metis* sp. Philippi: Gerber, 1981.

(This table continued on next page.)

TABLE 1 (cont'd)

Family LAOPHONTIDAE
Laophonte cornuta Philippi: Gerber, 1981.
Order MONSTRILLOIDA
Family MONSTRILLIDAE
Monstrilla sp.: Barnett, 1967; Gerber, 1981.
Subclass MALACOSTRACA
Order MYSIDACEA
Family MYSIDAE
Subfamily SIRIELLINAE
Siriella affinis Hanson: Murano, 1983.
Siriella aequiremis Hanson: Murano, 1983.
Siriella sp.: Hobsen and Chess, 1978.
Subfamily MYSINAE
Anisomysis chessi Murano: Murano, 1983.
Anisomysis constricta Murano: Murano, 1983.
Anisomysis enewetakensis Murano: Murano, 1983.
Mysinae sp.: Hobsen and Chess, 1978.
Subfamily GASTROSACCINAE
Anchialina grossa Hansen: Gerber, 1981.
Anchialina typica (Krøyer): Gerber, 1981.
Gastrosaccus bengalensis Hansen: Murano, 1983.
Gastrosaccus indicus Hansen: Gerber, 1981.
Gastrosaccus pacificus Hansen: Gerber, 1981.
Gastrosaccus parvus Hansen: Gerber, 1981.
Gastrosaccus sp.: Gerber, 1981.
Metamblyopsis sp.: Gerber, 1981.
Pseudanchialina inermis Illig: Gerber, 1981; Murano, 1983.
Order AMPHIPODA
Suborder HYPERIIDEA
Family HYPERIIDAE
Lestrigonus bengalensis Giles: Gerber, 1981 as *Hyperia dysschistus* Stebbing.
Lestrigonus latissima (Borallius): Gerber, 1981 as *Hyperia hydrocephalia* Vosseler.
Family SYNOPIIDAE
Synopia ultramarina Dana: Gerber, 1981.
Synopia variabilis Spandl: Bernard, 1965.
Order EUPHAUSIACEA
Family EUPHAUSIIDAE
Pseudeuphausia latifrons (G. O. Sars): Gerber, 1981.
Order DECAPODA
Family LUCIFERIDAE
Lucifer chacei Bowman, 1967.
Phylum CHAETOGNATHA
Class SAGITTOIDEA
Family SAGITTIDAE
Pterosagitta draco (Krohn): Alvarïno, personal communication: Gerber, 1981.
Sagitta bedfordii: Alvarïno, personal communication.
Sagitta bipunctata Quoy and Gaimard: Alvarïno, personal communication; Gerber 1981.
Sagitta enflata Grassi: Johnson, 1954; Gilmartin, 1958; Alvarino, personal communication; Gerber, 1981.
Sagitta ferox Doncaster: Alvarïno, personal communication.
Sagitta neglecta Aida: Gilmartin, 1958; Alvarïno, personal communication; Gerber, 1981.
Sagitta oceania: Alvarïno, personal communication.
**Sagitta pacifica* Tokioka: Alvarïno, personal communication.
Sagitta regularis Aida: Gilmartin, 1958; Alvarïno, personal communication; Gerber, 1981.
Sagitta robusta Doncaster: Johnson, 1954; Alvarïno, personal communication.
Sagitta serratodentata Krohn: Johnson, 1954; Gerber, 1981.
Phylum CHORDATA
Subphylum UROCHORDATA
Class THALIACEA
Order DOLIOLIDA (CYCLOMYARIA)
Family DOLIOLIDAE
Doliolum sp.: Kinzie, 1976.

* Only recorded outside lagoon but in the immediate vicinity of Enewetak Atoll.

(This table continued on next page.)

TABLE 1 (cont'd)

Order SALPIDA (DESMOMYARIA)
Family SALPIDAE
Salpa sp.: Gilmartin, 1958.
Thalia democratica (Forsskål): Gilmartin, 1958.
Class APPENDICULARIA (COPELATA: LARVACEA)
Family FRITILLARIDAE
†*Fritillaria megachile* Fol: Gerber, 1981.
Fritillaria sp.: Gerber, 1981.
Family OIKOPLEURIDAE
Oikopleura intermedia Lohmann: Gerber, 1981.
†*Oikopleura fusiformis* Fol: Gerber, 1981.
†*Oikopleura longicaudata* (Vogt): Gerber, 1981.
†*Oikopleura parva* Lohmann: Gerber, 1981.
†*Oikopleura rufescens* Fol: Gerber, 1981.

† These were identified in the ocean waters neighboring Bikini Atoll (Chiba et al., 1955).

Lagoon and the channel adjacent to Japtan Islet resulted in an additional 26 species (Gold and Morales, 1977), thus a total of 34 tintinnids is known from this area. Identification and nomenclature for the tintinnids are based on Campbell and Moore (1954), Corliss (1977), and Kofoid and Campbell (1939).

For discussion of other Ciliophora and Foraminifera, see Chapter 4, this volume.

CNIDARIA

Hydrozoa

Siphonophora

Calycophorid siphonophores collected in net samples form a small fraction of the zooplankton in this area and have been most extensively sampled by Sears (1950) during the spring and summer of 1946. Two species were found within Enewetak Lagoon and eight outside, with only one common to both areas. At nearby Bikini, Rongelap, and Rongerik Atolls, 27 additional species were recorded with about one-third of those recorded in the lagoons. These appear to be largely oceanic species but include *Abyla leukartii, A. trigona, Chelophyes appendiculata, Diphyes arctica, D. bojani, Enneagonum hyalinuar, Eudoxides spiralis, Galetta australis, G. chuni, G. bigelowi, Lensia campanella, L. cossack, L. fowleri, L. grimaldii, L. hotspur, L. multicristata, Rosacea plicata, Sulculeolaria monoica,* and *S. quadridentata*. Additional records of siphonophores identified from Enewetak Lagoon were made by Alvariño (personal communication) from samples collected in 1946 and by Gerber (1981) from 35 samples collected during the winters of 1972, 1974, and the summer of 1974. In this last study, eight species were recorded from the Enewetak Lagoon (which includes the three species previously recorded); most species increased in abundance during the summer. Only one physophorid siphonophore, the Portuguese man-of-war, *Physalia*, has been collected and identified from Enewetak Lagoon where occasionally it appears commonly, sometimes washing up on lagoon islet beaches.

Siphonophores were also recorded at Enewetak Lagoon by Johannes and Gerber (1974) during the summer of 1972 and at Majuro Atoll Lagoon by Hobson and Chess (1973), but no species were identified. Taxonomy and identification of siphonophores can be found in Sears (1950) and Totton and Bargmann (1965).

Hydroida

Various Anthomedusae have been reported from net tows made in the lagoon by Gilmartin (1958) and Gerber (1981) but not identified. At least one species of Anthomedusae has been identified to genus (C. Arneson) but is unavailable. Representatives of this group commonly occur in the lagoon plankton and are usually damaged beyond recognition in net collections. Two species of chondrophorans have been identified from the lagoon and are in the Mid-Pacific Marine Laboratory (MPML) reference collection.

SCYPHOZOA

Semaeostomae

Two species have been collected from Enewetak Lagoon and have been identified and placed in the MPML reference collection.

Rhizostomae

One species of this group, preserved in the MPML reference collection, has been identified from the lagoon. It was collected by Trench and Colley in August 1978 off Bokoluo Island (Alice) and in the lagoon in October 1980 by C. Arneson.

Two key works on the identification and taxonomy of the medusae (Hydroida and Scyphozoa) are Kramp (1961) and Mayer (1910).

CTENOPHORA

Tentaculata

Lobata

One specimen preserved in the MPML reference collection has been identified to genus and was collected in the lagoon off Enewetak Island December 28, 1975. Ctenophores were collected from the lagoon in April and December 1955 (Gilmartin, 1958) and in the winters of 1972, 1974, and summer 1974 by Gerber (1981) but not identified to species.

MOLLUSCA

Gastropoda

Two species of the holoplanktonic Thecosomata, collectively known as pteropods, have been reported from Enewetak Lagoon. Johnson (1949) and Gilmartin (1958) each reported one species from Enewetak and nearby Bikini, Rongelap, and Rongerik Lagoons. Pteropods were collected from shallow stations at Enewetak and Majuro Lagoons by Hobson and Chess (1973, 1978) but were not identified further. Gerber (1981) identified two species which commonly occurred in lagoon samples from shallow and deep stations; they were especially common in the summer months.

Only one unidentified species of the heteropod genus *Atlanta* was recorded by Gilmartin (1958) from Enewetak Lagoon where it is not very abundant. Members of this genus have been reported in low abundance in nearby oceanic waters (Chiba and Hirakawa, 1972). The classic taxonomic works on this and the above group have been done by Tesch (1946, 1949, 1950).

ARTHROPODA

Crustacea

Ostracoda

Planktonic ostracods have been recorded from Enewetak Lagoon (Gerber and Marshall, 1974; Hobson and Chess, 1978; Gerber, 1981) and Majuro Lagoon (Hobson and Chess, 1973). Those recorded by Gerber (1981) and most of those reported by Hobson and Chess (1973) belong to the order Myodocopa, but further identification was not made. Though they occur fairly regularly in net collections, ostracods are represented by only a few individuals per sample.

Copepoda

Approximately 58 species of calanoid copepods have been identified from Enewetak Lagoon. Johnson (1954) identified the 12 most common species from Enewetak, Rongelap, Rongerik, and Bikini Lagoons but unfortunately did not indicate which species came from each lagoon. His collections at Enewetak, Rongerik, and Rongelap Lagoons were made in June and at Bikini Lagoon from March to May in 1946. Twelve species of calanoids were identified by Gilmartin (1958) at Enewetak Lagoon from samples collected in April, November, and December 1955; eight of these species were not recorded by Johnson (1954). Two plankton samples were collected at Enewetak Lagoon in September 1959 and 1961 by Mahnken (1966) in conjunction with a detailed zooplankton study of Rongelap Lagoon. He identified 25 species from Enewetak Lagoon and 45 species from Rongelap Lagoon which included most of the species previously reported from Enewetak. In January and February 1966, Barnett (1967) studied the distribution of copepods at several locations in Enewetak Lagoon. He recorded about 46 species of calanoid copepods, most of which also occurred in Rongelap Lagoon. Gerber (1981) sampled Enewetak Lagoon during January and February 1972 and 1974, respectively, and in June through August 1974. He identified 45 species from a mid-lagoon station; most of those species had been previously recorded from this lagoon. Even after these studies at Enewetak, there are species of calanoid copepods which have been recorded from Rongelap that have not been identified from Enewetak Lagoon. Those species are *Euchirella* sp., *Labidocera bataviae* Scott, *Pontella fera*, *Pontella tenuiremis*, *Pontellina globosa*, *Pontellopsis krameri*, *Pontellopsis macronyx*, and *Undeuchaeta plumosa*. At Majuro Atoll Lagoon, two species of calanoid copepods (*Candacia discaudata* and *Undinula vulgaris*) which also occur at Enewetak Lagoon were recorded from the stomach contents of fish; a third species collected there, *Labidocera acuta*, has not been recorded from the other lagoons (Hobson and Chess, 1973). In a study of the feeding habits of various planktivorous fishes at Enewetak, Hobson and Chess (1978) identified three of the large size copepods to species and four others to the generic level; these had been reported previously. Calanoid copepods in reduced abundance were recorded by Johnson (1954) from outside Bikini Lagoon, but these species were not reported. Chiba et al. (1955) collected zooplankton in the open ocean near Bikini Atoll and throughout the Marshall Islands from May to June 1954. They presented 80 species of calanoid copepods, about half of which have been recorded from Enewetak Lagoon; the remaining species consisted of oceanic and deep water forms. There are many important works dealing with the taxonomy and identification of calanoid copepods which occur at Enewetak Lagoon. The most important works are Bradford (1974), Dakin and Colefax (1940), Delsman (1939), Frost and Fleminger (1968), Giesbrecht (1889), Grice (1961), Mori (1937), Scott (1909), Sewell (1929), Vervoort (1964), and Wilson (1942).

Cyclopoid copepods were first recorded from Enewetak and nearby atolls by Johnson (1954) during the sampling periods mentioned above. He recorded four species plus two genera consisting of several unidentified species. Gilmartin (1958) identified four species at Enewetak Lagoon, and Mahnken (1966) identified 12 species from Enewetak and five at Bikini and Rongelap Lagoons. These researchers used rather coarse mesh nets which did not adequately sample this group consisting mostly of smaller forms; this perhaps accounts for the few species recorded. About 27 species were recorded at Enewetak Lagoon by Barnett (1967) and included those species identified there previously; Gerber (1981) identified 28 species which included most of Barnett's species and several additional species. Only one cyclopoid copepod, *Corycaeus curtus*, recorded at Rongelap has not been found at Enewetak Lagoon. In the surrounding waters of Bikini Atoll, 29 species were found by Chiba et al. (1955), but only 13 of these occur within the lagoon at Enewetak. Four cyclopoid genera were recorded at Majuro Atoll Lagoon from the stomach contents of plankton feeding fishes (Hobson and Chess, 1973), all of which have been recorded from Enewetak and include *Oncaea* sp., *Corycaeus* sp., *Sapphirina* sp., and *Saphirella* sp. For identification and taxonomy of cyclopoid copepods at Enewetak, the following works should be consulted: Dahl (1912), Dakin and Colefax (1940), Farran (1911), Giesbrecht (1889), Mori (1937), Motoda (1963), Scott (1909), and Wilson (1942).

Few harpacticoid copepods are strictly holoplanktonic, and of these, five species have been found in the Enewetak Lagoon. They include members of the first three families presented in the checklist under this order. Gilmartin (1958) identified one of these species, Barnett (1967) identified three species, and Gerber (1981) found four of these species. At a shallow station (2 m depth) behind a windward reef area of the lagoon, Gerber (1981) collected in net tows 16 species of harpacticoids that are believed to be epibenthic types. These were restricted to the shallow station and may have been inadvertently washed from adjacent coral reefs. Harpacticoid copepods were also in the lagoon plankton and in the gut contents of various fishes (e.g., Gerber and Marshall, 1974; Hobson and Chess, 1978), but these were not identified. A thorough study of the epibenthic harpacticoid copepods has not been made at any location in the Marshall Islands. The five pelagic species noted above were not identified from net tow samples in the neighboring waters of Bikini Atoll (Chiba et al., 1955). This suggests that they are probably neritic types, surviving best in shallower protected areas such as atoll lagoons.

Both Barnett (1967) and Gerber (1981) identified members of a single genus belonging to the other Monstrilloida. Whether the same species were represented in both studies is not known, because no identifications were made to the species level. Monstrilloid copepods occurred only rarely in net collections in both studies, and no reference indicates that they occur outside of atoll lagoons in the Marshall Islands. Information on the identification and taxonomy of harpacticoid and monstrilloid copepods from Enewetak are scarce, but the following works are helpful: Dakin and Colefax (1940), Lang (1948), Scott (1909), and Vervoort (1964).

Mysidacea

A detailed investigation of the mysids at Enewetak Atoll has not been carried out. A planktonic mysid was collected in net tows by Gilmartin (1958) at Enewetak Lagoon, but the specimen was not identified. Swarms of mysids belonging to two genera (*Siriella* and Mysinae) were observed and collected over lagoon patch reefs at Enewetak by Hobson and Chess (1978); Gerber (1981) identified eight species of mysids from net tows at a nearby shallow station; and Murano (1983) identified seven species from net tows and emergence traps at depths between 2 and 10 m. Further samplings, especially at night, would no doubt reveal additional specimens. Unidentified mysids were recorded in the plankton and in the gut contents of plankton feeding fishes at nearby Majuro Atoll Lagoon by Hobson and Chess (1973). Plankton tows in the oceanic waters near Bikini Atoll by Chiba et al. (1955) revealed two species of mysids, *Siriella thompsoni* and *Siriella* sp., and Tattersall (1951) described two additional species of *Siriella* from the Marshall Islands (*S. vulgaris rostrata*, *S. anomala*) and *Anchialina typica* and *A. penicillata*. As noted earlier, the genus *Siriella* was first recorded inside the lagoon at Enewetak by Hobson and Chess (1978), and later two other lagoon *Siriella* were identified to species by Murano (1983). Several excellent works by Hansen (1910) and Tattersall (1957) have proved useful in identifying the mysids from Enewetak.

Isopoda

The isopods which have been collected in plankton net hauls from Enewetak Lagoon have not been identified to genera (e.g., Gilmartin, 1958; Hobson and Chess, 1978; and Gerber, 1981). This group is generally scarce in such samplings indicating that they are most likely of epibenthic origin rather than planktonic. Planktonic isopods from other atoll lagoons or in the oceanic waters in the Marshall Islands have not been collected.

Amphipoda

At least three and possibly four species of holoplanktonic amphipods that belong to the suborder Hyperiidea have been reported from the Enewetak Lagoon (Gerber, 1981). Earlier plankton collections by Gilmartin (1958) revealed one unidentified species, and Hobson and Chess (1978) recorded but did not identify several species of hyperiids. Many more nonplanktonic species occur within the lagoon (Barnard, 1965), and these are mostly gammarids which occur in the epibenthic shallow water habitat discussed elsewhere in this book. Barnard (1965) reported one gammarid species, *Synopia variabilis*, which was collected from Enewetak and Ifaluk Lagoons by both plankton haul and dip-netting with a night light; it is included in the checklist. Hyperiid amphipods have been recorded at Majuro Atoll (Hobson and Chess, 1973) where one species, *Lestrigonus bengalensis*, was identified from net tows and made up an important dietary component of antherinid fish. In the oceanic waters around the Marshall Islands, Chiba et al. (1955) collected nine species of planktonic amphipods, none of which appear to occur in Enewetak Lagoon. These are *Oxycephalus porcellus*, *Phronima pacifica*, *Phronima* sp., *Leptocotis tenuirostris*, *Parascelus edwardsi, Phronimopsis spinifera, Hyperioides sibaginis, Hyperia* sp., and *Anchylomera blossevillii*. For the taxonomy and identification of the amphipods from Enewetak, see Barnard (1965), Bowman and Gruner (1973), and Dakin and Colefax (1940).

Euphausiacea

A single species of euphausiid has been reported from Enewetak Lagoon where it occurs regularly at both shallow and deep stations (Gerber, 1981). This species was also the dominant euphausiid recorded inside the Great Barrier Reef Lagoon (Russell, 1934). Gilmartin (1958) reported euphausiids in his plankton hauls at Enewetak Lagoon but did not identify them. In the surrounding oceanic waters of Enewetak and Bikini Atolls, seven species of typically oceanic euphausiids were reported by Chiba et al. (1955), and none of these occurs in the atoll lagoons. They are *Stylocheiron carinatum, S. submii, Euphausia gracilis, E. gibba, E. krohnii, Thysanopoda obtusifrons*, and *T. tricuspidata*. Useful works concerning the identification and taxonomy of euphausiids include Dakin and Colefax (1940), Delsman (1939), Hansen (1910), Mauchline and Fisher (1969), and Mauchline (1980).

CHAETOGNATHA

At least nine species of chaetognaths have been reported and identified from Enewetak Lagoon, in addition to seven species from outside the lagoon or in the nearby ocean waters. They are an important planktonic group and appear in most net samplings. Johnson (1949, 1954) reported three species from net tows taken during 1946 at Enewetak Lagoon (June), and the lagoons at Rongelap (June), Rongerik (June), and Bikini (March to May) and from outside Bikini Atoll (March to May). Distribution of chaetognaths within Bikini Atoll was also studied. A translagoon study of plankton at Enewetak from April through December 1955 by Gilmartin (1958) revealed four species, most of which were abundant in the net samples. Gerber (1981) reported at least six species from a mid-lagoon station in the winter and summer (1972, 1974) with increased abundances in summer. Collections made in 1946 and later revealed six species from the lagoon and several more from outside, east of the lagoon (Alvariño, personal communication). In the neighboring waters around Bikini Atoll, extensive plankton collections were made in May and June 1954 by Chiba et al. (1955) and later by Tsuruta (1963). These researchers identified at least 16 species; the eight not found within the lagoons include *Sagitta decipiens, S. hexaptera, S. lyra, S. minima, S. pulchre, S. pseudoserratodentata, Krohnitta pacifica*, and *K. subtilis*. Three species of chaetognaths were reported from the gut contents of lagoon fish at Majuro Atoll (Hobson and Chess, 1973) and at Enewetak Atoll (Gerber and Marshall, 1974). Important sources for the identification of chaetognaths include Alvariño, (1967), Sund (1959), and Thomson (1947).

CHORDATA

Thaliacea

This group is much less abundant than the Larvacea in the Enewetak Lagoon and from nearby atolls. They were first reported from Enewetak by Gilmartin (1958) who identified two species from April through December in his translagoon plankton study of 1955. An additional species has been collected from the lagoon in 12 m of water and identified by R. A. Kinzie (MPML reference collection).

Appendicularia (Larvacea)

This is an abundant zooplankton group in the atoll lagoons and surrounding waters of the Marshall Islands. At least seven species have been reported from Enewetak Lagoon, five of which have been collected from outside the atoll. Johnson (1954) reported densities of appendicularians which were considerably higher for Enewetak and nearby atoll lagoons than in the nearby open ocean; he did not identify genera or species. At Enewetak Lagoon, Gilmartin (1958) also reported high densities of this group especially during April and in early November and identified them as *Oikopleura* sp. Gerber similarly (1981) found high densities of larvaceans in the lagoon especially in the summer; at least six species are recorded belonging to two families. In the waters near Bikini Atoll, Chiba et al. (1955) identified 16 species, five of which are common to Enewetak Lagoon. These additional species include *Fritillaria borealis* forma *sargassi, F. formica, F. haplostoma, F. pellucida, F. venusta, Oikopleura cophocerca, Oikopleura* sp., *Kowalevskaia tenuis, Megalocercus huxleyi, Stegosoma magnum*, and *Pelagopleura* sp. *Appendicularia* have been reported at Majuro Atoll Lagoon from the gut contents of plankton feeding fishes (Hobson and Chess, 1973); the species were not identified. The identification and taxonomy of the Thaliacea and Larvacea are included in the works of Bjornberg and Forneris (1955), Delsman (1939), and Fraser (1947).

CONCLUSIONS

There appears to be little difference of the holoplanktonic zooplankton species composition between Enewetak and nearby atoll lagoons such as Rongelap. This observation is largely based on the copepod data which have been most extensively studied at these two lagoons. Clearly, this faunal similarity reflects the rather similar habitats of the two lagoons and their similar locations with respect to the prevailing ocean currents.

The information available comparing the copepod species assemblege inside the lagoon with that of the surrounding ocean outside the lagoon demonstrates that they are different. The lagoon zooplankton populations are partially composed of oceanic species known to occur in the neighboring waters outside the atoll, in addition to neritic species which occur only in shallow protected environments. It has also been found that the density of zooplankton in the lagoons is considerably higher than in the surrounding ocean waters (Chap. 10, Volume 1). Thus, the zooplankton of lagoons in the Marshall Islands is composed of similar species, and we would expect only slight variations in community structure from lagoon to lagoon reflecting small habitat and geographic differences.

Included in this lagoon zooplankton, and yet ignored thus far, is the meroplanktonic component comprised mostly of the larvae of the many reef invertebrates and fishes as well as some adventurous benthic forms which occasionally move into the water column. Various researchers (e.g., Gerber and Marshall, 1974; Hobson and Chess, 1978) have shown that the meroplankton sometimes dominates the zooplankton and becomes an important food of reef and lagoon fishes.

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Chapter 21

Ostracoda (Myodocopina) of Enewetak Atoll

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INTRODUCTION

Ostracods in the superorder Myodocopa, excluding the planktonic suborder Halocypridina, which is outside the scope of the present report, have not previously been reported from Micronesia. A comprehensive checklist of Ostracoda from southeast Asia (Hanai et al., 1980) is concerned with the area between 25°N and 11°S latitude and 140°E and 85°E longitude. The area includes the western edge of Micronesia, but a brief perusal of the checklist revealed no listing of specimens from Micronesia.

A small collection of Enewetak ostracods in the suborder Myodocopina at the National Museum of Natural History, Smithsonian Institution, contains members of all five families that comprise the suborder (Table 1). Although the species in the collection are capable of swimming, and do so occasionally, they spend most of their existence crawling on, or burrowing in, the substrate. An exception to this is members of the mainly pelagic genus *Cypridina*, which is represented in the collection by two species. Some of the Enewetak specimens are illustrated in Fig. 1.

The feeding habits of the families differ: the Cylindroleberididae is composed of filter feeders, the Sarsiellidae and Rutidermatidae of carnivores, the Philomedidae of detritus feeders, and the Cypridinidae of scavengers, detritus feeders, and also carnivores (Kornicker, 1975).

TABLE 1

Checklist of Enewetak Atoll Ostracoda (Myodocopina)

Phylum ARTHROPODA
  Subphylum CRUSTACEA
    Class OSTRACODA
      Superorder MYODOCOPA
        Order MYODOCOPIDA
          Suborder MYODOCOPINA
            Superfamily CYPRIDINOIDEA
              Family CYPRIDINIDAE
                *†*Cypridina* spp.
                *†*Paravargula* sp.
                *†*Skogsbergia* sp.
              Family PHILOMEDIDAE
                *†*Harbansus* sp.
              Family RUTIDERMATIDAE
                *†*Rutiderma* sp.
              Family SARSIELLIDAE
                *†*Ancohenia* sp.
                *†*Anscottiella* sp.
                *†*Sarsiella* sp.
              Family CYLINDROLEBERIDIDAE
                *†*Parasterope* sp.
                *†*Cylindroleberis* sp.

* New Micronesian record.
† New Enewetak record.

BIOGEOGRAPHIC COMPARISONS AT GENERIC LEVEL

The genera *Skogsbergia*, *Harbansus*, *Rutiderma*, *Sarsiella*, *Parasterope*, and *Cylindroleberis* are worldwide in distribution; only *Parasterope* is present in Antarctic waters (Kornicker, 1975); and none has been reported from the Arctic Ocean.

The pelagic genus *Cypridina* is primarily Indo-Pacific.

Ancohenia is previously known from Maunalua Bay, Oahu Island, Hawaii (Kornicker, 1976:7) and Vuna Point, Taveuni, Fiji (Kornicker, 1981:12).

Anscottiella has previously been collected off Ceylon and Thailand (Poulsen, 1965:65; Kornicker, 1975:607; Kornicker and McKenzie, 1976:348).

Paravargula has previously been collected off the tip of South Africa and from the East-Indian region (Poulsen, 1962:204; Kornicker, 1975:3).

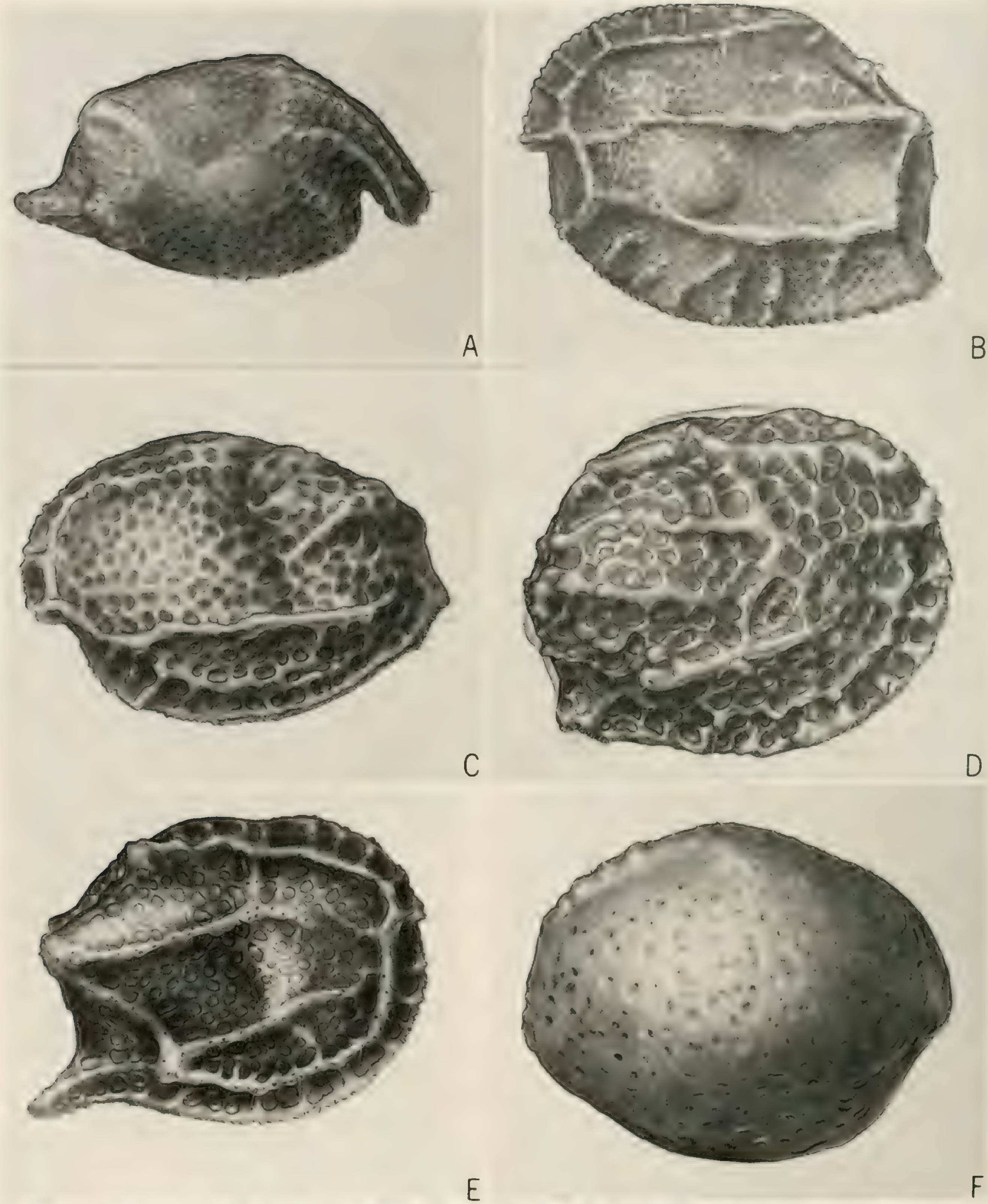

Fig. 1 a, *Harbansus* species, female, length 0.87 mm, USNM 158308; b, *Rutiderma* species, female, length 0.93 mm, USNM 158309; c, *Anscottiella* species, male, length 0.70 mm, USNM 158313; d, *Anscottiella* species, female, length 0.80 mm, USNM 158317; e, *Sarsiella* species, female, length 0.78 mm, USNM 158310; f, *Ancohenia* species, male, length 1.01 mm, USNM 158312.

Station Data

Specimens of *Cypridina* and *Anscottiella* were collected by C. Allan Child, National Museum of Natural History, Smithsonian Institution, in October 1969, by scraping the piling of a marine pier at the north end of the lagoon side of Enewetak Island in ⅓ to 2 m of water at low tide. The remaining specimens were collected by Edmund S. Hobson and James R. Chess, Southwest Fisheries Center, Tiburon Laboratory, National Marine Fisheries Service, in May 1979, from day and night airlift and emergence traps placed in the lagoon in the lee of Bokandrock Island in about 5 m of water and in the lee of a high section of interisland reef midway between Enewetak and Medren Islands in about 8 m of water. These samples were obtained from substrates of sand, coral, and coral rubble. Both species collected by C. Allan Child from the marine pier were also present in the samples of E. S. Hobson and J. R. Chess.

ACKNOWLEDGMENTS

I thank C. Allan Child, Edmund S. Hobson, and James R. Chess for collecting the specimens upon which this report is based. I also thank Raymond B. Manning and Anne C. Cohen for reviewing the manuscript and Carolyn Gast for rendering the shaded drawings of the carapaces.

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Chapter 22

Crustacea Decapoda (Penaeidea, Stenopodidea, Caridea, and Palinura) of Enewetak Atoll

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INTRODUCTION

Biological surveys made during 1946 and 1947 in the northern Marshall Islands included faunal collections that resulted in a publication by Chace (1955) on several groups of shrimps. In this work, six species of sergestid, pasiphaeid, processid, and alpheid shrimps were recorded from Enewetak. Since then the number of taxa from the atoll has increased until now nearly 150 decapod shrimp and lobster species are recognized. Pontoniines and alpheids account for 73% (106 species) of the total number. There are several new records not only for Enewetak but also for the Marshalls, and in some cases, for the Pacific. A taxonomic checklist (Table 1) and a section on collection data for new records are provided.

PENAEIDEA

Two penaeid species in the genus *Metapenaeopsis*, one a widely distributed Indo-West Pacific form and the other as yet unidentified, are now recorded for the first time from Enewetak. Among the sicyonid shrimps, the widely distributed Indo-West Pacific species, *Sicyonella maldivensis*, has been collected at Enewetak on the surface using a light at night. One planktonic sergestid, an undetermined species of *Lucifer*, was reported by Chace (1955) and was collected at Enewetak in the same manner. In 1967, Bowman recorded *L. chacei* as a new species from a number of Indo-West Pacific locations including Enewetak and Rongelap Atolls in the Marshalls.

TABLE 1

Checklist of Enewetak Penaeidea, Stenopodidea, Caridea, and Palinura*

Subphylum CRUSTACEA
- Class MALACOSTRACA
  - Order DECAPODA
    - Suborder DENDROBRANCHIATA
      - Infraorder PENAEIDEA
        - Superfamily PENAEOIDEA
          - Family PENAEIDAE
            - †*Metapenaeopsis borradailei* (De Man, 1910).
            - †*Metapenaeopsis* sp.
          - Family SICYONIIDAE
            - †*Sicyonella maldivensis* Borradaile, 1910.
        - Superfamily SERGESTOIDEA
          - Family SERGESTIDAE
            - *Lucifer chacei* Bowman, 1967: Bowman, 1967.
            - *Lucifer* sp.: Chace, 1955.

*The higher classification used here follows that of Bowman and Abele (1982).
†New records for Enewetak.

(This table continued on next page.)

TABLE 1 (cont'd)

Suborder PLEOCYEMATA
  Infraorder STENOPODIDEA
    Family STENOPODIDAE
      †*Microprosthema plumicorne* (Richters, 1880).
      †*Microprosthema scabricaudatum* (Richters, 1880).
      †*Odontozona sculpticaudata* Holthuis, 1947.
      †*Odontozona* sp. nov.
      †*Stenopus hispidus* (Olivier, 1811).
      †*Stenopus tenuirostris* De Man, 1888.
      †*Stenopus zanzibaricus* Bruce, 1976.
  Infraorder CARIDEA
    Superfamily PASIPHAEOIDEA
      Family PASIPHAEIDAE
        Leptochela irrobusta Chace, 1976: Chace, 1976.
          Leptochela robusta Stimpson, 1860: Chace, 1955.
    Superfamily RHYNCHOCINETOIDEA
      Family RHYNCHOCINETIDAE
        Rhynchocinetes hiatti Holthuis and Hayashi, 1967: Holthuis and Hayashi, 1967.
        Rhynchocinetes hendersoni Kemp, 1925: Holthuis and Hayashi, 1967.
          Rhynchocinetes marshallensis Edmondson, 1952: Edmondson, 1952.
        †*Rhynchocinetes* aff. *R. rigens* Gordon, 1936.
        †*Rhynchocinetes* sp.
    Superfamily PALAEMONOIDEA
      Family PALAEMONIDAE
        Subfamily PALAEMONINAE
          †*Brachycarpus biunguiculatus* (Lucas, 1846).
          †*Leandrites cyrtorhynchus* Fujino and Miyake, 1969.
        Subfamily PONTONIINAE
          †*Anchistus australis* Bruce, 1977.
          Anchistus miersi (De Man, 1888): Fankboner, 1972.
          †*Araiopontonia odontorhyncha* Fujino and Miyake, 1970.
          †*Conchodytes biunguiculatus* (Paulson, 1875).
          †*Conchodytes meleagrinae* Peters, 1852.
          †*Conchodytes tridacnae* Peters, 1852.
          †*Coralliocaris brevirostris* Borradaile, 1898.
          †*Coralliocaris graminea* (Dana, 1852).
          †*Coralliocaris nudirostris* (Heller, 1861).
          †*Coralliocaris superba* (Dana, 1852).
          †*Coralliocaris venusta* Kemp, 1922.
          Ctenopontonia cyphastreophila Bruce, 1979: Bruce, 1979b.
          †*Fennera chacei* Holthuis, 1951.
          †*Harpiliopsis beaupresii* (Audouin, 1826).
          †*Harpiliopsis depressa* (Stimpson, 1860).
          †*Harpiliopsis spinigera* (Ortmann, 1890).
          †*Jocaste japonica* (Ortmann, 1890).
          †*Jocaste lucina* (Nobili, 1901).
          †*Onycocaris quadratophthalma* (Balss, 1921).
          Palaemonella pottsi (Borradaile, 1915): Bruce, 1970.
          Palaemonella rotumana (Borradaile, 1898): Bruce, 1970.
          †*Palaemonella tenuipes* Dana, 1852.
          †*Palaemonella* sp.
          Paranchistus armatus (H. Milne Edwards, 1837): Bruce, 1975; 1979a.
            Paranchistus biunguiculatus (Borradaile, 1898): Rosewater, 1965.
          Paratypton siebenrocki Balss, 1914: Bruce, 1969.
          †*Periclimenaeus* sp.
          †*Periclimenes agag* Kemp, 1922.
          †‡*Periclimenes* (?)*amboinensis* (De Man, 1888).
          †*Periclimenes bayeri* Holthuis, 1981.
          Periclimenes brevicarpalis (Schenkel, 1902): Bruce, 1979a.

†New records for Enewetak.

‡The status of *P. amboinensis* (De Man) is not clear. It may be synonymous with *P. cornutus* Borradaile.

(This table continued on next page.)

TABLE 1 (cont'd)

Subfamily PONTONIINAE (cont'd)
†*Periclimenes commensalis* Borradaile, 1915.
†*Periclimenes cristimanus* Bruce, 1965.
†*Periclimenes denticulatus* Nobili, 1906.
†*Periclimenes elegans* (Paulson, 1875).
†*Periclimenes ensifrons* (Dana, 1852).
†*Periclimenes grandis* (Stimpson, 1860).
†*Periclimenes holthuisi* Bruce, 1969.
Periclimenes longirostris (Borradaile, 1915): Bruce, 1979a.
Periclimenes ornatellus Bruce, 1979: Bruce, 1979a.
Periclimenes ornatus Bruce, 1969: Bruce, 1979a.
Periclimenes pilipes Bruce and Zmarzly, 1983: Bruce and Zmarzly, 1983.
†*Periclimenes seychellensis* Borradaile, 1915.
Periclimenes soror Nobili, 1904: Bruce, 1978; 1979a.
†*Periclimenes spiniferus* (De Man, 1902).
Periclimenes tenuipes Borradaile, 1898: Bruce, 1979a.
†*Periclimenes tenuis* Bruce, 1969.
†*Philarius gerlachei* (Nobili, 1905).
†*Philarius imperialis* (Kubo, 1940).
†*Pontoniopsis comanthi* Borradaile, 1915.
†*Stegapontonia commensalis* Nobili, 1906.
Thaumastocaris streptopus Kemp, 1922: Bruce, 1979a.
Family GNATHOPHYLLIDAE
†*Gnathophyllum americanum* Guérin-Meneville, 1855.
†*Hymenocera picta* Dana, 1852.
Superfamily ALPHEOIDEA
Family ALPHEIDAE
Alpheopsis diabolis Banner, 1956: Banner and Banner, 1968.
Alpheopsis equalis Coutière, 1896: Banner and Banner, 1968.
Alpheus acutofemoratus Dana, 1852: Banner and Banner, 1968; Highsmith, 1981.
Alpheus alcyone De Man, 1902: Banner and Banner, 1968.
Alpheus alpheopsides Coutière, 1905: Banner and Banner, 1968.
Alpheus amirantei sizou Banner and Banner, 1967: Banner and Banner, 1968; Highsmith, 1981.
Alpheus bidens (Olivier, 1811): Banner and Banner, 1968.
Alpheus bradypus Coutière, 1905: Banner and Banner, 1968.
Alpheus brevipes Stimpson, 1860: Banner and Banner, 1968.
Alpheus bucephalus Coutière, 1905: Banner and Banner, 1968; Highsmith, 1981.
Alpheus clypeatus Coutière, 1905: Banner and Banner, 1968.
Alpheus collumianus Stimpson, 1861: Highsmith, 1981.
Alpheus collumianus medius Banner, 1956: Banner and Banner, 1968.
Alpheus diadema Dana, 1852: Banner and Banner, 1968.
Alpheus dolerus Banner, 1956: Banner and Banner, 1968.
Alpheus ehlerii De Man, 1909: Banner and Banner, 1968.
Alpheus frontalis H. Milne-Edwards, 1837: Banner and Banner, 1968.
Alpheus gracilis Heller, 1861.
Alpheus gracilis gracilis Heller, 1861: Banner and Banner, 1968.
Alpheus idiocheles Coutière, 1905: Banner and Banner, 1968.
†*Alpheus leviusculus* Dana, 1852.
Alpheus lobidens polynesica Banner and Banner, 1974.
Alpheus crassimanus Heller, 1865: Banner and Banner, 1968.
Alpheus lottini Guérin, 1829: Banner and Banner, 1968.
Alpheus obesomanus Dana, 1852: Banner and Banner, 1968.
Alpheus ovaliceps Coutière, 1905: Banner and Banner, 1968.
Alpheus pachychirus Stimpson, 1860: Banner and Banner, 1968.
Alpheus pacificus Dana, 1852: Banner and Banner, 1968.
Alpheus paracrinitus Miers, 1881: Banner and Banner, 1968.
Alpheus paralcyone Coutière, 1905: Banner and Banner, 1968.
Alpheus parvirostris Dana, 1852: Banner and Banner, 1968; Highsmith, 1981.
Alpheus samoa Banner and Banner, 1966: Banner and Banner, 1968.

†New records for Enewetak.

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TABLE 1 (cont'd)

Family ALPHEIDAE (cont'd)
- *Alpheus strenuus strenuus* Dana, 1852.
  - *Alpheus strenuus* Dana, 1852: Banner and Banner, 1968.
- *Alpheus sulcatus* Kingsley, 1878.
  - *Alpheus macrochirus* Richters, 1880: Banner and Banner, 1968.
- *Athanas areteformis* Coutière, 1903: Banner and Banner, 1968.
- *Athanas djiboutensis* Coutière, 1897: Chace, 1955; Banner and Banner, 1960, 1968.
- *Athanas dorsalis* (Stimpson, 1861): Banner and Banner, 1960, 1968.
- *Athanas esakii* Kubo, 1940: Banner and Banner, 1968.
- *Athanas indicus* (Coutière, 1903): Banner and Banner, 1960, 1968.
- *Athanas marshallensis* Chace, 1955: Chace, 1955; Banner and Banner, 1960, 1968.
- *Athanas rhothionastes* Banner and Banner, 1960: Banner and Banner, 1960, 1968.
- *Athanas verrucosus* Banner and Banner, 1960: Banner and Banner, 1960, 1968.
- *Automate dolichognatha* De Man, 1888.
  - *Automate gardineri* Coutière, 1902: Banner and Banner, 1968.
  - *Automate johnsoni* Chace, 1955: Chace, 1955.
- *Metalpheus paragracilis* (Coutière, 1897).
  - *Alpheus paragracilis* Coutière, 1897: Banner and Banner, 1968.
- *Metalpheus rostratipes* (Pocock, 1890).
  - *Alpheus rostratipes* Pocock, 1890: Banner and Banner, 1968.
- *Salmoneus serratidigitus* (Coutière, 1896).
  - *Salmoneus sibogae* (De Man, 1910): Banner and Banner, 1968.
- *Salmoneus tricristatus* Banner, 1959: Banner and Banner, 1968.
- *Synalpheus carinatus* (De Man, 1888): Banner and Banner, 1968.
- *Synalpheus charon* (Heller, 1861): Banner and Banner, 1968.
- *Synalpheus* near *coutierei* Banner, 1953: Highsmith, 1981.
- *Synalpheus demani* Borradaile, 1900: Banner and Banner, 1968.
- *Synalpheus hastilicrassus* Coutière. 1905: Banner and Banner, 1968.
- *Synalpheus heroni* Coutière, 1909.†
- *Synalpheus paraneomeris* Coutière, 1905: Banner and Banner, 1968.
- *Synalpheus stimpsonii* (De Man, 1888): Banner and Banner, 1968.
- *Synalpheus tumidomanus* (Paulson, 1875): Banner and Banner, 1968; Highsmith, 1981.

Family HIPPOLYTIDAE
- †*Hippolyte* (?)*ventricosa* H. Milne-Edwards, 1837.
- †*Hippolyte* sp.
- †*Ligur uveae* (Borradaile, 1899).
- †*Lysmata vittata* (Stimpson, 1860).
- †*Lysmata* sp.
- †*Saron marmoratus* (Olivier, 1811).
- †*Saron neglectus* De Man, 1902.
- †*Thor amboinensis* De Man, 1888.
- †*Thor maldivensis* Borradaile, 1915.
- †*Thor paschalis* (Heller, 1862).

Family PROCESSIDAE
- *Nikoides steinii* (Edmondson, 1935).
  - *Nikoides nanus* Chace, 1955: Chace, 1955.
- †*Nikoides multispinatus* Hayashi, 1981.
- †*Processa* (?)*japonica* (De Haan, 1844).
- †*Processa molaris* Chace, 1955.
- †*Processa neglecta* Hayashi, 1975.

Superfamily PANDALOIDEA

Family PANDALIDAE
- *Micropandalus hardingi* Bruce, 1983: Bruce, 1983.

Family THALASSOCARIDIDAE
- †*Thalassocaris crinata* (Dana, 1852).

Superfamily CRANGONOIDEA

Family CRANGONIDAE
- †*Pontophilus* sp. aff. *P. sabsechota* Kemp, 1911
- †*Vercoia gibbosa* Baker, 1904.

†New records for Enewetak.

(This table continued on next page.)

TABLE 1 (cont'd)

Infraorder PALINURA
  Superfamily PALINUROIDEA
    Family SYNAXIDAE
      †*Palinurellus wieneckii* (De Man, 1881).
    Family PALINURIDAE
      †*Panulirus longipes femoristriga* (von Martens, 1872).
      Panulirus pencillatus (Olivier, 1791): Ford et al., 1979; Cooke and MacDonald, 1981; Ebert and Ford, 1986.
    Family SCYLLARIDAE
      †*Parribacus antarcticus* (Lund, 1793).

†New records for Enewetak.

STENOPODIDEA

Identified stenopodid shrimps determined from Enewetak include the pantropical banded coral shrimp, *Stenopus hispidus; S. tenuirostris*, from the western Indian Ocean, Philippines, and the western Pacific; *S. zanzibaricus*, from the western Indian Ocean and central Pacific (Canton Island); *Odontozona sculpticaudata*, known from Malayan and northeastern Australian waters; and two species of *Microprosthema*. One of these, *M. scabricaudatum*, has been recorded from the western Indian Ocean, New Guinea, and the Ryukyu's, whereas *M. plumicorne* has previously been recorded only from Mauritius in the western Indian Ocean. All of these stenopodid shrimps are apparently new records from the Marshall Islands. J. W. Goy (personal communication) has also identified *S. hispidus* from Jaluit Atoll (USNM specimens). Recently, an undescribed species of *Odontozona* was found and awaits description.

CARIDEA

One widely distributed Indo-West Pacific pasiphaeid shrimp, a species of *Leptochela*, is known from Enewetak and several other Marshall Islands (Chace, 1955; 1976). It was said to have been the most common decapod found during the 1946 and 1947 survey and was collected at night on the surface using a light.

Four species of rhynchocinetid shrimps are recorded: *Rhynchocinetes hiatti* occurs at Enewetak as well as several other Pacific island areas; *R. hendersoni*, reported as a new species *(R. marshallensis)* from Enewetak by Edmondson (1952), is a wide-spread Indo-West Pacific form (Holthuis and Hayashi, 1967); a species approaching *R. rigens* is newly recorded from the atoll; a fourth species is as yet undetermined and awaits description (Holthuis, personal communication).

Palaemonid shrimps known from Enewetak are represented by 43 identified and 10 unidentified species in 18 genera. All but two species are members of the subfamily Pontoniinae. Rosewater (1965) reported a species of *Paranchistus* and Fankboner (1972) a species of *Anchistus* as symbionts from tridacnid clams. *Anchistus australis* and three species of *Conchodytes* can now be added to the list of symbionts associated with tridacnid and ostreid bivalves at Enewetak. *Paratypton siebenrocki*, a species forming galls in *Acropora* coral, was recorded from Enewetak by Bruce (1969). Two widely distributed Indo-West Pacific species of *Palaemonella (P. pottsi* and *P. rotumana)* were reported from Enewetak by Bruce (1970), the former a commensal on the crinoid *Comanthus bennetti* but more recently found on two additional crinoid species (Table 2). *Periclimenes soror*, a symbiont on many tropical asteroids, was first recorded from Enewetak by Bruce (1978). Laboratory sponsored projects in 1974 led to the collection and description of eight pontoniine shrimps, one being new and five being widely distributed tropical species previously unrecorded from the Marshall Islands (Bruce, 1979a). Four of these species were associated with sea anemones; one each was found on a sea star, sponge, and tridacnid clam; and one is apparently a free-living form. A reef coral workshop held at the Mid-Pacific Research Laboratory (MPRL) in 1976 led to the collection and description of a new genus and species of pontoniine shrimp associated with a stony coral (Bruce, 1979b). Studies on the commensals and parasites associated with comatulid crinoids (feather-stars) by Ann Fielding and Dennis Devaney in 1976 resulted in finding seven pontoniine and three alpheid shrimps as well as a galatheid and a brachyuran crab (Table 2). One of the pontoniines, *Periclimenes pilipes*, is a species described as new from Enewetak (Bruce and Zmarzly, 1983). A study detailing the biological relationships between Enewetak crinoids, their symbiotic crustaceans, and other invertebrates has recently been published (Zmarzly, 1984). Two species of *Harpiliopsis* and one species of *Fennera* are symbionts on pocilliporid corals. Similarly, the five species of *Coralliocaris* and two species of *Philarius*, herein recorded from Enewetak for the first time, are also symbionts of *Acropora* corals in other parts of the Indo-West Pacific (Bruce, 1974). Thirty of the 48 identified pontoniine shrimps recorded from Enewetak are also known from Heron Island, Australia (Bruce, 1981). The remainder are, with few exceptions, widespread tropical Indo-West Pacific or pantropical species. All but three *(Anchistus demani, Onycocaris stenolepis*, and *Pontonia hurii)* of the 20 pontoniines recorded by Holthuis

TABLE 2

Symbiotic Decapod Crustacea Associated with Crinoids at Enewetak Atoll

Symbiont*	Host crinoid†	No. symbionts/ No. hosts
	Palaemonidae	
Araiopontonia odontorhyncha	*Comanthus bennetti*	1/7
Palaemonella pottsi	*Comanthus parvicirrus*	1/2
	Comaster gracilis	3/6
Periclimenes? amboinensis	*Comanthus bennetti*	4/7
	Comanthus parvicirrus	1/2
Periclimenes commensalis	*Comanthus bennetti*	5/7
Periclimenes tenuis	*Comanthus bennetti*	1/7
Periclimenes pilipes	*Comanthus parvicirrus*	1/2
	Comanthina schegeli	1/2
Pontoniopsis comanthi	*Comanthus bennetti*	1/7
	Comanthus parvicirrus	1/2
	Alpheidae	
Athanas sp.	*Comaster gracilis*	2/6
Synalpheus carinatus	*Comanthina schegeli*	2/2
	Comanthus parvicirrus	1/2
Synalpheus stimpsoni	*Comanthus bennetti*	1/2
	Comanthus parvicirrus	1/7
	Comaster gracilis	5/6
	Galatheidae	
Allogalathea elegans	*Comanthina schegeli*	2/2
	Comanthus bennetti	3/7
	Parthenopidae	
Harrovia elegans	*Comaster gracilis*	2/6

*Determinations or verifications of palaemonids made by AJB; alpheids by A. H. Banner; galatheid by K. Baba; parthenopid by Ann Fielding.

†Determinations of *Comanthina schegeli* and *Comanthus parvicirrus* resulted from work by Debbie Zmarzly, Scripps Institution of Oceanography, during her more extensive research on crinoid ecology and symbionts in 1980.

(1953) from other atolls in the Marshall Islands have been found at Enewetak.

The gnathophyllid shrimp, *Hymenocera picta,* has been observed at Kwajalein and Enewetak atolls. At Enewetak, a pair was seen at night well back in a cave (S. Johnson, personal communication) and a specimen photographed in the Enewetak quarry. An ovigerous specimen of *Gnathophyllum americanum* was collected in the Enewetak lagoon. Both gnathophyllids are widely distributed throughout the Indo-West Pacific region; the latter species is also found in the tropical eastern Pacific and Caribbean.

Three species of alpheid shrimps were recorded at Enewetak by Chace (1955) based on collections from the northern Marshall Islands. More intensive study on Enewetak alpheids was made by A. H. Banner in February and March 1957. The results of this latter work (Banner and Banner, 1960; 1968) increased the known number of alpheids from Enewetak to 49 species including two new species of *Athanas* (three species of *Athanas* listed only from "Marshall Islands" in these two papers include specimens from Enewetak). The 1968 paper is especially important in providing station data with collection locality, depth, and habitat.* Beginning in 1976, examination of symbionts associated with comatulid crinoids at Enewetak revealed two species of *Synalpheus (S. carinatus* and *S. stimpsoni)* and an undetermined species of *Athanas* (Table 2). One or more species of alpheids have also been observed together with gobiid fishes in burrows made in Enewetak Lagoon sediment. Seven alpheid species were found by Highsmith (1981) as associates of six different corals. Only two, *Alpheus acutofemoratus* and *A. parvirostris*, were found in more than two coral heads of the same species, and the former alpheid was found in all but one of the corals studied. Altogether, 52 identified alpheid species in seven genera are now known from Enewetak of

*In 1961 a fire destroyed many of the specimens upon which these two papers were based (Banner and Banner, 1961). Fortunately, representatives of most of the species were deposited in the MPRL reference collection and are still available.

which two are new records. Nearly 80% (42 species) are broad ranging Indo-West Pacific forms, many recorded as far as the Red Sea as well as Indian and Pacific Oceans. An additional 10% (5 species) are pantropical with the balance showing a more restricted distribution. An additional 22 alpheid taxa were recorded from atolls other than Enewetak in the Marshall Islands (Banner, 1957; Banner and Banner, 1968). Several of these are now considered synonyms of species recorded herein from Enewetak, while the others may be expected to occur there (Table 3).

Eight identified hippolytid shrimps—members of the genera *Hippolyte, Ligur, Lysmata, Saron,* and *Thor*, each with a broad Indo-West Pacific distribution—are newly recorded from Enewetak. Two of these, *S. marmoratus* and *S. neglectus*, were also recorded from the southern Marshall Islands (Holthuis, 1953). Also, a new species of *Hippolyte*, to be reported at a later date (Holthuis, personal communication) and at least one undescribed *Lysmata*, have been found at Enewetak.

Among processid shrimps now known from Enewetak, one species of *Nikoides* was previously recorded from this atoll as well as Bikini, whereas a second species, *N. sibogae*, was collected only at Bikini (Chace, 1955). A third species, *N. multispinatus*, is newly recorded and was originally reported from the Great Barrier Reef and Ishigakijima Island, Japan. Three species of *Processa* including *P. molaris*—a new species recorded by Chace from Rongelap and Bikini—are now recorded from Enewetak.

A new genus and species of symbiotic pandalid shrimp, *Miropandalus hardingi*, has been found on branching black coral in waters off the seaward side of Enewetak Atoll (Bruce, 1983).

Thalassocaris crinita, is newly recorded from Enewetak. This species is known from Indonesia and other Indo-

TABLE 3

Non-Enewetak Marshall Island Alpheid Shrimp Records

Species	Present status*	Atoll
† *Alpheus amirantei* Coutière	Valid	Arno
† *A. arnoa* Banner	Valid	Arno
A. collumianus †*probabilis* Banner	*A. collumianus* Stimpson (Banner and Banner, 1981)	Arno
‡ *A. crockeri* Armstrong	Valid	Bikini
† *A. deuteropus* Hilgendorf	Valid	Arno
†‡ *A. gracilipes* Stimpson	Valid	Arno, Bikini, Rongerik
‡ *A. gracilis* var. *simplex* Banner	*A. gracilis* Heller (Banner and Banner, 1982)	Arno
† *A. lutini* Coutière	*A. obesomanus* Dana (Banner and Banner, 1966)	Arno
‡ *A. malleodigitus* (Spence-Bate)	Valid	Bikini, Rongelap
‡ *A. miersi* Coutière	Valid	Bikini
† *A. nanus* (Banner)	*Metalpheus rostratipes* (Pocock) (Banner and Banner, 1964)	Arno
A. paracrinitus var. †*bengalensis* Coutière	*A. paracrinitus* Miers (Banner and Banner, 1982)	Arno
†‡ *A. percyi* Coutière	Valid	Arno, Rongerik
‡ *A. styliceps* Coutière	Valid	Bikini, Rongelap
‡ *A. superciliaris* Coutière	Valid	Rongerik
† *A. ventrosus* H. Milne Edwards	*A. lottini* Guérin (Banner and Banner, 1981)	Arno
‡ *Alpheus* sp. No. IV	Incomplete specimen, still undescribed	Rongelap
‡ Aretopsis amabilis de Man	Valid	Rongelap
† *Metabetaeus minutus* (Whitelegge)	Valid	Arno
† *Synalpheus coutierei* Banner	Valid	Arno
‡ *S. laticeps* Coutière	Valid	Rongelap
† *S. lophodactylus* Coutière	Valid	Arno

*D. M. Banner (personal communication).
†Recorded in Banner, 1957.
‡Recorded in Banner and Banner, 1968.

Pacific waters including the Marshall Islands (Chace, 1955).

Two crangonid shrimps were taken in the Enewetak Lagoon. One is possibly a new species of *Pontophilus*, whereas the other, *Vercoia gibbosa*, was previously known only from south Australia.

PALINURA

At least four palinuran lobsters are represented at Enewetak. *Panulirus penicillatus* is a common inhabitant of the windward reef flat and was recorded from Arno Atoll in the southern Marshall Islands (Holthuis, 1953). This spiny lobster was the focus of population and other life history studies at Enewetak during 1978 and 1979 (Ford et al., 1979; Ebert and Ford, 1986). Juvenile (puerulus and post-puerulus) stages of this wide-spread Indo-West Pacific rock lobster have been recorded by Cooke and McDonald (1981) from Enewetak. Three specimens of *P. longipes femoristriga* were identified from a collection made in a surge channel near the outer reef. Although not previously reported from the Marshall Islands, this subspecies is reported widely from Japan, the Moluccas, New Guinea, eastern Australia and Polynesia (George and Holthuis, 1965). *Panulirus versicolor*, recorded by Holthuis (1953) from Arno, has not been reported at Enewetak. *Parribacus antarcticus* and *Palinurellus wieneckii* are now known from Enewetak. Although each of the last two species has a broad Indo-West Pacific distribution, only *P. antarcticus* had previously been recorded from the Marshall Islands (Arno) by Holthuis (op. cit.). The latter has also been recognized in waters off Kwajelein Atoll (S. Johnson, personal communication).

COLLECTION RECORDS

Taxa are listed in the same order as in the checklist under their respective families. Higher categories may be found in the checklist. These records are not known to have been previously published. When known, the islet, month, year, habitat, depth, collector, identifier, and number of specimens are given. Many of the specimens collected between 1956 and 1971 and determined by L. B. Holthuis (LBH) are deposited at the Allan Hancock Foundation. Other specimens have been deposited in several institutions, mainly MPRL, BPBM (Honolulu), RMNH (Leiden), and USNM. Identifiers AJB and DMD refer to the authors; other identifiers are named in full.

Family PENAEIDAE

Metapenaeopsis borradailei (De Man)

Enewetak Islet: Sept. 1980, lagoon, north end of islet, in sandy substrate using airlift, 12 m, DMD and P. Colin, id. LBH; 1 spec. (juv. F). Medren Islet: Aug. 1956, lagoon side, light at night, id. LBH; 1 spec.

Metapenaeopsis sp.

Aomon, Bijile, Lojwa Islets: July 1959, lagoon side, sand bottom, 1.8 to 7.3 m, F. C. Ziesenhenne, id. LBH; 1 spec. Enewetak Islet: Feb. 1982, on sand at night ("burying shrimps"), 5 m, S. Johnson, id. LBH; 1 spec. (M). Medren Islet: July 1959, lagoon side, sand bottom, 2.4 to 4.7 m, J. S. Garth, id. LBH; 1 spec.

Family SICYONIIDAE

Sicyonella maldivensis Borradaile

Medren Islet: Aug. 1956, lagoon side, light at night, id. LBH; 9 spec. (3 lots).

Family STENOPODIDAE

Microprosthema plumicorne (Richters)

Enewetak Islet: Dec. 1981, lagoon, under dead *Acropora*, 4 m, S. Johnson, id. P. Galloway and DMD; 1 spec., ovig.; BPBM.

Microprosthema scabricaudatum (Richters)

Alembel Islet: July 1959, lagoon side, *Acropora* coral, J. S. Garth, id. LBH; 1 spec.; BPBM.

Odontozona sculpticaudata Holthuis

Medren Islet: Feb. 1982, lagoon side, under dead coral, 5 m, S. Johnson, id. DMD; 1 spec., ovig.; BPBM.

Odontozona sp.

Lagoon: Sept. 1982, in submerged part of cement ship at night, 5 m, S. Johnson; 1 spec.; April 1983, exposed on rather silty bottom next to bulkhead of submerged part of cement ship, at night (ca. 2030 h), 5 m, S. Johnson; 2 spec.

Stenopus hispidus (Olivier)

Biken Islet: July 1975, oceanside, rotenone station, 9 m, P. B. Lamberson, id. DMD; 1 spec.; BPBM. Reefer 8 Pinnacle: June 1982, in cave, 8 m, S. Johnson, id. DMD; 2 spec. (1 ovig., 1 male); BPBM.

Stenopus tenuirostris De Man

Enewetak Atoll: May 1983, lagoon, under sheet of aluminum debris, 3 m, S. Johnson; id. DMD; 1 spec.; BPBM.

Stenopus zanzibaricus Bruce

Enewetak Islet: May 1983, lagoon, under sheet of aluminum debris, 3 m, S. Johnson, id. DMD; 2 spec.; BPBM.

Family RHYNCHOCINETIDAE

Rhynchocinetes hiatti Holthuis and Hayashi

Enewetak Atoll: May 1978, algal ridge, recovered from fish poison (rotenone) station, id. AJB; 5 spec. (juv.).

Rhynchocinetes rigens Gordon

Japtan Islet: Feb. 1982, lagoon, in submerged metal locker, 12 m, S. Johnson, id. LBH; 2 spec.

Rhynchocinetes sp. aff. *R. rigens*

Japtan Islet: May 1978, lagoon side, 100 yds. off pier at base of coral head, id. LBH; 1 spec. Lagoon Mooring Buoy Pinnacle: Feb. 1982, on ledge, night, 10 m, S. Johnson, id. LBH; 1 spec; BPBM.

Family PALAEMONIDAE

Anchistus australis Bruce

Ananij Islet: Aug. 1968, in *Tridacna squamosa* (Lam.), J. W. Knudsen, id. AJB; 1 spec. (ovig.). Jinderol Islet: March 1961, probably in *Tridacna noae* (Röding) [*Tridacna maxima* (Röding)], R. Palumbo, id. LBH; 2 spec., ovig. Medren Islet: July 1959, reef between south end of islet and wreck on reef, under large pancake coral cemented to reef, F. Ziesenhenne, id. LBH; 1 spec., ovig.

Anchistus miersi (De Man)
Alembel Islet: July 1959, north side, *Acropora* coral, J. S. Garth, id. LBH; 3 spec. Bokoluo Islet: Feb. 1968, in *Tridacna* sp., J. W. Knudsen, id. AJB; 2 spec. (ovig.). Jinedrol Islet: March 1961, lagoon side, probably in *Hippopus hippopus*, shallow water, R. Palumbo, id. LBH; ? spec.

Ariopontonia odontorhyncha Fujino and Miyake
Medren Islet: July 1975, ocean side, on crinoid *Comanthus bennetti*, 12 m, Lamberson, id. AJB; 1 spec. Medren Islet: Feb. 1976, lagoon, ca. ½ mile off islet, on crinoid *C. bennetti*, 6 to 9 m, D. M. Devaney and A. Fielding, id. AJB; 2 spec. (1 male, 1 ovig. female); BPBM.

Brachycarpus biunguiculatus (Lucas)
Biken Islet: May 1946, 2 miles south of islet, leeward side of reef, light at night, L. P. Schultz, id. LBH; 19 spec.

Conchodytes biunguiculatus (Paulson)
Pole Pinnacle: Nov. 1977, lagoon, 30.4 m, coll. and id. Ann Fielding; ? spec.

Conchodytes meleagrinae Peters
Enewetak Islet: April 1961, lagoon side, in *Pinctada? galtsoffi*, 6 m, E. S. Reese, id. J. Yaldwyn; 2 spec. (1 male, 1 female).

Conchodytes tridacnae Peters
Lojwa Islet: Feb. 1971, inside *Tridacna gigas*, J. Shoup, id. LBH; 4 spec. (2 ovig.). July 1976, inside *Tridacna maxima*, id. Ann Fielding; ? spec.

Coralliocaris brevirostris Borradaile
Enewetak Islet: July 1967, in *Acropora corymbosa*, just behind algal ridge, J. W. Knudsen, id. AJB; 1 spec., ovig.

Coralliocaris graminea (Dana)
Alembel Islet: July 1959, lagoon, north side, *Acropora*, J. S. Garth, id. LBH; 2 spec. Ananij Islet: Feb. 1957, lagoon side, dead *Acropora*, 1.8 m, A. H. Banner, id. LBH; 3 spec. Ananij Islet: Jan. 1960, lagoon side, north end, *Acropora*, E. S. Reese, id. LBH; 2 spec. Ananij Islet: Jan. 1960, lagoon side, from *Seriatopora*, E. S. Reese, id. LBH; 2 spec. Biken Islet: Feb. 1957, ocean side, inner edge reef flat, on *Acropora* and *Pocillopora*, 0.5 m, A. H. Banner, id. LBH; 2 spec., (1 male, 1 ovig.). Ikuren Islet: July 1959, ocean side, *Acropora*, J. S. Garth, id. LBH; 2 spec. Medren Islet: July 1959, lagoon side, living *Acropora*, J. Coatsworth, id. LBH; 1 spec.

Coralliocaris nudirostris (Heller)
Boken Islet: July 1957, southeast side, living coral, J. S. Garth, id. LBH; 1 spec. (female). Enewetak Islet: April 1961, in *Acropora hyacinthus*, E. S. Reese, id. LBH; 2 spec. Medren Islet: July 1959, lagoon side, coral, 3.6 to 4.7 m, J. Coatsworth, id. LBH; 2 spec.

Coralliocaris superba (Dana)
Biken Islet: Aug. 1956, ocean side in coral head on reef flat, common, found among coral branches, id. LBH; 1 spec. Boken Islet: July 1957, southeast side, living coral, J. S. Garth, id. LBH; 1 spec. Bokoluo Islet: March 1968, in *Acropora digitifera*, on ocean reef flat, J. W. Knudsen, id. AJB; 1 spec., (male). Enewetak Islet: April 1961, in *Turbinaria? danae*, E. S. Reese, id. LBH; 1 damaged spec., identity not fully certain. Enjebi Islet: July 1959, shore, F. C. Ziesenhenne, id. LBH; 2 spec. Japtan Islet: Jan. 1960, lagoon side, north end, *Acropora*, E. S. Reese, id. LBH; 2 spec. Jinimi Islet: July and Aug. 1961, lagoon side, 4.7 m, J. Shoup, id. LBH; 2 spec.

Coralliocaris venusta Kemp
Enewetak Islet: Lagoon coral mound, ¼ mile off islet, from live *Acropora*, 10 m, coll. S. Swerdloff, id. AJB; 1 spec. (ovig.). Enewetak Islet: Aug. 1969, lagoon, in *Acropora* sp., 10 m, J. W. Knudsen, id. AJB; 1 spec. (ovig.).

Fennera chacei Holthuis
Enewetak Islet: Feb. 1976, ocean side, coll. with crinoid *Comanthus schelegi*, 23 m, P. Lamberson, id. AJB; 1 spec.

Harpiliopsis beaupresii (Andouin)
Biken Islet: July and Aug. 1961, lagoon side, 2.4 m, J. Shoup, id. LBH; 5 spec. Boken Islet: July 1957, southeast side, *Pocillopora* coral, J. S. Garth, id. LBH; 5 spec. Enjebi Islet: July 1959, shore, F. C. Ziesenhenne, id. LBH; 2 spec. Japtan Islet: Jan. 1960, lagoon side, *Pocillopora* coral, 3 m, E. S. Reese, id. LBH; 2 spec. Medren Islet: July 1957, lagoon side, coral heads, 3 to 4.7 m, J. S. Garth, id. LBH; 1 spec. Medren Islet: July 1959, lagoon side, from *Pocillopora damicornis*, 3.6 to 4.7 m, J. Coatsworth, id. LBH; 2 spec.

Harpiliopsis depressa (Stimpson)
Ananij Islet: Feb. 1957, lagoon side, *Pocillopora* coral, 1.8 m, A. H. Banner, id. LBH; 2 spec. Biken Islet: July to Aug. 1961, lagoon side, 2.4 m, J. Shoup, id. LBH; 10 spec. Enewetak Islet: April 1961, in *Seriatopora? hystrix*, E. S. Reese, id. LBH; 2 spec. Enewetak Islet: July and Aug. 1961, lagoon side, 7.7 and 12 m, J. Shoup, id. LBH; 8 spec. (2 lots). Ikuren Islet: July 1959, coral, J. S. Garth, id. LBH; 3 spec.

Harpiliopsis spinigera (Ortmann)
Lojwa Islet: July 1967, behind reef on south side of islet, dead and overgrown coral with small amount of live coral, in *Stylophora pistillata (mordax)*, 2 m, J. W. Knudsen, id. AJB; 1 spec.

Jocaste japonica (Ortmann)
Biken Islet: July and Aug. 1961, lagoon side, 2.4 m, J. Shoup, id. LBH; several spec.

Jocaste lucina (Nobili)
Alembel Islet: July 1959, north side, living *Acropora* coral, J. S. Garth, id. LBH; 1 spec. Ananij Islet: Feb. 1957, lagoon side, dead *Acropora* coral, 1.8 m, A. H. Banner, id. LBH; 2 spec. Ananij Islet: Jan. 1960, north end, lagoon side, *Acropora* coral, E. S. Reese, id. LBH; 2 spec. (2 lots). Biken Islet: Aug. 1956, ocean side, formalin washings from coral, D. Reish, id. LBH; 4 spec. Biken Islet: Feb. 1957, ocean side, inner edge reef flat, from coral, A. H. Banner, id. LBH; 1 spec. Biken Islet: July and Aug. 1961, lagoon side, 2.4 m, J. Shoup, id.

LBH; 3 spec. Boken Islet: July 1957, southeast side, living coral, J. S. Garth, id. LBH; 5 spec. Enjebi Islet: July 1959, shore, F. C. Ziesenhenne, id. LBH; 2 spec. Ikuren Islet: July 1959, ocean side, living *Acropora* coral, J. S. Garth, id. LBH; 1 spec. Japtan Islet: Jan. 1960, lagoon side, north end, *Acropora* coral, E. S. Reese, id. LBH; 2 spec. (2 lots). Jinimi Islet: July and Aug. 1961, lagoon side, 4.7 m, J. Shoup, id. LBH; 10 spec. Medren Islet: July 1959, lagoon side, living *Acropora*, J. Coatsworth, id. LBH; 3 spec.

Leandrites cyrtorhynchus Fujino and Miyake

Japtan Islet: Feb. 1982, lagoon off Japtan pier, in metal shrimp locker, 12 m, S. Johnson, id. LBH; 6 spec. (1 ovig.).

Onycocaris quadratophthalma (Balss)

Ikuren Islet: Aug. 1956, ocean side, sponges from under surfaces of rocks, D. J. Reish, id. LBH; 5 spec.

Palaemonella pottsi (Borradaile)

Enewetak Islet: Feb. 1976, ocean side, on crinoid *Comanthus parvicirrus*, 30 m, P. Lamberson, id. AJB; 1 spec. Enewetak Islet: Feb. 1976, lagoon (Mini Power Plant Pinnacle), on 3 crinoids *Comaster gracilis*, 6 to 12 m, D. M. Devaney, id. AJB: 6 spec. (3 lots: 1 ovig. and 1 juv.; 1 male; 3).

Palaemonella rotumana (Borradaile)

Biken Islet: Feb. 1957, ocean side, inner edge of reef flat, from coral, 0.5 m, A. H. Banner, id. LBH; 1 spec. Bokonbako Islet: July 1957, ocean side, old coral heads, 0.3 m, D. J. Reish, id. LBH; 1 spec.

Palaemonella tenuipes Dana

Enewetak Islet: July 1957, ocean side, reef flat, J. S. Garth, id. LBH; 4 spec. Medren Islet: Feb. 1957, lagoon side, mixed coral, 2.4 m, A. H. Banner, id. LBH; 1 spec. Medren Islet: July 1957, lagoon side, coral, 3 to 4.7 m, J. S. Garth, id. LBH; 2 spec.

Palaemonella sp.

Ananij Islet: Feb. 1957, lagoon side, *Acropora* coral, 1.8 m, A. H. Banner, id. LBH; 1 spec.

Paranchistus armatus (H. Milne Edwards)

Alembel Islet: Sept. 1956, lagoon side, from *Tridacna gigas*, id. LBH; 1 spec. Jinedrol Islet: March 1961, lagoon side, probably in *Tridacna gigas*, shallow water, R. Palumbo, id. LBH; 1 spec. ovig.

Periclimenaeus sp.

Medren Islet: Feb. 1957, lagoon, south end, patch reef about 600 ft offshore, surrounding bottom sand, three dead, overgrown coral heads *(Pocillopora, Acropora, Porites)* broken up, 2.4 m, A. H. Banner, id. LBH; 1 spec.

Periclimenes agag Kemp

Enewetak Lagoon: Jan. 1982, under dead coral, 5 m, S. Johnson, AJB; 1 spec.

Periclimenes ?amboinensis (De Man)

Enewetak Islet: Feb. 1976, ocean side, on crinoid *Comanthus parvicirrus*, 31 m, P. Lamberson, id. AJB; 1 spec. (juv.). Medren Islet: Feb. 1976, lagoon, ca. ½ mile off islet, on 3 crinoids *Comanthus bennetti*, 6 to 9 m, DMD and A. Fielding, id. AJB; 6 spec. (3 lots, each with male and ovig. female).

Periclimenes bayeri Holthuis

Enewetak Islet: April 1961, from *Pocillopora verrucosa* or *P. elegans* coral, E. S. Reese, id. LBH; 3 spec. Enewetak Islet: July and Aug. 1961, ocean side, *Pocillopora? elegans* coral, 1.5 m, J. Shoup, id. LBH; 2 spec. Enewetak Islet: July and Aug. 1961, lagoon side, 7.7 m, J. Shoup, id. LBH; 2 spec.

Periclimenes commensalis Borradaile

Enewetak Islet: Feb. 1976, lagoon pinnacle ca. ½ to 1 mile off islet, on crinoid *Comanthus bennetti*, 5 m, DMD and A. Fielding, id. AJB; ? spec. Medren Islet: Feb. 1976, lagoon, ca. ½ mile off islet, on 4 crinoids *Comanthus bennetti*, 6 to 9 m, DMD and A. Fielding, id. AJB; 54 spec. (4 lots: 16; 4 plus post-larva: 22 including 1 ovig.; 9 including 2 ovig.).

Periclimenes cristimanus Bruce

Enewetak Islet: Aug. 1968, rock quarry, on sea urchin *Echinothrix calamaris*, J. W. Knudsen, id. AJB; 6 spec. (2 lots, one with 5 including ovig., another with 1 ovig.).

Periclimenes denticulatus Nobili

Billae and Runit Islet: July 1967, acroporid coral and algae in lagoon dredge hauls between the two islets, 29 to 32 m, J. W. Knudsen (Stn. 353), id. AJB; 2 spec.

Periclimenes elegans (Paulson)

Alembel Islet: Feb. 1957, reef flat, coral, 0.6 m, A. H. Banner, id. LBH; 1 spec. (discarded–moldy). Ananij Islet: July 1957, ocean side, reef flat, J. S. Garth, id. LBH; 1 spec. Biken Islet: July 1959, southeast side between ocean and lagoon, rock with sand substrate, dead coral, J. S. Garth, id. LBH; many spec. Bokoluo Islet: Aug. 1968, ocean reef, from *Porites* sp., J. W. Knudsen, id. AJB; 1 spec., ovig. Bokonbako Islet: July 1957, lagoon side, old coral heads, D. Reish, id. LBH; 1 spec. Enewetak Islet: July 1957, ocean side, reef flat, J. S. Garth, id. LBH; 5 spec. Enewetak Islet: Aug. 1968, J. W. Knudsen, id. AJB; 4 spec. (1 ovig.). Enjebi Islet: July 1957, ocean side, reef flat, J. S. Garth, id. LBH; 1 spec. Japtan Islet: Aug. 1968, inner reef flat pool, J. W. Knudsen, id. AJB; 7 spec. (3 ovig.). Japtan Islet: Aug. 1968, lagoon tide pools, J. W. Knudsen, id. AJB; 13 spec. (5 male, 8 female with 7 of these ovig.). Japtan Islet: Aug. 1968, reef flat pool, poison station, J. W. Knudsen, id. AJB; 7 spec., (2 ovig.). Lojwa Islet: July 1967, in *Stylophora pistillata (mordax)* 1.5 m, J. W. Knudsen, id. AJB; 1 spec. Lojwa Islet: Ocean reef pool, J. W. Knudsen, id. AJB; 1 spec. (male).

Periclimenes ensifrons (Dana)

Lujor Islet: June 1946, outside lagoon, intertidal, M. W. Johnson, id. LBH; 1 spec. (ovig.).

Periclimenes grandis (Stimpson)

Kedrol Islet: May 1946, intertidal, in pot holes, M. W. Johnson, id. LBH; 1 spec.

Periclimenes holthuisi Bruce

Enewetak Islet: March 1982, lagoon side, found in exposed tentacles of poritid coral (*Alveopora* or

Goniopora), 25 m, S. Johnson, id. DMD; 2 spec., (1 ovig., 1 juv.).

Periclimenes seychellensis Borradaile
Medren Islet: July 1957, lagoon side, algae on coral, D. J. Reish, id. LBH; 1 spec.

Periclimenes spiniferus (De Man)
Jinimi Islet: July and Aug. 1961, lagoon side, 4.7 m, J. Shoup, id. LBH; 4 spec.

Periclimenes tenuis Bruce
Enewetak Islet: Feb. 1976, lagoon pinnacle ca. ½ to 1 mile off islet; on crinoid *Comanthus bennetti*, 5 m, DMD and A. Fielding, id. AJB; 7 spec.

Philarius gerlachei (Nobili)
Alembel Islet: July 1959, near shore. F. C. Ziesenhenne, id. LBH; 1 spec. Boken Islet: July 1957, southeast side, living coral, J. S. Garth, id. LBH; 1 spec. Enewetak Islet: April 1961, in *Acropora hyacinthus* coral, E. S. Reese, id. LBH; 2 spec. (1 male, 1 female). Jinimi Islet: July and Aug. 1961, lagoon side, 4.7 m, J. Shoup, id. LBH; 2 spec. Medren Islet: July 1957, lagoon, coral, 3 to 4.7 m, J. S. Garth, id. LBH; 1 spec. Medren Islet: July 1959, lagoon side, coral, 3.6 to 4.7 m, J. Coatsworth, id. LBH; 1 spec.

Philarius imperialis (Kubo)
Ananij Islet: Jan. 1960, lagoon side, north end, *Acropora*, E. S. Reese, id. LBH; ? spec. Japtan Islet: Jan. 1960, lagoon side, north end, *Acropora*, E. S. Reese, id. LBH; 4 spec.

Philarius ?imperialis (Kubo)
Enewetak Islet: April 1961, in *Acropora hyacinthus* and *Pocillopora damicornis*, E. S. Reese, id. LBH; 9 spec. (2 lots). Enewetak Islet: July to Aug. 1961, lagoon side, 7.7 and 12 m, J. Shoup, id. LBH; 3 spec. (2 lots).

Pontoniopsis comanthi Borradaile
Enewetak Islet: Feb. 1976, ocean side, on crinoid *Comanthus parvicirrus*, 30 m, P. Lamberson, id. AJB; 2 spec. (1 male and 1 ovig. female). Medren Islet: Feb. 1976, lagoon, ca. ½ mile off islet, on crinoid *Comanthus bennetti*, 6 to 9 m, DMD and A. Fielding, id. AJB; 2 spec. (1 male and 1 ovig. female).

Stegopontonia commensalis Nobili
Enewetak Islet: Aug. 1968, on sea urchin *Diadema setosum*, J. W. Knudsen, id. AJB; 1 spec.

Family GNATHOPHYLLIDAE

Gnathophyllum americanum Guerin-Meneville
Enewetak Islet: July 1982, lagoon, under dead coral, 5 m, S. Johnson, id. AJB; 1 spec. (ovig.).

Hymenocera picta Dana
Enewetak Islet: 1982, quarry, 1 to 2 m, via color photo by S. Johnson.

Family ALPHEIDAE

Alpheus leviusculus Dana
Japtan Islet: July 1957, seaward reef flat, rock with loose dead coral and coral sand, 0.5 m tide, J. S. Garth, id. A. H. Banner *Synalpheus heroni* Coutière. Enewetak Atoll: March 1957, data destroyed in fire, id. A. H. Banner; 1 spec.

Synalpheus heroni Coutière

Family HIPPOLYTIDAE

Hippolyte ?ventricosa H. Milne Edwards
Medren Islet: July 1957, lagoon side, algae attached to old coral head, D. J. Reish, id. LBH; 2 spec.

Hippolyte sp.
Medren Islet: Sept. 1956, sediment bucket suspended at deep water pier, 22 day exposure, D. J. Reish, id. LBH; 2 spec.

Ligur uveae (Borradaile)
Cement Ship: Sept. 1982, inside portion of submerged part of ship, at night, 2 to 5 m, S. Johnson, id. AJB; 2 spec. (ovig.).

Lysmata vittata (Stimpson)
Enewetak Islet: May 1946, surface, L. P. Schultz, id. LBH; 2 spec. (ovig.).

Lysmata sp.
Enewetak Islet: Oct. 1982, algal ridge, from rotenone station, J. Randall, id. AJB; 1 spec. (ovig.). Medren Islet: July 1957, lagoon, old coral heads from 1.5 m of water, D. J. Reish, id. LBH; 1 spec., (incomplete).

Saron marmoratus (Olivier)
Biken Islet: Aug. 1956, ocean side, far end of island, formalin wash from brown staghorn coral, D. J. Reish, id. LBH; 2 spec. Biken Islet: July 1959, southeast side, between ocean and lagoon, rock with sand substrate, dead coral, J. S. Garth, id. LBH; 6 spec. Enewetak Islet: July and Aug. 1957, lagoon side, 5 m, J. Shoup, id. LBH; 2 spec. Jinimi Islet: July and Aug. 1957, lagoon side, 5 m, J. Shoup, id. LBH; 2 spec. Medren Islet: Feb. 1957, lagoon side, bottom sand, from two overgrown heads of *Pocillopora* and one branching *Acropora* plus bases, 2.4 m, A. H. Banner, id. LBH; 2 spec. Medren Islet: July 1957, lagoon side, coral, 3 to 4.7 m, J. S. Garth, id. LBH; 2 spec.

Saron neglectus De Man
Ananij Islet: Jan. 1960, lagoon side, off north end, from *Seriatopora hystrix*, E. S. Reese, id. LBH; 3 spec. Medren Islet: July 1957, lagoon side, coral heads and dead coral, 3 to 4.7 m, J. S. Garth, id. LBH; 2 spec.

Thor amboinensis (De Man)
Billae Islet: Aug. 1968, on anemone *Phymanthus paumotensis*, 1 to 2 m, J. W. Knudsen, id. AJB; 1 spec. Medren Islet: Feb. 1957, lagoon side, mixed coral, 2.4 m, A. H. Banner, id. LBH; 2 spec. (1 ovig.). Medren Islet: Feb. 1982, lagoon side, under dead coral, 5 m, S. Johnson, id. A. Fielding; 1 spec.

Thor maldivensis De Man
Medren Islet: July 1957, lagoon side, coral heads and dead coral, 3 to 4.7 m, T. Goreau and R. Neshida, id. LBH; 1 spec. (ovig.).

Thor paschalis (Heller)
Ananij Islet: Feb. 1957, lagoon side, *Acropora*, 1.8 m, A. H. Banner, id. LBH; 1 spec. Bokonbako Islet: July 1957, ocean side, old coral heads, 0.3 m, D. J. Reish, id. LBH; 2 spec. Medren Islet: Feb. 1957, lagoon side, south end, patch reef about 600 ft offshore, surrounding

bottom sand, 3 dead, overgrown coral heads, *Pocillopora, Acropora, Porites*, broken up, 2.4 m, A. H. Banner, id. LBH; 2 spec. Medren Islet: July 1957, ocean side, old coral heads, 0.3 m, D. J. Reish, id. LBH; 2 spec. Medren Islet: July 1957, coral heads and dead coral, 3 to 5 m, T. Goreau and R. Neshida, id. LBH; 1 spec.

Family PROCESSIDAE

Nikoides steinii (Edmondson)

Boken Islet: Sept. 1956, ocean side, opposite channel entrance, cemented coarse coral sand rock, D. J. Reish, id. LBH; 1 spec.

Nikoides multispinatus Hayashi

Enewetak Islet: Jan. 1982, lagoon at night, 5 m, under dead *Acropora* coral, S. Johnson, id. K. I. Hayashi, 2 spec. (ovig.).

Processa ?japonica (De Man)

Medren Islet: Lagoon side, dredging opposite middle of island, sand bottom, 2 to 3 fms. F. C. Ziesenhenne, id. LBH; 1 spec. (ovig.).

Processa molaris Chace

Biken Islet: Feb. 1957, ocean side, inner edge of outer reef flat, from coral, 0.5 m, A. H. Banner, id. LBH; 1 spec. (ovig.). Enjebi Islet: July 1959, shore, 0.3 m tide, F. C. Ziesenhenne, id. LBH; 1 spec. Medren Islet: July 1957, lagoon side, coral, 3 to 4.5 m, J. S. Garth, id. LBH; 1 spec.

Processa neglecta Hayashi

Medren Islet: June 1957, lagoon side, sand and worm tubes, 3 m, D. J. Reish, id. LBH; 2 spec.

Family PANDALIDAE

Miropandalus hardingi Bruce

Ribewon Islet: June 1982, on branch of antipatharian (black coral) in small cave, 23 m, S. Johnson, id. AJB; 1 spec (M).

Family THALASSOCARIDIDAE

Thalassocaris crinata (Dana)

Lagoon (11°26′N, 162°18′E): Aug. 1968, dredge, 60 m, J. Knudsen, id. AJB; 2 spec.

Family CRANGONIDAE

Pontophilus sp. aff. *P. sabsechota* Kemp

Medren Islet: July 1959, lagoon side, dredging opposite middle of island, sand bottom, 3.5 to 6 m, F. C. Ziesenhenne, id. LBH; 1 spec.

Vercoia gibbosa Baker

Medren Islet: 1982, small lagoon pinnacle at night, L. Boucher, id. AJB; 1 spec.

Family SYNAXIDAE

Palinurella wieneckii (De Man)

Enewetak Pinnacle: June 1981, in small cave, 10 m, coll. and id. S. Johnson; 1 spec. (carapace of molt).

Family PALINURIDAE

Panulirus longipes femoristriga (von Martens)

Enewetak Islet: Oct. 1969, ocean side surge channel, poison station, 0 to 8 m in channel, C. A. Child, id. LBH; 3 spec. USNM.

Panulirus penicillatus (Olivier)

Runit Islet: Sept. 1969, outer reef flats *Lithothamnion* ridge, rocks, and tidepools, low to flood tide, night, A. C. Child, id. LBH; 1 spec. USNM.

Family SCYLLARIDAE

Parribacus antarcticus (Lund)

Medren Islet: March 1976, ocean reef flat, in hollow on reef, low tide at night, Medrano, id. J. Lamberson; 1 spec. MPRL. Runit Islet: Sept. 1969, outer reef flats, *Lithothamnion* ridge, rocks, and tidepools, low to flood tide, at night, A. C. Child, id. LBH; 1 juv. spec. USNM.

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Chapter 23

Crustacea Decapoda (Brachyura and Anomura) of Enewetak Atoll

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INTRODUCTION

A preliminary report on the Crustacea Decapoda (Brachyura and Anomura) of Enewetak Atoll, Marshall Islands, was published by the first author in 1964. It reported the collecting of 19 families, 81 genera, and 147 species of brachyuran and anomuran crabs, mostly at Enewetak Atoll. The report was based on collections made by Donald J. Reish in 1956 and 1957; A. H. Banner in 1957; John S. Garth and Fred C. Ziesenhenne in 1957 and 1959, with the assistance of J. Coatsworth, L. Donaldson, T. Goreau, E. Held, R. Neshida, R. Palumbo, J. Roberts, E. Ryan, and A. Smith; and R. A. Boolootian, E. S. Reese, B. Sather, J. Shoup, and R. A. Stevenson in 1960 and 1961. Only those species were listed, however, that occurred in the two specialized habitats discussed: those found in association with branching corals and those obtained by dredging in the lagoon. (Reporting of Anomura was of a preliminary nature, giving number of families, genera, and species but listing only four species, two of them to genus only, from the lagoon-bottom habitat.) The overwhelming presence of the family Xanthidae was noted. These comprised 45% of the genera and 56% of the species of Brachyura encountered, a circumstance attributed to the abundance and variety of corals in which many of the xanthid species reside.

The present report, although still of a preliminary nature, is based additionally upon the more extensive collections made by Jens W. Knudsen, who visited Enewetak annually from 1965 through 1969 and again in 1971 and 1972; by Alan Havens, who visited the atoll in 1968, 1969, and 1970; and by C. Allan Child, who collected at Enewetak for the Smithsonian Institution in 1969. Smaller collections used in preparing the report were those of W. A. Bartos in 1944, F. C. Ziesenhenne in 1946, G. J. Bakus and B. H. Bussing in 1965, C. V. MacCoy in 1967, S. L. Brunenmeister and E. Chave in 1974 and 1975, A. Fielding in 1976 and 1978, and P. Colin and D. M. Devaney in 1980. Of the decapod crustaceans obtained in the Marshall Islands during Operation Crossroads in 1946 and 1947, the Portunidae (Stephenson and Rees, 1967), the Xanthidae (under study by John S. Garth), and the Porcellanidae (under study by Janet Haig) from Enewetak could be included. Although the earlier report (Garth, 1964) could compare what was then known of Enewetak Brachyura and Anomura with the limited work done in the Marshall Islands by the Pacific Science Board's Coral Atoll Survey (Holthuis, 1953), a much better comparison of the Enewetak fauna with those of other atolls of the northern Marshall Islands can now be made with reference to the earlier Operation Crossroads collections. The Porcellanidae from Marshall Islands other than Enewetak are also being studied by Haig.

Records of previous anomuran and brachyuran collecting in the Marshall Islands at atolls other than Enewetak are those of Balss (1938) from Ailinglablab, Ebon, Jaluit, Kwadelin (Kwajalein), Namu, and Namorik of the Ralik group; Likieb and Majeru (Majuro) of the Ratak group; of Miyake (1939) from the above plus Arno of the Ratak group; of Miyake (1943) (Porcellanidae only) from Jaluit; of Holthuis (1953) from Ailuk, Arno, Bikar, Jemo, Kwajalein, Lae, Likiep, Pokak, Taka, Ujae, Ujelang, Utrik, and Wotho; and of Stephenson and Rees (1967) (Portunidae only) from Bikini, Rongelap, and Rongerik.

LAND CRABS

The first decapod crustaceans encountered at Enewetak, as at any mid-Pacific atoll, and the only ones likely to be seen by many visitors, are the semiterrestrial and terrestrial species. These are the species that spend most of their lives at high-tide mark or above it, returning to the sea only to deposit their eggs, which require sea-water for hatching and for nurturing the larval stages. Anomuran crabs having this habit are hermit crabs of the family Coenobitidae, genus *Coenobita*, and the coconut crab, *Birgus latro*. Brachyuran crabs found in the terrestrial environment are grapsoid crabs of the families Gecarcinidae, Ocypodidae, and a few Grapsidae.

The spray zone on rocky shore is inhabited by the Sally Lightfoot crab, here *Grapsus tenuicrustatus* rather than *Grapsus grapsus* Linnaeus, 1758. The highest elevations of sandy beaches are inhabited by the grapsid crabs *Cyclograpsus* and *Pseudograpsus*; the intermediate elevations (with burrows extending below water level) are inhabited by the ghost crab, *Ocypode ceratophthalma*. The mole crab, *Hippa pacifica*, an anomuran, lives in the surf zone, burying itself quickly and emerging suddenly to grasp its food with its first pair of legs. Analogous situations on muddy beaches (rare at Enewetak) are inhabited by the ocypodid crabs *Macrophthalmus* and *Uca*. Where soil accumulates, as at the bases of coconut palms, the land crab *Gecarcinus*, family Gecarcinidae, burrows. The collector who turns inland will encounter the grapsids *Geograpsus crinipes* and *G. grayi* among leaf litter and the *Metasesarma* and *Sesarma* among roots and low branches.

It was no accident that the collector responsible for most of the records of land crabs in the Pacific Science Board's Coral Atoll Survey (Holthuis, 1953) was F. R. Fosberg, a terrestrial botanist, or that the first crabs to reach the senior author soon after arriving at Enewetak were brought to him by Edward Held and Ralph Palumbo, members of the University of Washington group studying the effects of radiation on terrestrial organisms. Thus every habitat available to them, both terrestrial and marine, has been colonized by these ubiquitous arthropods, the decapod crustaceans.

CRABS AS SYMBIONTS

The relationships between crabs and the corals in which they may be found vary widely, from parasitism and commensalism (or mutualism) to facultative symbiosis. In parasitism, the crab burrows into the coral or the coral grows around the crab, in both cases enclosing it. In commensalism, the crab, although apparently free-living, invariably selects a living coral of a particular kind as its host. Facultative symbiosis is a relationship in which the crab, while often found in living coral, is also found in dead coral, in coral rubble, or even on a noncoral, rubbly substrate.

The true parasites, long thought to include only the coral gall crabs and coral-burrowing crabs of the family Hapalocarcinidae, are now known to include some of the apparently free-living crabs of the family Xanthidae as well—in particular, the genera *Trapezia* and *Tetralia*, the former found on pocilloporid, the latter on acroporid corals. These were shown by Knudsen (1967) to feed on coral polyps, which they macerate with their specially adapted dactyls before ingesting. The genera *Domecia* and *Cymo*, different species of which occur on pocilloporid and acroporid corals, apparently have similar feeding habits, although only those of *Domecia* have been investigated (Patton, 1967).

Other crabs found in coral apparently use it only for shelter and protection from predators. These include not only xanthid crabs like *Liomera* (=*Carpilodes*) and *Pseudoliomera*—some species of which rarely, if ever, occur elsewhere—but also a host of genera such as *Chlorodiella*, *Phymodius*, and *Pilodius*, which are found abundantly in dead coral and coral rubble. These are joined by crab genera of other families: the smaller swimming crabs of the genus *Thalamita*, family Portunidae; a number of spider crabs, including *Perinea* and *Tylocarcinus*, family Majidae; hermit crabs of the genus *Calcinus*, family Diogenidae; *Coralliogalathea* and *Galathea*, family Galatheidae; and porcelain crabs of the genera *Pachycheles* and *Petrolisthes*, family Porcellanidae.

Small xanthid crabs of the genus *Actumnus* have been observed to carry a small piece of live coral as they move about the ocean bottom, much as a hermit crab carries a gastropod shell. *Actumnus antelmi* Ward, the species originally described as having this habit, occurs at Enewetak, but its coral-carrying propensity was not observed (Lamberts and Garth, 1977).

Crabs that use not a coral polyp but an actinian coelenterate, which they carry in each claw to fend off attackers, are members of the genera *Lybia* and *Polydectus*. Several species of diogenid hermit crabs of the genus *Dardanus* carry anemones on their shells. In both cases, the crab benefits from the stinging nematocysts of the coelenterate, and the anemone achieves mobility and probably food as well. The porcelain crab *Neopetrolisthes*, family Porcellanidae, inhabits several species of large anemones.

Crabs associated with living mollusks include the pinnotherid *Xanthasia murigera*, found in the mantle cavity of the giant clam, *Tridacna gigas*. Crabs associated with living echinoderms include the parthenopid *Harrovia elegans*, found on the crinoid *Comanthus*, and the galatheids *Allogalathea elegans* and *Galathea amboinensis*, also found on crinoids. The portunids *Lissocarcinus orbicularis* and *L. holothuricola* found in the respiratory tree or cloaca of the sea cucumbers *Holothuria atra* Jaeger and *Actinopyga mauritiana* (Quoy and Gaimard) proved impossible to partition between their holothurian hosts.

CRABS AS SUBJECTS FOR RESEARCH

The Anomura and Brachyura of Enewetak Atoll have proven valuable as subjects for research. The terrestrial hermit crabs, *Coenobita*, were used by University of Washington School of Fisheries personnel in determining residual activity from tests conducted by the Atomic Energy Commission in the late 1940s and early 1950s (Held, 1960). Reese (1968a) used the coconut crab, *Birgus latro*, in life history studies showing use of a shell by the glaucothoe larva. Hermit crabs, *Coenobita*, and the ghost crab, *Ocypode ceratophthalma*, were used by Reese in motion picture studies of locomotion. Experiments conducted by

Knudsen (1967) showed that the coral-inhabiting xanthid crabs, *Trapezia* and *Tetralia*, ate coral polyps after first macerating them and, hence, were true parasites rather than commensals. The coral burrowing crabs, family Hapalocarcinidae (Fize and Serène, 1957), were used by Knudsen in unpublished studies. The portunid crab, *Thalamita integra*, was used by Pomeroy and Kuenzler (1967) in studies of phosphorus turnover by coral reef animals. Highsmith (1981) involved the xanthid crabs, *Tetralia* and *Maldivia*, in studies of coral erosion by invertebrates and fishes. Intertidal crabs of the family Xanthidae were utilized by Havens (1974) in studies of competitive exclusion (the partitioning of food resources). Wenner (1977) and Wenner and Fusaro (1979) conducted studies of population structure and dynamics using the Pacific mole crab, *Hippa pacifica*. The xanthid crabs—*Dacryopilumnus eremita, Eriphia sebana, Phymodius ungulatus, Pilumnus longicornis*, and *Trapezia speciosa*—were shown by Danforth (1967, 1970) to host epicarid isopod parasites of hitherto undescribed species. The hermit crabs *Dardanus* were shown by Humes (1971) to be hosts of harpacticoid copepods. The hermit crabs *Calcinus* and *Diogenes* were used by Orians and King (1964) in studies on shell selection and invasion rates.

Systematic studies have been published on the genus *Petrolisthes*, family Porcellanidae, by Haig (1981); on coral-inhabiting crabs by Garth (1964); and on swimming crabs, family Portunidae, by Stephenson and Rees (1967), with additional studies by Garth, Haig, and Knudsen in progress.

POISONOUS CRABS

During the 1970s Garth and Alcala (1977) showed beyond a reasonable doubt that numerous reef-inhabiting crabs of the Indo-West Pacific are harmful when eaten because they are poisonous. Included among these are several common Enewetak species: *Daldorfia horrida* (Linnaeus), *Atergatis floridus* (Linnaeus), *Eriphia sebana* (Shaw and Nodder), and *Zozymus aeneus* (Linnaeus). The first is an elbow crab, family Parthenopidae; the remaining three are members of the family Xanthidae, as are most of the crabs found to be toxic to man and to domestic animals. The poison, a saxitoxin, is chemically indistinguishable from that produced by certain mollusks. It causes vomiting, followed by locomotory and neurological symptoms which, if not treated, result in paralysis and death.

Crab-caused fatalities have been documented, and the crabs were identified by competent taxonomists in the Ryukyu Islands, the Philippines, and Palau. Native populations of many South Sea island groups have traditions of killer crabs and vernacular names for the poisonous species. Although no poisonings from crabs are known to have occurred at Enewetak Atoll, crabs known to be poisonous elsewhere are common on the reef at Enewetak. Caution is urged in the handling of these crabs (a person who has handled such a crab might experience numbness after touching his tongue to his hand). Abstinence from their culinary use is also advised.

FOSSIL CRUSTACEANS

Fossil anomuran and brachyuran decapod species obtained by U. S. Geological Survey drillings at Enewetak and reported by Roberts (1964) include *Callichirus armatus* (A. Milne Edwards), *Callichirus articulatus* (Rathbun), *Actaeodes hirsutissimus* (Rüppell), and *Etisus laevimanus* (Randall). Although known from elsewhere in the Indo-West Pacific, these four species have not been found living at Enewetak. This could mean either that subtle changes have occurred in the reef environment that render Enewetak no longer a suitable habitat or, as seems more likely, that the suite of species inhabiting Enewetak is changing constantly as new species are introduced, become established, are eliminated by competitors, and become locally extinct until reintroduced in another cycle. It is also possible that further and more diligent searching may yet uncover these four species at Enewetak in the living state.

COLLECTING DECAPOD CRUSTACEANS*

Enewetak Atoll ascends abruptly to the surface where the North Equatorial Current, the prevailing trade winds, and the oceanic waves strike the atoll. Waves refract all the way around the atoll reef and penetrate the lagoon through channels or over the algal ridge. Therefore, we felt that every compass point, from windward to leeward, would have unique physical factors that influenced distribution of both coral species (plus morphotypes of coral species) and decapod crustaceans. This proved useful. Since several other experts were to receive crustacean specimens beyond our interest, much time was spent hunting new corals, crinoids, algae, and sediments that harbored decapods.

The intertidal zone is shallow (based on Kwajalein information), yet while zones are compressed, a centimeter elevation on the reef flat would usually yield some different brachyuran. We also believed zones directly below and above the tidal range were relatively shallow but became thicker (or deeper) down into the lagoon depth, or to the height of land and its vegetation on islands.

This, in theory, kept us close to the intertidal zone where we thought the greatest species density of decapods was to be, and apparently is, found. We collected on all but three of the 34 named islands. The northwest chain from Bogallua Island to Bogon Island was considered too dangerous for camping trips as opposed to 1-day M-boat runs. Our radio carried less than 5 miles and the Equatorial Current flowed westward. Later, the Garth–Knudsen teams found the restricted access limited the work on the northwest chain as compared to that done on the more accessible islands.

*This section was provided by Jens Knudsen.

The windward algal ridge receives the largest waves which supersaturate incoming water with oxygen. Algae grow here in a profusion of species and mass. Initially we used pry bars to loosen slabs from the algal ridge. These were placed in plastic bags or buckets while another team member attempted to secure all free decapods. Slabs were carried to the nearest island for cracking and collecting of decapods. Subsequently, a rigid, heavy-welded pipe cracking table with a car-decking top was designed and built for the purpose of cracking coral or slabs at any site including the algal ridge (Fig. 1). Buckets, hammers, and other equipment were secured to the table. A marker allowed note taking (even under water), so station numbers were issued and recorded as needed. Naturally someone held the table when very large waves were running. The yield of species was dramatically increased by the use of the cracking table.

Illuminated by a Coleman lantern, the reef-flat and algal ridge were also collected at night with excellent success. The algal ridge off Enewetak Island was also collected during waveless doldrums—until two large tsunamic waves came shoreward, throwing Knudsen 30 feet back onto the reef flat.

Small amounts of formaldehyde were applied full strength to the reef flat at low–low tide. The preservative diluted in patches of water and entered worm burrows, evicting numerous decapods which otherwise would have been impossible to collect. Behind the reef flat, formaldehyde was injected 6 inches deep in coral rubble. Soon afterwards, decapods that resembled chips of coral worked up to the surface and were captured with a guppy net.

On our first trip, we snorkeled every day and averaged about 5 to 10 miles of swimming per day in local areas. Always new corals or new formations, new wave patterns, reef drainage currents, etc., provided new records. Plastic bags were placed over corals or crinoids, and the coral and/or crinoid was removed with decapod species intact. The author was towed by our slow moving outboard skiff to survey miles of lagoon margin. A hand signal meant new coral formation—or possible shark attack. We snorkeled down to about 60 feet in quest of some crinoids and corals.

Collecting was successfully attempted with a dredge built and outfitted at Pacific Lutheran University (PLU). We used the dredge, powered by a skiff, in shallow water (to 30 feet). In deeper lagoon water, we used an M-boat in reverse, with the dredge rope and buoy ready to go overboard when fouled. Markers placed and recorded to allow work to continue the next day were never found again. However, many rare and some new records of crabs were worth the effort. A cable and winch, as opposed to pulling the cable by hand, would have greatly facilitated lagoon studies.

Islands possessed many species of decapods on land and even in trees. Since islands are scattered around much of the reef, and refracting waves strike islands differently,

Fig. 1 Cracking table on the algal ridge at Enewetak, about 1000 ft from land.

the intertidal and island sediments had to be sampled all the way around and at all elevations (the highest being 13 feet above sea level). Several islands were studied in great detail with some new records derived. Can-traps, baited traps, lantern light, etc., helped secure the nocturnal individuals. Crepuscular decapods were the least collected. Two locations were found where real mud occurred, and there *Uca*, the fiddler crab, was collected for the first time.

Some of my studies, such as the ecology and distribution of brachyurans at the north end of Enewetak Island, became so large and required so much space that they were self-defeating. Because of the high class loads (18 to 22 contact hours at PLU until about 1970), research data had to be set aside so long it lost its relevancy. Despite such failings, evidence has been produced of a much richer and grander decapod fauna than any had guessed existed. Yet I am convinced another 50 species must lurk there waiting. I would like to capture them . . . personally!

Students serving well at Enewetak include Jack Shannon, M. D.; David Pearson, Ph.D., Penn State; Douglas Lambrecht, M. D.; Douglas Holt; Richard Myking, teacher; John Rankin, teacher; David Soderlund, Ph.D., Cornell University; and Erik Severeid, business overseas.

Checklist of Anomura and Brachyura from Enewetak Atoll

Order DECAPODA
Suborder PLEOCYEMATA
Infraorder ANOMURA
Superfamily THALASSINOIDEA
Family CALLIANASSIDAE
*†*Callianassa* sp.
*†*Calliax* sp., aff. *novaebritanniae* (Borradaile, 1900).
Callichirus armatus (A. Milne Edwards, 1870).
‡*Callianassa armata*: Roberts, 1964.
Callichirus articulatus (Rathbun, 1906).
‡*Callianassa articulata*: Roberts, 1964.
*†*Callichirus vigilax* (De Man, 1916).
*†*Thomassinia* sp.
Family CALLIANIDEIDAE
*†*Callianidea* [undescribed sp.].
*†New genus [undescribed sp. 1].
*†New genus [undescribed sp. 2].
Family AXIIDAE
*†*Enoplometopus (Enoplometopus)* sp.
Enoplometopus (Holometopus) holthuisi Gordon, 1968: Holthuis, 1983.
*†New genus [? undescribed sp.].
Superfamily HIPPOIDEA
Family HIPPIDAE
*†*Hippa adactyla* Fabricius, 1787.
Hippa pacifica (Dana, 1852): Wenner, 1977; Fusaro, 1978; Wenner and Fusaro, 1979; Wenner and Haley, 1981.
Family ALBUNEIDAE
*†*Paralbunea dayriti* (Serène and Umali, 1965).
¶*Albunea ?elioti* Benedict, 1904.
¶*Albunea* sp.
Superfamily PAGUROIDEA
Family COENOBITIDAE
Birgus latro (Linnaeus, 1767): Gross, 1964; Reese, 1968a; Reese and Kinzie, 1968; Page and Willason, 1982.
Coenobita brevimanus Dana, 1852: Gross, 1964; Lawrence, 1976; Page and Willason, 1982.
*†*Coenobita cavipes* Stimpson, 1858.
Coenobita perlatus H. Milne Edwards, 1837: Held, 1960; Gross, 1964; Reese, 1969; Lawrence, 1976; Page and Willason, 1982.
Coenobita rugosus H. Milne Edwards, 1837: Lawrence, 1976; Page and Willason, 1982.
Family DIOGENIDAE
Aniculus aniculus (Fabricius, 1787): Reese, 1969; Forest, 1984.
*†*Aniculus* sp.

*New Enewetak record.
†New Marshall Islands record.
‡Fossil record.
¶J. S. Garth manuscript lists.

Calcinus elegans (H. Milne Edwards, 1836): Reese, 1969.
Calcinus gaimardii (H. Milne Edwards, 1848): Reese, 1969.
*†*Calcinus guamensis* Wooster, 1984.
¶*Calcinus* sp. indet. #2.
*†*Calcinus imperialis* Whitelegge, 1901.
Calcinus laevimanus (Randall, 1839): Reese, 1962; Reese, 1968b; Reese, 1969.
Calcinus latens (Randall, 1839): Provenzano, 1963; Orians and King, 1964; Reese, 1969; Humes, 1971.
Calcinus seurati Forest, 1951: Reese, 1969.
*†*Calcinus* sp., aff. *spicatus* Forest, 1951.
*†*Clibanarius* sp., aff. *boschmai* Buitendijk, 1937.
Clibanarius corallinus (H. Milne Edwards, 1848): Reese, 1969.
**Clibanarius eurysternus* (Hilgendorf, 1879).
*†*Clibanarius zebra rhabdodactylus* Forest, 1953.
¶*Clibanarius zebra* var. *rhabdodactylus*.
*†*Clibanarius* sp.
*†*Dardanus crassimanus* (H. Milne Edwards, 1836).
**Dardanus deformis* (H. Milne Edwards, 1836).
*†*Dardanus gemmatus* (H. Milne Edwards, 1848).
Dardanus guttatus (Olivier, 1812): Humes, 1971.
Dardanus lagopodes (Forsskål, 1775): Humes, 1971.
Dardanus sanguinolentus (Quoy and Gaimard, 1824): Provenzano, 1963.
¶*Dardanus sanguinolentus*.
Dardanus megistos (Herbst, 1804): Humes, 1971.
Dardanus scutellatus (H. Milne Edwards, 1848): Provenzano, 1963; Orians and King, 1964; Garth, 1964; Humes, 1971.
Dardanus woodmasoni (Alcock, 1905): Garth, 1964.
Diogenes gardineri Alcock, 1905: Provenzano, 1963; Orians and King, 1964.
¶*Diogenes* sp.
*†*Diogenes pallescens* Whitelegge, 1897.
*†*Paguristes* sp.
*†*Trizopagurus strigatus* (Herbst, 1804).
Family PAGURIDAE
*†*Catapagurus* sp.
*†*Pagurixus anceps* (Forest, 1954): McLaughlin and Haig, 1984.
¶*Pagurus* sp. (in part).
¶*Pagurus (Pagurixus)* sp. 1.
Pagurixus boninensis (Melin, 1939): McLaughlin and Haig, 1984.
Pagurixus maorus (Nobili, 1906): McLaughlin and Haig, 1984.
¶*Pagurus* sp. (in part).
¶*Pagurus (Pagurixus)* sp. 2.
*†New genus, sp.
Superfamily GALATHEOIDEA
Family GALATHEIDAE
Allogalathea elegans (Adams and White, 1848): Baba, 1977; Baba, 1979; Bruce and Zmarzly, 1983.
¶*Galathea elegans*.
*†*Coralliogalathea humilis* (Nobili, 1905).
¶*Galathea tridentirostris* Miyake, 1953.
*†*Galathea aegyptiaca* Paulson, 1875.
*†*Galathea affinis* Ortmann, 1892.
¶*Galathea spinosorostris* Dana, 1852 (in part).
¶*Galathea* sp., aff. *australiensis* Stimpson, 1858.
*†*Galathea amboinensis* De Man, 1888.
*†*Galathea* sp., aff. *tanegashimae* Baba, 1969.
¶*Galathea spinosorostris* Dana, 1852 (in part).
*†*Phylladiorhynchus serrirostris* (Melin, 1939).
¶*Galathea serrirostris*.
Family PORCELLANIDAE
**Neopetrolisthes maculatus* (H. Milne Edwards, 1837).
**Pachycheles johnsoni* Haig, 1965.
¶*Pachycheles sculptus* (H. Milne Edwards, 1837).

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*New Enewetak record.
†New Marshall Islands record.
¶J. S. Garth manuscript lists.

*†*Pachycheles pisoides* (Heller, 1865).
*†*Pachycheles spinipes* (A. Milne Edwards, 1873).
*†*Petrolisthes asiaticus* (Leach, 1820).
*†*Petrolisthes bispinosus* Borradaile, 1900.
Petrolisthes borradailei Kropp, 1984: Kropp, 1984.
¶*Petrolisthes lamarckii* (Leach, 1820) (in part).
*†*Petrolisthes coccineus* (Owen, 1839).
*†*Petrolisthes decacanthus* Ortmann, 1897.
Petrolisthes elegans Haig, 1981: Haig, 1981.
Petrolisthes fimbriatus Borradaile, 1898: Highsmith, 1981.
**Petrolisthes lamarckii* (Leach, 1820).
*†*Petrolisthes masakii* Miyake, 1943.
*†*Petrolisthes penicillatus* (Heller, 1862).
*†*Petrolisthes pubescens* Stimpson, 1858.
*†*Petrolisthes* [undescribed sp. 1, R. K. Kropp MS].
*†*Petrolisthes* [undescribed sp. 2, J. Haig and R. K. Kropp MS].
¶*Petrolisthes decacanthus* Ortmann, 1897 (in part).

Infraorder BRACHYURA
Section DROMIACEA
Superfamily DROMIOIDEA
Family DROMIIDAE
*†*Cryptodromia canaliculata* Stimpson, 1858.
*†*Cryptodromia* sp.
Family DYNOMENIDAE
Dynomene hispida Desmarest, 1825: Highsmith, 1981.
*†*Dynomene pilumnoides* Alcock, 1899.
**Dynomene praedator* A. Milne Edwards, 1879.
**Dynomene spinosa* Rathbun, 1911.
Section OXYSTOMATA
Superfamily CALAPPOIDEA
Family LEUCOSIIDAE
*† *Cryptocnemus haddoni* Calman, 1900.
*† *Ebalia woodmasoni* Alcock, 1986.
Ebaliopsis erosa (A. Milne Edwards, 1873): Garth, 1964.
**Heterolithadia* sp.
*†*Heteronucia venusta* Nobili, 1906.
*†*Merocryptus durandi* Serène, 1955.
*†*Myra fugax coalita* Hilgendorf, 1878.
*†*Nucia ingens* (Rathbun, 1911).
*†*Nucia speciosa* Dana, 1852.
*†*Oreophorus (Oreotlos) latus* Borradaile, 1903.
*†Species *incertae sedis*.
Family CALAPPIDAE
*†*Calappa calappa* (Linnaeus, 1758).
*†*Calappa gallus* (Herbst, 1803).
**Calappa hepatica* (Linnaeus, 1758):‡ Roberts, 1964.
Section OXYRHYNCHA
Superfamily MAJOIDEA
Family MAJIDAE
*†*Camposcia retusa* Latreille, 1825.
*†*Camposcia* sp.
**Cyclax suborbicularis* (Stimpson, 1858).
*†*Huenia brevifrons* Ward, 1941.
Huenia proteus De Haan, 1839: Garth, 1964.
*†*Hyastenus irami* (Laurie, 1906).
*†*Hyastenus uncifer* Calman, 1900.
*†*Hyastenus verrucosipes* (Adams and White, 1848).
*†*Hyastenus* sp.

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*New Enewetak record.
†New Marshall Islands record.
‡Fossil record.
¶J. S. Garth manuscript lists.

Menaethius monoceros (Latreille, 1825): Garth, 1964.
*†*Micippa margaritifera* Henderson, 1893.
Micippa philyra (Herbst, 1803): Garth, 1964.
*†*Micippa platypes* Rüppell, 1830.
*†*Micippa thalia* (Herbst, 1803).
*†*Naxiodes spinigera* Borradaile, 1903.
*†*Paratymolus bituberculatus* Miers, 1882.
Paratymolus sexspinosus Miers, 1884: Garth, 1964.
*†*Parazewa bocki* Balss, 1938.
Perinea tumida Dana, 1851: Garth, 1964.
Schizophrys aspera (H. Milne Edwards, 1834): Garth, 1964.
*†*Trigonothir obtusirostris* Miers, 1879.
*†*Tylocarcinus ?gracilis* Miers, 1879.
Tylocarcinus styx (Herbst, 1803): Garth, 1964.

Superfamily PARTHENOPOIDEA

Family PARTHENOPIDAE

*†*Actaeomorpha* sp., nr. *erosa* (Miers, 1878).
*†*Cryptopodia ?pan* Laurie, 1905.
**Daldorfia horrida* (Linnaeus, 1758).
*†*Daldorfia* (or *Parthenope*) sp.
Harrovia elegans De Man, 1888: Garth, 1964.
*†*Heterocrypta*? sp.
*†*Parthenope (Aulacolambrus) curvispinis* (Miers, 1879).
*†*Parthenope (Aulacolambrus) hoplonotus* (Adams and White, 1848).
*†*Parthenope (Aulacolambrus)* sp.
*†*Parthenope (Pseudolambrus)* sp.
Parthenope sp.: Garth, 1964.
*†*Thyrolambrus erosus* (Miers, 1879).
*†*Thyrolambrus* sp.

Section CANCRIDEA

Superfamily CORYSTOIDEA

Family ATELECYCLIDAE

*†*Kraussia integra* Rathbun, 1906.
*†*Kraussia* sp., cf. *marquesa* Serène, 1972.
*†*Kraussia nitida* Stimpson, 1858.
*†*Kraussia rastripes* F. Müller, 1857.
*†*Kraussia rugulosa* (Krauss, 1843).

Section BRACHYRHYNCHA

Superfamily PORTUNOIDEA

Family PORTUNIDAE

**Carupa tenuipes* Dana, 1851.
¶*Carupa laeviuscula* Heller, 1861.
*†*Catoptrus inaequalis* (Rathbun, 1906).
**Catoptrus nitidus* A. Milne Edwards, 1870.
*†*Catoptrus rathbunae* Serène, 1965.
*†*Catoptrus ?truncatifrons* De Man, 1887.
**Charybdis (Goniosupradens) erythrodactylus* (Lamarck, 1818).
*†*Coelocarcinus foliatus* Edmondson, 1930.
*†*Libistes villosus* Rathbun, 1924.
*†*Lissocarcinus holothuricola* Streets, 1877.
*†*Lissocarcinus orbicularis* Dana, 1852.
Portunus (Achelous) granulatus (H. Milne Edwards, 1834).
Portunus granulatus: Garth, 1964.
Portunus (Achelous) sp., nr. *orbicularis* (Richters, 1880).
Portunus orbicularis (Richters): Garth, 1964.
Portunus (Hellenus) longispinosus Stephenson and Campbell, 1959.
Portunus longispinosus (Dana, 1852): Garth, 1964.
Thalamita admete (Herbst, 1803): Garth, 1964; Stephenson and Rees, 1967.
Thalamita bouvieri Nobili, 1906: Stephenson and Rees, 1967.

*New Enewetak record.
†New Marshall Islands record.
¶J. S. Garth manuscript lists.

*†*Thalamita chaptalii* (Audouin, 1826).
*†*Thalamita coeruleipes* Jacquinot, 1852.
*†*Thalamita corrugata* Stephenson and Rees, 1961.
¶*Thalamita cooperi* (Borradaile, 1902).
*†*Thalamita dakini* Montgomery, 1931.
¶*Thalamita medipacifica* Edmondson, 1954.
Thalamita gloriensis Crosnier, 1962: Stephenson and Rees, 1967.
Thalamita gracilipes (A. Milne Edwards, 1873).
Thalamonyx gracilipes: Garth, 1964.
Thalamita integra Dana, 1852: Pomeroy and Kuenzler, 1967.
*†*Thalamita oculea* Alcock, 1899.
Thalamita picta Stimpson, 1858: Garth, 1964; Stephenson and Rees, 1967.
Thalamita pilumnoides Borradaile, 1902: Garth, 1964.
**Thalamita prymna* (Herbst, 1803).
*†*Thalamita quadrilobata* Miers, 1884.
*†*Thalamita sexlobata* Miers, 1886.
*†*Thalamita sima* H. Milne Edwards, 1834.
Thalamita spiceri Edmondson, 1954: Highsmith, 1981.
*†*Thalamita spinimana* Dana, 1852.
¶*Thalamita danae* Stimpson, 1858.
*†*Thalamita stimpsoni* A. Milne Edwards, 1861.
*†*Thalamita wakensis* Edmondson, 1925.
*†*Thalamita yoronensis* Sakai, 1969.
*†*Thalamita* sp., nr. *auauensis* Rathbun, 1906.
Thalamitoides quadridens A. Milne Edwards, 1869: Garth, 1964;‡ Roberts, 1964.

Superfamily XANTHOIDEA

Family XANTHIDAE

*†*Actaea* sp., nr. *bocki* Odhner, 1925.
*†*Actaea(?) cavipes* (Dana, 1852).
*†*Actaea margaritifera* Odhner, 1925.
*†*Actaea pulchella modesta* (De Man, 1888).
*†*Actaea quadriareolata* Takeda and Miyake, 1968.
*†*Actaea* sp.
**Actaeodes consobrinus* (A. Milne Edwards, 1873).
¶*Actaea consobrina*.
Actaeodes hirsutissimus (Rüppell, 1830).
‡*Actaea hirsutissima*: Roberts, 1964.
*†*Actumnus antelmei* Ward, 1942.
*†*Actumnus asper* (Rüppell, 1830).
*†*Actumnus setifer* (De Haan, 1835).
¶*Actumnus tomentosus* Dana, 1852.
*†*Actumnus* sp.
*†*Actumnus* (or *Pilumnus*) sp.
*† *Atergatis ?dilitatus* De Haan, 1835.
**Atergatis floridus* (Linnaeus, 1767).
*†*Atergatopsis signata* (Adams and White, 1848).
**Banareia nobilii* (Odhner, 1925).
¶*Actaea nobilii*.
*†*Banareia parvula* (Krauss, 1843).
¶*Actaea parvula*.
*†*Carpilius convexus* (Forsskål, 1775).
*†*Carpilius maculatus* (Linnaeus, 1758).
*†*Chlorodiella corallicola* Miyake and Takeda, 1968.
*†*Chlorodiella cytherea* (Dana, 1852).
Chlorodiella laevissima (Dana, 1852): Garth, 1964.
Chlorodiella nigra (Forsskål, 1775): Garth, 1964.
*†*Cycloxanthops cavatus* Rathbun, 1907.
Cymo andreossyi (Audouin, 1826): Garth, 1964.

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*New Enewetak record.
†New Marshall Islands record.
‡Fossil record.
¶J. S. Garth manuscript lists.

Cymo deplanatus A. Milne Edwards, 1873: Garth, 1964.
Cymo melanodactylus De Haan, 1835; Garth, 1964.
**Cymo quadrilobatus* Miers, 1884.
Dacryopilumnus eremita Nobili, 1906: Danforth, 1970.
*†*Dacryopilumnus rathbunae* Balss, 1932.
**Daira perlata* (Herbst, 1790).
Domecia glabra Alcock, 1899: Garth, 1964.
Domecia hispida Eydoux and Souleyet, 1842: Garth, 1964.
**Eriphia scabricula* Dana, 1852.
Eriphia sebana (Shaw and Nodder, 1803): Reese, 1969; Danforth, 1970.
¶*Eriphia laevimana* Guérin, 1838.
*†*Etisus bifrontalis* (Edmondson, 1935).
*†*Etisus demani* Odhner, 1925.
*†*Etisus* sp., nr. *demani* Odhner, 1925.
**Etisus dentatus* (Herbst, 1785).
Etisus electra (Herbst, 1801): Garth, 1964.
*†*Etisus frontalis* Dana, 1852.
‡*Etisus laevimanus* (Randall, 1839): Roberts, 1964.
*†*Etisus molokaiensis* (Rathbun, 1906).
*†*Etisus splendidus* Rathbun, 1906:‡ Roberts, 1964.
*†*Etisus* sp. 1.
*†*Etisus* sp. 2.
*†*Etisus* sp. 3.
Euxanthus exsculptus (Herbst, 1790): Garth, 1964.
*†*Euxanthus* (or *Hypocolpus*) sp.
Gaillardiellus rueppellii (Krauss, 1843).
Actaea reppellii [sic]: Garth, 1964.
Gaillardiellus superciliaris (Odhner, 1925).
Actaea superciliaris: Garth, 1964.
**Globopilumnus globosus* (Dana, 1852).
*†*Heteropilumnus* sp., cf. *longipes* (Stimpson, 1858).
**Lachnopodus ponapensis* (Rathbun, 1907).
¶*Paraxanthias haematostictus* Ward, 1930.
*†*Lachnopodus subacutus* (Stimpson, 1858).
**Lachnopodus tahitensis* De Man, 1889.
**Leptodius exaratus* (H. Milne Edwards, 1834).
**Leptodius gracilis* (Dana, 1852).
*†*Leptodius davaoensis* Ward, 1941.
**Leptodius nudipes* (Dana, 1852).
¶*Xantho danae* Odhner, 1925.
**Leptodius sanguineus* (H. Milne Edwards, 1834).
*†*Leptodius waialuanus* Rathbun, 1906.
Liocarpilodes armiger pacificus Balss, 1938: Garth, 1964; Highsmith, 1981.
Liocarpilodes biunguis (Rathbun, 1906): Highsmith, 1981.
Zozymodes biunguis: Garth, 1964.
¶*Xanthodius biunguis*.
Liocarpilodes integerrimus (Dana, 1852): Garth, 1964.
Liocarpilodes pumilus (Jacquinot, 1852): Garth, 1964.
¶*Zozymodes pumilus*.
¶*Zozymodes cristatus* (Borradaile, 1902).
Liomera bella (Dana, 1852).
Carpilodes bellus: Garth, 1964; Highsmith, 1981.
Liomera coelata (Odhner, 1825).
Carpilodes coelatus: Garth, 1964.
*†*Liomera loevis* (A. Milne Edwards, 1873).
¶*Carpilodes loevis*.
*†*Liomera monticulosa* (A. Milne Edwards, 1873).
¶*Carpilodes monticulosus*.

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*New Enewetak record.
†New Marshall Islands record.
‡Fossil record.
¶J. S. Garth manuscript lists.

*Liomera pallida (Borradaile, 1900).
¶Carpilodes pallidus.
*†Liomera rugata (H. Milne Edwards, 1834).
¶Carpilodes rugatus.
*†Liomera stimpsoni (A. Milne Edwards, 1865).
¶Carpilodes stimpsoni.
*Liomera tristis (Dana, 1852).
¶Carpilodes tristis.
*†Liomera sp.
¶Carpilodes sp.
*†Lophozozymus dodone (Herbst, 1801).
*†Lophozozymus incisus (H. Milne Edwards, 1834).
*Lophozozymus pulchellus A. Milne Edwards, 1867.
*†Lybia caestifera (Alcock, 1898).
*†Lybia tessellata (Latreille, 1812).
*Lydia annulipes (H. Milne Edwards, 1834).
*†Macromedaeus nudipes (A. Milne Edwards, 1867).
¶Xantho nudipes.
Maldivia palmyrensis Rathbun, 1923: Highsmith, 1981.
Maldivia triunguiculata (Borradaile, 1902): Highsmith, 1981.
*†Medaeus elegans A. Milne Edwards, 1867.
*†Medaeus ornatus Dana, 1852.
*†Neoxanthias impressus (Lamarck, 1818).
¶Xantho impressus.
*†Paractaea retusa (Nobili, 1905).
¶Actaea retusa.
Paractaea rufopunctata (H. Milne Edwards, 1834).
Actaea rufopunctata: Garth, 1964.
*†Paractaea rufopunctata f. plumosa Guinot, 1969.
*†Paractaea tumulosa (Odhner, 1925).
¶Actaea tumulosa.
*†Paramedaeus simplex (A. Milne Edwards, 1873).
¶Medaeus simplex.
*†Parapilumnus coralliophilus Takeda and Miyake, 1968.
Parapilumnus verrucosipes (Stimpson): Garth, 1964.
*†Parapilumnus ?incertus Takeda and Miyake, 1969.
¶Heteropilumnus sp., nr. quadrispinosus (Zehntner, 1894).
Paraxanthias notatus (Dana, 1852): Garth, 1964; Highsmith, 1981.
*†Paraxanthias pachydactylus (A. Milne Edwards, 1873).
*Phymodius ?granulatus (Targioni-Tozzetti, 1877).
*Phymodius laysani Rathbun, 1906.
*†Phymodius monticulosus (Dana, 1852).
Phymodius nitidus (Dana, 1852): Garth, 1964.
Phymodius ungulatus (H. Milne Edwards, 1834): Garth, 1964; Danforth, 1967, 1970.
Pilodius areolatus (H. Milne Edwards, 1834): Highsmith, 1981.
Chlorodopsis areolata: Garth, 1964.
Pilodius flavus Rathbun, 1906: Garth, 1964.
*†Pilodius melanodactylus (A. Milne Edwards, 1873).
¶Chlorodopsis melanodactylus.
Pilodius pilumnoides (White, 1847): Garth, 1964.
¶Chlorodopsis pilumnoides.
Pilodius pugil Dana, 1852: Garth, 1964.
‡Chlorodopsis pugil: Roberts, 1964.
*†Pilodius scabriculus Dana, 1852.
Pilodius spinipes Heller, 1861: Garth, 1964.
¶Chlorodopsis spinipes.
*†Pilumnus andersoni De Man, 1887.
*Pilumnus caerulescens A. Milne Edwards, 1873.

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*New Enewetak record.
†New Marshall Islands record.
‡Fossil record.
¶J. S. Garth manuscript lists.

*†*Pilumnus ?elegans* De Man, 1888.
Pilumnus longicornis Hilgendorf, 1878: Garth, 1964.
Pilumnus sp.: Danforth, 1970.
*†*Pilumnus ransoni* Forest and Guinot, 1961.
*†*Pilumnus rotumanus* Borradaile, 1900.
**Pilumnus tahitensis* De Man, 1890.
**Pilumnus vespertilio* (Fabricius, 1793).
*†*Pilumnus* sp.
Planopilumnus vermiculatus (A. Milne Edwards, 1873): Garth, 1974.
Polydectus cupulifer (Latreille, 1825): Garth, 1964.
*†*Pseudoliomera granosimanus* (A. Milne Edwards, 1865).
*†*Pseudoliomera helleri* (A. Milne Edwards, 1865).
¶*Actaea helleri*.
*†*Pseudoliomera* sp., nr. *helleri* (A. Milne Edwards, 1865).
¶*Actaea* sp., nr. *helleri*.
**Pseudoliomera lata* (Borradaile, 1902).
¶*Actaea lata*.
*†*Pseudoliomera* sp., nr. *lata* (Borradaile, 1902).
¶*Actaea* sp., nr. *lata*.
*†*Pseudoliomera rueppellioides* (Odhner, 1925).
¶*Actaea rueppellioides*.
Pseudoliomera speciosa (Dana, 1852).
Actaea speciosa: Garth, 1964.
**Pseudozius caystrus* (Adams and White, 1848).
**Pseudozius pacificus* Balss, 1938.
*†*Ralumia dahli* Balss, 1933.
Tetralia glaberrima (Herbst, 1799): Garth, 1964; Knudsen, 1967.
**Tetralia glaberrima rubridactylus* Patton, 1966.
Tetraloides nigrifrons (Dana, 1852).
Tetralia heterodacytyla Heller, 1861: Garth, 1964; Knudsen, 1967.
¶*Tetralia heterodacytyla fusca* Serène, 1959.
¶*Tetralia ?nigrifrons* Dana, 1852.
Trapezia cymodoce (Herbst, 1801): Garth, 1964; Knudsen, 1967.
*†*Trapezia dentata* Macleay, 1838.
Trapezia digitalis Latreille, 1825: Garth, 1964; Knudsen, 1967.
*†*Trapezia digitalis bella* Dana, 1852.
Trapezia sp., *digitalis* group: Garth, 1964.
Trapezia ferruginea Latreille, 1825: Garth, 1964; Knudsen, 1967.
*†*Trapezia guttata* Rüppell, 1830.
Trapezia rufopunctata (Herbst, 1799): Garth, 1964; Knudsen, 1967.
*†*Trapezia rufopunctata flavopunctata* Eydoux and Souleyet, 1841.
*†*Trapezia rufopunctata maculata* Macleay, 1838.
Trapezia speciosa Dana, 1852: Garth, 1964; Danforth, 1970.
Trapezia tigrina Eydoux and Souleyet, 1842.
Trapezia danai Ward, 1939: Garth, 1964; Knudsen, 1967.
Trapezia wardi Serène, 1970.
*†*Trapezia* sp. 1.
*†*Trapezia* sp. 2.
*†*Xanthias canaliculatus* Rathbun, 1906.
*†*Xanthias gilbertensis* Balss, 1938.
Xanthias lamarcki (H. Milne Edwards, 1834): Highsmith, 1981.
*†*Xanthias lividus* Lamarck, 1808.
*†*Xanthias punctatus* (H. Milne Edwards, 1834).
*†*Xantho* sp.
*†*Zozymodes cavipes* (Dana, 1852).
*†*Zozymus actaeoides* (A. Milne Edwards, 1867).
¶*Platypodia actaeoides*.
Zozymus sp., nr. *actaeoides* (A. Milne Edwards, 1867).
¶*Platypodia* sp., nr. *actaeoides*.

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*New Enewetak record.
†New Marshall Islands record.
¶J. S. Garth manuscript lists.

**Zozymus aeneus* (Linnaeus, 1758).
*† *Zozymus gemmula* Dana, 1852.
*† *Zozymus hawaiiensis* (Rathbun, 1907).
¶ *Platypodia hawaiiensis*.
*† *Zozymus kuekenthali* De Man, 1902.
Family GONEPLACIDAE
*† *Ceratoplax* sp.
*† Genus and species *incertae sedis*.
Family PALICIDAE
*† *Palicus jukesi* (White, 1847).
*† *Palicus whitei* (Miers, 1879).
*† *Palicus* sp., nr. *oahuensis* Rathbun, 1906.
Superfamily GRAPSOIDEA
Family GRAPSIDAE
* *Cyclograpsus integer* H. Milne Edwards, 1837.
¶ *Cyclograpsus parvulus* De Man, 1896.
*† *Cyclograpsus longipes* Stimpson, 1858.
*† *Cyclograpsus sanctaecrucis* Griffin, 1968.
Geograpsus crinipes (Dana, 1851): Page and Willason, 1982.
* *Geograpsus grayi* (H. Milne Edwards, 1853).
*† *Grapsus intermedius* De Man, 1888.
* *Grapsus longitarsus* Dana, 1851.
* *Grapsus tenuicrustatus* (Herbst, 1783): Page and Willason, 1982.
* *Metasesarma rousseauxi* H. Milne Edwards, 1853.
* *Metopograpsus thukuhar* (Owen, 1839).
Pachygrapsus minutus A. Milne Edwards, 1873: Highsmith, 1981.
*† *Pachygrapsus planifrons* De Man, 1888.
* *Pachygrapsus plicatus* H. Milne Edwards, 1837.
* *Percnon abbreviatum* (Dana, 1851).
*† *Percnon pilimanus* (A. Milne Edwards, 1873).
Percnon planissimum (Herbst, 1804): Highsmith, 1981.
*† *Plagusia depressa tuberculata* Lamarck, 1818.
*† *Plagusia immaculata* Lamarck, 1818.
*† *Plagusia speciosa* Dana, 1852.
* *Pseudograpsus albus* Stimpson, 1858.
*† *Sesarma (Holometopus)* sp.
Family GECARCINIDAE
* *Gecarcoidea lalandii* H. Milne Edwards, 1837.
Superfamily PINNOTHEROIDEA
Family PINNOTHERIDAE
* *Xanthasia murigera* White, 1846.
Superfamily OCYPODOIDEA
Family OCYPODIDAE
*† *Macrophthalmus (Macrophthalmus) telescopicus* (Owen, 1839) var.
* *Macrophthalmus (Mopsocarcinus) bosci* Audouin and Savigny, 1825.
Ocypode ceratophthalma (Pallas, 1872): Page and Willason, 1982.
Ocypode cordimana Desmarest, 1825: Page and Willason, 1982.
*† *Paracleistostoma* (or *Cleistostoma*) sp.
*† *Uca tetragonon* (Herbst, 1790).
*† Genus and species *incertae sedis*.
Superfamily HAPALOCARCINOIDEA
Family HAPALOCARCINIDAE
*† *Cryptochirus coralliodytes* Heller, 1861.
*† *Hapalocarcinus marsupialis* Stimpson, 1858.
*† *Neotroglocarcinus dawydoffi* (Fize and Serène, 1955).
Troglocarcinus viridis Hiro: Garth, 1964.
Pseudocryptochirus viridis (Hiro): Garth and Hopkins, 1968.
*† *Pseudocryptochirus crescentus* (Edmondson, 1925).
*† Species 1, *incertae sedis*.
*† Species 2, *incertae sedis*.

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*New Enewetak record.
†New Marshall Islands record.

SUMMARY

The Anomura presently known from Enewetak Atoll comprise 76 species, representing 29 genera and 10 families. Of this number, 48 species are new to Enewetak, and 43 are new to the Marshall Islands as well. The family Diogenidae is best represented, with 27 species in seven genera; the family Porcellanidae has 17 species in three genera. Expressed in percentages, of the 76 species listed, 63.15% are new to Enewetak, and 56.57% are new to the Marshall Islands. The Diogenidae contain 35.52% of the species and 24.13% of the genera; the Porcellanidae contain 22.36% of the species and 10.34% of the genera.

The Brachyura presently known from Enewetak Atoll comprise 291 species, representing 115 genera and 16 families. Of this number, 218 species are new to Enewetak, and 170 are new to the Marshall Islands as well. The family Xanthidae is best represented, with 155 species in 49 genera; the family Portunidae by 36 species in nine genera; the family Majidae by 23 species in 13 genera; and the family Grapsidae by 21 species in 10 genera. Expressed in percentages, 74.91% of the 291 species are new to Enewetak and 58.42% are new to the Marshall Islands as well. The Xanthidae contain 53.26% of the species and 42.60% of the genera; the Portunidae contain 12.37% of the species but only 7.82% of the genera; the Majidae contains 7.90% of the species and 11.3% of the genera; and the Grapsidae contain 7.22% of the species and 8.70% of the genera reported. (The number of species and genera new to Enewetak and the Marshall Islands would be even greater had not many been reported in publications in which the crabs, often identified by the first writer, were not the primary interest of the investigator who reported them but incidental as the hosts of isopod or copepod parasites or as agents of bioerosion of corals.)

Because so large a number of brachyuran crabs remain identified to genus (35) or even to family (3) only, no meaningful comparison with other crab faunas is possible at this time. This shortcoming will be rectified when the Enewetak crabs are elaborated a family at a time and the new or obscure species described and illustrated. The deficiency is particularly apparent in the family Parthenopidae, of which no comprehensive review has been made since the Siboga report (Flipse, 1930).

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Appendix

COLLECTION RECORDS

Anomuran Crustacea

Taxa are listed in the same order as in the checklist under their respective families. Higher categories may be found in the checklist. For most species reported below, the records are abbreviated, giving only the islet, year, and collector; following these records is a brief statement on habitat. Where only one or two records are available for a species, more detailed information is included for each. A summary of collectors, years of collection, identifiers, and deposition of material is given in Table 1.

Family CALLIANASSIDAE

Callianassa sp.

Enewetak: 1980, collected from the lagoon by airlift, P. Colin and D. M. Devaney.

Calliax sp., aff. *novaebritanniae* (Borradaile)

Enewetak: 1980, collected from the lagoon by airlift, P. Colin and D. M. Devaney.

Callichirus vigilax (De Man)

Enewetak: 1980, collected from the lagoon by airlift, P. Colin and D. M. Devaney.

Thomassinia sp.

Enewetak: 1980, collected from the lagoon by airlift, P. Colin and D. M. Devaney

Family CALLIANIDEIDAE

Callianidea [undescribed sp.]

Engebi: 1959, shore collecting, +0.5-foot tide, from coral, F. C. Ziesenhenne. Enyu: 1959, shore collecting at north end of island, 0.8-foot tide, in or under coral, F. C. Ziesenhenne.

New genus [undescribed sp. 1]

Off Rigili: 1957, ocean reef flat, inner edge about 100 feet out, from *Acropora* or *Pocillopora* in 1.5 feet of water, A. H. Banner.

New genus [undescribed sp. 2]

Engebi: 1959, shore collecting, +0.5-foot tide, from coral, F. C. Ziesenhenne.

Family AXIIDAE

Enoplometopus (Enoplometopus) sp.

Enewetak: 1969, in surge channel, 0 to 3 feet, C. E. Dawson. Enewetak: 1969, in surge channel, 2 to 10 feet, C. A. Child.

Enoplometopus (Holometopus) holthuisi Gordon

Enewetak: 1981, pinnacle, 10 m in small cave, fragments of both claws, S. Johnson.

Enoplometopus sp.

Off Enewetak: 1946, juvenile in *E. longirostris* stage, L. P. Schultz. Rigili: 1946, 2 miles south, leeward side of reef, light at night, juvenile in *E. longirostris* stage, L. P. Schultz.

New genus [?undescribed sp.]

Aaraanbiru: 1959, shore collecting, +0.6-foot tide, from coral, F. C. Ziesenhenne.

Family HIPPIDAE

Hippa adactyla Fabricius

Enewetak: 1975, lagoon side southwest end of islet, 10 to 20 m northeast cargo pier, in sand at water's edge, C. Fusaro.

Hippa pacifica (Dana)

Bogallua: 1968, J. W. Knudsen. Enewetak: 1968, A. Havens. Igurin: 1967, C. V. MacCoy. Rigili: 1956, student collector. On sandy beach, and in coarse sand and gravel on reef.

Family ALBUNEIDAE

Paralbunea dayriti (Serène and Umali)

Enewetak: 1966, dredged in lagoon at about 11°21.5′N, 162°20′E in 45 m of water, J. W. Knudsen. Enewetak: 1980, collected from the lagoon by airlift, P. Colin and D. M. Devaney.

Family COENOBITIDAE

Birgus latro (Linnaeus)

Igurin: 1960, E. S. Reese and R. A. Boolootian. Mui: 1957, L. Donaldson and E. Held. Rigili: 1957, J. S. Garth. On land.

Coenobita brevimanus Dana

Aaraanbiru: 1957, J. S. Garth. Igurin: 1960, E. S. Reese and R. A. Boolootian. Mui: 1957, L. Donaldson and E. Held. Rigili: 1957, J. S. Garth. On land.

Coenobita cavipes Stimpson

Igurin: 1960, E. S. Reese and R. A. Boolootian. Mui: 1957, L. Donaldson and E. Held. Mui: 1966, J. W. Knudsen. Rigili: 1960, B. Sather and R. Stevenson. Inland and on beach.

Coenobita perlatus H. Milne Edwards

Aomon, Bijile, and Rojoa: 1959, F. C. Ziesenhenne. Chinimi: 1965, G. Bakus. Igurin: 1956, student collector. Igurin: 1959, A. Smith and J. Coatsworth. Igurin: 1960, E. S. Reese and R. A. Boolootian. Medren: 1960, E. S. Reese and R. A. Boolootian. Medren: 1965, G. Bakus. Muzin, Kirinian, and Bokonaarappu: 1959, F. C. Ziesenhenne. Rigili: 1956, student collector. Rigili: 1957, J. S. Garth. Rigili: 1965, G. Bakus. Inland and on beach; on sandy bottom, outer reef flat; dredged in lagoon, 1.8 to 7.2 m.

Coenobita rugosus H. Milne Edwards

Aaraanbiru: 1959, F. C. Ziesenhenne. Aniyaanii: 1956, student collector. Aomon, Bijile, and Rojoa: 1959, F. C. Ziesenhenne. Igurin: 1959, A. Smith and J. Coatsworth. Igurin: 1960, E. S. Reese and R. A. Boolootian. Medren: 1959, F. C. Ziesenhenne. Medren: 1960, E. S. Reese. Muzin, Kirinian, and Bokonaarappu: 1959, F. C. Ziesenhenne. Rigili: 1956, student collectors. Inland and on beach; lagoon and seaward sides; on sandy bottom to 7.2 m.

Family DIOGENIDAE

Aniculus aniculus (Fabricius)

Aaraanbiru: 1959, F. C. Ziesenhenne. Enewetak: 1967, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Igurin: 1960, E. S. Reese and R. A. Boolootian. On reef flat and algal ridge.

Aniculus sp.

Off Bokandretok: 1974, 2.4 to 3 m on sandy bottom, S. L. Brunenmeister.

Calcinus elegans (H. Milne Edwards)

Aniyaanii: 1957, J. S. Garth. Bogen: 1957, J. S. Garth. Enewetak: 1961, E. S. Reese. Enewetak: 1965, 1967, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Engebi: 1957, J. S. Garth. Engebi: 1959, F. C. Ziesenhenne. Igurin: 1957, J. S. Garth. Medren: 1959, J. S. Garth. Medren: 1960, E. S. Reese. Medren: 1974 or 1975, S. L. Brunenmeister. Rigili: 1957, 1959, J. S. Garth. Runit: 1959, J. S. Garth. Enewetak Atoll, no further locality data: 1946, F. C. Ziesenhenne. Lagoon side of reef; seaward reef flat and algal ridge. Under rocks and dead coral, on dead coral heads, on live *Acropora* and *Pocillopora*.

Calcinus gaimardii (H. Milne Edwards)

Enewetak: 1968, J. W. Knudsen. Igurin: 1957, J. S. Garth. Medren: 1959, J. Roberts and/or F. C. Ziesenhenne. Rigili: 1956, student collector. On reef and on sandy beach; under and around *Porites* colonies.

Calcinus guamensis Wooster

Enewetak: 1966, 1967, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. On reef, from *Porites, Favia,* live *Acropora,* and live and dead *Pocillopora*.

Calcinus imperialis Whitelegge
Enewetak: 1967, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Reef flat and algal ridge, from *Acropora* and *Pocillopora* corals.

Calcinus laevimanus (Randall)
Aniyaanii: 1956, student collectors. Aniyaanii: 1957, J. S. Garth. Bokandretok: 1967, J. W. Knudsen. Enewetak: 1961, E. S. Reese. Enewetak: 1965, 1967, 1968, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Engebi: 1956, student collector. Engebi: 1957, 1959, J. S. Garth. Engebi: 1967, J. W. Knudsen. Igurin: 1957, 1959, J. S. Garth. Medren: 1956, student collectors. Medren: 1957, 1959, J. S. Garth. Medren: 1960, E. S. Reese. Medren: 1974 or 1975, S. L. Brunenmeister. Muti: 1965, G. Bakus. Muti: 1967, J. W. Knudsen. Rigili: 1959, J. S. Garth. Runit: 1959, J. S. Garth. Enewetak Atoll, no further locality data: 1946, F. C. Ziesenhenne. Seaward reef flat and beach on lagoon side; under rock, coral rubble, and dead corals, and in live *Porites* colonies.

Calcinus latens (Randall)
Aniyaanii: 1966, J. W. Knudsen. Aomon, Bijile, and Rojoa: 1959, F. C. Ziesenhenne. Bogallua: 1968, J. W. Knudsen. Bokandretok: 1967, J. W. Knudsen. Enewetak: 1961, E. S. Reese. Enewetak: 1966 to 1968, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Engebi: 1959, F. C. Ziesenhenne. Engebi: 1967, J. W. Knudsen. Igurin: 1959, J. S. Garth. Medren: 1957, A. H. Banner. Medren: 1957, T. Goreau. Medren: 1957, 1959, J. S. Garth. Medren: 1959, J. Coatsworth. Medren: 1960, E. S. Reese. Medren: 1974 or 1975, S. L. Brunenmeister. Between Medren and Muti: 1960, E. S. Reese. Muti: 1966, J. W. Knudsen. Rigili: 1959, J. S. Garth. Rojoa: 1966 to 1968, J. W. Knudsen. Runit: 1959, J. S. Garth. Sandy bottom and on corals in lagoon, to 9 m; seaward reef, from live and dead *Acropora* and *Porites* corals.

Calcinus seurati Forest
Enewetak: 1961, E. S. Reese. Medren: 1956, student collector. Medren: 1957, 1959, J. S. Garth. Medren: 1960, E. S. Reese. Medren: 1974 or 1975, S. L. Brunenmeister. Muzin, Kirinian, and Bokonaarappu: 1959, F. C. Ziesenhenne. On reef.

Calcinus sp., aff. *spicatus* Forest
Enewetak: 1967, from *Porites*, J. W. Knudsen. Rojoa: 1968, ocean reef three-fourths way out, green algal turf and burrows, J. W. Knudsen.

Clibanarius sp., aff. *boschmai* Buitendijk
Enewetak: 1975, collected intertidally from crevice in the benchrock at lagoon margin, northern end of island, S. L. Brunenmeister.

Clibanarius corallinus (H. Milne Edwards)
Aaraanbiru: 1959, F. C. Ziesenhenne. Aniyaanii: 1956, student collector. Aniyaanii: 1957, J. S. Garth. Enewetak: 1961, E. S. Reese. Enewetak: 1965, 1967, 1968, J. W. Knudsen. Enewetak: 1974, 1975, S. L. Brunenmeister. Engebi: 1959, F. C. Ziesenhenne. Igurin: 1959, J. S. Garth. Medren: 1959, J. S. Garth. Medren: 1960, E. S. Reese. Between Medren and Muti: 1960, E. S. Reese. Rigili: 1959, J. S. Garth. Runit: 1959, J. S. Garth. Intertidal on reef flat.

Clibanarius eurysternus (Hilgendorf)
Between Aomon and Bijile: 1975, in shallow of blind channel, lagoon side, E. Chave. Enewetak: 1975, intertidally on benchrock, lagoon side, at northern end of island, S. L. Brunenmeister.

Clibanarius zebra rhabdodactylus Forest
Enewetak: 1967, from under cemented slabs at the highest place the slabs occur on the beach, J. W. Knudsen. Enewetak: 1975, collected intertidally from crevice in the benchrock at lagoon margin, northern end of island, S. L. Brunenmeister.

Clibanarius sp.
Enewetak: 1975, under intertidal on seaward reef flat under large rock, in large aggregation; also intertidally on benchrock at lagoon margin, northern end of island, S. L. Brunenmeister. (A species with antennules, antennae, and eyestalks orange, chelipeds brown with light orange fingers, legs banded orange and black.)

Dardanus crassimanus (H. Milne Edwards)
Off Bokandretok, just across interisland channel from Enewetak: 1974, collected at 2.4 to 3 m on sandy bottom around coral heads, S. L. Brunenmeister.

Dardanus deformis (H. Milne Edwards)
Off Bokandretok: 1974, S. L. Brunenmeister. Medren: 1959, F. C. Ziesenhenne. Between Medren and Muti: 1960, E. S. Reese. Muti: 1956, student collector. Enewetak Atoll, no further locality data: 1946, F. C. Ziesenhenne. Reef, ocean side; lagoon side; sublittoral, 0.6 to 9 m on sand and coral rubble.

Dardanus gemmatus (H. Milne Edwards)
Between Enewetak and Bokandretok: 1974, collected at low tide in shallows of interisland channel on sandy bottom with coral rubble, crabs carrying anemones on shells, S. L. Brunenmeister.

Dardanus guttatus (Olivier)
Between Aomon and Bijile: 1975, E. Chave. Off Enewetak: 1967, 1968, J. W. Knudsen. Off Enewetak: 1974 or 1975, S. L. Brunenmeister. Between Medren and Muti: 1960, E. S. Reese. Off Muti: 1967, J. W. Knudsen. Rigili: 1959, J. S. Garth. On reef, in channels, and in lagoon; littoral and to depths of 30 m.

Dardanus lagopodes (Forsskål)
Aaraanbiru: 1959, J. S. Garth. Off Bokandretok: 1974, S. L. Brunenmeister. Enewetak: 1967, J. W. Knudsen. Between Medren and Muti: 1960, E. S. Reese. Muzin, Kirinian, and Bokanaarappu: 1959, F. C. Ziesenhenne. Rigili: 1959, J. S. Garth. Enewetak Atoll, 11°25′N, 162°13′E: 1967, J. W. Knudsen. In lagoon, littoral, diving to 9 m on and around corals, and dredged at 45 m.

Dardanus megistos (Herbst)
Muti: 1968, collected in 6 m of water at night, J. W. Knudsen. Rigili: 1959, southeast side between ocean and lagoon, +0.8 foot tide, from rock and dead coral, J. S. Garth.

Dardanus scutellatus (H. Milne Edwards)
Aomon, Bijile, and Rojoa: 1959, F. C. Ziesenhenne. Off Bokandretok: 1974, S. L. Brunenmeister. Chinieero: 1960, E. S. Reese. Medren: 1957, 1959, J. S. Garth. Medren: 1960, E. S. Reese. Muti: 1956, student collector. In lagoon, littoral to 12 m, on sandy bottoms around and on coral heads and among coral rubble.

Dardanus woodmasoni (Alcock)
Aomon, Bijile, and Rojoa: 1959, 1.8 to 7.2 m on sandy bottom, lagoon side, F. C. Ziesenhenne.

Diogenes gardineri Alcock
Aomon, Bijile, and Rojoa: 1959, F. C. Ziesenhenne. Enewetak: 1966, 1967, J. W. Knudsen. Medren: 1959, J. S. Garth. Between Piiraai and Runit: 1967, J. W. Knudsen. On sandy bottoms in lagoon, 1.8 to 24 m.

Diogenes pallescens Whitelegge
Enewetak Atoll: 1966, in lagoon 100 yds west of marker, ran 250 yds due south, shell–sponge bottom at 60 m, J. W. Knudsen. Enewetak Atoll: 1968, in lagoon at 11°26′N, 162°17.5′E, dredging near coral mound, bottom of shell and some algae at 60 m, J. W. Knudsen.

Paguristes sp.
Medren: 1959, J. Coatsworth, J. S. Garth. Rojoa: 1967, J. W. Knudsen. Enewetak Atoll, 11°26′N, 162°17.5′E: 1968, J. W. Knudsen. Behind reef on coral, 1.5 m; in lagoon, to 45 m.

Trizopagurus strigatus (Herbst)
Enewetak: 1974 or 1975, in interisland channel at northern end of island, low tide at about 0.3 m depth, S. L. Brunenmeister. Medren: 1959, reef between island and L. C. T. wreck, intertidal at +0.8-foot tide, J. Roberts and/or F. C. Ziesenhenne.

Family PAGURIDAE

Catapagurus sp.
Enewetak Atoll: 1966, dredging in lagoon on sponge and sand bottom, depth not indicated, J. W. Knudsen. Enewetak Atoll: 1968, dredging in lagoon at 11°26′N, 162°17.5′E, in 30 m depth on bottom of broken coral and shell, J. W. Knudsen.

Pagurixus anceps (Forest)
Bogallua: 1968, J. W. Knudsen. Bokandretok: 1967, J. W. Knudsen. Enewetak: 1975, S. L. Brunenmeister. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Igurin: 1959, J. S. Garth. Medren: 1957, T. Goreau and R. Neshida. Rojoa: 1967, J. W. Knudsen. Intertidal under rocks and to 15 ft, lagoon side; more frequently on reef flat at low water, from *Porites*, *Acropora*, and *Favia*, some live.

Pagurixus boninensis (Melin)
Medren: 1957, about 8 ft, from *Pocillopora* and *Acropora*, A. H. Banner.

Pagurixus maorus (Nobili)
Aniyaanii: 1966, in mostly dead *Acropora*, J. W. Knudsen. Between Piiraai and Runit: 1967, from 95 to 105 ft in lagoon, J. W. Knudsen. Rojoa: 1966, northwest side on outer reef channel, from dead *Acropora*, J. W. Knudsen. Enewetak Atoll: 1968, dredging in lagoon at 11°26′N, 162°17.5′E, 100 ft, broken coral and shell with much live coral, J. W. Knudsen.

New genus, sp.
Muti: 1966, collected at pier from dead and heavily encrusted pocilloporid coral, J. W. Knudsen.

Family GALATHEIDAE

Allogalathea elegans (Adams and White)
Near Jierorv, at about 11°26′N, 162°21′E: 1967, J. W. Knudsen. Off Medren: 1968, 1971, J. W. Knudsen. Enewetak Atoll, 11°29′N, 162°19′E: J. W. Knudsen. Enewetak Atoll: 1976 or 1978, A. Fielding. In lagoon, to 9 m; all specimens from crinoids.

Coralliogalathea humilis (Nobili)
Bogombogo: 1957, D. Reish. Enewetak: 1967, J. W. Knudsen. Enewetak: 1967, S. Swerdloff. Rigili: 1965, J. W. Knudsen. Enewetak Atoll, 11°25′N, 162°13′E: 1967, J. W. Knudsen. On reef from dead corals and live *Acropora*; dredged in lagoon in 45 m on bottom of sponge, dead shell, coral, and algae.

Galathea aegyptiaca Paulson
Aniyaanii: 1960, north lagoon side, from coral head, E. S. Reese.

Galathea affinis Ortmann
Aniyaanii: 1957, A. H. Banner. Aniyaanii: 1966, 1967, J. W. Knudsen. Between Billee and Bokonaarappu: 1967, J. W. Knudsen. Bogallua: 1968, J. W. Knudsen. Bogombogo: 1957, D. Reish. Bokandretok: 1965, J. W. Knudsen. Enewetak: 1965, 1967, 1968, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Engebi: 1967, J. W. Knudsen. Igurin: 1965, J. W. Knudsen. Between Kirinian and Muzin: 1965, J. W. Knudsen. Medren: 1957, T. Goreau and R. Neshida. Medren: 1959, J. Coatsworth. Rigili: 1965, 1968, J. W. Knudsen. Rojoa: 1966, 1967, J. W. Knudsen. On reef to 4.5 m in live and dead corals, including *Acropora* and *Porites*; dredged in lagoon at 30 m.

Galathea amboinensis De Man
Enewetak Atoll: 1976 or 1978, from crinoids, A. Fielding.

Galathea sp., aff. *tanegashimae* Baba
Enewetak: 1967, S. Swerdloff. Jierorv: 1967, 1968, J. W. Knudsen. Medren: 1957, A. H. Banner. Rojoa: 1966, J. W. Knudsen. On reef and in lagoon, to 9 m depth; on corals including live and dead *Acropora*, and from crinoids.

Phylladiorhynchus serrirostris (Melin)
Enewetak: 1967, from coral head in lagoon about 300 yds. from laboratory site, J. W. Knudsen. Medren: 1957, diving in 3 to 4.5 m, coral heads and dead coral, T. Goreau and R. Neshida.

Family PORCELLANIDAE

Neopetrolisthes maculatus (H. Milne Edwards)
Bokandretok: 1968, J. W. Knudsen. Medren: 1971, J. W. Knudsen. Between Medren and Enewetak: 1968, J. W. Knudsen. Rigili: 1968, J. W. Knudsen. To 3 m depth in channels and lagoon, from anemones.

Pachycheles johnsoni Haig
Bijile: 1968, A. Havens. Bokandretok: 1967, J. W.

Knudsen. Bokandretok: 1968, A. Havens. Enewetak: 1965 to 1967, J. W. Knudsen. Enewetak: 1968, A. Havens. Enewetak: 1969, C. A. Child. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Engebi: 1959, F. C. Ziesenhenne. Engebi: 1967, J. W. Knudsen. Mui: 1967, J. W. Knudsen. Muti: 1966, 1968, J. W. Knudsen. Rigili: 1957, A. H. Banner. Rigili: 1966, J. W. Knudsen. On reef, intertidal or shallow subtidal, frequently in or under live and dead *Porites*, *Pocillopora*, and *Acropora*; occasionally under rocks.

Pachycheles pisoides (Heller)
Enewetak: 1969, surge channel and blow hole about 20 ft back from outer reef edge, C. A. Child. Between Enewetak and Bokandretok: 1966, on reef inside algal ridge, from dead encrusted algae or from *Pocillopora*, J. W. Knudsen.

Pachycheles spinipes (A. Milne Edwards)
Chinieero: 1965, J. W. Knudsen. Enewetak: 1965, 1967, J. W. Knudsen. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. On reef, from corals.

Petrolisthes asiaticus (Leach)
Bogen: 1957, J. S. Garth. Bokandretok: 1967, J. W. Knudsen. Bokandretok: 1968, A. Havens. Enewetak: 1965, J. W. Knudsen. Enewetak: 1968, A. Havens. Enewetak or Gugegwe [Kwajalein Atoll]: 1946, F. C. Ziesenhenne. Engebi: 1957, J. S. Garth. Igurin: 1959, J. S. Garth. Jieruro: 1946, M. W. Johnson. Medren: 1957, J. S. Garth. Medren: 1965, J. W. Knudsen. Muti: 1957, J. S. Garth. Muti: 1965, G. Bakus. Muti: 1967, 1968, J. W. Knudsen. Rigili: 1956, student collector. Rigili: 1959, J. S. Garth. Runit: 1959, J. S. Garth. Runit: 1965, J. W. Knudsen. Runit: 1968, A. Havens. On reef, usually under rocks and coral rubble.

Petrolisthes bispinosus Borradaile
Bokandretok: 1967, J. W. Knudsen. Enewetak: 1965, 1967, J. W. Knudsen. Enewetak: 1969, C. E. Dawson, C. A. Child. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Mui: 1967, T. Smith. Muti: 1968, J. W. Knudsen. On seaward reef flat and algal ridge, in corals including *Pocillopora*.

Petrolisthes borradailei Kropp
Aniyaanii: 1956, student collector. Bogen: 1957, J. S. Garth. Bokandretok: 1967, J. W. Knudsen. Enewetak: 1965, 1967, J. W. Knudsen. Engebi: 1957, J. S. Garth. Igurin: 1959, J. S. Garth. Muti: 1965, 1968, J. W. Knudsen. Muti: 1965, G. Bakus. Muti: 1968, A. Havens. Rigili: 1957, J. S. Garth. Runit: 1959, J. S. Garth. On reef, usually under rocks and in coral rubble.

Petrolisthes coccineus (Owen)
Enewetak: 1969, surge channel and blow hole about 20 ft back from outer reef edge, C. A. Child. Engebi: 1967, algal ridge, J. W. Knudsen.

Petrolisthes decacanthus Ortmann
Enewetak: 1967, algal ridge, J. W. Knudsen. Enewetak: 1969, outer reef rim and surge channels along north one-third of island, C. E. Dawson and C. A. Child. Enewetak: 1969, surge channel and blow hole about 20 ft back from outer reef edge, C. A. Child.

Petrolisthes elegans Haig
Enewetak: 1965, 1967, J. W. Knudsen. Enewetak: 1969, C. A. Child. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Medren: 1965, J. W. Knudsen. Muti: 1968, J. W. Knudsen. Rujoru: 1946, M. W. Johnson. Reef flat and algal ridge, under rocks and from corals, including *Pocillopora*.

Petrolisthes fimbriatus Borradaile
Aniyaanii: 1957, J. S. Garth. Aniyaanii: 1967, J. W. Knudsen. Bogen: 1966, J. W. Knudsen. Bokandretok: 1967, J. W. Knudsen. Bokandretok: 1968, A. Havens. Enewetak: 1957, J. S. Garth. Enewetak: 1965 to 1968, J. W. Knudsen. Enewetak: 1968, A. Havens. Enewetak or Gugegwe [Kwajalein Atoll]: 1946, F. C. Ziesenhenne. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Engebi: 1956, student collector. Engebi: 1957, J. S. Garth. Igurin: 1957, 1959, J. S. Garth. Igurin: 1965, J. W. Knudsen. Jeiroju: 1946, J. P. E. Morrison. Jieruro: 1946, M. W. Johnson. Medren: 1957, 1959, J. S. Garth. Medren: 1965, J. W. Knudsen. Muti: 1957, J. S. Garth. Muti: 1965, 1968, J. W. Knudsen. Muti: 1965, G. Bakus. Muti: 1968, A. Havens. Piiraai: 1968, A. Havens. Rigili: 1956, D. Reish. Rigili: 1959, J. S. Garth. Rigili: 1966, 1968, J. W. Knudsen. Runit: 1959, J. S. Garth. Enewetak Atoll, no further locality data: 1944, W. A. Bartos. Enewetak Atoll, no further locality data: 1946, F. C. Ziesenhenne. On reef, under rocks and from rubble; occasionally from corals.

Petrolisthes lamarckii (Leach)
Aniyaanii: 1957, J. S. Garth. Bokandretok: 1967, J. W. Knudsen. Bokandretok: 1968, A. Havens. Enewetak: 1965, 1967, 1968, J. W. Knudsen. Enewetak: 1968, A. Havens. Engebi: 1957, J. S. Garth. Igurin: 1957, 1959, J. S. Garth. Medren: 1959, J. S. Garth. Medren: 1965, J. W. Knudsen. Mui: 1968, A. Havens. Muti: 1957, J. S. Garth. Muti: 1965, G. Bakus. Muti: 1967, 1968, J. W. Knudsen. Muti: 1968, A. Havens. Piiraai: 1968, A. Havens. Rigili: 1957, 1959, J. S. Garth. Rigili: 1966, J. W. Knudsen. Runit: 1959, J. S. Garth. Runit: 1965, J. W. Knudsen. Enewetak Atoll, no further locality data: 1946, F. C. Ziesenhenne. On reef, usually under rocks and in coral rubble.

Petrolisthes masakii Miyake
Enewetak: 1969, surge channel and blow hole about 20 ft back from outer reef edge, C. A. Child.

Petrolisthes penicillatus (Heller)
Off Bokandretok: 1968, A. Havens. Enewetak: 1968, J. W. Knudsen. Enewetak: 1968, A. Havens. Enewetak: 1969, C. A. Child. Between Enewetak and Bokandretok: 1966, J. W. Knudsen. Medren: 1965, 1968, J. W. Knudsen. Rigili: 1965, J. W. Knudsen. On reef, to 0.9 m depth, under rocks and rubble, and in *Porites*, *Acropora*, and *Pocillopora*.

Petrolisthes pubescens Stimpson
Bokandretok: 1968, channel southwest of island, under rock, A. Havens.

Petrolisthes [undescribed sp. 1]
Rigili: 1965, north end of island from live *Pocillopora elegans*, J. W. Knudsen.

Petrolisthes [undescribed sp. 3]
Enewetak: 1967, J. W. Knudsen. Enewetak: 1968, A. Havens. Enewetak: 1969, C. A. Child. Engebi: 1967, J. W. Knudsen. Reef flat and ridge, some specimens from corals.

TABLE 1

Data on Collections of Anomura*

Collector(s)	Date	Identifier	Depository
Bakus, G.	1965	J. Haig	AHF
Banner, A.H.	1957	J. Haig, M. de Saint Laurent, P. McLaughlin	AHF
Bartos, W. A.	1944	J. Haig	USNM
Brunenmeister, S. L.	1974, 1975	S. Brunenmeister, P. McLaughlin, J. Haig	
Chave, E.	1975	P. McLaughlin	
Child, C. A.	1969	J. Haig, L. B. Holthuis	USNM, RMNH
Coatsworth, J.	1959	J. Haig	AHF, MPRL
Colin, P., and D. M. Devaney	1980	M. de Saint Laurent, J. Haig	BPBM
Dawson, C. E.	1969	J. Haig, L. B. Holthuis	USNM, RMNH
Donaldson, L., and E. Held	1957	J. S. Garth	AHF, MPRL
Fielding, A.	1976, 1978	K. Baba	BPBM
Fusaro, C.	1975	C. Fusaro	BPBM
Garth, J. S.	1957, 1959	J. S. Garth, J. Haig P. McLaughlin	AHF, MPRL
Goreau, T., and R. Neshida	1957	J. Haig, P. McLaughlin	AHF, MPRL
Havens, A.	1968	J. Haig	AHF
Johnson, M. W.	1946	J. Haig	USNM
Johnson, S.	1981	L. B. Holthuis	BPBM, MPRL, USNM
Knudsen, J. W.	1965 to 1968	J. Haig	AHF
	1971	P. McLaughlin	AHF
MacCoy, C. V.	1967	J. Haig	AHF
Morrison, J. P. E.	1946	J. Haig	USNM
Reese, E. S.	1960, 1961	E. S. Reese, J. Haig	AHF
Reese, E. S., and R. A. Boolootian	1960	E. S. Reese, J. Haig	AHF
Reish, D.	1956, 1957	J. Haig	AHF
Roberts, J.	1959	J. Haig	AHF
Sather, B., and R. Stevenson	1960	J. Haig	AHF
Schultz, L. P.	1946	L. B. Holthuis	USNM
Smith, A., and J. Coatsworth	1959	J. Haig	AHF
Smith, T.	1967	J. Haig	AHF
Student collectors	1956	J. S. Garth	MPRL
Swerdloff, S.	1967	J. Haig	AHF
Ziesenhenne, F. C.	1946, 1959	J. S. Garth, J. Haig, M. de Saint Laurent	AHF

*AHF, Allan Hancock Foundation; BPBM, Bernice P. Bishop Museum; MPRL, Mid-Pacific Research Laboratory, Enewetak; RMNH, Rijksmuseum van Natuurlijke Historie, Leiden; USNM, National Museum of Natural History, Smithsonian Institution.

Brachyuran Crustacea

Taxa are listed in the same order as in the checklist under their respective families. Higher categories and also synonyms may be consulted in the checklist. Because plans are to give complete data—including islet, substrate, depth, month, and year of collecting—in future publications, only collectors' surnames in chronological order are given here. Their respective periods of activity at Enewetak Atoll and the present depository of their collections will be found in Table 2.

Family DROMIIDAE
Cryptodromia canaliculata Stimpson
EMBL, Reish, Garth, Ziesenhenne, Bakus, Knudsen.
Cryptodromia sp.
Knudsen.
Family DYNOMENIDAE
Dynomene hispida Desmarest
Garth, Reese, Knudsen, Havens, Child, Highsmith.
Dynomene pilumnoides Alcock
Knudsen.
Dynomene praedator A. Milne Edwards
Knudsen.
Dynomene spinosa Rathbun
Garth, Knudsen, Havens.
Family LEUCOSIIDAE
Cryptocnemus haddoni Calman
Havens.
Ebalia woodmasoni Alcock
Knudsen.
Ebaliopsis erosa (A. Milne Edwards)
Garth, Ziesenhenne, Knudsen.
Heterolithadia sp.
Knudsen.
Heteronucia venusta Nobili
Knudsen, Havens.
Merocryptus durandi Serène
Knudsen.
Myra fugax coalita Hilgendorf
Knudsen.
Nucia ingens (Rathbun)
Knudsen.
Nucia speciosa Dana
Knudsen.
Oreophorus (Oreotlos) latus Borradaile
Knudsen, Havens.
Species *incertae sedis*
Knudsen.
Family CALAPPIDAE
Calappa calappa (Linnaeus)
Knudsen, Havens.
Calappa gallus (Herbst)
Garth, Knudsen, Fielding.
Calappa hepatica (Linnaeus)
EMBL, Reish, Garth, Ziesenhenne, Knudsen, Havens, Child, USGS (fossil).

Family MAJIDAE
Camposcia retusa Latreille
Garth.
Camposcia sp.
Knudsen.
Cyclax suborbiculatus (Stimpson)
Garth, Ziesenhenne, Knudsen, Havens.
Huenia brevifrons Ward
Knudsen.
Huenia proteus De Haan
Ziesenhenne, Knudsen.
Hyastenus irami (Laurie)
Banner, Knudsen, Child.
Hyastenus uncifer Calman
Knudsen, Child.
Hyastenus verrucosipes (Adams and White)
Knudsen.
Hyastenus sp.
Knudsen.
Menaethius monoceros (Latreille)
Reish, Banner, Garth, Ziesenhenne, Reese, Knudsen, Havens, Child.
Micippa margaritifera Henderson
Knudsen.
Micippa philyra (Herbst)
Garth, Ziesenhenne, Knudsen.
Micippa platypes Rüppell
Reish, Ziesenhenne, Stokes, Knudsen, Havens.
Micippa thalia (Herbst)
Knudsen.
Naxioides spinigera Borradaile
Knudsen.
Paratymolus bituberculatus Miers
Knudsen.
Paratymolus sexspinosus Miers
Garth.
Parazewa bocki Balss
Knudsen.
Perinea tumida Dana
Reish, Banner, Garth, Ziesenhenne, Reese, Knudsen, Havens.
Schizophrys aspera (H. Milne Edwards)
Garth, Reese, Knudsen, Child.
Trigonothir obtusirostris Miers
Palumbo, Knudsen.
Tylocarcinus ?gracilis Miers
Knudsen.
Tylocarcinus styx (Herbst)
Banner, Garth, Reese, Shoup, Knudsen, Havens, Child.

Family PARTHENOPIDAE
Actaeomorpha sp., nr. *erosa* (Miers)
Knudsen.
Cryptopodia ?pan Laurie
Knudsen.
Daldorfia horrida (Linnaeus)
EMBL, Garth, Knudsen, Havens.

Daldorfia (or *Parthenope*) sp.
Knudsen.
Harrovia elegans De Man
Garth.
?*Heterocrypta* sp.
Knudsen, Havens.
Parthenope (Aulacolambrus) curvispinis (Miers)
Knudsen.
Parthenope (Aulacolambrus) hoplonotus (Adams and White)
Knudsen.
Parthenope (Aulacolambrus) sp.
Knudsen, Havens.
Parthenope (Pseudolambrus) sp.
Knudsen.
Parthenope sp.
Knudsen.
Thyrolambrus erosus (Miers)
Knudsen.
Thyrolambrus sp.
Knudsen.

Family ATELECYCLIDAE
Kraussia integra Rathbun
Knudsen, Havens.
Kraussia sp., cf. *marquesa* Serène
Knudsen.
Kraussia nitida Stimpson
Garth.
Kraussia rastripes F. Müller
Havens.
Kraussia rugulosa (Krauss)
EMBL, Garth, Knudsen, Havens, Child.

Family PORTUNIDAE
Carupa tenuipes Dana
Ziesenhenne, Knudsen, Havens.
Catoptrus inaequalis (Rathbun)
Knudsen.
Catoptrus nitidus A. Milne Edwards
Garth, Ziesenhenne.
Catoptrus rathbunae Serène
Ziesenhenne.
Catoptrus ?truncatifrons De Man
Havens.
Charybdis (Goniosupradens) erythrodactylus (Lamarck)
Havens, Fielding.
Coelocarcinus foliatus Edmondson
Havens.
Libistes villosus Rathbun
Knudsen, Havens.
Lissocarcinus holothuricola Streets
Knudsen.
Lissocarcinus orbicularis Dana
Garth, Shoup, Knudsen, Havens.
Portunus (Achelous) granulatus (H. Milne Edwards)
Ziesenhenne, Knudsen, Havens.
Portunus (Achelous) sp., nr. *orbicularis* (Richters)
Garth, Ziesenhenne.
Portunus (Hellenus) longispinosus Stephenson and Campbell
Reish, Garth, Ziesenhenne, Knudsen, Havens.
Thalamita admete (Herbst)
EMBL, Reish, Garth, Ziesenhenne, Knudsen, Havens, Child.
Thalamita bouvieri Nobili
Knudsen.
Thalamita chaptalii (Audouin)
Knudsen.
Thalamita coeruleipes Jacquinot
Knudsen, Havens.
Thalamita corrugata Stephenson and Rees
Knudsen.
Thalamita dakini Montgomery
Knudsen, Havens, Child.
Thalamita gloriensis Crosnier
Morrison.
Thalamita gracilipes (A. Milne Edwards)
Garth, Ziesenhenne, Knudsen, Havens.
Thalamita integra Dana
Pomeroy and Kuenzler.
Thalamita oculea Alcock
Knudsen.
Thalamita picta Stimpson
EMBL, Garth, Ziesenhenne, Knudsen, Havens, Child.
Thalamita pilumnoides Borradaile
Garth, Knudsen.
Thalamita prymna (Herbst)
Knudsen, Havens, Child, Fielding.
Thalamita quadrilobata Miers
Knudsen.
Thalamita sexlobata Miers
Knudsen.
Thalamita sima H. Milne Edwards
Knudsen.
Thalamita spiceri Edmondson
Garth, Knudsen, Havens, Highsmith.
Thalamita spinimana Dana
EMBL, Garth.
Thalamita stimpsoni A. Milne Edwards
Knudsen.
Thalamita wakensis Edmondson
Knudsen, Havens.
Thalamita yoronensis Sakai
Knudsen.
Thalamita sp., nr. *auauensis* Rathbun
Knudsen.
Thalamitoides quadridens A. Milne Edwards
Banner, Garth, Reese, Knudsen, USGS (fossil).

Family XANTHIDAE
Actaea sp., nr. *bocki* Odhner
Knudsen.
Actaea(?) *cavipes* Dana
Knudsen, Havens.
Actaea margaritifera Odhner
Knudsen.
Actaea pulchella modesta (De Man)
Knudsen.

Actaea quadriareolata Takeda and Miyake
Banner, Garth, Knudsen.
Actaea sp.
Knudsen, Havens.
Actaeodes consobrinus (A. Milne Edwards)
Garth, Reese, Knudsen, Havens.
Actaeodes hirsutissimus (Rüppell)
USGS (fossil).
Actumnus antelmei Ward
Knudsen.
Actumnus asper (Rüppell)
Knudsen.
Actumnus setifer (De Haan)
Knudsen.
Actumnus sp.
Knudsen.
Actumnus (or *Pilumnus*) sp.
Knudsen.
Atergatis ?dilitatus De Haan
de Gruy.
Atergatis floridus (Linnaeus)
Knudsen.
Atergatopsis signata (Adams and White)
Knudsen, Burke.
Banareia nobilii (Odhner)
Knudsen.
Banareia parvula (Krauss)
Knudsen.
Carpilius convexus (Forsskål)
Johnson, Ziesenhenne, Knudsen, Havens, Fielding.
Carpilius maculatus (Linnaeus)
Knudsen, Fielding.
Chlorodiella corallicola Miyake and Takeda
Knudsen.
Chlorodiella cytherea (Dana)
Ziesenhenne, Knudsen, Havens.
Chlorodiella laevissima (Dana)
Reish, Garth, Ziesenhenne, Reese, Knudsen, Havens.
Chlorodiella nigra (Forsskål)
Reish, Banner, Garth, Shoup, Knudsen, Havens.
Cycloxanthops cavatus Rathbun
Garth, Knudsen, Havens.
Cymo andreossyi (Audouin)
Banner, Reese, Knudsen.
Cymo deplanatus A. Milne Edwards
Ziesenhenne, Reese, Shoup, Knudsen, Child.
Cymo melanodactylus De Haan
Garth, Reese, Knudsen.
Cymo quadrilobatus Miers
Knudsen.
Dacryopilumnus eremita Nobili
Knudsen, Havens.
Dacryopilumnus rathbunae Balss
Knudsen, Havens.
Daira perlata (Herbst)
Havens.
Domecia glabra Alcock
Banner, Garth, Ziesenhenne, Reese, Shoup, Knudsen, Havens, Child.
Domecia hispida Eydoux and Souleyet
Reese, Shoup, Knudsen, Havens.
Eriphia scabricula Dana
Morrison, EMBL, Garth, Ziesenhenne, Knudsen, Havens, Child.
Eriphia sebana (Shaw and Nodder)
Morrison, EMBL, Garth, Ziesenhenne, Bakus, Knudsen, Havens, Child.
Etisus bifrontalis (Edmondson)
Knudsen.
Etisus demani Odhner
Johnson, Knudsen, Garth, Havens.
Etisus sp., nr. *demani* Odhner
Knudsen, Havens.
Etisus dentatus (Herbst)
Garth, Ziesenhenne, Knudsen, Havens, Child.
Etisus electra (Herbst)
Reish, Knudsen.
Etisus frontalis Dana
Knudsen.
Etisus laevimanus Randall
USGS (fossil).
Etisus molokaiensis (Rathbun)
Garth, Havens.
Etisus splendidus Rathbun
Fielding, USGS (fossil).
Etisus sp. 1
Knudsen, Havens.
Etisus sp. 2
Knudsen, Havens.
Etisus sp. 3
Havens.
Euxanthus exsculptus (Herbst)
Garth.
Euxanthus (or *Hypocolpus*) sp.
Knudsen.
Gaillardiellus rueppellii (Krauss)
Ziesenhenne, Knudsen.
Gaillardiellus superciliaris (Odhner)
Reish, Banner, Garth, Ziesenhenne, Reese, Shoup, Knudsen, Havens, Child.
Globopilumnus globosus (Dana)
Knudsen, Havens.
Heteropilumnus sp., cf. *longipes* (Stimpson)
Knudsen, Havens.
Lachnopodus ponapensis (Rathbun)
Knudsen, Havens.
Lachnopodus subacutus (Stimpson)
Knudsen, Havens, Fielding.
Lachnopodus tahitensis De Man
EMBL, Garth, Knudsen, Havens, Child, Burke.
Leptodius davaoensis Ward
Havens, Child.
Leptodius exaratus (H. Milne Edwards)
Reish, Garth, Bussing, Knudsen, Child.
Leptodius gracilis (Dana)
Ziesenhenne, Bakus, Knudsen, Havens.
Leptodius nudipes (Dana)
Knudsen, Havens.

Leptodius sanguineus (H. Milne Edwards)
Ziesenhenne, Morrison, Johnson, EMBL, Garth, Bakus, Knudsen, Havens, Child.

Leptodius waialuanus Rathbun
Knudsen, Havens, Child.

Liocarpilodes armiger pacificus Balss
Ladd, Banner, Garth, Reese, Shoup, Knudsen, Havens, Highsmith.

Liocarpilodes biunguis (Rathbun)
Ladd, EMBL, Reish, Garth, Knudsen, Havens, Child, Highsmith.

Liocarpilodes integerrimus (Dana)
Reish, Knudsen, Havens.

Liocarpilodes pumilus (Jacquinot)
Ladd, EMBL, Knudsen.

Liomera bella (Dana)
Bartos, Morrison, Banner, Garth, Ziesenhenne, Shoup, Bakus, Knudsen, Havens, Highsmith.

Liomera coelata (Odhner)
Banner.

Liomera loevis (A. Milne Edwards)
Garth.

Liomera monticulosa (A. Milne Edwards)
Reese, Knudsen.

Liomera pallida (Borradaile)
Knudsen, Havens.

Liomera rugata (H. Milne Edwards)
Ziesenhenne, Garth, Knudsen, Havens.

Liomera stimpsoni (A. Milne Edwards)
Knudsen.

Liomera tristis (Dana)
Garth.

Liomera sp.
Knudsen.

Lophozozymus dodone (Herbst)
Knudsen, Child.

Lophozozymus incisus (H. Milne Edwards)
Johnson.

Lophozozymus pulchellus A. Milne Edwards
Shoup, Knudsen, Havens.

Lybia caestifera (Alcock)
Knudsen.

Lybia tessellata (Latreille)
Ziesenhenne, Stokes, Knudsen, Havens.

Lydia annulipes (H. Milne Edwards)
Knudsen, Havens, Fielding.

Macromedaeus nudipes (A. Milne Edwards)
Garth, Knudsen, Havens, Child.

Maldivia palmyrensis Rathbun
Knudsen, Highsmith.

Maldivia triunguiculata (Borradaile)
Knudsen, Havens, Highsmith.

Medaeus elegans A. Milne Edwards
Knudsen, Havens.

Medaeus ornatus Dana
Knudsen, Havens.

Neoxanthias impressus (Lamarck)
Garth, Ziesenhenne, Knudsen, Burke.

Paractaea retusa (Nobili)
Knudsen, Havens.

Paractaea rufopunctata (H. Milne Edwards)
Banner, Garth, Knudsen, Havens.

Paractaea rufopunctata f. *plumosa* Guinot
Knudsen.

Paractaea tumulosa (Odhner)
Knudsen.

Paramedaeus simplex (A. Milne Edwards)
Knudsen, Havens, Child.

Parapilumnus coralliophilus Takeda and Miyake
Shoup, Knudsen, Havens.

Parapilumnus ?incertus Takeda and Miyake
Knudsen.

Paraxanthias notatus (Dana)
Ladd, Reish, EMBL, Banner, Garth, Ziesenhenne, Knudsen, Havens, Highsmith.

Paraxanthias pachydactylus (A. Milne Edwards)
Knudsen, Havens.

Phymodius ?granulatus (Targioni-Tozzetti)
Knudsen.

Phymodius laysani Rathbun
Reese, Knudsen, Havens.

Phymodius monticulosus (Dana)
Garth, Knudsen.

Phymodius nitidus (Dana)
Garth, Knudsen, Havens.

Phymodius ungulatus (H. Milne Edwards)
Banner, Reish, Garth, Reese, Shoup, Knudsen, Havens.

Pilodius areolatus (H. Milne Edwards)
Ziesenhenne, Johnson, Ladd, EMBL, Garth, Ziesenhenne, Shoup, Bakus, Knudsen, Havens, Highsmith.

Pilodius flavus Rathbun
Reese, Knudsen, Havens.

Pilodius melanodactylus (A. Milne Edwards)
Knudsen.

Pilodius pilumnoides (White)
Morrison, Reish, Garth, Knudsen, Havens.

Pilodius pugil Dana
Johnson, Reish, Banner, Ziesenhenne, USGS (fossil).

Pilodius scabriculus Dana
Knudsen, Havens.

Pilodius spinipes Heller
Reish, Banner, Garth, Knudsen, Havens.

Pilumnus andersoni De Man
Knudsen, Havens.

Pilumnus caerulescens A. Milne Edwards
Knudsen, Havens, Child.

Pilumnus ?elegans De Man
Knudsen.

Pilumnus longicornis Hilgendorf
Banner, Garth, Knudsen, Havens, Child.

Pilumnus ransoni Forest and Guinot
Knudsen.

Pilumnus rotumanus Borradaile
Knudsen.
Pilumnus tahitensis De Man
Knudsen, Havens.
Pilumnus vespertilio (Fabricius)
Knudsen.
Pilumnus sp.
Havens.
Planopilumnus vermiculatus (A. Milne Edwards)
Banner, Knudsen, Havens.
Polydectus cupulifer (Latreille)
Banner, Knudsen, Havens, Child.
Pseudoliomera granosimanus (A. Milne Edwards)
Knudsen, Havens.
Pseudoliomera helleri (A. Milne Edwards)
Knudsen.
Pseudoliomera sp., nr. *helleri* (A. Milne Edwards)
Knudsen.
Pseudoliomera lata (Borradaile)
Knudsen.
Pseudoliomera sp. nr. *lata* (Borradaile)
Knudsen.
Pseudoliomera rueppellioides (Odhner)
Knudsen.
Pseudoliomera speciosa (Dana)
Reish, Reese and Stevenson, Shoup, Knudsen, Havens.
Pseudozius caystrus (Adams and White)
Ziesenhenne, Johnson, EMBL, Garth, Knudsen, Havens, Child.
Pseudozius pacificus Balss
Garth, Knudsen.
Ralumia dahli Balss
Knudsen.
Tetralia glaberrima (Herbst)
Morrison, Ladd, Reish, EMBL, Banner, Garth, Ziesenhenne, Reese, Shoup, Knudsen, Havens, Child.
Tetralia glaberrima rubridactylus Patton
Reese, Child
Tetraloides nigrifrons (Dana)
Garth, Ziesenhenne, Reese, Shoup, Knudsen, Havens.
Trapezia cymodoce (Herbst)
Morrison, EMBL, Garth, Reese and Stevenson, Shoup, Knudsen, Havens, Child.
Trapezia dentata Macleay
Knudsen, Child.
Trapezia digitalis Latreille
Garth, Ziesenhenne, Shoup, Knudsen, Havens.
Trapezia digitalis bella Dana
Knudsen.
Trapezia sp., *digitalis* group
Reese, Knudsen.
Trapezia ferruginea Latreille
Morrison, Banner, Reish, Garth, Ziesenhenne, Reese and Stevenson, Shoup, Knudsen, Havens, Child.
Trapezia guttata Rüppell
Ladd, Reish?, Reese, Shoup, Bussing, Knudsen, Havens.
Trapezia rufopunctata (Herbst)
Knudsen.
Trapezia rufopunctata flavopunctata Eydoux and Souleyet
Knudsen.
Trapezia rufopunctata maculata Macleay
Garth, Reese and Stevenson, Shoup, Knudsen.
Trapezia speciosa Dana
Ladd, Ziesenhenne, Knudsen, Havens.
Trapezia tigrina Eydoux and Souleyet
Reish?, Garth, Ziesenhenne, Reese and Stevenson, Shoup, Knudsen, Havens, Child.
Trapezia sp. 1
Knudsen, Havens.
Trapezia sp. 2
Havens.
Xanthias canaliculatus Rathbun
Knudsen, Havens.
Xanthias gilbertensis Balss
Knudsen.
Xanthias lamarcki (H. Milne Edwards)
Ziesenhenne, Morrison, Johnson, Ladd, EMBL, Garth, Ziesenhenne, Knudsen, Havens, Highsmith.
Xanthias lividus Lamarck
Knudsen.
Xanthias punctatus (H. Milne Edwards)
Knudsen, Havens.
Xantho sp.
Knudsen.
Zozymodes cavipes (Dana)
Ziesenhenne.
Zozymus actaeoides (A. Milne Edwards)
Knudsen.
Zozymus sp., nr. *actaeoides* (A. Milne Edwards)
Knudsen.
Zozymus aeneus (Linnaeus)
Morrison, Ladd, Garth, Ziesenhenne, Knudsen, Havens.
Zozymus gemmula Dana
Knudsen.
Zozymus hawaiiensis (Rathbun)
Knudsen.
Zozymus kuekenthalii De Man
Knudsen, Havens.

Family GONEPLACIDAE
Ceratoplax sp.
Knudsen.
Genus and species *incertae sedis*
Knudsen.

Family PALICIDAE
Palicus jukesi (White)
Knudsen.
Palicus whitei (Miers)
Knudsen.
Palicus sp., nr. *oahuensis* Rathbun
Ziesenhenne.

Family GRAPSIDAE
Cyclograpsus integer H. Milne Edwards
Knudsen, Child.

Cyclograpsus longipes Stimpson
Knudsen, Havens.
Cyclograpsus sanctaecrucis Griffin
Knudsen.
Geograpsus crinipes (Dana)
Held, Knudsen, Havens, Fielding.
Geograpsus grayi (H. Milne Edwards)
Held, Knudsen, Havens, Fielding.
Grapsus intermedius De Man
Knudsen.
Grapsus longitarsus Dana
EMBL, Held, Child, Havens.
Grapsus tenuicrustatus (Herbst)
EMBL, Garth, Ziesenhenne, Reese and Boolootian, Knudsen, Havens.
Metasesarma rousseauxi H. Milne Edwards
Knudsen.
Metopograpsus thukuhar (Owen)
Knudsen, Havens.
Pachygrapsus minutus A. Milne Edwards
EMBL, Reish, Garth, Ziesenhenne, Bakus, Knudsen, Havens, Child, Highsmith.
Pachygrapsus planifrons De Man
Garth, Bakus, Knudsen, Havens, Child.
Pachygrapsus plicatus H. Milne Edwards
EMBL, Bakus, Knudsen, Havens, Child.
Percnon abbreviatum (Dana)
Knudsen, Havens, Child.
Percnon pilimanus (A. Milne Edwards)
Knudsen, Havens, Child, Fielding.
Percnon planissimum (Herbst)
EMBL, Bakus, Knudsen, Havens, Child, Highsmith.
Plagusia depressa tuberculata Lamarck
Knudsen, Havens.
Plagusia immaculata Lamarck
Fielding.
Plagusia speciosa Dana
Knudsen, Havens, Child, Fielding.
Pseudograpsus albus Stimpson
EMBL, Knudsen, Havens.
Sesarma (Holometopus) sp.
Knudsen.

Family GECARCINIDAE
Gecarcoidea lalandii H. Milne Edwards
Knudsen, Fielding.

Family PINNOTHERIDAE
Xanthasia murigera White
Garth.

Family OCYPODIDAE
Macrophthalmus (Macrophthalmus) telescopicus (Owen)
Knudsen.
Macrophthalmus (Mopsocarcinus) bosci Audouin and Savigny
Garth, Knudsen.
Ocypode ceratophthalma (Pallas)
EMBL, Garth, Ziesenhenne, Reese and Boolootian, Bakus, Child.
Ocypode cordimana Desmarest
Knudsen, Fielding.
Paracleistosoma (or *Cleistosoma*) sp.
Knudsen.
Uca tetragonon (Herbst)
Knudsen.
Genus and species *incertae sedis*
Knudsen.

Family HAPALOCARCINIDAE
Cryptochirus coralliodytes Heller
Bakus, Knudsen, Wijsman.
Hapalocarcinus marsupialis Stimpson
Reese, Shoup, Knudsen, Havens.
Neotroglocarcinus dawydoffi (Fize and Serène)
Reese and Stevenson, BPBM.
Pseudocryptochirus crescentus Edmondson
Pichon.
Species 1, *incertae sedis*
Knudsen.
Species 2, *incertae sedis*
Knudsen.

TABLE 2

Data on Collections of Brachyura*

Collector(s)	Date	Identifier	Depository
Bakus, G. J., and B. H. Bussing	1965	J. Garth	AHF
Banner, A. H.	1957	J. Garth	AHF, MPRL
Bartos, W. A.	1944	†J. Garth	USNM
Burke, R.	1978	J. Garth	BPBM
Child, C. A.	1969	J. Garth	USNM
Coatsworth, J.	1959	J. Garth	AHF, MPRL

*AHF, Allan Hancock Foundation; BPBM, Bernice P. Bishop Museum; MPRL, Mid-Pacific Research Laboratory, Enewetak; USNM, National Museum of Natural History, Smithsonian Institution.

†Xanthidae only; the Portunidae were identified by Stephenson and Rees (1967).

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TABLE 2 (cont'd)

Collector(s)	Date	Identifier	Depository
de Gruy	1978	J. Garth	BPBM
Fielding, A.	1976, 1978	J. Garth	BPBM
Garth, J. S.	1957, 1959	J. Garth and others	AHF, MPRL
Goreau, T., and R. Neshida	1957	J. Garth	AHF, MPRL
Havens, A. D.	1968, 1969, 1970	A. Havens, J. Garth	AHF
Held, E.	1957	J. Garth	AHF
Johnson, M. W.	1946	†J. Garth	USNM
Knudsen, J. W.	1965 to 1968, 1971, 1972	J. Garth and others	AHF
Ladd, H. S.	1952	†J. Garth	USNM
Morrison, J. P. E.	1946	†J. Garth	USNM
Palumbo, R.	1957	J. Garth	AHF
Pichon, M.	1976	M. Takeda	BPBM
Reese, E. S., and R. A. Boolootian	1960	J. Garth	AHF
Reese, E. S., and R. A. Stevenson	1961	J. Garth	AHF
Reish, D.	1956, 1957	J. Garth	AHF, MPRL
Ryan, E.	1957	J. Garth	AHF
Shoup, J.	1961	J. Garth	AHF
Stokes, D.	1965	J. Garth	AHF
Wijsman, M.	1976	M. Takeda	BPBM
Ziesenhenne, F. C.	1946, 1957, 1959	† J. Garth	AHF, USNM AHF, MPRL

†Xanthidae only; the Portunidae were identified by Stephenson and Rees (1967).

Chapter 24

Holothurians of Enewetak Atoll

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INTRODUCTION

Most of the species of holothurians recorded in the checklist (Table 1) that follows were included in an unpublished systematic report by B. M. Cutress prepared for the Mid-Pacific Research Laboratory in 1956. Collection records based on that study are presented in the Appendix. Except for a short paper on *Labidodemas semperianum* by Cherbonnier (1970) and another on *Thelenota anax* by Lamberson (1978), the scant published literature on holothurians of Enewetak is nonsystematic.

Hartman (1954) reported the polynoid, *Gastrolepida clavigera*, as a symbiont on *Stichopus horrens* and *Holothuria gyrifer (H. hilla)* at Enewetak Atoll. Pomeroy and Kuenzler (1967) included *H. (Halodeima) atra* and *H. (Platyperona) difficilis* among faunistic components at Enewetak examined for the excretion and turnover time of phosphorus. Reish (1968) noted that *Gastrolepida clavigera* was found on *H. atra, H. gyrifer (H. hilla), Actinopyga*

TABLE 1

Checklist of Enewetak Holothurians

Phylum ECHINODERMATA
- Class HOLOTHUROIDEA
  - Order DENDROCHIROTIDA
    - Family CUCUMARIIDAE
      - *Afrocucumis africana* (Semper): Lawrence, 1980; Lawrence and Guille, 1982.
  - Order ASPIDOCHIROTIDA
    - Family HOLOTHURIIDAE
      - *Actinopyga mauritiana* (Quoy and Gaimard): Bakus, 1968, 1973; Lawrence, 1980; Lawrence and Guille, 1982.
      - *†*Actinopyga ?mauritiana* juvenile.
      - **Bohadschia argus* Jaeger, 1883.
      - **Holothuria (Thymiosycia) arenicola* Semper, 1868.
      - *Holothuria (Halodeima) atra* Jaeger: Pomeroy and Kuenzler, 1967; Bakus, 1968, 1973; Webb et al., 1977; Ebert, 1978; Lawrence, 1980; Lawrence and Guille, 1982.
      - *Holothuria (Platyperona) difficilis* Semper: Pomeroy and Kuenzler, 1967; Bakus 1968, 1973; Lawrence, 1980; Lawrence and Guille, 1982.
      - *Holothuria (Thymiosycia) hilla* Lesson: Bakus, 1968; Lawrence, 1980; Lawrence and Guille, 1982.
      - **Holothuria (Thymiosycia) impatiens* (Forsskål), 1775.
      - *Holothuria (Mertensiothuria) leucospilota* (Brandt): Bakus, 1968, 1973; Smith et al., 1973; Lawrence, 1980; Lawrence and Guille, 1982.
      - **Holothuria (Mertensiothuria) pervicax* Selenka, 1867.
      - *Labidodemas semperianum* Selenka: Cherbonnier, 1970.
      - **Labidodemas ?semperianum*, juvenile.

*New published Enewetak record.
†Very small specimen.

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TABLE 1 (cont'd)

Family STICHOPODIDAE
Stichopus chloronotus Brandt: Lawrence, 1980.
**Stichopus horrens* Selenka, 1867.
**Stichopus variegatus* Semper, 1868.
*†*Stichopus ?variegatus* juvenile.
Thelenota ananas (Jaeger): Humes, 1973; Lamberson, 1978.
Thelenota anax H. L. Clark: Rowe and Doty, 1977; Lamberson, 1978.
Order APOPIDA
Family CHIRIDOTIDAE
Chiridota rigida Semper: Lawrence, 1980; Lawrence and Guille, 1982.
Family SYNAPTIDAE
**Euapta godeffroyi* (Semper), 1868.
**Pendekaplectana nigra* (Semper), 1868.
Synapta maculata (Chamisso and Eysenhardt): Bakus, 1968, 1973.

*New published Enewetak record.
†Very small specimen.

mauritiana, and *Stichopus horrens* at Enewetak. Bakus (1968, 1973) reported on defense mechanisms and the ecology of several species. Enewetak was one site for a study (Bakus and Green, 1974) on changes in toxicity of holothurians with relation to various latitudes, water temperatures, and habitats. Presence of a tumor in one of 10 specimens of *H. (Mertensiothuria) leucospilota* was reported by Smith et al. (1973). Humes (1973) recorded a parasitic copepod on *Thelenota ananas*. In their report on Guam holothurians, Rowe and Doty (1977) included Enewetak in the general distribution of *T. anax*. Some aspects of the biology of *H. (H.) atra* were studied by Webb et al. (1977) and Ebert (1978). Lawrence (1980) recorded numbers and biomass of eight species of holothurians on the Enewetak reef flat. The organic composition of the body wall of six species of Enewetak holothurians was analyzed by Lawrence and Guille (1982).

BIOGEOGRAPHY

According to distribution summaries for various Indo-Pacific species (H. L. Clark, 1921, 1946; A. M. Clark and Rowe, 1971), 18 of the 20 holothurian species known at present from Enewetak Atoll are widely distributed throughout the Indo-West Pacific. The other two, *Thelenota anax* and *Chiridota rigida*, range from northern Australia northward to the Philippines and eastward to the West and Central Pacific.

Of the 18 Indo-West Pacific species, those most widely distributed are *Holothuria (Platyperona) difficilis* (Red Sea to the Hawaiian and Easter islands), *H. (Thymiosycia) arenicola* (Red Sea to the Hawaiian, Galapagos, and Cocos Islands; Caribbean; Bermuda) and *H. (T.) impatiens* (Red Sea to Hawaii, Caribbean, Mediterranean). Twelve other species range from the shores of East Africa or the Red Sea to the Central Pacific: *Actinopyga mauritiana*, *H. (Halodeima) atra*, *H. (T.) hilla*, *H. (Mertensiothuria) pervicax*, *H. (M.) leucospilota*, *Stichopus chloronotus*, *S. horrens*, and *Euapta godeffroyi* to the Hawaiian Islands; *Stichopus variegatus*, *Thelenota ananas*, and *Synaptula maculata* to the Line and (or) Society islands; and *Pendaplectana nigra* to the Marshall Islands. The other three have not been reported from Africa or the Red Sea. *Afrocucumis africanus* ranges from Mauritius to Fiji; *Bohadschia argus*, from the Seychelles islands to the Marshall Islands, and *Labidodemas semperianum*, from the Maldives to the Hawaiian and Society islands.

Of the 78 holothurian species recorded from Pacific islands (A. M. Clark and Rowe, 1971), only 20 (26%) are represented at Enewetak. On the other hand, a vast majority (90%) of the Enewetak species also ranges into the Indian Ocean, compared with 68% of the total Pacific species recorded by Clark and Rowe. With the possible exception of the surprisingly low number of species found, the composition of the holothurian fauna at Enewetak could be predicted from the geographical position of that atoll and may be indicative of the reproductive strategies of the widespread species. Unfortunately, little is known of larval development of the species or length of larval life. Incidentally, it may be noted that Oshima (1916) reported brood-care in *Afrocucumis africana* in Japan, which is unusual for a widespread, tropical echinoderm.

Juvenile specimens of three species (*Actinopyga ?mauritiana*, *Labidodemas ?semperianum*, and *Stichopus ?variegatus*) have been collected at Enewetak, and figures of their spicules have been included. Due to the element of doubt regarding their identification and the distinctiveness of their color and spicules, all three forms have been included in the key that follows.

KEY TO SPECIES

1. Body sausage-shaped; podia present, as pedicels (tube feet) and papillae; body wall sometimes thick and muscular, not sticky to touch; spicules tables, rods or plates, never anchors, anchor plates, or wheels 2
   Body worm-like; podia absent; body wall thin, usually sticky to touch; spicules anchors, anchor plates, and wheels 20

2. Tentacles dendritic (richly branched); pedicels in double rows along each ambulacrum; spicules in body wall large knobbed, lenticular, perforated plates and smooth, perforated plates and rods (Fig. 3a); color uniformly deep violet, almost black in life, gray-brown in alcohol; body length up to 7 cm (Fig. 6a) *Afrocucumis africana* (Semper)
   Tentacles peltate or peltato-digitate (leaf-shaped); podia usually clearly differentiated into ventral pedicels and dorsal papillae 3

3. Gonads in two tufts, one on either side of dorsal mesentery; body stout, flattened ventrally into distinct sole, squarish in cross section or arched dorsally, with large dorsal and lateral papillae; among spicules either C-shaped rods or dichotomously branched rods 4
   Gonads in single tuft to left of dorsal mesentery; body either cylindrical or arched dorsally and flattened into sole ventrally, with numerous, small, dorsal papillae; spicules tables, flat buttons, and/or branched rods, never C-shaped rods 9

4. Spicules in body wall minute grains and slender, dichotomously branched rods (Fig. 1f) 5
   Spicules tables, C- or S-shaped rods, perforated rods and, in some forms, rosettes 6

5. Dorsal papillae united into groups of two to eight, the largest groups forming stellate figures; color of specimens at Enewetak yellowish red, reddish brown, or light brown; in some specimens, transverse reddish black lines between dorsal papillae; body length up to 70 cm (Fig. 5c) *Thelenota ananas* (Jaeger)
   Dorsal surface with numerous small and some large papillae, several papillae often joined basally but not forming stellate figures; color light gray or yellowish gray with spots of tan, brown, or red and, in some specimens, a broken network of reddish black between large papillae; body length up to 72.5 cm (Fig. 5a, b) *Thelenota anax* H. L. Clark

6. Rosettes absent or, at most, very rare; tables small with small disk; no large tack-like tables (Fig. 1d); dorsal papillae limited to ambulacra; color in life usually uniformly very dark green except dorsal papillae tipped with orange or scarlet; at Enewetak, some specimens dark olive to blue-black; body length up to about 30 cm (Fig. 5d) *Stichopus chloronotus* Brandt
   Rosettes common; tack-like tables present or absent 7

7. In the papillae, large robust tables with conical, usually single-pointed spire and large disk with numerous perforations (Fig. 1c); color dark olive green mottled with deep brownish green in life, dull ocher in alcohol; body length up to about 16 cm (Fig. 5e) *Stichopus horrens* Selenka
   No large tack-like tables in papillae 8

8. Tables (in specimen examined) small, 35 to 42 μm high and wide; C- and S-shaped spicules 35 to 55 μm long, rosettes 19 to 46 μm long (Fig. 1a); color of specimen examined uniformly dark brown, almost black; colors reported in literature either variegated white or gray with brown and yellow, some specimens showing tinges of pink, lavender, or red, or uniformly dark or light brown; body length commonly 30 to 40 cm but apparently reaching more than 100 cm *Stichopus ?variegatus* Semper
   Tables (in specimen examined) 39 to 70 μm high, 39 to 62 μm across disk; C-shaped spicules up to 70 μm long; rosettes to 54 μm long (Fig. 1b); color mottled brown and orange-yellow dorsally, uniformly dirty orange-yellow ventrally; body length 4.6 cm (Fig. 5f) *Stichopus ?variegatus* juvenile

9. Body wall with dichotomously branched X-shaped spicules (rosettes) and rods, never tables 10
   Tables always among spicules 12

10. No large calcified anal teeth but five groups of anal papillae; spicules laterally smooth rods and rosettes (Fig. 3b); color brown-gray with golden brown or black-ringed darker blotches; body length up to about 30 cm (Fig. 6c) *Bohadschia argus* Jaeger
    Anus surrounded by five conspicuous, calcified teeth 11

(Key to Species continued on page 267.)

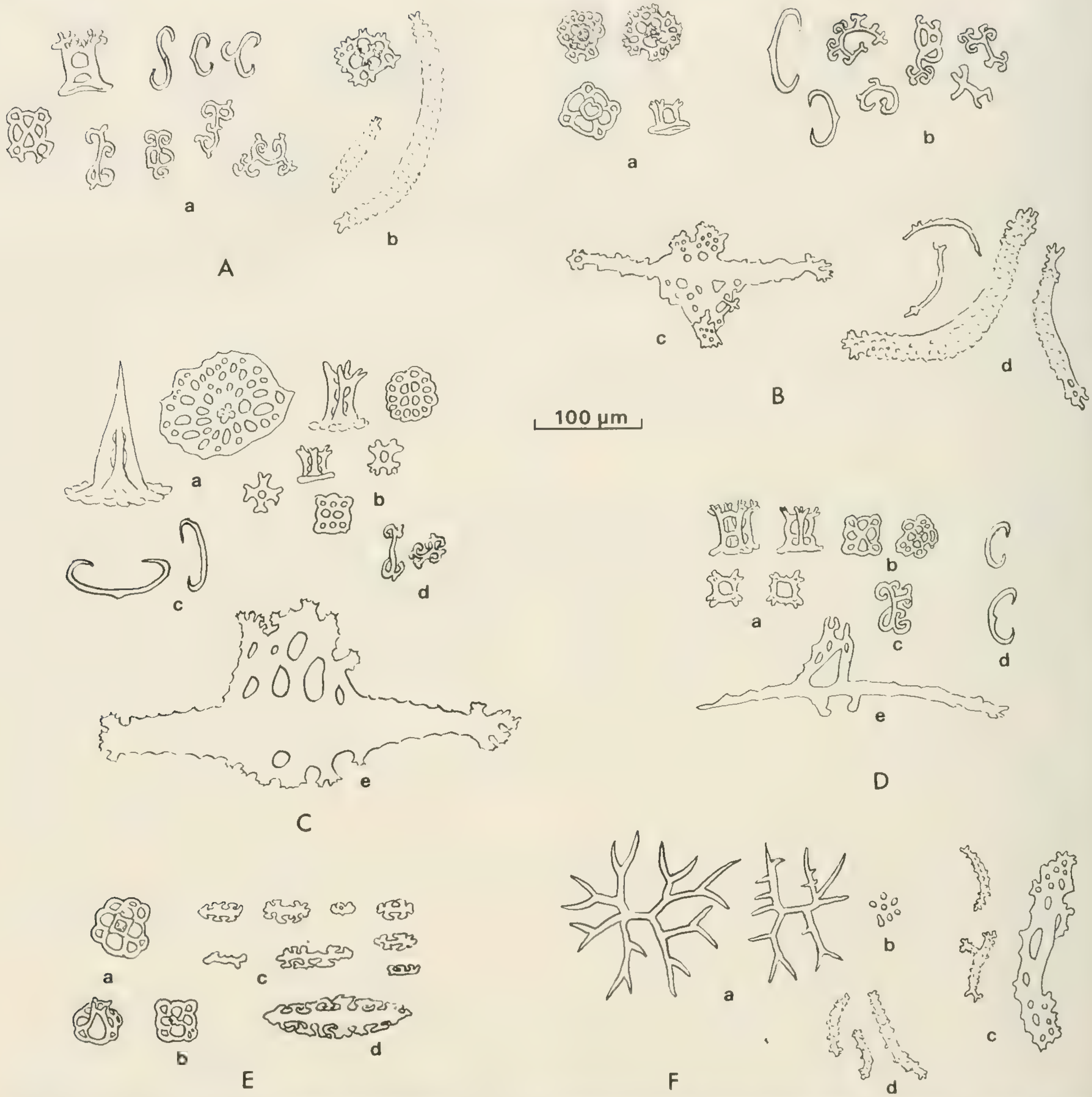

Fig. 1A, *Stichopus ?variegatus* Semper. a, tables, C-, S- and X-shaped spicules and rosettes, dorsal integument; b, table disk and supporting rods, tentacles.

B, *Stichopus ?variegatus*, juvenile. a, tables, dorsal and ventral integument; b, C-shaped spicules and rosettes, dorsal integument; c, perforated rods, ventral pedicels; d, rods, tentacles.

C, *Stichopus horrens* Selenka. a, large table, side view and disk of large table, dorsal papilla; b, smaller tables, side views, disks and tops of spires, dorsal integument; c, C-shaped spicules, dorsal and ventral integument; d, rosettes, dorsal integument; e, supporting rod, ventral pedicel (redrawn from Fisher, 1907, Pl. 70, Fig. 1).

D, *Stichopus chloronotus* Brandt. a, tables, side view and tops of spires, dorsal and ventral integument; b, disks of tables, ventrum; c, d, rosette and C-shaped spicules, dorsal and ventral integument; e, rod, ventral pedicel (redrawn from Mitsukuri, 1912, text Fig. 27 and Theél, 1886, Pl. 7, Fig. 6).

E, *Holothuria pervicax* Selenka. a, tables, side view and disk; b, table with rudimentary spire; c, rods of various shapes; d, larger rod; all from dorsal and ventral integument (redrawn from Fisher, 1907, Pl. 68, Fig. 2).

F, *Thelenota ananas* (Jaeger). a, dichotomously branched rods, dorsal and ventral integument; b, minute, smooth granules, dorsal and ventral integument; c, spinous rods and perforate rods, ventral pedicels; d, rod, tentacle.

(Key to Species cont'd.)

11\. Dorsal spicules laterally branched rods up to 120 μm long and rosettes 38 to 54 μm long; in ventral body wall, small oval grains and rods without lateral projections (Fig. 3d); color light chocolate brown, usually mottled with grayish white; body length up to about 20 cm (Fig. 7d) *Actinopyga mauritiana* (Quoy and Gaimard)
Dorsally, in single specimen examined, laterally branched rods up to 102 μm long, rosettes to 77 μm long; ventral spicules rods with lateral edges smooth, roughened, or finely branched, no oval grains (Fig. 3c); dorsal color yellowish white with three broad, irregular, transverse bands of brownish black, ventral surface uniformly yellowish white with bright yellow pedicels; body length 5.5 cm (Fig. 7e) *Actinopyga ?mauritiana* juvenile

12\. Calcareous ring ribbon-like, with radial pieces shorter than broad and interradials similar but tending to be curved; podia comparatively few, in double rows confined to ambulacra or, dorsally, more or less scattered 13
Calcareous ring stout and relatively strong, not ribbon-like, radial plates either as long as broad or longer than broad, not curved; podia crowded ventrally, numerous, and scattered dorsally 14

13\. Spicules in body wall tables with spire ending in four to six long, simple or bifurcate, horizontal spines or four short, vertical spines, together with smooth rods with simple, branched, or perforated ends (Fig. 3e); 20 tentacles; color translucent pinkish white in life, opaque white in alcohol; body length up to 25 cm (Fig. 6d) *Labidodemas semperianum* Selenka
Spicules in body wall incomplete or complete tables, the latter with spires of four (usually) or three pillars crowned with three or more forked spines or simple circlet of fine spines, also spiny or smooth dichotomously branched, X-shaped rods (Fig. 7f); up to 18 tentacles; color in life bright, translucent canary yellow with very fine, closely spaced brown specks and scattered small brown spots, in alcohol tannish yellow; body length up to 2.5 cm (Fig. 6b) *Labidodemas ?semperianum* Selenka

14\. Spicules in body wall tables with reduced disk, rosettes and small perforated plates (Fig. 2a); color uniformly purplish black; body length up to about 30 cm (Fig. 6g) *Holothuria (Halodeima) atra* Jaeger
Spicules in body wall tables with well-developed, smooth or spinous disk and buttons, complete or incomplete 15

15\. Buttons typically complete and regular; disk of tables with smooth rim 16
Buttons commonly incomplete and asymmetrical or reduced to knobbed bars; disk of tables with smooth or spinous rim 19

16\. Buttons flat, thin, oval, with four or more pairs of small holes and with distinct median optical discontinuity; perforate plates in pedicels (Fig. 2d); color uniformly rich olive brown or reddish brown, lighter on ventral side; body length up to 10 cm (Fig. 6f) *Holothuria (Platyperona) difficilis* Semper
Buttons not flat and thin; color not uniformly brown 17

17\. Buttons 75 to 93 μm long, with three pairs of holes; disk of tables squarish, 78 to 95 μm wide; perforated rods in pedicels up to 233 μm long (Fig. 2f); color yellowish brown, with irregular, transverse bands or blotches of purplish brown dorsally; body length up to 15 cm (Fig. 7c) *Holothuria (Thymiosycia) impatiens* (Forsskål)
Buttons, tables, and rods smaller 18

18\. Buttons up to 78 μm long, with three (usually) or four pairs of holes; disk of tables 62 to 68 μm wide, spire ending in 20 or more teeth; pedicel rods up to 27 μm long (Fig. 2e); color white to tan with two longitudinal rows of brown spots dorsally and very fine, reddish brown spots scattered over all surfaces; body length up to about 20 cm (Fig. 7a, b) *Holothuria (Thymiosycia) arenicola* Semper
Buttons up to 78 μm long, with three to five pairs of holes, disk of tables 62 to 75 μm wide, spire ending in fewer than 20 teeth; pedicel rods up to about 190 μm long (Fig. 2c); color in life yellowish brown, with yellow-tan dorsal papillae; body length up to 30 cm (Fig. 6e) *Holothuria (Thymiosycia) hilla* Lesson

19\. Tables with smooth but sometimes uneven rim, spire reduced; buttons reduced, often as knobbed bars (Fig. 1e); color mottled cream and brown or gray, with some yellow, base of dorsal papillae with red ring; body length to about 20 cm (Fig. 6h) *Holothuria (Mertensiothuria) pervicax* Selenka
Tables well-developed, top of spire with eight to 12 spines, disk usually spinous; some buttons regular with three pairs of holes, others incomplete and asymmetrical (Fig. 2b); color purplish brown to almost black; body length up to about 20 cm (Fig. 6i) *Holothuria (Mertensiothuria) leucospilota* (Brandt)

(Key to Species continued on page 271.)

Fig. 2A, *Holothuria (Halodeima) atra* Jaeger. a, tables, side views, disks, and a crown; b, X-shaped and irregular rod-like spicules, ventral integument; c, small granule-like deposits, tentacles.

B, *Holothuria (Mertensiothuria) leucospilota* (Brandt). a, tables; b, buttons and rods, dorsal and ventral integument; c, rods, tentacles.

C, *Holothuria (Thymiosycia) hilla* Lesson. a, b, tables and buttons, dorsal and ventral integument, and perforated rod, dorsal papilla; c, rods, tentacles.

D, *Holothuria (Platyperona) difficilis* Semper. a, b, tables and buttons, dorsal and ventral integument; c, perforated plate, dorsal papilla; d, rods, tentacles.

E, *Holothuria (Thymiosycia) arenicola* Semper. a, b, c, tables, buttons and perforated rods, dorsal and ventral integument; d, rods, tentacles.

F, *Holothuria (Thymiosycia) impatiens* (Forskål). a, b, c, tables, buttons, perforated rods, dorsal and ventral integument; d, rods, tentacles.

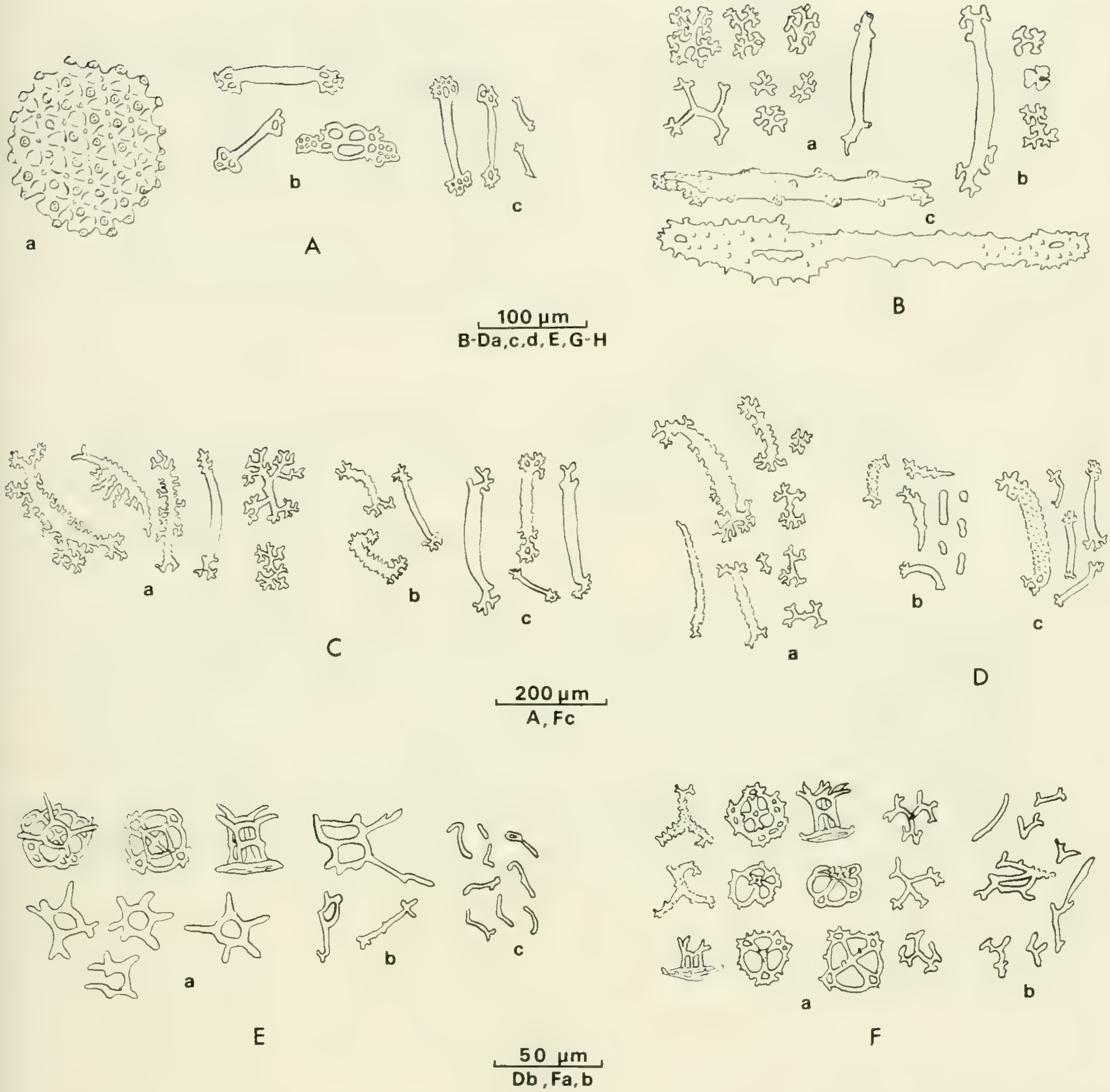

Fig. 3A, *Afrocucumis africana* (Semper). a, thick, perforated and spined disks, dorsal and ventral integument; b, rods, dorsal integument; c, rods, tentacles.
B, *Bohadschia argus* Jaeger. a, rosettes and rod, dorsal integument and papilla; b, rod and rosettes, ventral integument; c, rods, tentacles.
C, *Actinopyga ?mauritiana* (Quoy and Gaimard). a, rods and rosettes, dorsal integument; b, rods, ventral integument; c, rods, tentacles.
D, *Actinopyga mauritiana* (Quoy and Gaimard). a, rods and rosettes, dorsal integument; b, rods and small grains, ventral integument; c, rods, tentacles.
E, *Labidodemas semperianum* Selenka. a, tables, disks, side view and from crowns, dorsal and ventral integument; b, rods, ventral integument; c, rods, tentacles.
F, *Labidodemas ?semperianum*, juvenile. a, tables, complete and incomplete, and X-shaped spicules, spined and smooth, dorsal and ventral integument; b, rods, tentacles.

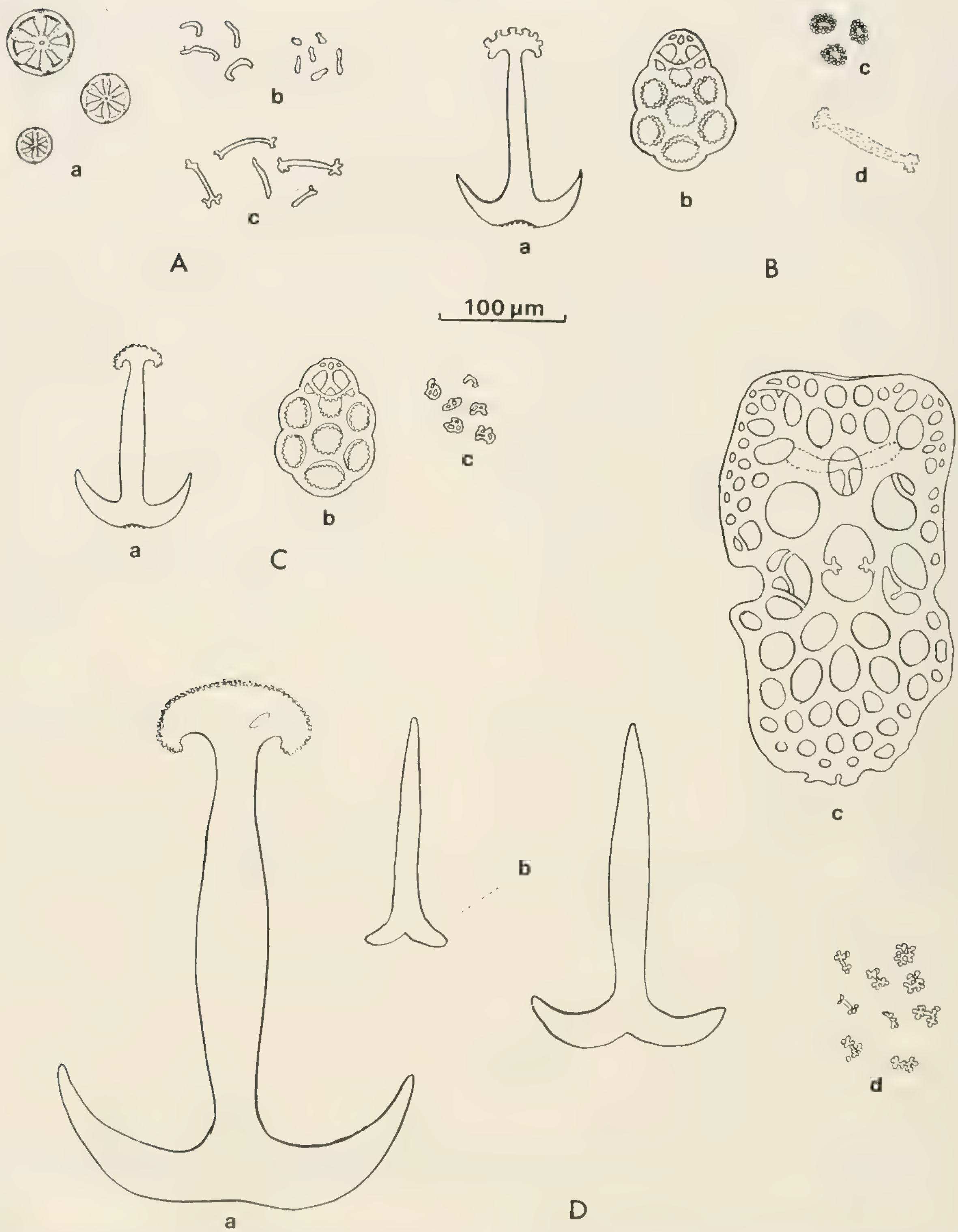

Fig. 4A, *Chiridota rigida* Semper. a, b, wheels, rods and grains, body wall and integument; c, rods, tentacles.
B, *Euapta godeffroyi* (Semper). a, b, c, anchor, anchor plate and rosettes, body wall and integument; d, rod, tentacles (as reported and figured by Fisher, 1907, p. 722, Pl. 81, Fig. 3b; not found in Enewetak specimen nor mentioned by Semper).
C, *Pendekaplectana nigra* (Semper). a, b, c, anchor, anchor plate and rosettes, body wall and integument.
D, *Synapta maculata* (Chamisso and Eysenhardt). a, b, c, d, anchor, young anchors, anchor plate and rosettes, body wall and integument.

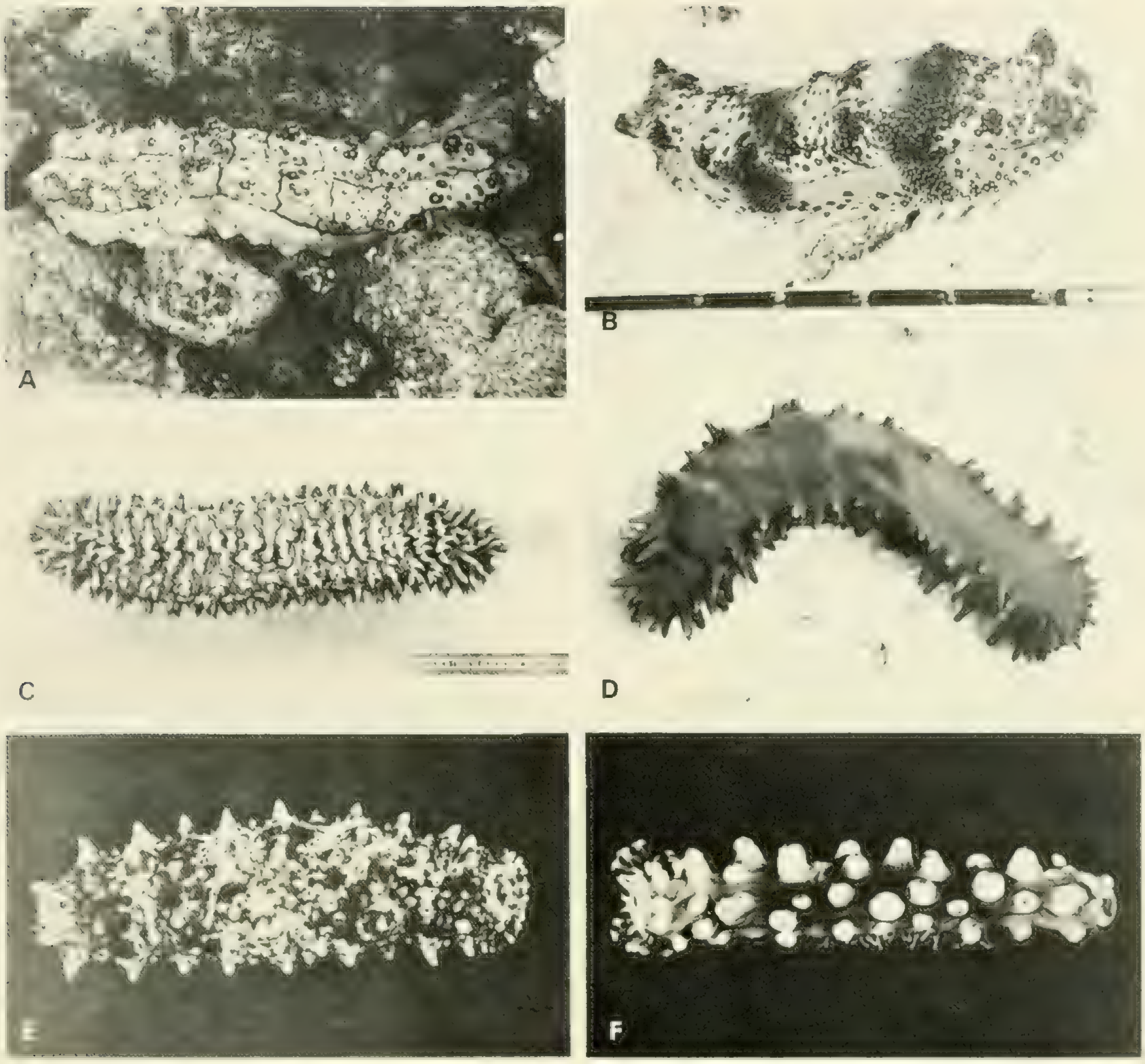

Fig. 5A, B, *Thelenota anax* H. L. Clark. Live specimen on reef at Enewetak, about 55 cm long (photographed by Janet Lamberson).
C, *Thelenota ananas* (Jaeger). Live specimen from Enewetak, about 55 cm long, partially contracted (photographed by Janet Lamberson).
D, *Stichopus chloronotus* Brandt. Live specimen *in situ*, Enewetak (photographed by Scott Johnson).
E, *Stichopus horrens* Selenka. Live specimen from Hawaii, 20 cm long.
F, *Stichopus ?variegatus* Semper, juvenile. Preserved specimen from Enewetak, 5 cm long.

(Key to Species cont'd.)

20. Spicules in body wall wheels and small, curved rods and smooth grains; 11 to 12 tentacles (Fig. 4a); color translucent brownish red, with scattered, raised patches of white (accumulations of wheels) dorsally; body length up to 5 cm (Fig. 7f) — *Chiridota rigida* Semper
    Spicules in body wall anchors and perforated anchor plates, never wheels; 15 tentacles — 21

21. Stock of anchors with six to eight minutely spined branches, rosettes granular, subcircular, with hole in center (Fig. 4b); color yellowish grayish white, with greenish or brown stripes or blotches dorsally; body length up to about 40 cm (Fig. 7h) — *Euapta godeffroyi* (Semper)
    Stock of anchors unbranched — 22

22. Anchors very large, 85 to 100 μm long and 60 to 70 μm across flukes; anchor plates also large, up to 75 μm long; rosettes small dichotomously branched rods (Fig. 4d); color yellow-brown to grayish white with or without pattern of dark gray spots; body length up to about 2 m (Fig. 7i) *Synapta maculata* (Chamisso and Eysenhardt)

Anchors and plates not massive, up to 30 μm and 22 μm long, respectively; rosettes small, irregular, perforate buttons (Fig. 4c); color translucent reddish brown, with many small, diffuse white spots; body length to about 20 cm (Fig. 7g) *Pendekaplectana nigra* (Semper)

APPENDIX

Collection Records

These records are only of holothurians collected for the reference collections at the Enewetak Marine Biological Laboratory (EMBL) (later the Mid-Pacific Marine Laboratory [MPML]). Most of the specimens were collected in 1955 by Charles E. Cutress at snorkeling depths and were identified by Bertha Cutress. During subsequent years, a few specimens were added to the collections by Robert W. Hiatt, J. J. Naughton, J. S. Pearse, G. A. Hiatt, and Janet Lamberson. These were identified by F. W. E. Rowe, B. Cutress, and J. Lamberson. Records of Enewetak holothurians mentioned in published literature (Table 1) are not included here.

Afrocucumis africana
Aniyaanii (Ananij): May 8, 1955, inner reef, attached to under surfaces of loose coral or rock. Enewetak: under rocks around quarry.

Actinopyga mauritiana
Medren: May 10, 1955, inner reef, between coral in tide pools and surge channels. Two commensal worms the same color as the ground color of the holothurian were found among the tube feet of one specimen and were preserved separately. Seen but not collected in 1955 at Aniyaanii (Ananij), Igurin, Runit, and Japtan. Enewetak: ocean reef off runway.

Actinipyga ?mauritiana juvenile
Aniyaanii (Ananij): May 11, 1955, inner reef, under rubble.

Bohadschia argus
Nancy (Elle): lagoon side, 2.7 m.

Holothuria (Thymiosycia) arenicola
Runit: June 20, 1955, buried in sand under loose coral on causeway. Sand Island: channel.

Holothuria (Halodeima) atra
Runit: June 20, 1955, in open on sandy or coral bottom of tide pools. Seen but not collected in 1955 at Igurin, Aniyaanii (Ananij), Medren, and Japtan. Enewetak: ocean reef north of island.

Holothuria (Platyperona) difficilis
Aniyaani (Ananij): May 8 and June 21, 1955, inner reef attached to under surfaces of coral or rubble. Enewetak: under rocks around quarry.

Holothuria (Thymiosycia) hilla
Aniyaanii (Ananij): June 21, 1955, attached to under surfaces of coral or rubble. Enewetak: ocean side, north end, under rocks just below beach; Sand Island; Enjebi: ocean side.

Holothuria (Thymiosycia) impatiens
Runit: June 20, 1955, under rock on causeway.

Holothuria (Mertensiothuria) leucospilota
Runit: June 20, 1955, under loose coral in pools on causeway. Igurin: May 11, 1955, inner reef, under rubble. Seen but not collected in 1955 at Aniyaanii (Ananij), Medren, and Japtan. Enewetak: ocean side, north end.

(Collection records continued on page 275.)

(Fig. 6 on page 273.) ⟶

Fig. 6A, *Afrocucumis africana* (Semper). Preserved specimen from Enewetak, 4.7 cm long.
B, *Labidodemas ?semperianum*, juvenile. Preserved Enewetak specimens, 2.25 and 2.5 cm long.
C, *Bohadschia argus* Jaeger. Live specimen *in situ*; Cocos Lagoon, Guam (photographed by Charles Birkeland).
D, *Labidodemas semperianum* Selenka. Preserved Enewetak specimen, 20 cm long.
E, *Holothuria (Thymiosycia) hilla* Lesson. Live specimen from Hawaii, 19 cm long.
F, *Holothuria (Platyperona) difficilis* Semper. Preserved Enewetak specimen, 6 cm long.
G, *Holothuria (Halodeima) atra* Jaeger. Live specimen from Hawaii, 30 cm long.
H, *Holothuria (Mertensiothuria) pervicax* Selenka. Live specimen from Hawaii, 18 cm long.
I, *Holothuria (Mertensiothuria) leucospilota* (Brandt). Live specimen from Hawaii, 20 cm long.

(Fig. 7 on page 274.) ⟶

Fig. 7A, B, *Holothuria (Thymiosycia) arenicola* Semper. a, preserved specimen from Enewetak, 8 cm long; b, live specimen from Hawaii, 19 cm long.
C, *Holothuria (Thymiosycia) impatiens* (Forskål). Preserved Enewetak specimen, 17.5 cm long.
D, *Actinopyga mauritiana*, juvenile. Preserved specimen from Hawaii, 20 cm long.
E, *Actinopyga ?mauritiana*, juvenile. Preserved Enewetak specimen, 5.5 cm long.
F, *Chiridota rigida* Semper. Preserved Enewetak specimen, 5 cm long.
G, *Pendekaplectana nigra* (Semper). Preserved Enewetak specimen, 12 cm long.
H, *Euapta godeffroyi* (Semper). Preserved Enewetak specimen, 21 cm long.
I, *Synaptula maculata* (Chamisso and Eysenhardt). Small preserved specimen from Enewetak, 21 cm long.

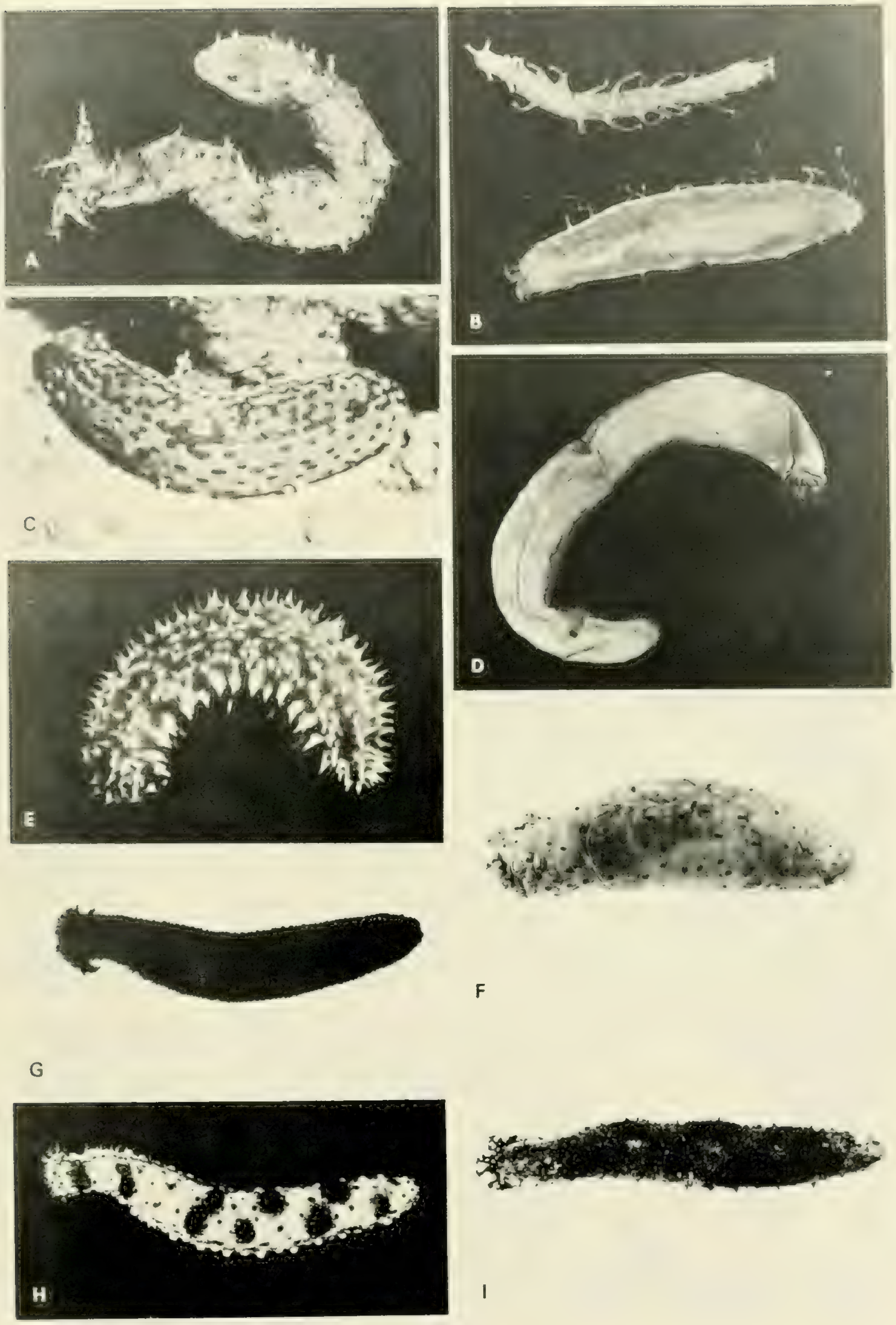

Fig. 6

Fig. 7

Holothuria (Mertensiothuria) pervicax

Runit: June 20, 1955, under loose coral in pools on ocean side of causeway.

Labidodemas semperianum

Aniyaanii (Ananij): June 21, 1955, buried in sand under rock near causeway. Aaraanbiru (Alembel): in sand on sea reef.

Labidodemas ?semperianum juvenile

Aniyaanii (Ananij): June 21, 1955, attached to underside of coral rock.

Stichopus chloronotus

Enjebi: northwest ocean reef between Bokoluo and Oak craters, in open among coral heads and rubble, also in shallow quarries, intertidal to 2 m. Lojwa (Ursula): June 21, 1963, extremely abundant on reef flat, usually in open alongside *Holothuria atra*; heavily infested with snails in body wall; one *Carapus* found out of four specimens.

Stichopus horrens

Enewetak: July 19, 1963, quarry, under live coral.

Stichopus ?variegatus

Aaraabiru (Alembel): sea reef near shore.

Stichopus ?variegatus juvenile

Medren: June 21, 1955, inside piece of coral.

Thelenota ananas

Medren: September 1956, sea reef channel. On rubble at top or base of pinnacles, also near concrete ship 10 m depth. Japtan: Oct. 5, 1975, near concrete ship, 10 m depth; also around pinnacles and patch reefs in lagoon. Enewetak: top of sunken barge in lagoon, 1 m depth; one specimen had spotted commensal crab, collected as it tried to enter holothurian's mouth.

Thelenota anax

Enewetak: lagoon side; Sand Island; Medren; Japtan: on top or bottom of rock pinnacles, 5 to 30 m.

Chiridota rigida

Aniyaanii (Ananij): June 21, 1955, in groups buried in sand beneath coral or rubble or between coral in tide pools. Sand Island.

Euapta godeffroyi

Aniyaanii (Ananij): May 8, 1955, inner reef, in or on sand under loose coral or rubble. Runit: June 20, 1955; Enewetak: quarry.

Pendekaplectana nigra

Aniyaani (Anaij): May 8, 1955, inner reef, under rubble. Runit: June 20, 1955, ocean side of causeway, under loose coral.

Synapta maculata

Runit: June 20, 1955, ocean side of causeway, under loose coral in pool. Enjebi: Cactus Crater.

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Chapter 25

Echinodermata Other than Holothuroidea of Enewetak Atoll

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INTRODUCTION

The echinoderm fauna at Enewetak became known through publications by A. H. Clark (1952, 1954) that recorded nonholothurian species from several of the Marshall Islands. These two publications included nine Asteroidea, nine Ophiuroidea, and 19 Echinoidea from Enewetak. The Crinoidea and Holothuroidea were not recorded from the atoll.

In the late 1950s and early 1960s, Fred C. Ziesenhenne, then with the Allan Hancock Foundation (AHF), was asked by the Mid-Pacific Research Laboratory (MPRL) to provide an identified reference collection of nonholothurian echinoderms. His identifications, based on specimens that he collected and those collected by students and researchers working at MPRL, provided not only a valuable reference collection but also increased the number of taxa known from Enewetak. An unpublished report, which includes habitat information and keys to many of the species, was prepared by F. C. Ziesenhenne and R. A. Boolootian and was left at the laboratory for use by visiting researchers. The holothurians were being studied separately by Bertha Cutress, and her work has been updated in a separate chapter for the present volume (see Cutress and Rowe, Chapter 24).

Since these early efforts, new studies and additional records of echinoderms have been compiled by MPRL personnel and other researchers working at Enewetak. This chapter brings together these numerous records (Table 1).

Although the majority of Enewetak's shallow-water (to about 100 m) echinoderms is reasonably well known, fauna from deeper waters, especially in passes and off the seaward reef face, is still incompletely known. Less than 1% of the species so far recorded have been taken in water deeper than 100 m.

In comparison with the Marshall Islands as a whole, knowledge of the Enewetak echinoderms is considerable. At this one atoll, 86% of all Marshall Islands species are now known to occur at Enewetak.

CRINOIDEA

Although crinoids had been reported from the Marshall Islands by Gislén (1940) and A. H. Clark (1952, 1954), no species from Enewetak were included. Crinoids collected in the late 1950s and identified by F. C. Ziesenhenne included *Comanthus bennetti* and *Comaster gracilis*, species recorded previously in the Marshall Islands from Rongelap and Bikini by A. H. Clark (1952) and from Arno by A. H. Clark (1954). Banner and Banner (1968) reported the alpheid shrimp, *Synalpheus demani*, from *C. bennetti* collected at Enewetak. Zmarzly (personal communication) doubts the association of alpheids with this crinoid and, based on her studies, feels that the host was a different species. One of the Enewetak specimens of *C. bennetti* examined by the author and Ann Fielding had a single alpheid, *S. stimpsoni*, associated; two other alpheids were also associated with other crinoid species at Enewetak (Devaney and Bruce, Chapter 22, this volume). One of these, *S. carinatus*, was also noted in association with "crinoids" at Enewetak by Banner and Banner (1968). Humes (1972) reported a new species of copepod from *C. bennetti*, and Bartolini et al. (1973) examined pigments from Enewetak specimens of this crinoid.

In 1976, Devaney and Fielding examined Enewetak crinoids for their symbionts; crustaceans, polychaetes, myzostomes, and other invertebrates were noted and collected. It was thought that only *Comanthus bennetti* and *Comaster gracilis* were represented in the material examined. Subsequently, however, due to a more intensive study on Enewetak crinoid ecology and their symbionts by Zmarzly in 1980, two additional species (*Comanthina schlegeli* and *Comanthus parvicirrus*) were recognized among the 1976 material. The crustaceans associated with these crinoids have been tabulated in the present volume (Devaney and Bruce, pp. 225-226), and more information was given in Zmarzly (1984). The small 10-armed antedonid, *Dorometra nana*, was collected in 1976 off one of the southern windward islets (Ananij) beneath coral in limestone rubble at 18

TABLE 1

Checklist of Echinodermata Other than Holothuroidea from Enewetak Atoll

Phylum ECHINODERMATA
Subphylum CRINOZOA
Class CRINOIDEA
Family COMASTERIDAE
Comanthina schlegeli (Carpenter, 1881): Zmarzly, 1984.
Comanthus bennetti (Müller, 1841): Banner and Banner, 1968; Humes, 1972; Bartolini et al., 1973; Zmarzly, 1984.
Comanthus parvicirrus (Müller, 1841): Zmarzly, 1984.
Comaster gracilis (Hartlaub, 1890); Zmarzly, 1984.
Family EUDIOCRINIDAE
Eudiocrinus tenuissimus Gislén, 1940: Zmarzly, 1984.
Family ANTEDONIDAE
Dorometra nana (Hartlaub, 1890): Zmarzly, 1984.
Subphylum ASTEROZOA
Class STELLEROIDEA
Subclass ASTEROIDEA
Family ASTROPECTINIDAE
Astropecten polyacanthus Müller and Troschel, 1842: A. H. Clark, 1952.
Family OREASTERIDAE
**Choriaster granulatus* Lütken, 1869.
Culcita novaeguineae Müller and Troschel, 1842: A. H. Clark, 1952; Humes, 1971; Bruce, 1979.
Family OPHIDIASTERIDAE
*†*Fromia hemiopla* Fisher, 1913.
Fromia milleporella (Lamarck, 1816).
‡*Fromia balansae* Perrier, 1875: A. H. Clark, 1952.
**Fromia monilis* Perrier, 1875.
**Gomophia egyptiaca* Gray, 1840.
**Leiaster speciosus* von Martens, 1866.
Linckia laevigata (Linnaeus, 1758): A. H. Clark, 1952.
Linckia multifora (Lamarck, 1816): A. H. Clark, 1952; 1954.
**Neoferdina cumingi* Gray, 1840.
**Ophidiaster granifer* Lütken, 1871: A. H. Clark, 1952.
Ophidiaster robillardi de Loriol, 1885: Marsh, 1977.
Ophidiaster lorioli Fisher, 1906: A. H. Clark, 1952.
Family ASTEROPSEIDAE
**Asteropsis carinifera* (Lamarck, 1816).
Family ASTERINIDAE
*§*Asterina anomala* H. L. Clark, 1921.
Family ASTERINIDAE
Asterina burtoni Gray, 1840: A. M. Clark and Rowe, 1971.
Asterina cephea (Müller and Troschel, 1842): A. H. Clark, 1952.
Family ACANTHASTERIDAE
Acanthaster planci (Linnaeus, 1758): Allen, 1972; Highsmith, 1980.
Family MITHRODIDAE
**Mithrodia clavigera* (Lamarck, 1816).
Family ECHINASTERIDAE
Echinaster luzonicus (Gray, 1840).
Othilia luzonica Gray: A. H. Clark, 1952; Lawrence and Guille, 1982.
Subclass OPHIUROIDEA
Family OPHIOMYXIDAE
**Neoplax crassipes* Koehler, 1922.
**Ophiomyxa australis* Lütken, 1869.
Family GORGONOCEPHALIDAE
**Astroboa nuda* (Lyman, 1874).

*New record at Enewetak.

†Enewetak specimens determined by F. C. Ziesenhenne at AFH (1 dry) and MPRL; those reported as *E. hemiopla* from Bikini by A. H. Clark (1952) probable juveniles of other species (L. M. Marsh, personal communication.)

‡Considered probably referrable to *F. milleporella* after reexamination by L. M. Marsh (personal communication).

§Considered as possible syn. of *Asterina burtoni* by A. M. Clark and Rowe, 1971, p. 68.

(This table continued on next page.)

TABLE 1 (cont'd)

Family AMPHIURIDAE
Amphiodia sp.[*]
Amphipholis squamata (Delle Chiaje, 1829).[*]
Amphiura luetkeni Duncan, 1879: Highsmith, 1981.
Family OPHIACTIDAE
Ophiactis savignyi (Müller and Troschel, 1842): A. H. Clark, 1952; Highsmith, 1981.
Family OPHIOTRICHIDAE
[*]*Macrophiothrix longipeda* (Lamarck, 1816).
[*]*Macrophiothrix rhabdota* H. L. Clark, 1915.
Macrophiothrix sp.: Highsmith, 1981.
[*]*Ophiothela danae* Verrill, 1869.
Ophiothrix (Ophiothrix) exigua Lyman, 1874: A. H. Clark, 1952.
[*]*Ophiothrix (Acanthophiothrix) proteus* Koehler, 1905.
[*]*Ophiothrix (Acanthophiothrix) purpurea* von Martens, 1867.
[*]*Ophiothrix (Ophiothrix) trilineata* (Lütken, 1869).
Family OPHIOCOMIDAE
[*]*Ophiarthrum elegans* Peters, 1851.
Ophiocoma anaglyptica Ely, 1944: A. H. Clark, 1952; Devaney, 1967, 1970; Chartock, 1972; Sloan et al., 1979.
Ophiocoma brevipes Peters, 1851: A. H. Clark, 1952; Devaney, 1970; Chartock, 1972; Sloan et al., 1979.
Ophiocoma dentata Müller and Troschel, 1842: Devaney, 1970; Chartock, 1972.
Ophiocoma doederleini Loriol, 1899: Pomeroy and Kuenzler, 1967; Devaney, 1970; Chartock, 1972; Sloan et al., 1979.
Ophiocoma erinaceus Müller and Troschel, 1842: A. H. Clark, 1952; Chartock, 1972; Sloan et al., 1979.
Ophiocoma pica Müller and Troschel, 1842: A. H. Clark, 1952; Chartock, 1972; Sloan et al., 1979.
Ophiocoma pusilla (Brock, 1888): Devaney, 1970.
Ophiocoma scolopendrina (Lamarck, 1816): A. H. Clark, 1952; Chartock, 1972; Sloan et al., 1979.
Ophiocomella sexradia (Duncan, 1887): Highsmith, 1981.
Ophiocomella clippertoni A. H. Clark, 1939: A. H. Clark, 1952.
Ophiomastix caryophyllata Lütken, 1869: Devaney, 1978.
Ophiomastix marshallensis Devaney, 1978: Devaney, 1978.
Ophiomastix mixta Lütken, 1869: A. H. Clark, 1952; Devaney, 1978.
Ophiomastix palaoensis Murakami, 1943: Devaney, 1978.
Ophiomastix variabilis Koehler, 1905: Devaney, 1978; Highsmith, 1981.
Ophiopsila sp.: Highsmith, 1981.
Family OPHIONEREIDIDAE
Ophionereis porrecta Lyman, 1860: Highsmith, 1981.
[*]*Ophionereis* sp.
Family OPHIODERMATIDAE
[*]*Ophiarachna affinis* Lütken, 1869.
[*]*Ophiarachnella gorgonia* (Müller and Troschel, 1842).
Ophiarachnella parvispina H. L. Clark, 1925: Devaney, 1974.
[*]*Ophioconis permixta* Koehler, 1905.
Ophiopeza spinosa (Ljungman, 1867): Devaney, 1974.
Family OPHIURIDAE
[*]*Ophiolepis superba* H. L. Clark, 1915.
¶*Ophiolepis* sp.
Ophioplocus imbricatus (Müller and Troschel, 1842): Lawrence and Guille, 1982.
[*]*Ophiura kinbergi* (Ljungman, 1867).
Subphylum ECHINOZOA
Class ECHINOIDEA
Family CIDARIDAE
[*]*Chondrocidaris gigantea* A. Agassiz, 1863.
Eucidaris metularia (Lamarck, 1816): A. H. Clark, 1952.
Family ECHINOMETRIDAE
Echinometra mathaei (de Blainville, 1825): A. H. Clark; 1952; Pomeroy and Kuenzler, 1967; Lawrence, 1970; Russo, 1980; Ebert, 1982.

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*New record at Enewetak.
¶Within the *Ophiolepis cincta* complex of species under investigation by the author.

(This table continued on next page.)

TABLE 1 (cont'd)

Family ECHINOMETRIDAE (cont'd)
Echinometra oblonga (de Blainville, 1825).
Echinometra mathaei var. *oblonga* (de Blainville): A. H. Clark, 1952.
Echinostrephus aciculatus A. Agassiz, 1863: A. H. Clark, 1952; Pomeroy and Kuenzler, 1967; Russo, 1980; Lawrence, and Guille, 1982; Ebert, 1982.
**Heterocentrotus mammillatus* (Linnaeus, 1758).
Heterocentrotus trigonarius (Lamarck, 1816): A. H. Clark, 1952; Odum and Odum, 1955; Lawrence and Dawes, 1969; Humes, 1970; Ebert, 1982.
Family DIADEMATIDAE
**Diadema savignyi* Michelin, 1845.
Echinothrix calamaris (Pallas, 1774): A. H. Clark, 1952; Humes, 1977.
Echinothrix diadema (Linnaeus, 1758): A. H. Clark, 1952; Lawrence and Guille, 1982; Ebert, 1982.
Family PARASALENIIDAE
Parasalenia gratiosa A. Agassiz, 1863: A. H. Clark, 1952; Highsmith, 1981.
Family TEMNOPLEURIDAE
Mespilia globulus (Linnaeus, 1758): A. H. Clark, 1952.
Family TOXOPNEUSTIDAE
Cyrtechinus verruculatus (Lütken, 1864): Highsmith, 1981.
**Toxopneustes pileolus* (Lamarck, 1816).
Tripneustes gratilla (Linnaeus, 1758): A. H. Clark, 1952.
Family ECHINONEIDAE
Echinoneus abnormalis de Loriol, 1883: A. H. Clark, 1952.
Echinoneus cyclostomus Leske, 1778: A. H. Clark, 1952.
Family SCHIZASTERIDAE
**Diploporaster savignyi* (Fourtau, 1904).
Family FIBULARIIDAE
Echinocyamus australis (Desmoulins, 1835).
Fibularia australis Desmoulins: A. H. Clark, 1952.
**Echinocyamus crispus* Mazetti, 1893.
Echinocyamus megapetalus H. L. Clark, 1914: A. H. Clark, 1952.
Fibularia ovulum Lamarck, 1788: A. H. Clark, 1952.
Fibularia volva L. Agassiz and Desor, 1847: A. H. Clark, 1952.
Family SPATANGIDAE
Maretia planulata (Lamarck, 1816).
Maretia ovata (Leske, 1778): A. H. Clark, 1952.
Family BRISSIDAE
Brissus latecarinatus (Leske, 1778): Pomeroy and Kuenzler, 1967.
Metalia dicrana H. L. Clark, 1917: A. H. Clark, 1952.
**Metalia spatagus* (Linnaeus, 1758).
Rhynobrissus hemiasteroides A. Agassiz, 1879: Pomeroy and Kuenzler, 1967.
Family CLYPEASTERIDAE
**Clypeaster reticulatus* (Linnaeus, 1758).
Family LAGANIDAE
Laganum depressum L. Agassiz, 1841: A. H. Clark, 1952.

*New record at Enewetak.

to 21 m and was identified by the author. Additional specimens of this species have been found under coral rubble in the lagoon. *Dorometra nana* had been recorded from Ebon and Jaluit by Gislén (1940). In 1980 at Enewetak, a five-armed *Eudiocrinus*, tentatively identified as *E. tenuissimus*, was found in recesses on the steep seaward dropoff near Rigili islet. Gislén (1940) recorded this species originally from Jaluit Atoll in the Marshalls.

Six crinoid species are now known from Enewetak shallow waters; all but one *(E. tenuissimus)* occur in other Indo-West Pacific areas outside the Marshall Islands (A. M. Clark and Rowe, 1971). Additional crinoids recorded from other Marshall Islands include: *Cenometra bella* var. *magnifica* from Jaluit (Gislén, 1940), as well as *Stephanometra indica* (as *S. protectus*) from Ebon and Jaluit (Gislén, 1940) and (as *S. indica protectus*) from Rongelap and Rongerik (A. H. Clark, 1952).

Six of the nine crinoids known from the Marshall Islands have been found at Enewetak. Seven species are known from Guam and 21 from Palau (Meyer and Macurda, 1980); Enewetak shares four species with Guam and five with Palau.

OPHIUROIDEA

Gorgonocephalidae

A basket star, *Astroboa nuda*, is the first species in this family to be recorded from the Marshall Islands. One specimen was found at a depth of 13 m in a cave on the seaward side just north of Kidrenen Islet on the southwest side of Enewetak.

Ophiomyxidae

The Ophiomyxidae are represented by two species at Enewetak. One, *Ophiomyxa australis*, is known from Bikini and Rongerik (A. H. Clark, 1952) and Jaluit (as *O. brevispina* in Koehler, 1927). The other is a single specimen of *Neoplax crassipes*, known from the Philippines and was collected in shallow water.

Amphiuridae

Three amphiurids are now known from Enewetak. These include an undetermined *Amphiodia* collected from lagoon sediment. *Amphipholis squamata*, a cosmopolitan species, is common in shallow water around Enewetak; two specimens have been collected at Bikini (AHF). *Amphiura luetkeni* is the only amphiurid previously recorded from the Marshall Islands (Highsmith, 1981). It is often associated with live coral. Outside of the Marshall Islands, *A. luetkeni* is known from Ceylon to Polynesia.

Ophiactidae

One ophiactid, the cosmopolitan species *Ophiactis savignyi*, has been recorded from Enewetak (A. H. Clark, 1952; Highsmith, 1981). It is often found in sponges.

Ophiotrichidae

At least three genera of Ophiotrichidae are known from Enewetak. *Macrophiothrix* is represented by *M. longipeda*, originally reported from the Marshall Islands by A. H. Clark (1952) from Bikini; Devaney considers Koehler's (1927) *Ophiothrix galatheae* from Jaluit as probably referrable to this species. Another species is considered as *M. rhabdota* and is a new record for the Marshall Islands. Highsmith (1981) reported and identified *Macrophiothrix* sp. *Ophiothela danae* is an associate of alcyonacean corals. At least four species of *Ophiothrix* occur at Enewetak; only *O. exigua* was previously recorded from the atoll. *Opiothrix (Acanthophiothrix) purpurea* was found on a gorgonian coral; A. H. Clark (1952) also reported this species (as *O. lepida*) from a gorgonian at Bikini Atoll. At Enewetak, *O. trilineata* is frequently associated with branching coral such as *Pocillopora*; A. H. Clark (1952) reported it previously from Bikini. The two specimens found at Enewetak were collected at the base of coral *(Goniastrea)* in the lagoon on a pinnacle (South Medren) at a depth of 8.1 to 13.3 m.

Ophiocomidae

The ophiocomids are diverse at Enewetak represented by 16 species in five genera with a new record, *Ophiarthrum elegans*. One specimen of *Ophiopsila* remains to be identified to species.

Ophionereididae

Two species of the ophionereids are recognized: *Ophionereis porrecta* and *Ophionereis* sp., which resemble those recorded by A. H. Clark (1952) from Bikini Atoll as *Ophionereis degeneri*.

Ophiodermatiidae

Five ophiodermatids occur at Enewetak. *Ophiarachna affinis*, *Ophiarachnella gorgonia*, and *Ophioconis permixta* are new records for the Marshall Islands. *Ophiopeza spinosa* was recorded (as *Ophiopezella spinosa* by A. H. Clark, 1952) from Bikini and Rongerik Atolls. The only other ophiodermatid recorded from the Marshall Islands is *Ophiopezella (Ophiopeza) dubiosa* from Jaluit (Koehler, 1927).

An additional specimen of the uncommon *Ophiarachnella parvispina*, reported from Enewetak by Devaney (1974), was located in the Allan Hancock Foundation from the intertidal lagoon, July 17, 1960.

Ophiuridae

Of the four ophiurids known from Enewetak only one, *Ophioplocus imbricatus*, a widespread warm water Indo-West Pacific species has been previously reported from this atoll. All four ophiurids have been reported from elsewhere in the Marshall Islands (A. H. Clark, 1952).

The Collection Records list the habitats of the newly reported species of Ophiuroidea. Table 2 lists comments on ophiuroid color, anatomy, disc and arm length size, and repository.

ASTEROIDEA

Astropectinidae

The family Astropectinidae is represented by a single widespread Indo-West Pacific species, *Astropecten polyacanthus*, collected in the lagoon (A. H. Clark, 1952). Two small specimens were collected at Bikini Atoll in July 1946 and identified by F. C. Ziesenhenne (AHF).

Oreasteridae

The family Oreasteridae is represented by two species. *Culcita novaeguineae* has been collected on the ocean reef at Enewetak (A. H. Clark, 1952) and from the lagoon and channel. Symbiotic crustaceans were recorded from this species by Humes (1971) and Bruce (1979). A second oreasterid, *Choriaster granulatus* hitherto unknown from the Marshall Islands, was discovered during the Hawaii

TABLE 2

Comments on Color, Disc and Arm Length, Size, and Repository

Neoplax crassipes, color deep brown with white markings, one specimen dry with disc diameter (d.d) 13 mm, AHF.

Ophiomyxa australis, color in alc. dull straw, arm spines tipped with red-brown, disc and mouth light gray, 1 alc. MPRL.

Astroboa nuda, color above disc purplish black also main arm axes except lighter belts of hooklets, a darker band between each row, broader above and narrowly curved distally around sides of arms; narrow depressed longitudinal dark line down center of arms, more distal arm branches quite light in color; lower surface of arms lighter than above without dark bands or longitudinal line, a few distal branches with some dark color not uniform, 1 dry, d.d. 85 mm, MPRL.

Amphiura luetkeni, red and white disc with reddish arms.

Amphiodia sp., white disc, white arms, 1 dry, disc 2.5 to 3 mm, arm 60 mm, BPBM.

Macrophiothrix longipeda, from Araanbiru, 1 alc. d.d. 23.5 mm, arm 300 mm, MPRL; from Engebi, 1 alc, d.d. 5.5 mm, arm 132 mm, MPRL; from Engebi, 1 spec., disc 13 mm, arm 155 mm, MPRL.

Macrophiothrix rhabdota, 1 dry, d.d. 8 mm, arms broken, MPRL; 1 alc. d.d. 8 mm, arms broken, AHF.

Ophiothela danae, disc blue or green, arms annulated with narrow band of light or dark across, 10+ dry, disc 0.7 to 4 mm usually with six arms or in fissiparous stage with only three arms, BPBM.

Ophiothrix (Acanthophiothrix) proteus, 1 dry, d.d. 9 mm, arms 100 to 110 mm, BPBM.

Ophiothrix (Acanthophiothrix) purpurea, color of wide, dark stripe or along middle or narrow dark stripe bordered by light lines on dorsal side of arms; arm spines banded dark and light; radial shields bare, but between, radially and interradially, either granular stumps or stumps and a few long spines, marginally and on ventral side, disc with stumps and spines widely spaced, 1 alc., d.d. 7 mm, BPBM.

Ophiothrix (Ophiothrix) trilineata, from Enewetak Islet, 1 spec., gonads ripe; from Japtan Islet, 1 spec. gonads ripe; from Medren, 2 spec., gonads ripe.

Ophianthrum elegans, living color dark black, arms red and whitish band with some small dark speckling between arm spines with irregular dark and light marks, from Enewetak, 1 alc., d.d. 12 mm, BPBM; Sand Islet, 2 alc., d.d. 10, d.d. 13 mm, BPBM; Lagoon, color dark black with red arms, 1 dry, BPBM.

Ophionereis sp., from Enewetak Islet, 2 dry, d.d. 5, d.d. 6, BPBM.

Ophiarachna affinis, 1 alc. d.d. 12 mm, MPRL.

Ophiarachnella gorgonia, from Enewetak Islet, 1 dry, d.d. 12 mm, BPBM; from Rabaion Islet, 3 dry, d.d. 14 to 16 mm, AHF.

Ophioconis permixta, 1 alc., d.d. 2 mm, BPBM.

Ophiolepis superba, from Enewetak Islet, 1 alc., d.d. 24 mm, AHF.

Ophiolepis sp. after *O. cinta*, from Enewetak Islet, 1 dry d.d. 13 mm, 1 dry, d.d. 11.5 mm, BPBM; from Lagoon, 1 spec. d.d. 7 mm, AHF.

Ophiura kinbergi, from Engebi Islet, 1 juv., alc., d.d. 3 mm, MPRL.

Undersea Research Laboratory dives in 1981 at a depth of 122 to 130 m.

Ophidiasteridae

This family has the largest number of species represented at Enewetak, with at least 10 now recorded. Four have been reported previously from the Marshall Islands; all are widespread Indo-West Pacific species.

Asteropseidae

The Asteropseidae is recorded for the first time in the Marshall Islands in the form of *Asteropsis carinifera*, a species which ranges in the Indo-West Pacific from Hawaii through Oceania and into the Indian Ocean.

Asterinidae

The Asterinidae at Enewetak are represented by two species and possibly a third *(Asterina coronata)* determined by F. C. Ziesenhenne. All three have been previously recorded from the Marshall Islands (A. H. Clark, 1952).

Acanthasteridae

Acanthaster planci, the crown-of-thorns sea star, is known at Enewetak from studies of its predatory activity on scleractinian corals (Highsmith, 1980, 1982) and a fish symbiont (Allan, 1972).

Mithrodiidae

The family Mithrodiidae is newly recorded from Enewetak and the Marshall Islands, on the basis of a widespread Indo-West Pacific species, *Mithrodia clavigera*.

Echinasteridae

Echinaster luzonicus is known from Enewetak and elsewhere in the Marshall Islands (A. H. Clark, 1952). Lawrence and Guille (1982) recorded the dry weight organic composition of this sea star and other echinoderms from Enewetak.

ECHINOIDEA

Cidaridae

The cidarids are represented by two species. *Eucidaris metularia* has been found in shallow water at Enewetak and Rongerik and to a depth of 88 m at Bikini (A. H. Clark, 1952). Specimens of *Chondrocidaris gigantea* were collected from approximately 130 m and confirm an earlier record from Bikini based on one spine (A. H. Clark, 1952). This species has been observed at Kwajalein by divers (S. Johnson, personal communication). Additional cidarid species were observed and photographed in deeper waters (to 360 m depth) off the seaward side of Enewetak during submersible dives in 1981.

Echinometridae

Three genera and species of Echinometridae occur at Enewetak. Four of the species have been reported from Enewetak previously, and these range widely in the Indo-West Pacific. The fifth species, *Heterocentrotus mammillatus*, is now known from the atoll on the basis of one specimen. This species ranges from the Philippines to Hawaii and the Tuamotus. Banner and Banner (1960, 1968) reported collecting the caridean shrimp *Athanas dorsalis* from large *Heterocentrotus* sea urchins at Enewetak and elsewhere. They also reported another alpheid, *A. indicus*, associated with burrowing sea urchins in the genus *Echinometra*.

Diadematidae

The Diadematidae includes *Diadema savignyi*, a widely distributed Indo-West Pacific species, newly recorded from the Marshall Islands. *Echinothrix calamaris* and *E. diadema* are also known from Enewetak and others of the Marshall Islands (A. H. Clark, 1952, 1954).

Parasaleniidae and Temnopleuridae

One representative of both the Parasalenidae and Temnopleuridae (*Parasalenia gratiosa* and *Mespilia globulus*, respectively) has been reported at Enewetak and elsewhere in the Marshall Islands (A. H. Clark, 1952). These species are widespread in the Indo-West Pacific.

Toxopneustidae

The Toxopneustidae has three Enewetak species; *Crytechinus verruculatus* and *Tripneustes gratilla* have been previously reported from Rongelap, Bikini (A. H. Clark, 1952), and Enewetak (Highsmith, 1981); *Tripneustes gratilla* is recorded only from Enewetak by A. H. Clark (1952). *Toxopneustes pileolus* is newly recorded from the atoll and the Marshall Islands.

Schizasteridae

Among the irregular echinoid families, there is evidence that at least one, possibly two, members of the Schizasteridae occur in the lagoon substrata (V. Fry, personal communication).

Fibulariidae

The Fibulariidae were known at Enewetak by two species each of *Echinocyamus* and *Fibularia* reported by A. H. Clark (1952). A third species of *Echinocyamus*, *E. crispus*, is a new record. This may be a senior synonym for *E. elongatus*, a species recorded from Bikini by A. H. Clark (1952).

Spatangidae

The only spatangid known from Enewetak is *Maretia planulata* (as *M. ovata*) from Enewetak and Bikini by A. H. Clark (1952). This is one of the most common echinoids in certain areas of the Enewetak Lagoon (V. Fry, personal communication).

Brissidae

Three genera and four species of Brissidae, *Brissus*, *Metalia*, and *Rhynobrissus* are found at Enewetak. Three of the species have been reported previously from the atoll. A. H. Clark (1952, 1954) recorded *Brissus latecarinatus* from Enewetak and from elsewhere in the Marshall Islands. *Rhynobrissus hemiasteroides* is recorded by Pomeroy and Kuenzler (1967), and *Metalia spatagus* is newly recorded from Enewetak and the Marshall Islands.

Clypeasteridae

Clypeaster reticulatus, the only representative of the Clypeasteridae known from the Marshall Islands: (A. H. Clark, 1952, Bikini; 1954, Taka and Ujae) is newly recorded from Enewetak.

Laganidae

The family Laganidae is represented by *Laganum depressum* at Enewetak and other Marshall Islands (A. H. Clark, 1952, 1954).

COLLECTION RECORDS

Ophiomyxidae

Neoplax crassipes

Enewetak Islet: July 16, 1960, shallow coral head, J. H.

Roberts, orig. det. F. C. Ziesenhenne, verified by D. M. Devaney (AHF).

Ophiomyxa australis

Enewetak Islet: August 1957, 7 to 8 m, Richard Nishioka, orig. det. F. C. Ziesenhenne, verified by D. M. Devaney (MPRL).

Gorgonocephalidae

Astroboa nuda

Kidrenen Islet: May 26, 1976, ocean side, depth of 13 m in a cave on the seaward side just north of Kidrenen Islet, det. D. M. Devaney (MPRL).

Amphiuridae

Amphipholis squamata

Lagoon: July 1960, shallow, J. H. Roberts (Stn. 252-B), id. F. C. Ziesenhenne; 1 dry (AHF). Enewetak Islet: July 25, 1957, "found abundantly" in the sludge area of the sewage plant discharge line; the only area where silt and sediment were found on the reef; coll. and id. F. C. Ziesenhenne; 80 alc. (30 MPRL; 55 AHF). Runit Islet: July 8, 1959, intertidal, 0.8 ft tide, coll. J. S. Garth and F. C. Ziesenhenne, id. F. C. Ziesenhenne; 1 alc. (AHF). Japtan Islet: July 19, 1957, seaward reef; coll. and id. F. C. Ziesenhenne; 20 to 30 alc. (MPRL). Engebi Islet: July 21, 1959, intertidal, 0.5 ft tide, coll. J. S. Garth and F. C. Ziesenhenne, id. F. C. Ziesenhenne; 4 alc. (AHF). Igurin Islet: July 11, 1959, intertidal, 1.1 ft tide, coll. by J. S. Garth and F. C. Ziesenhenne, id. F. C. Ziesenhenne, 1 alc. (AHF). Enewetak Islet: Aug. 9, 1965, under coral, rock, quarry, D. R. Stokes, det. D. M. Devaney, 1 spec. (BPBM).

Amphiodia sp.

Lagoon: Sept. 24, 1980, airlift sample of lagoon bottom, 35 ft off Enewetak Islet, coll. and id. D. M. Devaney, 1 dry (BPBM).

Ophiotrichidae

Macrophiothrix longipeda

Araanbiru Islet: July 22, 1959, id. F. C. Ziesenhenne (MPRL). Engebi Islet: July 21, 1959; id. F. C. Ziesenhenne; 2 spec. alc. (MPRL). Igurin Islet: September 1956, outer reef, 2 to 3 ft depth, coll. D. Watson, id. F. C. Ziesenhenne, 1 spec. (MPRL). Japtan Islet: July 18, 1959, id. F. C. Ziesenhenne; 4 spec. (MPRL). (Note, at least 10 additional lots at AHF [not examined by D. M. Devaney, det. by F. C. Ziesenhenne]).

Macrophiothrix rhabdota

Enewetak Islet: Feb. 24, 1957, coll. A. H. Banner, id. F. C. Ziesenhenne, 1 spec. dry (MPRL). Enewetak Islet: Feb. 27, 1957, lagoon side about ⅓ of length of southern tip of islet, sandy bottom ca. 2 m deep, heads of *Pocillopora* and branching *Acropora*, A. H. Banner (Stn. B. E. 11), id. F. C. Ziesenhenne, verified (insofar as possible) by D. M. Devaney, 1 spec. alc. (AHF).

Ophiothela danae

Enewetak Islet: May 21, 1975, depth 8 ft, lagoon, clinging to soft nephtheid coral colony that was attached to chunks of dead coral buried in sandy bottom, coll. L. Ciereszko, det. D. M. Devaney, 17 spec. (6 MPRL, 11 BPBM). Biken Islet: Aug. 1, 1975, ocean side on reddish orange gorgonian coral, 30 m coll. J. Lamberson, det. D. M. Devaney, 10+ spec. dry (BPBM).

Ophiothrix (Acanthophiothrix) proteus

Enewetak Islet: Dec. 13, 1976, lagoon pinnacle, north end of islet, depth 60 to 70 ft, extracted from live coral, *Porites andrewsi*, coll. and det. D. M. Devaney, 1 spec. dry (BPBM).

Ophiothrix (Acanthophiothrix) purpurea

Deep Pass: July 1963, between Medren and Japtan, depth 18 m, coll. R. Grigg, det. D. M. Devaney, 1 spec. alc. (BPBM); Rigili and Giriinien Islets: Feb. 5, 1973, entwined in branches of gorgonian coral, 30 m depth, coll. and det. D. M. Devaney, 1 spec. (BPBM).

Ophiothrix (Ophiothrix) trilineata

Enewetak Islet: June 26, 1965, in coral *Pocillopora* sp., depth 1.6 m, coll. D. Stokes, det. D. M. Devaney, 1 spec. Japtan Islet: July 22, 1965, coll. D. Stokes, det. D. M. Devaney, 1 spec. Medren Islet: Aug. 8, 1965, quarry, from *Pocillopora* sp., coll. D. Stokes, det. D. M. Devaney, 2 spec.

Ophiocomidae

Ophianthrum elegans

Enewetak Islet: Sept. 3, 1965, lagoon, just off shore under rocks, 1.7 m depth, coll. D. R. Stokes, 1 spec., alc. (BPBM). Sand Islet: Sept. 7, 1966, off northwest end of islet, 1 m depth, coll. M. Youngbluth, det. D. M. Devaney, 2 spec., alc. (BPBM). Lagoon: Sept. 13, 1980, pinnacle across from Medren Islet under coral slab on side of pinnacle with rubble beneath, 8 m depth, coll. by C. Arneson, det. D. M. Devaney, 1 spec. (BPBM).

Ophionereidae

Ophionereis sp.

Enewetak Islet: Sept. 3, 1965, lagoon, just off shore under rocks, 1.8 m depth, coll. D. R. Stokes, det. D. M. Devaney, 2 spec., dry (BPBM).

Ophiodermatidae

Ophiarachna affinis

Rigili Islet: Sept. 3, 1957, 7 m depth, coll. Roberts, det. D. M. Devaney, 1 spec. alc. (MPRL).

Ophiarachnella gorgonia

Enewetak Islet: July 19, 1959, reef south end of islet, coll. and det. F. C. Ziesenhenne, 3 spec. (MPRL); Aug. 14, 1965, quarry, under coral rocks, 1 m depth, coll. D. R. Stokes, det. D. M. Devaney, 1 spec., dry (BPBM). Rabaion Islet: July 12, 1959, northwest end of islet, coll. and det. F. C. Ziesenhenne, 3 spec. dry (AHF).

Ophioconis permixta

Medren Islet: Feb. 7, 1976, lagoon outcrop, shallow 3 to 4 m, with (?on) crinoid *Comanthus bennetti*, coll. D. M. Devaney and A. Fielding, det. D. M. Devaney, 1 spec. alc. (BPBM).

Ophiuridae

Ophiolepis superba

Enewetak Islet: July 15, 1961, in tide pools on seaward reef, 0.3 to 1.0 m depth, coll. C. E. King, det. F. C. Ziesenhenne, 1 spec. alc. (AHF).

Ophiolepis sp. aff. *O. cinta*

Enewetak Islet: Aug. 14, 1965, under coral rocks, 1 m depth, S. R. Stokes, det. D. M. Devaney, 1 spec. dry (BPBM); 0.7 to 1.0 m depth, coll. J. H. Roberts, Jr., det. D. M. Devaney, 1 spec. dry (AHF). Lagoon: from coral head, coll. and det. D. M. Devaney, 1 spec. (AHF).

Ophiura kinbergi

Engebi Islet: July 21, 1959, intertidally, sand under boulder, coll. and det. F. C. Ziesenhenne; 1 juv. spec., alc., (MPRL). Biliiri Islet: lagoon, July 24, 1959, dredged at 3.5 to 5.2 depth, coll. and det. F. C. Ziesenhenne; 4 spec., dry (AHF).

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Chapter 26

Protochordates of Enewetak Atoll

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INTRODUCTION

Protochordates are members of two acraniate subphyla—Tunicata and Cephalochordata. Tunicates include the sessile ascidians and the pelagic larvaceans and thaliaceans. Few of either subphyla have been recorded from Enewetak.

TUNICATA

Even though ascidians are known to be abundant and diverse at Enewetak, only 10 species have been reported in the literature (Eldredge, 1967). These names are provided in the checklist (Table 1). All of the forms known to occur at the atoll belong to the family Didemnidae. Of these reported in 1967, two name changes were executed by Kott (1980). The original specimens of *Diplosoma virens* should now be named *Diplosoma similis*, and the unidentified *Trididemnum* sp. should be named *T. clinides*. Enewetak is the type locality and the only known location of *Didemnum gintonicum* from a coral knoll at Kinedrol (Chinieero) and *Diplosoma hiatti* from the reef between Japtan and Jinimi (Chinimi).

The remaining species have widespread distributions. *Diplosoma macdonaldi* is found in the tropical and subtropical waters of the Atlantic and Pacific, and *Diplosoma (Lissoclinum) fragile* is known from Bermuda and the West Indies as well as from Japan, Malaysia, and other Pacific islands. These two species and *Didemnum moseleyi* and *Diplosoma similis* are found in Hawaiian waters. *Didemnum moseleyi* is also known from Japan, Philippine Islands, Malaysia, Australia, Tasmania, New Caledonia, south Arabia, and from several other Pacific island locations. The

TABLE 1

Checklist of Ascidians and Cephalochordates of Enewetak Atoll

Phylum CHORDATA
- Subphylum TUNICATA
  - Class ACIDIACEA
    - Order ENTEROGONA
      - Suborder APLOUSOBRANCHIATA
        - Family DIDEMNIDAE
          - *Didemnum gintonicum* Eldredge: Eldredge, 1967.
          - *Didemnum grande* (Herdman): Eldredge, 1967.
          - *Didemnum moseleyi* (Herdman): Eldredge, 1967.
          - *Didemnum quincuciale* Michaelson: Eldredge, 1967.
          - *Diplosoma similis* (Sluiter): Kott, 1980.
            - *Diplosoma (Diplosoma) virens* Hartmeyer: Eldredge, 1967.
          - *Diplosoma (Diplosoma) hiatti* Eldredge: Eldredge, 1967.
          - *Diplosoma (Diplosoma) macdonaldi* Herdman: Eldredge, 1967.
          - *Diplosoma (Lissoclinum) fragile* (Van Name): Eldredge, 1967.
          - *Trididemnum clinides* Kott: Kott, 1980.
            - *Trididemnum* sp.: Eldredge, 1967.
          - *Trididemnum cyclops* Michaelson: Eldredge, 1967.
- Subphylum CEPHALOCHORDATA
  - Family ASYMMETRONTIDAE
    - *Notasymmetron caudatum* (Willey): Schultz (1953).

known distribution of *Diplosoma similis* (as separated from *Diplosoma virens*) includes Indonesia, the Great Barrier Reef, Fiji, Japan, and questionably the Philippine Islands. *Didemnum grande*, a widespread species, is found in Japan, Philippine Islands, Malaysia, Australia, Tasmania, south Arabia, and Palmyra in the Line Islands. *Didemnum quincunciale* has been known previously only from Zanzibar and *Trididemnum cyclops* from Australia and Madagascar.

Tokioka (1967) studied the ascidians in the U. S. National Museum and recorded four species from other atolls in the Marshall Islands. These are:

Diplosoma virens Hartmeyer, 1909 *(Leptoclinum virens)*—Ebon
Ascidia aperta Sluiter, 1904—Rongelap
Polycarpa cryptocarpa (Sluiter, 1885)—Bikini
Polycarpa iwayamae Tokioka, 1950—Arno

No specimens were found from Enewetak.

Didemnids show an increase in diversity toward the Indo-Malayan region. The didemnid fauna of Enewetak contains a number of widespread species, showing its strong faunistic affinity to the Indo-West Pacific.

Seven species of larvaceans (Gerber, 1981) and two species of thaliaceans (salps) (Gilmartin, 1958) have been reported from plankton samples taken at Enewetak. These species are discussed in Chapter 20 in this volume.

CEPHALOCHORDATA

Cephalochordata include the lancelets commonly known as *Amphioxus*. A small cephalochordate specimen dredged from the lagoon at Bikini was identified provisionally as *Notasymmetron caudatum* (Willey) by Schultz (1953). At least one unidentified specimen was seen in the Mid-Pacific Marine Laboratory collections.

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Chapter 27

Annotated Checklist of the Fishes of Enewetak Atoll and Other Marshall Islands

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INTRODUCTION

Intensive fish collecting was carried out in the Marshall Islands in 1946 and 1947 in connection with and following the atom bomb tests of Operation Crossroads. These collections were deposited in the National Museum of Natural History of the Smithsonian Institution in Washington, D. C. Additional Marshall Islands fishes were taken in 1948 and 1949 during expeditions of the Applied Fisheries Laboratory of the University of Washington. All these fishes, plus collections from the Mariana Islands, were studied by Leonard P. Schultz, then Curator of Fishes of the National Museum of Natural History, and his collaborators, Wilbert M. Chapman, Earl S. Herald, Ernest A. Lachner, Arthur D. Welander, and Loren P. Woods. The result was the valuable three-volume work on the fishes of the Marshall and Mariana Islands (1953 to 1966). A total of 543 species of fishes was reported from the Marshall Islands in these three volumes. Unfortunately, a study of the family with the largest number of species, the Gobiidae, was not completed.

Very few fishes were reported from the Marshall Islands prior to 1953. Günther (1873 to 1910) listed 31 species from the atolls of Ebon, Jaluit, and Majuro [though his *Anguilla mauritiana* and *Monacanthus ayraudi* are probable locality errors, and his *Echeneis scutata (Remora australis)* is suspect]. Kendall and Goldsborough (1911) recorded 58 species. In a study of poisonous fishes of the Marshalls, Hiyama (1943) illustrated 71 species in color. The text (translated from the Japanese by Van Campen, 1950) deals more with the toxicity of these fishes than their classification, but the high quality of most of the figures enables one to make positive identifications to species.

Donald W. Strasburg (1953) submitted a report to the Office of Naval Research entitled *Fishes of the Southern Marshall Islands*. He treated 345 species in this report, largely from collections made at Arno. He worked closely with Schultz et al. and had access to their manuscripts on Marshall Islands fishes. He listed 26 species of fishes that were not included in the manuscripts of Schultz et al. at that time (later a few of these fishes were reported in Vols. 2 and 3 of *Fishes of the Marshall and Marianas Islands*).

Ichthyological activity in the Marshall Islands continued in the years following the research of Schultz et al., largely as a result of the establishment of the Mid-Pacific Research Laboratory on Enewetak (initially named Eniwetok Marine Biological Laboratory). Also of importance has been the presence of a number of scuba divers at Kwajalein with an interest in fishes. Some of these are expert underwater photographers, and their efforts to capture the rare or unusual species on film have provided new records of fishes from the archipelago.

Randall (1986) reviewed all the new records and new species of fishes of the Marshall Islands that have been documented since Schultz et al., including those of Strasburg's Office of Naval Research report (since few copies were distributed). A total of 86 such fishes was found in the literature, and another 106 new records were added by Randall. Also there are about 45 species of fishes from the Marshalls which are still undescribed.

In addition to new records and new species, many changes in the names of fishes as listed by Schultz et al. have been made in recent publications.

The present paper provides a checklist (Table 1) of the reef, shore, and epipelagic fishes known from the Marshall Islands. We record a total of 817 species in 338 genera and 92 families. Deep-water fishes have been omitted from

TABLE 1

Checklist of the Fishes of the Marshall Islands

Phylum CHORDATA
Class CHONDRICHTHYS
Subclass ELASMOBRANCHII
Order HEXANCHIFORMES
Family HEXANCHIDAE
Hexanchus griseus (Bonnaterre, 1788): Randall, 1986.
Order LAMNIFORMES
Family GINGLYMOSTOMATIDAE
Nebrius concolor Rüppell, 1837
Ginglymostoma ferrugineum Schultz, 1953.
Nebrius ferrugineus Randall, 1980a.
Family ISURIDAE
Carcharodon carcharias (Linnaeus, 1758): Schultz, 1953.
Family CARCHARHINIDAE
Carcharhinus albimarginatus (Rüppell, 1837): Schultz, 1953.
Carcharhinus amblyrhynchos (Bleeker, 1856).
Carcharhinus menisorrah Schultz, 1953. Garrick (1982) concluded that the true *C. menisorrah* (Valenciennes in Müller and Henle) is a junior synonym of *C. falciformis* (Bibron in Müller and Henle).
Carcharhinus falciformis (Bibron, 1841): Garrick, 1982.
Carcharhinus galapagensis (Snodgrass and Heller, 1905): Randall, 1980a.
Carcharhinus limbatus (Valenciennes, 1841): Randall, 1980a.
Carcharhinus longimanus (Poey, 1861).
Carcharhinus brachyurus Schultz, 1953. Garrick (1982) stated that the specimens Schultz identified as *C. brachyurus* are *C. longimanus*. Garrick pointed out that *C. maou* (Lesson) is an older name for *longimanus*, but he gave reasons for retaining the long-established *longimanus*.
Carcharhinus melanopterus (Quoy and Gaimard, 1824): Schultz, 1953.
Galeocerdo cuvier (Peron and Lesueur, 1822): Schultz, 1953.
Negaprion acutidens (Rüppell, 1837).
Hemigaleops fosteri Schultz and Welander, 1953. Garrick and Schultz in Gilbert (1963) referred *Hemigaleops fosteri* to the synonymy of *Negaprion acutidens*.
Triaenodon obesus (Rüppell, 1837). Schultz (1953) classified this shark in the Triakidae; recent authors place it in Carcharhinidae; however, A. Baranes and G. Dingerkus (MS) plan to reclassify it in the Hemigaleidae.
Order RAJIFORMES
Family DASYATIDIDAE
Dasyatis sp. Sighted by the senior author at Enewetak.
Taeniura melanospilos Bleeker, 1853: Randall, 1980a.
Taeniura brocki Schultz, 1953.
Urogymnus sp. A specimen collected in the Enewetak Lagoon is under study by the senior author.
Family MYLIOBATIDAE
Aetobatus narinari (Euphrasen, 1790): Randall, 1986 (after Strasburg).
Family MOBULIDAE
Manta alfredi (Krefft, 1868): Schultz, 1953.
Class OSTEICHTHYES
Subclass ACTINOPTERYGII
Order ELOPIFORMES
Family ALBULIDAE
Albula glossodonta (Forsskål, 1775): Randall, 1986. Shaklee and Tamaru (1981) have shown that there are two species of *Albula* in the Hawaiian Islands (and elsewhere in the Indo-Pacific region), neither of which is *A. vulpes* (Linnaeus), now known to be restricted to the Atlantic.
Order ANGUILLIFORMES
Family MORINGUIDAE
Moringua ferruginea Bliss, 1883.
Moringua macrocephala Schultz, 1953.
Moringua macrochir Schultz, 1953. Gosline and Strasburg (1956) showed the remarkable differences of immature Hawaiian *Moringua* from adults and between the sexes (including vertebral counts), as have Castle and Böhlke (1976) for the western Atlantic *Moringua edwardsi* (Jordan and Bollman). Gosline and Strasburg identified their Hawaiian material as *M. macrochir* Bleeker. Castle (1968a) believes the Hawaiian species (and thus presumably the specimens from the Marshall Islands identified by Schultz as *macrochir*) is *M. ferruginea*. Also, Castle regards *M. macrocephala* (Bleeker) as the immature form of *macrochir*.

(This table continued on next page.)

TABLE 1 (cont'd)

Family MORINGUIDAE (cont'd)
Moringua javanica (Kaup, 1856): Schultz, 1953.
Moringua bicolor Schultz, 1953. Castle (1968a) stated that *M. bicolor* Kaup is a possible mature male of *javanica*.
Moringua linearis Gray, 1831: Schultz, 1953. Schultz's identification is questionable.
Moringua microchir Bleeker, 1853.
Moringua abbreviata Schultz, 1953. Castle (1968a) is followed in regarding *M. abbreviata* (Bleeker) as a probable synonym of *microchir*.
Family XENOCONGRIDAE
Kaupichthys atronasus Schultz, 1953.
Kaupichthys brachychirus Schultz, 1953.
Kaupichthys hyoproroides (Strömann, 1896).
Kaupichthys diodontus Schultz, 1953. Böhlke and Smith (1968) showed that *K. diodontus* Schultz (1943) and *K. atlanticus* Böhlke are junior synonyms of *K. hyoproroides*, named from a leptocephalus larva.
Family MURAENIDAE
Anarchias allardicei Jordan and Starks, 1906: Schultz, 1953.
Anarchias cantonensis (Schultz, 1943): Schultz, 1953.
Anarchias seychellensis Smith, 1962.
Anarchias leucurus Schultz, 1953. Randall and McCosker (1975) reidentified Marshall Islands *A. leucurus* as *seychellensis*.
Echidna leucotaenia Schultz, 1943: Schultz, 1953.
Echidna nebulosa (Ahl, 1789): Schultz, 1953.
Echidna polyzona (Richardson, 1844): Schultz, 1953.
Echidna unicolor Schultz, 1953.
Enchelycore bikiniensis (Schultz, 1953).
Gymnothorax bikiniensis Schultz, 1953.
Enchelycore bayeri (Schultz, 1953).
Gymnothorax bayeri Schultz, 1953.
Enchelynassa canina (Quoy and Gaimard, 1824): Schultz, 1953.
Gymnomuraena zebra (Shaw, 1797).
Echidna zebra Schultz, 1953.
Gymnothorax buroensis (Bleeker, 1857): Schultz, 1953.
Gymnothorax enigmaticus McCosker and Randall, 1982.
Gymnothorax rupelli Schultz, 1953—an unjustified emendation of *G. rueppelliae* (McClelland). The latter is a valid species often misidentified as *G. petelli* (Bleeker), a junior synonym.
Gymnothorax fimbriatus (Bennett, 1831): Schultz, 1953.
Gymnothorax favagineus var. *isingteenus* Hiyama, 1943.
Gymnothorax flavimarginatus (Rüppell, 1828): Schultz, 1953.
Gymnothorax fuscomaculatus (Schultz, 1953). McCosker and Rosenblatt (1975) have determined that the genus *Rabula* (in which Schultz described both *fuscomaculata* and *marshallensis*) is based on an aberrant specimen of the temperate eastern Pacific *Gymnothorax mordax* (Ayres).
Gymnothorax gracilicaudus Jenkins, 1903: Schultz, 1953.
Gymnothorax javanicus (Bleeker, 1859): Schultz, 1953.
Gymnothorax margaritophorus Bleeker, 1864: Schultz, 1953
Gymnothorax marshallensis (Schultz, 1953).
Gymnothorax melatremus Schultz, 1953.
Gymnothorax meleagris (Shaw and Nodder, 1795): Schultz, 1953.
Gymnothorax monochrous Bleeker, 1864: Schultz, 1953.
Gymnothorax monostigma (Regan, 1909): Schultz, 1953.
Gymnothorax pindae Smith, 1962.
Gymnothorax moluccensis Schultz, 1953. Randall and McCosker (1975) determined that Schultz's material is *G. pindae*, not *G. moluccensis* (Bleeker).
Gymnothorax rueppelliae (McClelland, 1845).
Gymnothorax petelli Schultz, 1953. Randall (1973) and McCosker and Rosenblatt (1975) have shown that *G. petelli* of Schultz and other authors is the true *G. rueppelliae*.
Gymnothorax undulatus (Lacepède, 1803): Schultz, 1953.
Gymnothorax zonipectis Seale, 1906: Schultz, 1953.
Rhinomuraena quaesita Garman, 1888: Günther, 1910; Schultz, 1953.
Siderea picta (Ahl, 1789).
Gymnothorax pictus Schultz, 1953.
Siderea prosopeion (Bleeker, 1853).
Gymnothorax thrysoideus (non-Richardson) Hiyama, 1943; Schultz, 1953.

(This table continued on next page.)

TABLE 1 (cont'd)

Family MURAENIDAE (cont'd)
Uropterygius concolor Rüppell, 1837: Schultz, 1953. Schultz's identification should be confirmed.
Uropterygius fuscoguttatus Schultz, 1953.
Uropterygius kamar McCosker and Randall, 1977: Randall, 1986.
Uropterygius macrocephalus (Bleeker, 1865).
Uropterygius reidi Schultz, 1953. Gosline (1958) placed *U. reidei* Schultz (1943) in the synonymy of *U. knighti* (Jordan and Starks).
Uropterygius knighti Schultz, 1953. McCosker et al. (1984) have referred *U. knighti* and *U. necturus* (Jordan and Gilbert) to the synonymy of *U. macrocephalus*, now known to be a trans-Pacific species.
Uropterygius marmoratus (Lacepède, 1803): Schultz, 1953.
Uropterygius supraforatus (Regan, 1909): Schultz, 1953.
Uropterygius dentatus Schultz, 1953, from Johnston Island, was synonymized by Gosline (1958).
Uropterygius xanthopterus Bleeker, 1859: Schultz, 1953.
Family CONGRIDAE
Ariosoma scheelei (Stromman, 1896).
Ariosoma obud Schultz, 1953. P. H. J. Castle (personal communication) wrote us, "it seems highly likely" that *A. obud* Herre is a junior synonym of *A. scheelei*, a species with low vertebral counts. Three Bishop Museum specimens from Enewetak have 116 to 120 vertebrae (low for the genus—see Castle, 1968b).
Conger cinereus cinereus Rüppell, 1828.
Conger noordziekii Schultz, 1953. Kanazawa (1958) placed *C. noordziekii* Bleeker in the synonymy of *cinereus*.
Gorgasia sp. An apparent undescribed species; 19 specimens from Enewetak, with 181 to 189 vertebrae.
Heteroconger hassi (Klausewitz and Eibl-Eibesfeldt, 1959): Böhlke and Randall, 1981; Randall, 1986.
Taenioconger hassi Matsuura, 1984.
Poeciloconger fasciatus Günther, 1871: Randall, 1986.
Family OPHICHTHIDAE
Apterichtus klazingai (Weber, 1913): Randall, 1986. McCosker (1977) has shown that this generic name replaces *Verma*. Also some species of *Apterichtus* have been mistakenly described in *Sphagebranchus* and *Caecula*.
Brachysomophis sauropsis Schultz, 1953.
Callechelys marmoratus (Bleeker, 1853): Schultz, 1953.
Callechelys melanotaenia Bleeker, 1864: Schultz, 1953.
Leptenchelys pinnaceps Schultz, 1953. McCosker (1970) stated that this taxon is a junior synonym of *C. melanotaenia*.
Cirricaecula johnsoni Schultz, 1953.
Leiuranus semicinctus (Lay and Bennett, 1839): Schultz, 1953.
Muraenichthys gymnotus Bleeker, 1864: Schultz, 1953.
Muraenichthys laticaudata (Ogilby, 1897): Schultz, 1953.
Muraenichthys macropterus Bleeker, 1857: Schultz, 1953.
Muraenichthys schultzei Bleeker, 1857: Schultz, 1953.
Muraenichthys sibogae Weber and de Beaufort, 1916: Schultz, 1953.
Myrichthys bleekeri Gosline, 1951.
Myrichthys semicinctus Schultz, 1953. Gosline (1951) provided a new name for *Ophisurus fasciatus* var. *semicinctus* Bleeker, preoccupied by *O. semicinctus* Lay and Bennett.
Myrichthys colubrinus (Boddaert, 1781): Schultz, 1953.
Myrichthys maculosus (Cuvier, 1817): Schultz, 1953.
Myrophis uropterus (Temminck and Schlegel, 1842): Schultz, 1953.
Ophichthus sp. Under study by John E. McCosker.
Phyllophichthus xenodontus Gosline, 1951: Randall, 1986 (after Strasburg).
Schismorhynchus labialis (Seale, 1917).
Leptenchelys labialis Schultz, 1953. McCosker (1970) described a new genus, *Schismorhynchus*, for *labialis*.
Schultzidia johnstonensis Schultz and Woods, 1949: Schultz, 1953.
Schultzidia retropinnis (Fowler, 1933): Schultz, 1953.
Order CLUPEIFORMES
Family CLUPEIDAE
Dussumieria hasselti Bleeker, 1850: Schultz and Welander, 1953.
Herklotsichthys quadrimaculatus (Rüppell, 1837): Randall, 1986 [after Strasburg, who identified this clupeid from Arno as *Harengula kunzei* (Bleeker)].
Spratelloides atrofasciatus Schultz, 1953.
Spratelloides delicatulus (Bennett, 1831): Schultz and Welander, 1953.
Order SALMONIFORMES
Family SYNODONTIDAE
Saurida gracilis (Quoy and Gaimard, 1824): Schultz, 1953.
Synodus binotatus Schultz, 1953.

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TABLE 1 (cont'd)

Family SYNODONTIDAE (cont'd)
Synodus englemani Schultz, 1953. Cressey (1981) revised *Synodus*; he recognized this species and *S. binotatus* as valid.
Synodus variegatus (Lacepède, 1803): Schultz, 1953.
Synodus sp.
Order GONORYNCHIFORMES
Family CHANIDAE
Chanos chanos (Forsskål, 1775): Randall, 1986.
Order GOBIESOCIFORMES
Family GOBIESOCIDAE
Liobranchia stria Briggs, 1955: Schultz, 1966.
Order LOPHIIFORMES
Family ANTENNARIIDAE
Antennarius analis (Gosline, 1957): Randall, 1986.
Antennarius coccineus (Lesson, 1831): Schultz, 1966.
Antennarius pictus (Shaw and Nodder, 1794): Randall, 1986. Theodore W. Pietsch (personal communication) informed us that *A. pictus* is a senior synonym of *A. chironectes* Lacepède (the name used by most recent authors for this species).
Antennarius randalli Allen, 1970: Randall, 1986.
Antennarius rosaceus (Smith and Radcliffe, 1912).
Trichophryne rosaceus Schultz, 1966.
Antennatus tuberosus (Cuvier, 1817): Randall, 1986.
Antennarius bigibbus Fowler, 1928.
Order GADIFORMES
Family BREGMACEROTIDAE
Bregmaceros nectabanus Whitley, 1941.
Bregmaceros mcclellandi Schultz, 1953. Marshall Islands material (including a Bishop Museum specimen from the Enewetak Lagoon) was reidentified as *B. nectabanus*, following D'Ancona and Cavinato (1965).
Order OPHIDIIFORMES
Family OPHIDIIDAE
Brotula townsendi Fowler, 1900: Schultz, 1960.
Family BYTHITIDAE
Brosmophyciops pautzkei Schultz, 1960. Cohen and Nielson (1978) are followed in considering Bythitidae a family for this and related fishes.
Dinematichthys iluocoeteoides Bleeker, 1855: Schultz, 1960. A badly needed revision of the genus *Dinematichthys* and allies has just been commenced by Allegra N. Sedor of the University of Southern California. More than one species of the genus occurs in the Marshall Islands; it is not clear that the name *iluocoeteoides* can be confidently applied to any of them.
Family CARAPIDAE
Carapus homei (Richardson, 1846): Schultz, 1960.
Carapus mourlani (Petit, 1934): Schultz, 1960. Schultz identified his material as *C. mourlani* "with considerable uncertainty," though pointed out that his specimens are clearly distinct from his *C. homei* (which Arnold, 1956, listed as a senior synonym of *mourlani*).
Jordanicus gracilis (Bleeker, 1856): Schultz, 1960.
Order ATHERINIFORMES
Family BELONIDAE
Ablennes hians (Valenciennes, 1846): Schultz, 1953.
Platybelone argalus platyura (Bennett, 1832).
Belone platyura Schultz, 1953.
Strongylura incisa (Valenciennes, 1846): Schultz, 1953.
Rhaphiobelone robusta Schultz, 1953. Mees (1962) and Parin (1967) placed this taxon in the synonymy of *S. incisa*.
Tylosurus crocodilus crocodilus (Peron and Lesueur, 1821).
Family HEMIRAMPHIDAE
Euleptorhamphus viridis (van Hasselt, 1824): Schultz, 1953.
Hyporhamphus acutus acutus (Günther, 1871): Collette, 1974.
Hyporhamphus acutus Schultz, 1953.
Hyporhamphus affinis (Günther, 1866): Parin et al., 1980.
Hyporhamphus dussumieri Schultz, 1953.
Hyporhamphus dussumieri (Valenciennes, 1846): Parin et al., 1980.
Hyporhamphus laticeps Schultz, 1953.
Oxyporhamphus micropterus micropterus Parin et al., 1980.

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TABLE 1 (cont'd)

*Family EXOCOETIDAE
  Cypselurus antoncichi Woods and Schultz, 1953.
  Cypselurus spilonotopterus (Bleeker, 1866): Woods and Schultz, 1953.
  Cypselurus unicolor (Valenciennes, 1846): Woods and Schultz, 1953.
  Exocoetus volitans Linnaeus, 1758: Woods and Schultz, 1953.
  Parexocoetus mento mento (Valenciennes, 1864).
    Parexocoetus mento Woods and Schultz, 1953.
  Prognichthys sp. Woods and Schultz, 1953.
Family ATHERINIDAE
  Atherinomorus lacunosus (Bloch and Schneider, 1801).
    Pranesus pinguis Schultz, 1953. Whitehead and Ivantsoff (1983) placed *Atherina pinguis* Lacepède in the synonymy of *Atherinomorus lacunosus*.
  Atherion elymus Jordan and Starks, 1901.
    Atherion elymus asper Schultz, 1953. Walter Ivantsoff (personal communication) does not recognize Schultz's subspecies of *A. elymus*.
  Hypoatherina barnesi Schultz, 1953.
  Hypoatherina ovalaua (Herre, 1935).
    Allanetta ovalaua Schultz, 1953. Generic change from Whitehead and Ivantsoff, 1983.
  Stenatherina panatela (Jordan and Richardson, 1908).
    Stenatherina temminckii Schultz, 1953. Walter Ivantsoff (personal communication) has corrected this misidentification by Schultz.
Family ISONIDAE
  Iso hawaiiensis Gosline, 1952: Randall, 1986.
Order BERYCIFORMES
Family ANOMALOPIDAE
  Photoblepharon palpebratus (Boddaert, 1781): Randall, 1986.
Family HOLOCENTRIDAE
  Myripristis adusta Bleeker, 1853: Randall, 1986.
  Myripristis amaena (Castelnau, 1873).
    Myripristis argyromus Woods, 1953. Greenfield (1974) placed *M. argyromus* Jordan and Evermann in the synonymy of *M. amaenus* (Castelnau).
  Myripristis berndti Jordan and Evermann, 1903: Woods, 1953.
  Myripristis kuntee Cuvier, 1831.
    Myripristis multiradiatus Woods, 1953. Greenfield (1974) synonymized *M. multiradiatus* Günther with *M. kuntee*.
  Myripristis murdjan (Forsskål, 1775): Woods, 1953.
    Myripristis bowditchae Woods, 1953. Randall and Guézé (1981) placed this species, *M. parvidens* Cuvier, and *M. axillaris* Valenciennes in the synonymy of *M. murdjan*.
  Myripristis pralinia Cuvier, 1829: Woods, 1953.
  Myripristis violacea Bleeker, 1851.
    Myripristis microphthalmus Woods, 1953. Greenfield (1974) synonymized *M. microphthalmus* Bleeker with *violacea*.
  Myripristis vittata Cuvier, 1831: Randall, 1986.
  Neoniphon argenteus (Valenciennes, 1831).
    Holocentrus laevis Woods, 1953. Shimizu and Yamakawa (1979) placed *Holocentrus laeve* Günther in the synonymy of *argenteus*. Randall and Heemstra (1985) have shown that *Neoniphon* Castelnau replaces the generic name *Flammeo* Jordan and Evermann.
  Neoniphon opercularis (Valenciennes, 1831).
    Holocentrus opercularis Woods, 1953.
  Neoniphon sammara (Forsskål, 1775).
    Holocentrus sammara Woods, 1953.
  Plectrypops lima (Valenciennes, 1831).
    Holotrachys lima Woods, 1953. Woods and Sonoda (1973) showed that *Holotrachys* Günther is a generic synonym of *Plectrypops* Gill.
  Sargocentron caudimaculatum (Rüppell, 1838): Randall, 1986. Matsuura and Shimizu (1982) noted that *Sargocentron* Fowler is an older name than *Adioryx* Starks.
  Sargocentron diadema (Lacepède, 1802).
    Holocentrus diadema Woods, 1953.

*Parin (1960; translation 1963) listed nine species of *Cypselurus*, in addition to the three included here, three of *Prognichthys*, and *Parexocoetus brachypterus brachypterus* from Oceania. Possibly some of these species will eventually be found in the Marshalls area. Randall (1955a) reported *Cypselurus suttoni* and *Prognichthys albimaculatus* from the nearby Gilbert Islands.

(This table continued on next page.)

TABLE 1 (cont'd)

Family HOLOCENTRIDAE (cont'd)
Sargocentron melanospilos (Bleeker, 1858): Randall, 1986.
Sargocentron microstoma (Günther, 1859).
Holocentrus microstomus Woods, 1953.
Sargocentron punctatissimum (Cuvier, 1829).
Holocentrus lacteoguttatus Woods, 1953. Randall and Heemstra (1985) pointed out that *S. punctatissimum* has priority over *S. lacteoguttatum* (Cuvier).
Sargocentron praslin (Lacepède, 1802): Randall, 1986.
Sargocentron spiniferum (Forsskål, 1775).
Holocentrus spinifer Woods, 1953.
Sargocentron tiere (Cuvier, 1829).
Holocentrus tiere Woods, 1953.
Sargocentron tiereoides (Bleeker, 1853).
Holocentrus tieroides Woods, 1953.
Sargocentron violaceum (Bleeker, 1853): Shimizu and Yamakawa, 1979.
Order GASTEROSTEIFORMES
Family AULOSTOMIDAE
Aulostomus chinensis (Linnaeus, 1766): Schultz, 1953.
Family FISTULARIIDAE
Fistularia commersonii Rüppell, 1838.
Fistularia petimba Schultz, 1953. Fritzsche (1976) showed that shallow-water Indo-Pacific specimens of *Fistularia* that most authors have called *petimba* are *F. commersonii*. The name *petimba* is correct for the deep-water tropical Atlantic and Indo-West-Pacific species with small spines posteriorly on the lateral line.
Family SOLENOSTOMIDAE
Solenostomus paradoxus (Pallas, 1870).
Solenostomus armatus Schultz, 1953. Ronald A. Fritzsche (personal communication) has reidentified Schultz's specimen (27.5 mm SL from a plankton tow off Bikini) as a juvenile of *S. paradoxus*.
Family SYNGNATHIDAE
Choeroichthys sculptus (Günther, 1870): Dawson (1976); Randall, 1986 (after Strasburg).
Corythoichthys flavofasciatus (Rüppell, 1838).
Corythoichthys flavofasciatus conspicillatus Herald, 1953. Dawson (1977a) could find no substantial basis for Herald's division of this species to subspecies.
Corythoichthys intestinalis (Ramsay, 1881).
Corythoichthys intestinalis waitei Herald, 1953.
Corythoichthys nigripectus Herald, 1953.
Corythoichthys schultzi Herald, 1953.
Cosmocampus banneri (Herald and Randall, 1972).
Cosmocampus maxweberi (Whitley, 1933).
Syngnathus maxweberi Herald, 1953. Dawson (1980) referred *S. maxweberi* to the genus *Cosmocampus* Dawson.
Doryrhamphus excisus excisus Kaup, 1956.
Doryrhamphus melanopleura melanopleura Herald, 1953. Dawson (1981) placed *D. melanopleura* (Bleeker) in the synonymy of *D. excisus* Kaup.
Dunckerocampus dactyliophorus (Bleeker, 1853): Herald, 1953.
Halicampus brocki (Herald, 1953).
Halicampus mataafae (Jordan and Seale, 1906): Herald, 1953.
Ichthyocampus bikiniensis Herald, 1953. Dawson (1977b) wrote that he is unable to refer this species, which Herald described from two planktonic postlarvae, to any genus, but the origin of the dorsal fin on the trunk rules out its placement in *Ichthyocampus*. It is probably the young of *Halicampus*, *Phoxocampus*, or *Corythoichthys* (C. E. Dawson, personal communication).
Micrognathus brevirostris pygmaeus Fritzsche, 1981.
Micrognathus brevirostris Herald, 1953.
Phoxocampus diacanthus (Schultz, 1943).
Ichthyocampus diacanthus Herald, 1953. Dawson (1977b) erected *Phoxocampus* for this species and two other pipefishes.
Order SCORPAENIFORMES
Family SCORPAENIDAE
Dendrochirus biocellatus (Fowler, 1938): Schultz, 1966.
Dendrochirus zebra (Cuvier, 1829): Randall, 1986.
Parascorpaena mcadamsi (Fowler, 1938): Randall, 1986.
Parascorpaena mossambica (Peters, 1855).
Sebastapistes mcadamsi Schultz, 1966.

(This table continued on next page.)

TABLE 1 (cont'd)

Family SCORPAENIDAE (cont'd)
Pterois antennata (Bloch, 1787): Schultz, 1966.
Pterois radiata Cuvier, 1829: Schultz, 1966.
Pterois volitans (Linnaeus, 1758): Kendall and Goldsborough, 1911; Allen and Eschmeyer, 1973.
Scorpaenodes brocki (Schultz, 1966).
Hypomacrus brocki Schultz, 1966.
Scorpaenodes guamensis (Quoy and Gaimard, 1824): Schultz, 1966.
Scorpaenodes hirsutus Smith, 1957: Randall, 1986.
Scorpaenodes kelloggi (Jenkins, 1903): Schultz, 1966.
Scorpaenodes parvipinnis (Garrett, 1863): Schultz, 1966.
Scorpaenopsis diabolus (Cuvier, 1829).
Scorpaenopsis gibbosa Schultz, 1966. Eschmeyer and Randall (1975) stated that the true *S. gibbosa* appears to be restricted to the Indian Ocean.
Scorpaenopsis fowleri (Pietschmann, 1934): Eschmeyer and Randall, 1975. This small species is only tentatively placed in the genus *Scorpaenopsis*.
Scorpaenopsis sp. A new species which will be described by William N. Eschmeyer and Kaza Rama Rao.
Sebastapistes cyanostigma (Bleeker, 1856).
Sebastapistes albobrunnea Schultz, 1966. Eschmeyer and Rama Rao (MS) have shown that *Scorpaena albobrunnea* Günther is a junior synonym of *cyanostigma*.
Sebastapistes mauritiana (Cuvier, 1829).
Scorpaena corallicola Schultz, 1966. Eschmeyer and Randall (1975) placed *S. corallicola* (Jenkins) in the synonymy of *S. ballieui* (Sauvage). Eschmeyer and Rama Rao (MS) regard *Sebastapistes ballieui* as a Hawaiian endemic. The closely related *S. mauritiana* is a wide-ranging Indo-Pacific species that does not occur in Hawaii.
Sebastapistes strongia (Cuvier, 1829).
Sebastapistes bynoensis Schultz, 1966. *Sebastapistes bynoensis* Richardson is a junior synonym of *Parascorpaena picta* (Cuvier), (Eschmeyer and Rama Rao, MS). The Bikini specimen identified as *S. bynoensis* by Schultz is *strongia*.
Synanceia verrucosa Bloch and Schneider, 1801: Schultz, 1966.
Taenianotus triacanthus Lacepède, 1802: Schultz, 1966.
Family CARACANTHIDAE
Caracanthus maculatus (Gray, 1831): Schultz, 1966.
Caracanthus unipinna (Gray, 1831).
Caracanthus unipinnus Schultz, 1966.
Family APLOACTINIDAE
Cocotropus sp. An undescribed species which will be named by Stuart G. Poss.
Family PLATYCEPHALIDAE
Thysanophrys arenicola Schultz, 1966.
Thysanophrys chiltonae Schultz, 1966.
Thysanophrys malayanus (Bleeker, 1853).
Thysanophrys papillolabium Schultz, 1966. Leslie W. Knapp (personal communication) regards this species as a junior synonym of *malayanus*.
Wakiyus welanderi Schultz, 1966.
Order PEGASIFORMES
Family PEGASIDAE
Eurypegasus draconis (Linnaeus, 1776): Randall, 1986.
Order PERCIFORMES
Family SERRANIDAE
Anthias bartlettorum Randall and Lubbock, 1981.
Anthias bicolor Randall, 1979.
Anthias dispar (Herre, 1955): Randall and Lubbock, 1981.
Anthias pascalus (Jordan and Tanaka, 1927): Randall and Lubbock, 1981.
Anthias pleurotaenia Bleeker, 1857: Randall, 1986.
Anthias randalli Lubbock and Allen, 1978.
Anthias smithvanizi Randall and Lubbock, 1981.
Anthias ventralis ventralis Randall, 1979.
Anyperodon leucogrammicus (Valenciennes, 1828): Schultz, 1953.
Belonoperca chabanaudi Fowler and Bean, 1930: Schultz, 1953.
Cephalopholis argus (Bloch and Schneider, 1801): Schultz, 1953. Randall and Ben-Tuvia (1983) have shown that *Cephalopholis guttatus* (Bloch) is an earlier name for this species, but they have petitioned the International Commission for Zoological Nomenclature to suppress *C. guttatus* (Bloch) in order to retain the long-established *C. argus*.
Cephalopholis leopardus (Lacepède, 1801): Schultz, 1953.
Cephalopholis miniatus (Forsskål, 1775): Schultz, 1953.

(This table continued on next page.)

TABLE 1 (cont'd)

Family SERRANIDAE (cont'd)

Cephalopholis sexmaculata (Rüppell, 1830): Randall and Ben-Tuvia, 1983.

Cephalopholis sonnerati (Valenciennes, 1828): Randall, 1986.

Cephalopholis spiloparaea (Valenciennes, 1828).

Cephalopholis analis Randall, 1986.

Cephalopholis urodeta (Bloch and Schneider, 1801).

Cephalopholis urodelus Schultz, 1953.

Epinephelus caeruleopunctatus (Bloch, 1790): Kendall and Goldsborough, 1911; Randall, 1986.

Epinephelus cyanopodus (Richardson, 1846).

Serranus flavocaeruleus Hiyama, 1943. Many authors have mistakenly regarded *E. flavocaeruleus* (Lacepède) as a synonym of *E. hoedtii (cyanopodus)*.

Epinephelus kohleri Schultz, 1953. Katayama (1960) and Randall (1980a) placed this species in the synonymy of *E. hoedtii*. *Epinephelus cyanopodus* is a still older name for the species (Randall and Whitehead, 1985).

Epinephelus fasciatus (Forsskål, 1775).

Epinephelus emoryi Schultz, 1953. Katayama (1960) correctly referred *emoryi* to the synonymy of *fasciatus*.

Epinephelus fuscoguttatus (Forsskål, 1775). Schultz (1953) confused two species under the heading *E. fuscoguttatus*. His illustration (Plate 26 A) is *E. microdon*. Randall (1964a) distinguished these two related species.

Epinephelus hexagonatus (Bloch and Schneider, 1801): Schultz, 1953.

Epinephelus lanceolatus (Bloch, 1790): Schultz, 1966.

Epinephelus macrospilos (Bleeker, 1855). *Epinephelus macrospilos* Schultz, 1953.

Serranus howlandi Günther, 1883 and *Epinephelus spilotus* Schultz, 1953 are synonyms. Randall (1955a) erroneously regarded *E. spilotus* as a synonym of *E. corallicola* (Valenciennes).

Epinephelus maculatus (Bloch, 1790).

Epinephelus medurensis Schultz, 1953. Randall (1980a) regarded *E. medurensis* (Günther) as a synonym of *E. maculatus*.

Epinephelus melanostigma Schultz, 1953. Randall (1955a) provisionally placed this species in the synonymy of *E. hexagonatus*. It is now known to be valid.

Epinephelus merra Bloch, 1793: Schultz, 1953.

Epinephelus microdon (Bleeker, 1856).

Epinephelus fuscoguttatus Schultz, 1953 (in part).

Epinephelus horridus Schultz, 1966. *Serranus horridus* Valenciennes is a junior synonym of *E. fuscoguttatus* (Forsskål).

Epinephelus ongus (Bloch, 1790).

Epinephelus summana Schultz, 1953. Randall and Ben-Tuvia (1983) have shown that *E. summana* (Forsskål) is endemic to the Red Sea. The related *E. ongus* occurs elsewhere in the Indo-Pacific.

Epinephelus socialis (Günther, 1873): Schultz, 1953. Randall (1980a) mistakenly used a photo of *E. ongus* from Ponape to illustrate *E. socialis*.

Epinephelus spilotoceps Schultz, 1953. Randall (1955a) was in error referring this species to the synonymy of *E. hexagonatus*.

Epinephelus tauvina (Forsskål, 1775).

Epinephelus elongatus Schultz, 1953. Katayama (1960) and Randall (1964a) regarded this species as a synonym of *E. tauvina*.

Gracila albomarginata (Fowler and Bean, 1930): Randall, 1986.

Grammistes sexlineatus (Thunberg, 1792): Schultz, 1953.

Grammistops ocellatus Schultz, 1953.

Liopropoma pallidum (Fowler, 1938).

Ypsigramma pallida Schultz, 1953.

Liopropoma susumi (Jordan and Seale, 1906).

Ypsigramma lineata Schultz, 1953. Randall (1955a) referred this species to the synonymy of *Liopropoma susumi*.

Ypsigramma brocki Schultz, 1953. Randall (1955a) stated that *Y. brocki* is a probable synonym of *Liopropoma susumi*. This fish is also a possible hybrid of *Liopropoma susumi* and *L. pallidum*; it is still under study.

Liopropoma sp. A small species with two broad red stripes on side of body which extend into caudal fin; it will be described by Randall and Taylor who are revising the genus.

Luzonichthys waitei (Fowler, 1931).

Luzonichthys robustus Fourmanoir, 1977. Randall (1981b) regarded *L. robustus* as a probable synonym of *L. waitei*.

Plectranthias fourmanoiri Randall, 1980.

Plectranthias nanus Randall, 1980.

Plectropomus laevis (Lacepède, 1801).

Plectropomus leopardus Schultz, 1953 (non-Lacepède).

Plectropomus melanoleucus Randall, 1980a. Hoese et al., 1981, suspected that *P. laevis* (Lacepède) would have priority over *P. melanoleucus* (Lacepède); this has been confirmed (Randall and Hoese, in press). What Schultz called *P. leopardus* is the most common color phase of this species.

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TABLE 1 (cont'd)

Family SERRANIDAE (cont'd)
Plectropomus oligacanthus (Bleeker, 1854): Hiyama, 1943; Randall, 1986.
Plectropomus areolatus (Rüppell, 1830).
Plectropomus truncatus Schultz. Randall and Hoese (in press) have shown that *P. truncatus* Fowler is a junior synonym of *P. areolatus*.
Pogonoperca punctata (Valenciennes, 1830): Randall, 1986.
Pseudogramma bilinearis (Schultz, 1943).
Aporops bilinearis Schultz, 1953. Randall (1955a) synonymized the genus *Aporops* with *Pseudogramma*.
Pseudogramma polyacantha (Bleeker, 1856): Schultz, 1953.
Pseudogramma sp. A new species to be described by J. Randall who plans a revision of the genus.
Variola louti (Forsskål, 1775): Schultz, 1953.
Family PSEUDOCHROMIDAE
Pseudochromis aurea marshallensis Schultz, 1953.
Pseudochromis tapeinosoma Bleeker, 1853: Schultz, 1953.
Pseudoplesiops revellei Schultz, 1953.
Pseudoplesiops rosae Schultz, 1953.
Pseudoplesiops sargenti Schultz, 1953.
Pseudoplesiops sp. One specimen from Kwajalein.
Family ACANTHOCLINIDAE
Acanthoplesiops hiatti Schultz, 1953.
Family PLESIOPIDAE
Calloplesiops altivelis (Steindachner, 1903): Randall, 1986.
Plesiops coeruleolineatus Rüppell, 1835.
Plesiops melas Schultz, 1953. Schultz (1966, addendum) (after Inger, 1955) reidentified his Marshall Islands material as *P. coeruleolineatus*.
Plesiops corallicola Bleeker, 1853.
Plesiops nigricans Schultz, 1953. Inger (1955) has shown, from material available to him for his revision of *Plesiops*, that the true *P. nigricans* (Rüppell) is endemic to the Red Sea.
Family CIRRHITIDAE
Amblycirrhitus bimacula (Jenkins, 1903).
Cirrhitoidea bimacula Schultz, 1960.
Cirrhitichthys oxycephalus (Bleeker, 1855): Günther, 1873; Randall, 1963a.
Cirrhitus pinnulatus (Bloch and Schneider, 1801): Schultz, 1960.
Isocirrhitus sexfasciatus (Schultz, 1960).
Cirrhitoidea sexfasciata Schultz, 1960. Randall (1963a) created the monotypic genus *Isocirrhitus* for this species.
Oxycirrhites typus Bleeker, 1857: Randall, 1986.
Paracirrhites arcatus (Cuvier, 1829).
Gymnocirrhites arcatus Schultz, 1960.
Paracirrhites forsteri (Bloch and Schneider, 1801): Schultz, 1960.
Paracirrhites hemistictus (Günther, 1874): Schultz, 1960.
Family KUHLIIDAE
Kuhlia marginata (Cuvier, 1829): Schultz, 1953.
Kuhlia mugil (Bloch and Schneider, 1801).
Kuhlia taeniura Schultz, 1953. Randall (1973) showed that *K. mugil* is an earlier name for *K. taeniura* (Cuvier).
Family PRIACANTHIDAE
Heteropriacanthus cruentatus (Lacepède, 1801).
Priacanthus cruentatus Schultz, 1953.
Priacanthus hamrur (Forsskål, 1775): Schultz, 1953.
Family APOGONIDAE
Apogon coccineus Rüppell, 1838.
Apogon erythrinus Lachner, 1953. Smith (1961) could find no reason for maintaining *A. erythrinus* Snyder as a distinct species.
Apogon cyanosoma Bleeker, 1853.
Apogon novae-guineae Lachner, 1953. The author and Ernest A. Lachner have determined that the specimens tentatively identified by Lachner as *A. novaeguineae* appear to be *A. cyanosoma*. Marshall Islands specimens differ from typical *cyanosoma* in having yellow instead of orange stripes.
Apogon doryssa (Jordan and Seale, 1906): Randall, 1986.
Apogon ellioti Day, 1875: Randall, 1986 (after Strasburg).
Apogon evermanni Jordan and Snyder, 1904: Randall and Böhlke, 1981.

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TABLE 1 (cont'd)

Family APOGONIDAE (cont'd)
Apogon exostigma (Jordan and Starks, 1906): Lachner, 1953.
Apogon fraenatus Lachner, 1953. Randall (1955a) reidentified Lachner's Marshall Islands specimens as *A. exostigma*. *Apogon fraenatus* Valenciennes is a valid species but apparently does not occur in the Marshall Islands.
Apogon fuscus Quoy and Gaimard, 1824.
Apogon savayensis Lachner, 1953. *Apogon savayensis* Günther is a junior synonym of *A. fuscus*.
Apogon guamensis Valenciennes, 1832.
Apogon nubilus Lachner, 1953. Thomas H. Fraser (personal communication) informed us that *A. guamensis* is an earlier name for this species than *A. nubilus* Garman.
Apogon kallopterus Bleeker, 1856.
Apogon snyderi Jordan and Evermann, 1904.
Apogon leptacanthus Bleeker, 1856: Strasburg, 1966.
Apogon graeffii Günther, 1873.
Apogon nigrofasciatus Lachner, 1953.
Apogon novemfasciatus Cuvier, 1828: Lachner, 1953.
Apogon taeniophorus Regan, 1908.
Apogon robustus Lachner, 1953. Randall and Lachner (1986) reidentified Marshall Islands specimens as *A. taeniophorus*.
Apogon taeniopterus Bennett, 1835.
Apogon menesemops Lachner, 1953. The authors agree with Smith (1961) in considering this species a synonym of *A. taeniopterus*.
Apogon trimaculatus Cuvier 1828: Lachner, 1953.
Apogonichthys ocellatus (Weber, 1913).
Apogon ocellatus Lachner, 1953.
Archamia fucata (Cantor, 1850): Lachner, 1953.
Cheilodipterus isostigma (Schultz, 1940).
Cheilodipterops isostigma Lachner, 1953. Randall (1955a) and Fraser (1972) placed the genera *Cheilodipterops* and *Paramia* in the synonymy of *Cheilodipterus*.
Cheilodipterus macrodon Lacepède, 1802: Lachner, 1953.
Cheilodipterus quinquelineatus Cuvier, 1828.
Paramia quinquelineata Lachner, 1953.
Cheilodipterus truncatus Günther, 1873: Lachner, 1953.
Foa sp. Two specimens (BPBM 28761, 28 to 29 mm) from a *Halimeda* bed in 19 to 27 m in the Kwajalein Lagoon may represent an undescribed species.
Fowleria isostigma (Jordan and Seale, 1906).
Apogon isostigma Lachner, 1953.
Fowleria marmorata (Alleyne and Macleay, 1876).
Apogon marmoratus Lachner, 1953. Fraser (1972) wrote that the nominal species of *Fowleria* should be restudied because of the contrasting treatments by Lachner (1953) and Smith (1961).
Gymnapogon gracilicauda Lachner, 1953.
Gymnapogon urospilotus Lachner, 1953.
Rhabdamia cypselurus Weber, 1909: Fraser, 1972.
Apogon cypselurus Lachner, 1953.
Rhabdamia gracilis (Bleeker, 1856): Fraser, 1972.
Apogon gracilis, Lachner, 1953.
Siphamia fuscolineata Lachner, 1953.
Family MALACANTHIDAE
Hoplolatilus cuniculus Randall and Dooley, 1974: Randall, 1986.
Hoplolatilus starcki Randall and Dooley, 1974.
Malacanthus brevirostris Guichenot, 1858: Randall, 1986.
Malacanthus latovittatus (Lacepède, 1801): Randall, 1986.
Family ECHENEIDIDAE
Echeneis naucrates Linnaeus, 1758: Lachner, 1966.
Remora australis (Bennett, 1840).
Echeneis scutata Günther, 1876. Lachner (1966) treated this species as a synonym of *R. australis*. Günther's locality, "Maduro," should be confirmed.
Remora remora (Linnaeus, 1758): Lachner, 1966.
Family CARANGIDAE
Alectis ciliaris (Bloch, 1787): Randall, 1986.
Atule mate (Cuvier, 1833): Randall, 1986.
Selaroides leptolepis Strasburg, 1953.

(This table continued on next page.)

TABLE 1 (cont'd)

Family CARANGIDAE (cont'd)
Carangoides ferdau (Forsskål, 1775).
Carangoides gilberti Woods, 1953. William F. Smith-Vaniz (personal communication) has determined that the true *ferdau* is the species some recent authors such as Woods have labelled *gilberti*, and the species usually identified as *C. ferdau jordani* Nichols is *C. orthogrammus* (Jordan and Gilbert).
Carangoides orthogrammus (Jordan and Gilbert, 1881).
Carangoides ferdau jordani Woods, 1953.
Carangoides plagiotaenia Bleeker, 1857: Randall, 1986.
Caranx ignobilis (Forsskål, 1775): Randall, 1980a.
Caranx lugubris Poey, 1861: Woods, 1953.
Caranx melampygus Cuvier, 1833: Woods, 1953.
Caranx sexfasciatus Quoy and Gaimard, 1825: Woods, 1953.
Decapterus muroadsi (Temminck and Schlegel, 1844): Woods, 1953.
Elagatis bipinnulata (Quoy and Gaimard, 1825): Woods, 1953.
Gnathanodon speciosus (Forsskål, 1775): Schultz, 1966, addendum; Randall, 1986 (after Strasburg).
Scomberoides lysan (Forsskål, 1775).
Scomberoides sancti-petri Woods, 1953. Smith-Vaniz and Staiger (1973) have shown that *S. lysan* is an earlier name for this species than *S. sanctipetri* (Cuvier).
Selar crumenophthalmus (Bloch, 1793).
Trachurops crumenophthalmus Woods, 1953.
Trachinotus bailloni (Lacepède, 1801): Woods, 1953.
Trachinotus blochii (Lacepède, 1801): Randall, 1986.
Family CORYPHAENIDAE
Coryphaena hippurus Linnaeus, 1758: Schultz, 1953.
Family LUTJANIDAE
Aphareus furca (Lacepède, 1801).
Aphareus furcatus Schultz, 1953.
Aprion virescens Valenciennes, 1830: Schultz, 1953.
Lutjanus bohar (Forsskål, 1775): Schultz, 1953.
Lutjanus fulvus (Bloch and Schneider, 1801): Randall, 1986 (after Strasburg).
Lutjanus marginatus Kendall and Goldsborough, 1911.
Lutjanus flavipes Hiyama, 1943. Randall (1973) noted that *L. fulvus* predates *L. vaigiensis* (Quoy and Gaimard) and *L. marginatus* (Cuvier), the names usually given to this common lutjanid.
Lutjanus gibbus (Forsskål, 1775): Schultz, 1953.
Anthias heraldi Schultz, 1953. Heemstra (1972) showed that this taxon is a juvenile *L. gibbus*.
Lutjanus kasmira (Forsskål, 1775): Schultz, 1953.
Lutjanus monostigma (Cuvier, 1828).
Lutjanus monostigmus Schultz, 1953.
Lutjanus semicinctus Quoy and Gaimard, 1824: Hiyama, 1943; Randall, 1986.
Lutjanus vitta (Quoy and Gaimard, 1824): Randall, 1986 (after Strasburg).
Lutjanus semicinctus Quoy and Gaimard, 1824: Hiyama, 1943; Randall, 1986.
Lutjanus vitta (Quoy and Gaimard, 1824): Randall, 1986 (after Strasburg).
Macolor niger (Forsskål, 1775): Schultz, 1953.
Family CAESIONIDAE
Caesio caerulaurea Lacepède, 1801: Randall, 1986.
Caesio teres Seale, 1906.
Caesio xanthonotus Schultz, 1953.
Pterocaesio marri Schultz, 1953.
Pterocaesio kohleri Schultz, 1953. Kent E. Carpenter, who is revising the family, believes this is the same species as *P. marri*.
Pterocaesio tile (Cuvier, 1830): Schultz, 1953.
Pterocaesio sp.
Family HAEMULIDAE
Plectorhinchus obscurus (Günther, 1871): Randall, 1986.
Plectorhinchus picus (Cuvier, 1830): Randall, 1986.
Family LETHRINIDAE
Gnathodentex aureolineatus (Lacepède, 1802): Schultz, 1953.
Gymnocranius microdon (Bleeker, 1851): Randall, 1986 (after Strasburg) used the name *microdon* for the Marshall Islands *Gymnocranius* with reservations. The genus *Gymnocranius* needs revision.
Lethrinus amboinensis Bleeker, 1854: Randall, 1980a (after Sato, 1978).
Lethrinus variegatus Schultz, 1953.

(This table continued on next page.)

TABLE 1 (cont'd)

Family LETHRINIDAE (cont'd)

?*Lethrinus reticulatus* Schultz, 1953. Schultz provided no illustrations of any of the five species of *Lethrinus* he reported from the Marshall Islands, and Sato (1978) made reference to only two of them, *kallopterus* and *miniatus* (*elongatus*). The small specimens identified as *reticulatus* by Schultz are only tentatively regarded as *amboinensis* here.

Lethrinus elongatus Valenciennes, 1830.

Lethrinus miniatus Schultz, 1953. Randall and Wheeler (MS) have determined that the true *L. miniatus* (Bloch and Schneider) is a species most authors have identified as *L. chrysostomus* Richardson.

Lethrinus harak (Forsskål, 1775): Schultz, 1953.

Lethrinus kallopterus Bleeker, 1856: Schultz, 1953.

Lethrinus ramak (Forsskål, 1775): Randall, 1986.

Lethrinus xanthochilus Klunzinger, 1870: Randall, 1980a.

Lethrinus microdon Schultz, 1953.

Monotaxis grandoculis (Forsskål, 1775).

Family NEMIPTERIDAE

Pentapodus caninus (Cuvier, 1830): Randall, 1986.

Scolopsis lineatus Quoy and Gaimard, 1824.

Scolopsis cancellatus Strasburg, 1953 (mimeo report to ONR); Hiatt and Strasburg, 1960. Barry C. Russell (personal communication) has informed us that *S. lineatus* is an older name for this species than *S. cancellatus* (Cuvier).

Family GERREIDAE

Gerres argyreus (Bloch and Schneider, 1801): Schultz, 1953.

Family MULLIDAE

Mulloides flavolineatus (Lacepède, 1801).

Mulloidichthys samoensis Lachner, 1960.

Mulloides vanicolensis (Valenciennes, 1831).

Mulloidichthys auriflamma Lachner, 1960.

Mulloidichthys vanicolensis Lachner, 1960.

Mulloides pflugeri Steindachner, 1901: Randall, 1986.

Parupeneus barberinoides (Bleeker, 1852): Randall, 1986.

Upeneus atrocingulatus Kner, 1870. Lachner (1960) erred in considering *U. atrocingulatus* as a synonym of *P. trifasciatus*.

Parupeneus barberinus (Lacepède, 1801): Lachner, 1960.

Parupeneus bifasciatus (Lacepède, 1801): Randall, 1986.

Parupeneus crassilabrus Lachner, 1960.

Parupeneus cyclostomus (Lacepède, 1801): Lachner, 1960.

Parupeneus heptacanthus (Lacepède, 1802): Randall, 1986.

Parupeneus multifasciatus (Quoy and Gaimard, 1824).

Parupeneus trifasciatus Lachner, 1960. Randall (MS) regards *P. trifasciatus* (Lacepède) as a synonym of *P. bifasciatus* (Lacepède). The species in the central and western Pacific identified by most authors as *trifasciatus* should be called *P. multifasciatus*. It is not known from the western Indian Ocean.

Parupeneus pleurostigma (Bennett, 1831): Lachner, 1960.

Upeneus taeniopterus Cuvier, 1829: Randall, 1986.

Family PEMPHERIDIDAE

Parapriacanthus beryciformes Franz, 1910: Schultz, 1953.

Pempheris oualensis Cuvier, 1831: Schultz, 1953.

Family KYPHOSIDAE

Kyphosus cinerascens (Forsskål, 1775): Schultz, 1953.

Kyphosus vaigiensis (Quoy and Gaimard, 1825): Randall, 1986.

Family EPHIPPIDIDAE

Platax orbicularis (Forsskål, 1775): Randall, 1986 (after Strasburg).

Family CHAETODONTIDAE

Chaetodon auriga Forsskål, 1775: Woods, 1953.

Chaetodon bennetti Cuvier, 1831: Burgess, 1978.

Chaetodon citrinellus Cuvier, 1831: Woods, 1953.

Chaetodon ephippium Cuvier, 1831: Woods, 1953.

Chaetodon kleinii Bloch, 1790: Woods, 1953.

Chaetodon lineolatus Cuvier, 1831: Burgess, 1978.

Chaetodon lunula (Lacepède, 1802): Woods, 1953.

Chaetodon melannotus Bloch and Schneider, 1801: Woods, 1953.

Chaetodon mertensii Cuvier, 1831: Woods, 1953.

Chaetodon meyeri Bloch and Schneider, 1801: Woods, 1953.

Chaetodon ornatissimus Cuvier 1831: Woods, 1953.

(This table continued on next page.)

TABLE 1 (cont'd)

Family CHAETODONTIDAE (cont'd)

Chaetodon punctatofasciatus Cuvier, 1831: Woods, 1953.

Chaetodon quadrimaculatus Gray, 1833: Woods, 1953.

Chaetodon rafflesi Bennett, 1830: Burgess, 1978 (from underwater photo by Scott Johnson, but locality Kwajalein, not Enewetak).

Chaetodon reticulatus Cuvier, 1831: Woods, 1953.

Chaetodon semeion Bleeker, 1855: Woods, 1953.

Chaetodon tinkeri Schultz, 1951: Randall, 1986.

Chaetodon trifascialis Quoy and Gaimard, 1825.

Megaprotodon strigangulus Woods, 1953.

Chaetodon trifascialis Mungo Park, 1797: Woods, 1953.

Chaetodon ulietensis Cuvier, 1831.

Chaetodon falcula Woods, 1953. Burgess (1978) wrote that *C. falcula* Bloch is an Indian Ocean species that is often not distinguished from the Pacific *C. ulietensis*.

Chaetodon unimaculatus Bloch, 1787: Woods, 1953.

Chaetodon vagabundus Linnaeus, 1758: Randall, 1986 (after Strasburg).

Forcipiger flavissimus Jordan and McGregor, 1898.

Forcipiger longirostris Woods, 1953. Randall and Caldwell (1970) showed that most authors have used the name *longirostris* for the most common of the two species of the genus (the one with the shorter snout); the correct name for this butterflyfish is *F. flavissimus*.

Forcipiger longirostris (Broussonet, 1782): Randall and Caldwell, 1970.

Hemitaurichthys polylepis (Bleeker, 1857): Burgess, 1978.

Heniochus acuminatus (Linnaeus, 1758): Fowler, 1928.

Heniochus chrysostomus Cuvier, 1831.

Heniochus permutatus Woods, 1953. Burgess (1978) reidentified Woods' material of this species from the Marshall Islands as *H. chrysostomus*.

Heniochus monoceros Cuvier, 1831: Woods, 1953.

Heniochus varius (Cuvier, 1829): Randall, 1986.

Family POMACANTHIDAE

Centropyge bicolor (Bloch, 1787): Randall, 1986.

Centropyge bispinosus (Günther, 1860): Woods and Schultz, 1953.

Centropyge flavissimus (Cuvier, 1831): Woods and Schultz, 1953.

Centropyge heraldi Woods and Schultz, 1953.

Centropyge loriculus (Günther, 1874): Randall, 1986.

Centropyge multicolor Randall and Wass, 1974.

Centropyge multifasciatus (Smith and Radcliffe, 1911): Randall, 1986.

Centropyge vrolikii (Bleeker, 1853): Randall, 1986 (after Strasburg).

Genicanthus bellus Randall, 1975: Randall, 1986.

Genicanthus watanabei (Yasuda and Tominaga, 1970): Randall, 1986.

Pomacanthus imperator (Bloch, 1787): Woods and Schultz, 1953.

Pygoplites diacanthus (Boddaert, 1772): Woods and Schultz, 1953.

Family POMACENTRIDAE

Abudefduf septemfasciatus (Cuvier, 1830): Woods and Schultz, 1953.

Abudefduf sexfasciatus (Lacepède, 1801).

Abudefduf coelestinus Allen, 1975. Allen, Bauchot, and Desoutter (1978) placed *A. coelestinus* (Cuvier) in the synonymy of *A. sexfasciatus*.

Abudefduf sordidus (Forsskål, 1775): Woods and Schultz, 1960.

Amblyglyphidodon aureus (Cuvier, 1830).

Abudefduf aureus Woods and Schultz, 1960.

Amblyglyphidodon curacao (Bloch, 1787).

Abudefduf curacao Woods and Schultz, 1960.

Amblyglyphidodon leucogaster (Bleeker, 1847): Randall, 1986.

Amphiprion chrysopterus Cuvier, 1830.

Amphiprion bicinctus Woods and Shultz, 1960. Allen (1972a) found specimens of the true *A. bicinctus* Rüppell only from the Red Sea.

Amphiprion melanopus Bleeker, 1852: Woods and Schultz, 1960.

Amphiprion perideraion Bleeker, 1955: Woods and Schultz, 1960.

Amphiprion tricinctus Schultz and Welander, 1953.

Chromis acares Randall and Swerdloff, 1973.

Chromis agilis Smith, 1960: Randall and Swerdloff, 1973.

Chromis leucurus Woods and Schultz, 1960.

(This table continued on next page.)

TABLE 1 (cont'd)

Family POMACENTRIDAE (cont'd)
- *Chromis amboinensis* (Bleeker, 1873): Allen, 1975.
- *Chromis atripectoralis* Welander and Schultz, 1951.
- *Chromis atripes* Fowler and Bean, 1928: Randall, 1986.
- *Chromis elerae* Fowler and Bean, 1928: Randall, 1986.
- *Chromis lepidolepis* Bleeker, 1877: Woods and Schultz, 1960.
- *Chromis margaritifer* Fowler, 1946.
  - *Chromis dimidiatus* Woods and Schultz, 1960. Randall, Ida, and Moyer (1981) stated that *C. dimidiata* (Klunzinger) is an Indian Ocean species.
- *Chromis ternatensis* (Bleeker, 1956): Woods and Schultz, 1960. Recent examination of the syntypes of *Chromis caerulea* (Cuvier, 1830) revealed them to be the damselfish widely known as *C. ternatensis*. A petition has been prepared for the International Commission on Zoological Nomenclature to suppress *C. caerulea* in favor of *C. ternatensis*. The next available name for the species known as *C. caerulea* is *C. viridis* (Cuvier, 1830) (Randall, Bauchot, and Desoutter, 1985).
- *Chromis vanderbilti* (Fowler, 1941): Randall, 1986.
- *Chromis viridis* (Cuvier, 1830).
  - *Chromis caeruleus* Woods and Schultz, 1960. See remarks under *C. ternatensis* above.
- *Chromis xanthura* (Bleeker, 1854): Allen, 1975.
- *Chromis* sp.
  - *Chromis* sp. A of Allen, 1975.
- *Chrysiptera biocellata* (Quoy and Gaimard, 1825).
  - *Abudefduf biocellatus* Woods and Schultz, 1960.
- *Chrysiptera caeruleolineata* (Allen, 1973): Randall, 1986.
- *Chrysiptera glauca* (Cuvier, 1830).
  - *Abudefduf glaucus* Woods and Schultz, 1960.
- *Chrysiptera leucopoma* (Lesson, 1830).
  - *Abudefduf leucopomus* Woods and Schultz, 1960.
  - *Abudefduf amabilis* Woods and Schultz, 1960. Allen (1975) discovered that *amabilis* and *leucopomus* are two very different color forms of the same species associated with different reef flat zones.
- *Chrysiptera traceyi* Woods and Schultz, 1960.
- *Dascyllus aruanus* (Linnaeus, 1758): Woods and Schultz, 1960.
- *Dascyllus reticulatus* (Richardson, 1846): Woods and Schultz, 1960.
- *Dascyllus trimaculatus* (Rüppell, 1828): Kendall and Goldsborough, 1911; Woods and Schultz, 1960.
- *Lepidozygus tapeinosoma* (Bleeker, 1856): Randall, 1986.
- *Plectroglyphidodon dickii* (Liénard, 1839).
  - *Abudefduf dicki* Woods and Schultz, 1960.
- *Plectroglyphidodon imparipennis* (Vaillant and Sauvage, 1875).
  - *Abudefduf imparipennis* Woods and Schultz, 1960.
- *Plectroglyphidodon johnstonianus* (Fowler and Ball, 1924).
  - *Abudefduf johnstonianus* Woods and Schultz, 1960.
- *Plectroglyphidodon lacrymatus* (Quoy and Gaimard, 1825).
  - *Abudefduf lacrymatus* Woods and Schultz, 1960.
- *Plectroglyphidodon leucozona* (Bleeker, 1859).
  - *Abudefduf leucozona* Woods and Schultz, 1960.
- *Plectroglyphidodon phoenixensis* (Schultz, 1943).
  - *Abudefduf phoenixensis* Woods and Schultz, 1960.
- *Pomacentrus amboinensis* Bleeker, 1868: Randall, 1986 (after Strasburg).
- *Pomacentrus brachialis* (Cuvier, 1830).
  - *Pomacentrus melanopterus* Woods and Schultz, 1960. Gerald R. Allen (personal communication) has replaced the name *P. melanopterus* Bleeker with *P. brachialis*.
- *Pomacentrus coelestis* Jordan and Starks, 1901: Woods and Schultz, 1960.
- *Pomacentrus pavo* (Bloch, 1787): Woods and Schultz, 1960.
- *Pomacentrus vaiuli* Jordan and Seale, 1906: Woods and Schultz, 1960.
- *Pomachromis exilis* (Allen and Emery, 1973).
- *Stegastes fasciolatus* (Ogilby, 1889).
  - *Pomacentrus jenkinsi* Woods and Schultz, 1960. Allen (1975) found that *fasciolatus* is an earlier name for *P. jenkinsi* Jordan and Evermann. At that time he classified it and the following species in the genus *Eupomacentrus*. Emery and Allen (1980) determined that *Stegastes* is a senior generic synonym for *Eupomacentrus*.
- *Stegastes nigricans* (Lacepède, 1803).
  - *Pomacentrus nigricans* Woods and Schultz, 1960.
- *Stegastes lividus* (Bloch and Schneider, 1801).
  - *Pomacentrus lividus* Günther, 1881.

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TABLE 1 (cont'd)

Family MUGILIDAE
Chaenomugil leuciscus (Günther, 1871).
Neomyxus chaptalii Schultz, 1953. James M. Thomson (personal communication) stated that *Chaenomugil leuciscus* is the correct name for the specimens Schultz identified as *N. chaptalii* (Eydoux and Souleyet). This and the following mugilid generic placements were made with his counsel.
Chelon labiosus (Valenciennes, 1836).
Plicomugil labiosus Schultz, 1953.
Crenimugil crenilabis (Forsskål, 1775): Schultz, 1953.
Liza vaigiensis (Quoy and Gaimard, 1825).
Chelon vaigiensis Schultz, 1953.
Valamugil engeli (Bleeker, 1858).
Chelon engeli Schultz, 1953.
Family SPHYRAENIDAE
Sphyraena barracuda (Walbaum, 1792): Schultz, 1953.
Sphyraena forsteri Cuvier, 1829: Schultz, 1953.
Sphyraena helleri Jenkins, 1901: Schultz, 1953.
Sphyraena genie Klunzinger, 1870: Schultz, 1953.
Family POLYNEMIDAE
Polydactylus sexfilis (Valenciennes, 1831): Schultz, 1953.
Family LABRIDAE
Anampses caeruleopunctatus Rüppell, 1828: Schultz, 1960.
Anampses melanurus Bleeker, 1857: Randall, 1986.
Anampses meleagrides Valenciennes, 1839: Randall, 1986.
Anampses twistii Bleeker, 1856: Schultz, 1960.
Bodianus anthioides (Bennett, 1831): Randall, 1986.
Bodianus axillaris (Bennett, 1831): Randall, 1986.
Bodianus diana (Lacepède, 1801): Randall, 1986.
Bodianus loxozonus (Snyder, 1908): Randall, 1986.
Cheilinus arenatus Valenciennes, 1840: Randall, 1981c.
Cheilinus bimaculatus Valenciennes, 1840: Randall, 1986.
Cheilinus celebicus Bleeker, 1853: Schultz, 1960.
Cheilinus chlorourus (Bloch, 1791): Schultz, 1960.
Cheilinus digrammus (Lacepède, 1801): Schultz, 1960.
Cheilinus fasciatus (Bloch, 1791): Schultz, 1960.
Cheilinus orientalis Günther, 1862: Randall, 1986.
Cheilinus oxycephalus Bleeker, 1853: Schultz, 1960.
Cheilinus trilobatus Lacepède, 1801: Schultz, 1960.
Cheilinus undulatus Rüppell, 1835: Randall, Head, and Sanders, 1978.
Cheilinus unifasciatus Streets, 1877.
Cheilinus rhodochrous Woods, 1960.
Cheilio inermis (Forsskål, 1775): Randall, 1986.
Cirrhilabrus exquisitus Smith, 1957: Randall, 1986.
Cirrhilabrus sp.
Cirrhilabrus temmincki Schultz, 1960. This is an undescribed species allied to *C. temminckii* Bleeker (Randall, MS).
Cirrhilabrus sp. A new species, found on dense beds of benthic algae in lagoons of Enewetak and Kwajalein in 18.5 to 27.5 m (Randall, MS).
Cirrhilabrus sp. A new species related to *C. cyanopleura* (Bleeker) (Randall, MS).
Cirrhilabrus sp. A new species found in outer reef areas in 30 m or more (Randall, MS).
Coris aygula Lacepède, 1801: Schultz, 1960.
Coris gaimard (Quoy and Gaimard, 1824): Schultz, 1960.
Coris variegata (Rüppell, 1835): Schultz, 1960.
Cymolutes praetextatus (Quoy and Gaimard, 1834): Schultz, 1960.
Cymolutes torquatus (Valenciennes, 1839): Randall, 1986.
Epibulus insidiator (Pallas, 1770): Schultz, 1960.
Gomphosus varius Lacepède, 1801: Schultz, 1960.
Gomphosus tricolor Schultz, 1960. Strasburg and Hiatt (1957) discovered that *G. tricolor* Quoy and Gaimard is the male of *G. varius*.
Halichoeres biocellatus Schultz, 1960.
Halichoeres chrysus Randall, 1980.
Halichoeres hortulanus (Lacepède, 1801): Schultz, 1960.

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TABLE 1 (cont'd)

Family LABRIDAE (cont'd)
Halichoeres margaritaceus (Valenciennes, 1839): Schultz, 1960.
Halichoeres marginatus Rüppell, 1835: Schultz, 1960.
Halichoeres melanurus (Bleeker, 1851).
Halichoeres hoeveni Schultz, 1960.
Halichoeres kallochroma Schultz, 1960. Randall (1980b) concluded that Schultz misidentified the female of *H. melanurus* as *H. hoevenii* Bleeker [actually *hoevenii* is the female of *H. vrolikii* (Bleeker)] and the male as *H. kallochroma* (Bleeker).
Halichoeres melasmapomus Randall, 1980.
Halichoeres richmondi Fowler and Bean, 1928: Randall, 1986.
Halichoeres trimaculatus (Quoy and Gaimard, 1834): Schultz, 1960.
Halichoeres sp. Probably undescribed; close to *H. hartzfeldii* (Bleeker).
Hemigymnus fasciatus (Bloch, 1792): Schultz, 1960.
Hemigymnus melapterus (Bloch, 1791): Schultz, 1960.
Hologymnosus annulatus (Lacepède, 1801): Randall, 1982.
Labrichthys unilineatus (Guichenot, 1847).
Labrichthys cyanotaenia Schultz, 1960. Randall and Springer (1973) showed that *L. unilineatus* has priority over *L. cyanotaenia* Bleeker.
Labroides bicolor Fowler and Bean, 1928: Schultz, 1960.
Labroides dimidiatus (Valenciennes, 1839): Schultz, 1960.
Labroides pectoralis Randall and Springer, 1975.
Labropsis alleni Randall, 1981.
Labropsis micronesica Randall, 1981.
Labropsis xanthonota Randall, 1981.
Macropharyngodon meleagris (Valenciennes, 1839): Schultz, 1960.
Macropharyngodon pardalis Schultz, 1960. Randall (1978b) determined that *M. pardalis* (Kner) is the female of *M. meleagris*.
Macropharyngodon negrosensis Herre, 1932: Randall, 1978b.
Novaculichthys taeniourus (Lacepède, 1801).
Xyrichthys taeniourus Schultz, 1960.
Paracheilinus sp. An undescribed species related to *P. filamentosus* Allen (Randall, MS).
Pseudocheilinus evanidus Jordan and Evermann, 1903: Randall, 1986 (after Strasburg).
Pseudocheilinus hexataenia (Bleeker, 1857): Schultz, 1960.
Pseudocheilinus octotaenia Jenkins, 1900: Schultz, 1960.
Pseudocheilinus tetrataenia Schultz, 1960.
Pseudocheilinus sp. A new species with a large ocellated black spot on side of caudal peduncle.
Pseudocoris yamashiroi (Schmidt, 1930): Smith-Vaniz and Randall (MS) discuss this species in their revision of the genus.
Pseudodax moluccanus (Valenciennes, 1839): Randall, 1986.
Pseudojuloides cerasinus (Snyder, 1904): Randall, 1986.
Pteragogus cryptus Randall, 1981.
Pteragogus guttatus Schultz, 1960. Randall (1981c) reidentified the specimen from Rongelap which Schultz called *P. guttatus* (Fowler and Bean).
Stethojulis bandanensis (Bleeker, 1851).
Stethojulis axillaris Schultz, 1960.
Stethojulis linearis Schultz, 1960. Randall and Kay (1974) showed that *S. axillaris* (Quoy and Gaimard) is the initial phase of the Hawaiian endemic species *S. balteata* (Quoy and Gaimard), and *S. linearis* Schultz is the terminal male of *S. bandanensis*.
Stethojulis strigiventer (Bennett, 1832): Schultz, 1960.
Thalassoma amblycephalum (Bleeker, 1856).
Thalassoma amblycephalus Schultz, 1960.
Thalassoma hardwicke (Bennett, 1830).
Thalassoma hardwickei Schultz, 1960.
Thalassoma lunare (Linnaeus, 1758): Schultz, 1960.
Thalassoma lutescens (Lay and Bennett 1839): Schultz, 1960.
Thalassoma purpureum (Forsskål, 1775): Schultz, 1960.
Thalassoma umbrostygma Schultz, 1960 (in part). Randall and Edwards (1984) have shown that *T. umbrostygma* (Rüppell) is a junior synonym of *T. purpureum* based on the initial phase (holotype of *umbrostygma* examined in Senckenberg Museum). The initial phase of *purpureum* is nearly identical in color to that of *T. trilobatum*.
Thalassoma quinquevittatum (Lay and Bennett, 1839).
Thalassoma quinquevittatus Schultz, 1960.

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TABLE 1 (cont'd)

Family LABRIDAE (cont'd)

Thalassoma trilobatum (Lacepède, 1801).

Thalassoma fuscum Schultz, 1960. *Thalassoma fuscum* (Lacepède), described in *Labrus*, is a junior homonym of *L. fuscus* Gmelin, as pointed out by Randall, 1955a.

Thalassoma umbrostygma Schultz, 1960 (in part).

Wetmorella albofasciata Schultz and Marshall, 1954: Randall, 1983.

Wetmorella nigropinnata (Seale, 1900).

Wetmorella ocellata Schultz and Marshall, 1954. Randall (1983) determined that *W. ocellata* is a junior synonym of *W. nigropinnata*.

Xyrichtys aneitensis (Günther, 1862).

Hemipteronotus aneitensis Schultz, 1960.

Xyrichtys celebicus (Bleeker, 1856).

Hemipteronotus celebicus Schultz, 1960.

Xyrichtys pavo Valenciennes, 1839: Randall, 1986.

Family SCARIDAE

Calotomus carolinus (Valenciennes, 1839).

Calotomus spinidens Schultz, 1958; Schultz, 1960. Bruce and Randall (1985) showed that Schultz and some other authors have misidentified *C. carolinus* as *C. spinidens* (Quoy and Gaimard).

Calotomus spinidens (Quoy and Gaimard, 1824): Randall, 1986.

Cetoscarus bicolor (Rüppell, 1829).

Chlorurus bicolor Schultz, 1958; Schultz, 1960.

Chlorurus pulchellus Schultz, 1958; Schultz, 1960. Randall (1963b) found that *Cetoscarus pulchellus* (Rüppell) is the terminal male of *C. bicolor*.

Hipposcarus longiceps (Valenciennes, 1839).

Scarus harid Schultz, 1958; Schultz, 1960. Randall and Bruce (1983) showed that *Hipposcarus harid* (Forsskål) is an Indian Ocean species distinct from the Pacific *H. longiceps*.

Scarus altipinnis (Steindachner, 1879).

Scarus brevifilis Schultz, 1958; Schultz, 1960.

Scarus chlorodon Schultz, 1958; Schultz, 1960. Randall and Choat (1980) pointed out that *S. chlorodon* Jenyns is the terminal male (and a junior synonym) of *S. prasiognathos* Valenciennes. *Scarus brevifilis* (Günther) is a junior synonym of *S. altipinnis* based on the initial phase.

Scarus atropectoralis Schultz, 1958; Randall, 1986.

Scarus bleekeri (de Beaufort, 1940): Randall and Choat, 1980.

Scarus dimidiatus Bleeker, 1859: Randall, 1986.

Scarus festivus Valenciennes, 1840.

Scarus lunula Schultz, 1958; Schultz 1960. Randall and Bruce (1983) determined that *S. festivus* is an older name for *S. lunula* (Snyder).

Scarus flavipectoralis Schultz, 1958: Randall and Choat, 1980.

Scarus forsteni (Bleeker, 1861): Randall, 1986. Schultz (1958; 1969) confused two scarids under the name *S. lepidus* (non-Jenys). Randall and Choat (1980) followed but used the name *S. tricolor* Bleeker. Randall (1986) has shown that the true *S. tricolor* apparently does not occur in the Marshall Islands, but the related *S. forsteni* does.

Scarus frenatus Lacepède, 1802: Randall, 1986.

Scarus frontalis Valenciennes, 1839.

Scarus jonesi Schultz, 1958; Schultz, 1960. Randall and Bruce (1983) mentioned that *S. frontalis* has priority over *S. jonesi* (Streets) in their account of the related *S. enneacanthus* Lacepède.

Scarus ghobban Forsskål, 1775: Randall, 1986.

Scarus gibbus Rüppell, 1828.

Scarus microrhinos Schultz, 1958; Schultz, 1960. Smith (1959) showed that Schultz (1958) was in error in applying the name *Chlorurus gibbus* (Rüppell) to the largest of the parrotfishes, *Bolbometopon muricatum* (Valenciennes). *Bolbometopon muricatum* is not known from the Marshall Islands, but it occurs in the Gilberts and the Line Islands so it might eventually be found in the southern Marshalls. *Scarus microrhinos* Bleeker is regarded as a junior synonym of *S. gibbus* by Randall and Bruce (1983), following Schultz (1969).

Scarus globiceps Valenciennes, 1840: Schultz, 1958; Schultz, 1960.

Scarus aeruginosus Schultz, 1958, 1960 (in part). Randall and Bruce (1983) documented this misidentification. The true *S. aeruginosus* Valenciennes is a junior synonym of the Red Sea endemic *S. ferrugineus* Forsskål (Randall and Ormond, 1978).

Scarus niger Forsskål, 1775: Randall, 1986.

Scarus oviceps Valenciennes, 1839: Randall, 1986.

Scarus psittacus Forsskål, 1775.

Scarus forsteri Schultz, 1958; Schultz, 1960. Randall and Ormond (1978) demonstrated that *S. psittacus* (the type species of *Scarus*) is a senior synonym of *S. forsteri* Valenciennes; they described a neotype of *S. psittacus*.

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TABLE 1 (cont'd)

Family SCARIDAE (cont'd)
Scarus taeniurus Schultz, 1958; Schultz, 1960. *Scarus taeniurus* Valenciennes is also a junior synonym of *S. psittacus* (Randall and Bruce, 1983).
Scarus rubroviolaceus Bleeker, 1849: Randall, 1980a.
Scarus schlegeli (Bleeker, 1861): Schultz, 1958; Schultz, 1960.
Scarus sordidus Forsskål, 1775: Schultz, 1958; Schultz, 1960.
Scarus spinus (Kner, 1868).
Scarus formosus Schultz, 1958; Schultz, 1960. Randall and Choat (1980) showed that the true *S. formosus* Valenciennes is a junior synonym of the Hawaiian endemic species *S. dubius* Bennett.
Family CREEDIIDAE
Chalixodytes tauensis Schultz, 1943: Schultz, 1960.
Limnichthys donaldsoni Schultz, 1960.
Family TRICHONOTIDAE
Trichonotus sp. Closely related to *T. elegans* Shimada and Yoshino, 1984.
Family MUGILOIDIDAE
Parapercis millipunctata (Günther, 1860).
Parapercis cephalopunctata Schultz, 1960. Randall (MS) has shown that *Percis cephalopunctatus* Seale is a junior synonym of *Parapercis millipunctata*.
Parapercis clathrata Ogilby, 1910: Schultz, 1960.
Parapercis cylindrica (Bloch, 1792): Schultz, 1960.
Family BLENNIIDAE
Aspidontus dussumieri (Valenciennes, 1836).
Petroscirtes quadrimaculatus Kendall and Goldsborough, 1911.
Petroscirtes fluctuans Schultz, 1960. Smith-Vaniz and Randall (1973) found that *Aspidontus dussumieri* is an older name for *P. fluctuans* Weber.
Aspidontus taeniatus Quoy and Gaimard, 1834: Schultz, 1960.
Astrosalarias fuscus holomelas (Günther, 1866): Springer and Smith-Vaniz (1968); Smith-Vaniz and Springer (1971).
Cirripectus fuscoguttatus Strasburg and Schultz, 1953: Schultz and Chapman, 1960.
Cirripectes polyzona (Bleeker, 1868).
Cirripectes sebae Schultz and Chapman, 1960. Jeffrey T. Williams (MS) has determined that *C. sebae* (Valenciennes) is a junior synonym of *C. castaneus* (Valenciennes); thus *C. polyzona* is the correct name for the Schultz and Chapman specimens.
Cirripectes quagga (Fowler and Ball, 1924): Schultz and Chapman, 1960.
Cirripectes stigmaticus Strasburg and Schultz, 1953: Schultz and Chapman, 1960.
Cirripectus variolosus (Valenciennes, 1836): Schultz and Chapman, 1960.
Ecsenius bicolor (Day, 1888): Strasburg, 1967.
Ecsenius opsifrontalis Chapman and Schultz, 1952; Schultz and Chapman, 1960.
Entomacrodus caudofasciatus (Regan, 1909): Springer, 1982; Randall, 1986.
Entomacrodus cymatobiotus Schultz and Chapman, 1960.
Entomacrodus sealei Bryan and Herre, 1903.
Entomacrodus incisolabilatus Schultz and Chapman, 1960. Springer (1967) referred this taxon to the synonymy of *E. sealei*.
Entomacrodus striatus (Valenciennes, 1836).
Salarias marmoratus Günther, 1877 (non-*Blennius marmoratus* Bennett).
Entomacrodus plurifilis marshallensis Schultz and Chapman, 1960. Springer (1967) placed this nominal subspecies in the synonymy of *E. striatus*.
Entomacrodus thalassinus thalassinus (Jordan and Seale, 1906): Springer, 1967.
Entomacrodus thalassinus Schultz and Chapman, 1960.
Exallias brevis (Kner, 1868): Schultz and Chapman, 1960.
Istiblennius coronatus (Günther, 1872): Schultz and Chapman, 1960. These authors stated that *I. nitidus* (Günther, 1877) (non-*nitidus* Günther, 1861) is the male form. Günther recorded it from Jaluit.
Istiblennius edentulus (Bloch and Schneider, 1801): Schultz and Chapman, 1960.
Istiblennius gibbifrons (Quoy and Gaimard, 1824).
Istiblennius rodenbaughi Schultz and Chapman, 1960. Doubtfully distinct at the species level from *gibbifrons*.
Istiblennius lineatus (Valenciennes, 1836): Schultz and Chapman, 1960.
Istiblennius paulus (Bryan and Herre, 1903): Schultz and Chapman, 1960.
Meiacanthus atrodorsalis atrodorsalis (Günther, 1877): Smith-Vaniz, 1976.
Meiacanthus atrodorsalis Schultz, 1960.
Parenchelyurus hepburni (Snyder, 1908): Springer, 1972.
Petroscirtes mitratus Rüppell, 1830: Schultz, 1960.
Petroscirtes xestus Jordan and Seale, 1906: Smith-Vaniz, 1976.

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TABLE 1 (cont'd)

Family BLENNIIDAE (cont'd)
Plagiotremus laudandus laudandus (Whitley, 1961): Smith-Vaniz, 1976.
Plagiotremus rhinorhynchos (Bleeker, 1852): Randall, 1986.
Plagiotremus tapeinosoma (Bleeker, 1857): Schultz, 1960.
Praealticus sp. An unidentified species from an underwater photograph taken in Kwajalein.
Rhabdoblennius rhabdotrachelus (Fowler and Ball, 1924): Schultz and Chapman, 1960.
Rhabdoblennius snowi (Fowler, 1928): Schultz and Chapman, 1960.
Salarias fasciatus (Bloch, 1786): Randall, 1986 (after Strasburg).
Stanulus seychellensis Smith, 1959.
Fallacirripectes minutus Schultz and Chapman, 1960 and *F. wellsi* Schultz and Chapman, 1960. Smith-Vaniz and Springer (1971) relegated *F. minutus* and *F. wellsi* to the synonymy of *Stanulus seychellensis*.
Family TRIPTERYGIIDAE
Enneapterygius capidata (Rosenblatt in Schultz, 1960).
Enneapterygius chica (Rosenblatt in Schultz, 1960).
Enneapterygius hemimelas (Kner and Steindachner, 1866): Schultz, 1960.
Enneapterygius minutus (Günther, 1877): Schultz, 1960.
Enneapterygius nanus Schultz, 1960.
Helcogramma hudsoni (Jordan and Seale, 1906): Hansen, 1982.
Norfolkia brachylepis (Schultz, 1960).
Tripterygion brachylepis Schultz, 1960.
Family SCHINDLERIIDAE
Schindleria praematurus (Schlindler, 1930): Schultz, 1960.
Family CALLIONYMIDAE
Callionymus simplicicornis Valenciennes, 1837: Fricke, 1982.
Diplogrammus goramensis (Bleeker, 1858): Schultz, 1960.
Synchiropus laddi Schultz, 1960.
Synchiropus morrisoni Schultz, 1960.
Synchiropus ocellatus (Pallas, 1770): Randall, 1986.
Family GOBIIDAE
Allomicrodesmus dorotheae Schultz, 1966. Dawson (1974) showed that this species is not a microdesmid; Victor G. Springer (personal communication) classifies it as a goby of the subfamily Xenisthminae.
Amblyeleotris fasciata (Herre, 1953).
Amblyeleotris guttata (Fowler, 1938).
Amblyeleotris steinitzi (Klausewitz, 1974).
Amblyeleotris wheeleri Polunin and Lubbock, 1977.
Amblygobius decussatus (Bleeker, 1855).
Amblygobius phalaena (Valenciennes, 1837).
Amblygobius rainfordi (Whitley, 1940).
Asterropteryx ensiferus (Bleeker, 1865).
Asterropteryx semipunctatus Rüppell, 1830.
Bathygobius cocosensis (Bleeker, 1854).
Bathygobius fuscus fuscus (Rüppell, 1830).
Cabillus tongarevae (Fowler, 1927).
Callogobius bauchotae Goren, 1979.
Callogobius centrolepis Weber, 1909.
Callogobius hasselti (Bleeker, 1851).
Callogobius maculipinnis (Fowler, 1918).
Callogobius okinawae (Snyder, 1980).
Callogobius sclateri (Steindachner, 1880).
Callogobius sp.
Cryptocentrus strigilliceps (Jordan and Seale, 1906).
Ctenogobiops aurocingulus (Herre, 1935).
Ctenogobiops sp.
Eviota afelei Jordan and Seale, 1906.
Eviota distigma Jordan and Seale, 1906.
Eviota fasciola Karnella and Lachner, 1981.
Eviota infulata (Smith, 1956).
Eviota melasma Lachner and Karnella, 1980.
Eviota nebulosa Smith, 1958.
Eviota sebreei Jordan and Seale, 1906.
Eviota smaragdus Jordan and Seale, 1906.

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TABLE 1 (cont'd)

Family GOBIIDAE (cont'd)
Eviota zonura Jordan and Seale, 1906.
Eviota spp. (2 species).
Fusigobius neophytus (Günther, 1877).
Fusigobius spp. (2 species).
Gnatholepis anjerensis (Bleeker, 1850).
Gnatholepis scapulostigma Herre, 1953.
Gobiodon citrinus (Rüppell, 1838).
Gobiodon erythrospilus Bleeker, 1875.
Gobiodon okinawae Sawada, Arai, and Abe, 1972.
Gobiodon rivulatus (Rüppell, 1830): Günther, 1877.
Heterelectris sp.
Istigobius decoratus (Herre, 1927).
Istigobius ornatus (Rüppell, 1930).
Istigobius rigilius (Herre, 1953).
Kelloggella centralis Hoese, 1975.
Lotilia graciliosa Klausewitz, 1960.
Macrodontogobius wilburi Herre, 1936.
Oplopomops diacanthus (Schultz, 1943).
Oplopomus oplopomus (Valenciennes, 1837).
Opua nephodes E. K. Jordan, 1925.
Pandaka pruinosa (Jordan and Seale, 1906).
Paragobiodon echinocephalus (Rüppell, 1830): Günther, 1877.
Paragobiodon lacunicolus Kendall and Goldsborough, 1911.
Paragobiodon melanosomus (Bleeker, 1852).
Paragobiodon modestus (Regan, 1908).
Paragobiodon xanthosomus (Bleeker, 1852).
Pleurosicya bilobatus (Koumans, 1941).
Pleurosicya muscarum (Jordan and Seale, 1906).
Priolepis farcimen (Jordan and Evermann, 1903).
Silhouettea sp.
Stiphodon elegans (Steindachner, 1879).
Trimma caesiura Jordan and Seale, 1906.
Trimma eviotops Schultz, 1943.
Trimma naudei Smith, 1956.
Trimma okinawae (Aoyagi, 1949).
Trimma spp. (6 species).
Valenciennea puellaris Tomiyama, 1956.
Valenciennea sexguttatus (Valenciennes, 1837).
Valenciennea strigatus (Broussonet, 1782).
Valenciennea sp.
Vanderhorstia ambanoro (Fourmanoir, 1957).
Vanderhorstia spp. (2 species).
Xenisthmus chapmani (Schultz, 1966).
Kraemericus chapmani Schultz, 1966. Victor G. Springer (personal communication) advised us that *K. chapmani* is not a kraemeriid but a goby of the genus *Xenisthmus*.
Xenisthmus sp.
Family ELEOTRIDIDAE
Ophieleotris aporos (Bleeker, 1854).
Family KRAEMERIIDAE
Kraemeria bryani Schultz, 1941: Schultz, 1966.
Kraemeria samoensis Steindachner, 1906: Schultz, 1966.
Family MICRODESMIDAE
Gunnellichthys monostigma Smith, 1958: Strasburg, 1967.
Gunnellichthys pleurotaenia Bleeker, 1858: Schultz, 1966.
Paragobioides grandoculis Kendall and Goldsborough, 1911.
Nemateleotris helfrichi Randall and Allen, 1973.
Nemateleotris magnifica Fowler, 1938: Randall and Allen, 1973.
Ptereleotris evides (Jordan and Hubbs, 1925): Randall and Hoese, 1985.
Ptereleotris hanae (Jordan and Snyder, 1901): Randall and Hoese, 1985.
Ptereleotris heteroptera (Bleeker, 1855): Randall and Hoese, 1985.

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TABLE 1 (cont'd)

Family MICRODESMIDAE (cont'd)
- *Ptereleotris microlepis* (Bleeker, 1856): Randall and Hoese, 1985.
- *Ptereleotris zebra* (Fowler, 1938): Randall and Hoese, 1985.

Family ACANTHURIDAE
- *Acanthurus achilles* Shaw, 1803: Schultz and Woods, 1953.
- *Acanthurus blochii* Valenciennes, 1835.
  - *Acanthurus mata* Schultz and Woods, 1953. Randall (MS) has shown that many authors have been mistaken in applying the name *A. mata* to this fish. It is the earliest name for the species that most authors have identified as *A. bleekeri* Günther, 1861.
- *Acanthurus guttatus* Bloch and Schneider, 1801: Schultz and Woods, 1953.
- *Acanthurus lineatus* (Linnaeus, 1758): Schultz and Woods, 1953.
- *Acanthurus maculiceps* (Ahl, 1923): Randall, 1986.
- *Acanthurus mata* (Cuvier, 1829).
  - *Acanthurus bleekeri* Schultz and Woods, 1953. See discussion under *A. blochii*.
- *Acanthurus nigricans* (Linnaeus, 1758).
  - *Acanthurus aliala* Woods and Schultz, 1953. Randall (1956) placed *A. aliala* Lesson in the synonymy of *A. glaucopareius* Cuvier; both, however, are synonyms of *A. nigricans* (Linnaeus) (Randall, MS).
- *Acanthurus nigricauda* Duncker and Mohr, 1929.
  - *Acanthurus nigricans* Schultz and Woods, 1953. *Acanthurus nigricans* (Linnaeus) is the species most authors have identified as *A. glaucopareius*.
  - *Acanthurus gahhm* Randall, 1956. *Acanthurus gahhm* (Forsskål) is an endemic Red Sea species.
- *Acanthurus nigrofuscus* (Forsskål, 1775).
  - *Acanthurus elongatus* Schultz and Woods, 1953 (in part). Randall (1956) indicated that *nigrofuscus* is the oldest name for this species; *A. elongatus* (Lacepède) is not the same fish.
- *Acanthurus nigroris* Valenciennes, 1835.
  - *Acanthurus elongatus* Schultz and Woods, 1953 (in part).
- *Acanthurus olivaceus* Bloch and Schneider, 1801: Schultz and Woods, 1953.
- *Acanthurus pyroferus* Kittlitz, 1834.
  - *Acanthurus leucosternon* Schultz and Woods, 1953. Randall (1956) showed that this is a misidentification; *A. leucosternon* Bennett is an Indian Ocean species.
- *Acanthurus thompsoni* (Fowler, 1923).
  - *Acanthurus philippinus* Schultz and Woods, 1953. Randall (1956) referred *A. philippinus* Herre to the synonymy of *A. thompsoni*.
- *Acanthurus triostegus triostegus* (Linnaeus, 1758): Woods and Schultz, 1953.
- *Acanthurus xanthopterus* Valenciennes, 1835: Randall, 1980a.
- *Ctenochaetus binotatus* Randall, 1955b: Randall, 1986.
- *Ctenochaetus hawaiiensis* Randall, 1955b: Randall, 1986.
- *Ctenochaetus marginatus* (Valenciennes, 1835).
  - *Ctenochaetus* sp. Hiyama, 1943.
  - *Ctenochaetus cyanoguttatus* Randall, 1955b.
- *Ctenochaetus striatus* (Quoy and Gaimard, 1825): Schultz and Woods, 1953.
- *Ctenochaetus strigosus* (Bennett, 1828): Randall, 1986.
- *Naso annulatus* (Quoy and Gaimard, 1825): Schultz and Woods, 1953.
- *Naso brevirostris* (Valenciennes, 1835): Schultz and Woods, 1953.
- *Naso hexacanthus* (Bleeker, 1855): Schultz and Woods, 1953.
- *Naso lituratus* (Bloch and Schneider, 1801): Schultz and Woods, 1953.
- *Naso tuberosus* Lacepède, 1801: Randall, 1986.
- *Naso unicornis* (Forsskål, 1775): Schultz and Woods, 1953.
- *Naso vlamingii* (Valenciennes, 1835): Schultz and Woods, 1953.
- *Paracanthurus hepatus* (Linnaeus, 1766): Randall, 1981d.
- *Zebrasoma flavescens* (Bennett, 1828): Schultz and Woods, 1953 (in part).
- *Zebrasoma scopas* (Cuvier, 1829).
  - *Zebrasoma flavescens* Schultz and Woods, 1953 (in part). Randall (1955c) showed that *Z flavescens* and *Z. scopas* are distinct species.
- *Zebrasoma veliferum* (Bloch, 1795): Schultz and Woods, 1953.

Family ZANCLIDAE
- *Zanclus cornutus* (Linnaeus, 1758): Woods, 1953.
  - *Zanclus canescens* Woods, 1953. Randall (1955a) demonstrated that *Z. canescens* (Linnaeus) is the late postlarval stage of *Z. cornutus*. The latter has priority due to decision of the first revisor, Cuvier, 1831.

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TABLE 1 (cont'd)

Family SIGANIDAE
Siganus argenteus (Quoy and Gaimard, 1825): Woods, 1953.
Siganus rostratus Woods, 1953. Woodland (in press) has shown that *argenteus*, named for the late postlarval stage of this species, has priority over *S. rostratus* (Valenciennes).
Siganus puellus (Schlegel, 1852): Randall, 1986.
Siganus punctatus (Bloch and Schneider, 1801): Woods, 1953.
Siganus vulpinus (Schlegel and Müller, 1844): Woods, 1953.
Family SCOMBRIDAE
Acanthocybium solandri (Cuvier, 1831): Schultz, 1960.
Euthynnus affinis (Cantor, 1849).
Euthynnus affinis yaito Schultz, 1960.
Grammatorcynus bilineatus (Rüppell, 1836): Schultz, 1960.
Gymnosarda unicolor (Rüppell, 1836).
Gymnosarda nuda Schultz, 1960. Collette and Gibbs (1963) and Collette and Chao (1975) are followed in using the name *G. unicolor* for the Dogtooth Tuna. Lewis (1968) identified parasitic copepods from a scombrid at Enewetak he identified as *Sarda orientalis*. This species is not known from the Marshall Islands. From the parasites found he probably had *Gymnosarda unicolor* (Bruce B. Collette and Roger F. Cressey, personal commmunication).
Katsuwonus pelamis (Linnaeus, 1758): Schultz, 1960.
Thunnus albacares (Bonnaterre, 1788).
Neothunnus albacora macropterus Schultz, 1960. Collette and Gibbs (1963) and Gibbs and Collette (1967) stated that *Neothunnus macropterus* (Temminck and Schlegel) is a synonym of *T. albacares*.
Family NOMEIDAE
Psenes sp. Schultz, 1960.
Family BOTHIDAE
Arnoglossus intermedius (Bleeker, 1866): Woods, 1966.
Bothus mancus (Broussonet, 1782): Woods, 1966.
Bothus pantherinus (Rüppell, 1830): Woods, 1966.
Order PLEURONECTIFORMES
Family PLEURONECTIDAE
Samariscus triocellatus Woods, 1966.
Family SOLEIDAE
Aesopia heterorhinos (Bleeker, 1856): Woods, 1966.
Aseraggodes melanostictus (Peters, 1876): Woods, 1966.
Aseraggodes smithi Woods, 1966.
Aseraggodes whitakeri Woods, 1966.
Order TETRAODONTIFORMES
Family BALISTIDAE
Balistapus undulatus (Mungo Park, 1797): Woods, 1966.
Balistoides conspicillum (Bloch and Schneider, 1801).
Balistes niger Kendall and Goldsborough, 1911.
Balistoides niger Woods, 1966. Randall and Klausewitz (1973) showed that *Balistes niger* Bonnaterre is a homonym; therefore, *B. conspicillum* becomes the valid name.
Balistoides viridescens (Bloch and Schneider, 1801): Woods, 1966.
Canthidermis senticosus (Richardson, 1848): Woods, 1966.
Melichthys niger (Bloch, 1786): Randall and Klausewitz, 1973.
Melichthys vidua (Solander, 1844): Woods, 1966.
Odonus niger (Rüppell, 1837): Hiyama, 1943; Randall, 1986 (after Strasburg).
Pseudobalistes flavimarginatus (Rüppell, 1829): Randall, 1986 (after Strasburg).
Balistes flavimarginatus Hiyama, 1943.
Pseudobalistes fuscus (Bloch and Schneider, 1801): Woods, 1966.
Rhinecanthus aculeatus (Linnaeus, 1758): Woods, 1966.
Rhinecanthus rectangulus (Bloch and Schneider, 1801): Woods, 1966.
Sufflamen bursa (Bloch and Schneider, 1801): Woods, 1966.
Sufflamen chrysoptera (Bloch and Schneider, 1801): Woods, 1966.
Sufflamen fraenatus (Latreille, 1804).
Sufflamen capistratus Woods, 1966. *Sufflamen fraenatus* is the oldest name for this species (Frederick H. Berry, personal communication).
Xanthichthys auromarginatus (Bennett, 1831): Randall, Matsuura, and Zama, 1978.
Xanthichthys caeruleolineatus Randall, Matsuura, and Zama, 1978: Randall, 1986.

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TABLE 1 (cont'd)

Family MONACANTHIDAE
Aluterus scriptus (Osbeck, 1765).
Alutera scripta Woods, 1966.
Amanses scopas (Cuvier, 1829): Woods, 1966.
Brachaluteres taylori Woods, 1966.
Cantherhines dumerilii (Hollard, 1854).
Amanses carolae Woods, 1966. Randall (1964b) determined that *Cantherhines carolae* (Jordan and McGregor) is a junior synonym of *C. dumerilii*.
Cantherhines fronticinctus (Playfair and Günther, 1867): Randall, 1986.
Cantherhines pardalis (Rüppell, 1837).
Amanses sandwichiensis Woods, 1966. Randall (1964b) showed that *C. sandwichiensis* (Quoy and Gaimard) is endemic to the Hawaiian Islands. The correct name for the wide-ranging species from elsewhere in the Indo-Pacific is *C. pardalis*.
Oxymonacanthus longirostris (Bloch and Schneider, 1801): Woods, 1966.
Paraluteres prionurus (Bleeker, 1851): Woods, 1966.
Paramonacanthus cryptodon (Bleeker, 1855): Woods, 1966.
Paramonacanthus oblongus (Temminck and Schlegel, 1846): Woods, 1966.
Pervagor alternans (Ogilby, 1899).
Pervagor melanocephalus marshallensis Woods, 1966. Synonymy from Hutchins, 1986.
Pervagor aspricaudatus Hollard, 1854.
Pervagor melanocephalus johnstonensis Woods, 1966.
Pervagor melanocephalus (Bleeker, 1853). This record based on one specimen reported by Hutchins, 1986.
Family OSTRACIIDAE
Lactoria fornasini (Bianconi, 1846): Woods, 1966.
Ostracion cubicus Linnaeus, 1758: Woods, 1966.
Ostracion meleagris Shaw, 1796: Woods, 1966.
Family TETRAODONTIDAE
Amblyrhynchotes honckenii (Bloch, 1785): Randall, 1986 (after Strasburg).
Arothron hispidus (Linnaeus, 1758): Woods and Schultz, 1966.
Arothron manilensis (Procé, 1822): Randall (1985) has shown that the strongly striped *A. manilensis* is a distinct species from the related unmarked *A. immaculatus* (Bloch and Schneider).
Arothron mappa (Lesson, 1826): Randall, 1986 (after Strasburg).
Arothron meleagris (Lacepède, 1798): Woods and Schultz, 1966.
Arothron nigropunctatus (Bloch and Schneider, 1801): Woods and Schultz, 1966.
Arothron stellatus (Bloch and Schneider, 1801).
Arothron alboreticulatus Woods and Schultz, 1966.
Canthigaster amboinensis (Bleeker, 1865): Woods, 1966.
Canthigaster bennetti (Bleeker, 1854): Randall, 1986.
Canthigaster coronata (Vaillant and Sauvage, 1875): Randall, 1986.
Canthigaster epilampra (Jenkins, 1903): Randall, 1986.
Canthigaster janthinoptera (Bleeker, 1855).
Canthigaster jactator Woods. Allen and Randall (1977) regarded *C. jactator* (Jenkins) as a Hawaiian endemic. The related widespread species from elsewhere in the Indo-Pacific region is *C. janthinoptera*.
Canthigaster solandri (Richardson, 1844): Woods, 1966.
Canthigaster valentini (Bleeker, 1953): Randall, 1986.
Family DIODONTIDAE
Diodon hystrix Linnaeus, 1758: Woods, 1966.
Diodon liturosus Shaw, 1804: Randall, 1986.

this list. Only a few such fishes have been reported from the area. Schultz in Schultz et al. (1953), for example, listed only two myctophids, *Myctophum brachygnathos* (Bleeker) and *Diaphus schmidti* Tåning, both by name only. Of the Gonostomatidae, Grey (1960) recorded only *Diplophos* sp. (*taenia* complex), *Gonostoma atlanticum* Norman, and *G. ebelingi* Grey from the Marshalls region. R. K. Johnson recently identified a giganturid (BPBM 26320, 62.3 mm SL) taken with a midwater trawl at 11°20′N, 162°07′E at a depth of 0 to 200 m as *Rosaura indica* (Brauer).

There has not been adequate sampling of deep-water fishes from the Marshall Islands or, for that matter, from the islands of Oceania in general (except the Hawaiian Islands). Even species of moderate depths (100 to 300 m), such as snappers of the genera *Etelis* and *Pristipomoides* have not been reported from the Marshalls, though some surely occur there. If complete collections were made of mesopelagic, bathypelagic, and deep benthic fishes, these would have to be treated differently from a zoogeographic standpoint than shore fishes. In his excellent review of the biogeography of the Pacific Plate with emphasis on fishes, Springer (1982) discussed shore fishes (those from depths less than 100 m), not deeper water species (except some from the Hawaiian Islands).

We solicited from Ernest A. Lachner and Christine Baer a preliminary list of the Gobiidae from the Marshall Islands to include with the present checklist. We have added a few species to their list from Bishop Museum specimens, and Douglass F. Hoese has added some from a collection of about 150 lots of gobies sent him by Ronald S. Nolan, who conducted his doctoral thesis research on reef fishes at Enewetak. Hoese and E. O. Murdy also advised on some gobiid name changes. Randall and Hoese (1985) have removed the gobioid genera *Nemateleotris* and *Ptereleotris* from the family Gobiidae and provisionally placed them in the subfamily Ptereleotrinae of the family Microdesmidae.

Although we have endeavored to make the present checklist as current as possible, we wish to emphasize that it is far from definitive. Species of shore fishes surely remain to be collected from the Marshall Islands (though we believe we have more than the 95% level in this respect). The estimated 45 new species which have been collected need to be described. Most important, many of the taxonomic groups of Indo-Pacific fishes need to be revised. Inevitably, such studies will result in changes in scientific names now in widespread use. Among those groups most in need of revision are the Mobulidae; Dasyatididae; all of the eel families; the Bythitidae; the scorpaenid genera *Scorpaena (sensu lato)*, *Scorpaenodes*, and *Scorpaenopsis*; the serranid genera *Anthias*, *Cephalopholis*, *Epinephelus*, *Plectropomus*, and *Pseudogramma*; Pseudochromidae; Kuhliidae; Priacanthidae; Apogonidae; the carangid genera *Carangoides*, *Decapterus*, and *Trachinotus*; the Caesionidae; the haemulid genus *Plectorhinchus*; the lethrinid genera *Gymnocranius* and *Lethrinus*; the Nemipteridae; Gerreidae; Mullidae; Pempherididae; Kyphosidae; the pomacentrid genera *Chromis*, *Chrysiptera*, and *Pomacentrus*; the Mugilidae; Sphyraenidae; Polynemidae; the labrid genera *Cheilinus*, *Cirrhilabrus*, *Coris*; *Halichoeres*, *Pseudocheilinus*, *Pteragogus*, and *Xyrichtys*; the scarid genus *Scarus*; the blenniid genera *Cirripectes*, *Istiblennius*, *Praealticus*, *Rhabdoblennius*, and *Salarias*; the Tripterygiidae; the callionymid genera *Callionymus* and *Diplogrammus*; the Gobiidae; the acanthurid genus *Naso*; the soleid genus *Aseraggodes*; and the tetraodontid genus *Arothron*. Fortunately, many of these groups are under study, and clarification of their taxonomy can be expected reasonably soon.

The present checklist is tied closely to the work of Schultz et al. Anyone working on Marshall Islands fishes will surely begin with these three volumes. This list will, therefore, serve as a supplement to provide additions and name changes. We have cited all the fish names of Schultz et al. When these names have been changed, they are listed as synonyms below the correct name and are indented three spaces. When needed, an annotation is provided to explain the name change and give the authority.

Only those synonyms are listed that were used as valid names in Schultz et al. The author given for each of these synonyms is the one responsible for the Marshall Islands record, not the author of the species (unless named as new in Schultz et al. or in other papers on the Marshall Islands fish fauna).

We have eliminated the listing of Schultz et al. each time Schultz or one of his collaborators is cited in the checklist. Thus Schultz, 1953, implies Schultz in Schultz et al., 1953. Similarly, we have shortened Cuvier (or Valenciennes) in Cuvier and Valenciennes to just Cuvier (or Valenciennes).

Subgeneric categories have not been included in the checklist.

The order of presentation is phylogenetic, approximating that of Greenwood et al. (1966).

We have not made a documentation of the different atolls at which the various species of fishes have been collected. Such listing is provided by Schultz et al. and by Randall (1986). Little difference in the fish fauna can be expected from one atoll to the next within the Marshall Islands, particularly those of about the same latitude. There are differences, however, from the northern to the southern Marshalls. More species of fishes are presently known from the northern atolls because these have been more heavily collected. This is especially true of Bikini and Enewetak. Bikini is the atoll best represented in the material at the National Museum of Natural History, but the extensive Bishop Museum collections made by the senior author and associates over the last 16 years at Enewetak have made it the locality with the most species. We believe, however, that the southern atolls would have a slightly richer fish fauna if the collecting effort were equal. A number of conspicuous species that have been found at Kwajalein or other southern atolls in the Marshalls have not been observed at Enewetak. Examples are *Myripristis adustus*, *Sargocentron rubrum*, *Anthias bartlettorum*, *Epinephelus caeruleopunctatus*, *Plectropomus oligacanthus*, *Carangoides plagiotaenia*, *Pterocaesio* sp., *Scolopsis lineatus*, *Heniochus varius*, *Halichoeres richmondi*, *Scarus bleekeri*, *Amblygobius decussatus*, *Acanthurus maculiceps*, *Siganus vulpinus*, and *Balistoides conspicillum*. This, of course, is not to say that they are truly absent from Enewetak.

How does the fish fauna of the Marshall Islands compare with the rest of the Indo-West-Pacific region? Of the estimated total of 20,000 species of fishes in the world, about 8000 are shallow, warm-water marine species (Cohen, 1970). The majority of these warm-water fishes occurs in the vast Indo-West-Pacific region. Using two different methods to arrive at an estimate, Springer (1982) concluded that there are about 4000 species of fishes in the tropical Indo-West-Pacific region. Cohen (1973), however, estimated 3000 to 4000 for the Indian Ocean alone. If Cohen is correct, Springer admitted his estimate for the

Indo-West-Pacific as a whole is much too low. By analyzing the 111 shorefish families which occur nonmarginally on the Pacific Plate, Springer estimated that there are 461 genera and an estimated 1312 species. Thus the Marshall Islands, with 817 species, have 62% of the total Pacific Plate fish fauna.

Proper comparisons between island groups of the Pacific are possible only when there has been a comparable collecting effort as well as an accurate compilation of species. This would seem to be the case only for the Hawaiian Islands, Society Islands, Samoa Islands, southern Mariana Islands, and Easter Island.

Randall (1981a) stated that approximately 610 species of fishes occur in the Hawaiian Archipelago. By excluding those which are pelagic, deep sea, or freshwater species, he arrived at 420 which could be regarded as reef and shore fishes. This figure should be modified to 460 to include epipelagic species, recent new records, and new species (to make it equivalent to estimates herein from other island groups). The extreme isolation of the Hawaiian Islands, both geographically and hydrographically, accounts for its somewhat impoverished fish fauna.

Randall (1973) provided a preliminary checklist of 616 fishes from the Society Islands. By eliminating those which occur in deep water or fresh water but adding new records, the list is revised to 620.

Wass (1984) has prepared a checklist of fishes of the Samoa Islands. His total for the list is 958, which includes 84 identified only to genus. If those which occur in deep water and in fresh water are eliminated, along with dubious literature records, the total is lowered to 915. The Samoa Islands lie marginally on the Pacific Plate. There is a continental component to the fish fauna of Samoa due to its proximity to the continental plate. These islands are mostly high islands with a greater variety of habitats than one finds on atolls. Furthermore, they are less isolated from other island groups than are the Marshalls. Therefore, a greater number of species of fishes should be expected from Samoa.

Shepard and Myers (1981) published a preliminary checklist of the fishes of Guam and other southern Mariana Islands. Their total is 801, from which 12 should be subtracted due to occurrence in deep water or fresh water. Myers (MS submitted to *Micronesica*) has raised the number of fishes for the Marianas to 854 (not including freshwater and deep-sea species). The Marianas are also high islands which lie on the margin of the Pacific Plate.

Randall and Cea Egaña (1984) made a checklist of the fishes of Easter Island. Only 130 shore and epipelagic species have been found at this small, remote South Pacific island. Recent collecting by Randall and colleagues has raised the total to 155 species.

Springer (1982) has provided an analysis of endemic fishes of the Pacific Plate. He placed them in three categories. Type 1 endemics are those that are widely distributed on the Plate, Type 2 are those that are limited to a few islands or island groups, and Type 3 are those that are found only at a single island or island group. The Marshall Islands have 28 of the 48 Type 1 Plate endemics tabulated by Springer. Of the Type 2 endemics, Springer listed only *Pomachromis exilis* and *Labropsis micronesica* from the Marshalls. Type 3 endemics (the most common type) are found mainly at high islands. Springer mentioned only three from the Marshalls, *Acanthoplesiops hiatti*, *Amphiprion tricinctus*, and *Cirricaecula johnsoni*. To these one might add *Hypoatherina barnesi*, *Pseudochromis aurea marshallensis*, and *Aseraggodes smithi*.

In the Pacific, the Hawaiian Archipelago has the highest percentage of endemism among its shore fishes, with 30%; Easter Island is next with 27.3%; Lord Howe

TABLE 2

Summary of Nonsystematic Fish Research at Enewetak

Type of study	Fish taxa*	Reference
	Ecology and Behavior	
Acoustics and environment	*Holocentrus* spp., *Myripristis* spp.	Horch and Salmon, 1973
	Carcharhinidae	Nelson and Johnson, 1972
Artificial reefs	Reef fishes	Nolan, 1974
Coral reef community	Reef fishes	Hiatt and Strasburg, 1960
	Reef fishes	Odum and Odum, 1955
	Chaetodontidae, Pomacentridae	Reese, 1973
	Acanthurus guttatus, *A. triostegus*, *Scarus jonesi*	Webb and Wiebe, 1975
	Acanthuridae and Scaridae	Weibe et al., 1975
Fauna of nuclear test crater	Reef fishes	Nolan et al., 1955

*The scientific names given in the table are those that appeared in the publication cited. Some of these names have been changed (see checklist herein).

(This table continued on next page.)

TABLE 2 (cont'd)

Type of study	Fish taxa*	Reference
	Ecology and Behavior	
Feeding and food habits	Reef fishes	Bakus, 1967
	Chromis caeruleus; plankton-feeding fishes	Gerber and Marshall, 1974a; 1974b
	Reef fishes	Hiatt and Strasburg, 1960
	Carcharhinus melanopterus, C. menisorrah, Triaenodon obesus	Hobson, 1963
	Reef fishes	Hobson and Chess, 1978
	Chaetodontidae	Reese, 1977
	Acanthurus triostegus, Holocentrus spinifer, Scarus gibbus, S. jonesi	Smith and Paulson, 1974
	Chromis spp.	Swerdloff, 1970
Reproduction	*Crenimugil crenilabis*	Helfrich and Allen, 1975
	Chromis caeruleus	Swerdloff, 1970
Shark behavior and biology	*Carcharhinus melanopterus, C. menisorrah, Triaenodon obesus*	Hobson et al., 1961
	Carcharhinus menisorrah	Johnson and Nelson, 1973
	Carcharhinus amblyrhynchos	Nelson, 1982
	Triaenodon obesus	Randall, 1977
	Carcharhinus melanopterus	Randall and Helfman, 1973
Social behavior	Acanthuridae Pomacentrus jenkensi	Barlow, 1974a; 1974b
Symbiosis	*Siphamia fuscolineata*	Allen, 1972b
	Reef and pelagic fishes parasitized by copepods (for listing see Devaney, Chapter 19, this volume)	Lewis, 1968
	Abudefduf abdominalis, Aspidontus filamentosus, A. taeniatus, Ecsenius bicolor, Labroides spp. and host fishes, *Meiacanthus atrodorsalis, Runula laudandus*	Losey, 1971; 1972; 1974; 1975
	Acanthurus spp., *Amblygobius phalaena, Cryptocentroides maculosus, Ptereleotris microlepis, Valenciennea puellaris, V. sexguttatus, V. strigatus, Zebrasoma* spp.	Paulson, 1978
	Chromis spp.	Swerdloff, 1970
Territoriality and home range	Chaetodontidae	Reese, 1973; 1978
	Chromis spp.	Swerdloff, 1970
Zooplankton composition	Fish eggs, *Monocanthus* and other fish larvae	Gilmartin, 1958
	Fish eggs	Johannes and Gerber, 1974
	Physiology and Histology	
Cell structure	*Carcharhinus melanopterus, Negaprion acutidens*	Bullock and Corwin, 1979
	Carcharhinus spp., rays	Corwin, 1977a; 1974b; 1978
	Carcharhinus melanopterus	Saland et al., 1974
Phosphorus exchange	Reef fishes	Pomeroy and Kuenzler, 1967
Senses	*Carcharhinus melanopterus*	Fay et al., 1974
	Reef fishes	Munz and McFarland, 1973
	Carcharhinus melanopterus, C. menisorrah	Tester, 1963
Tooth development	*Carcharhinus menisorrah, Triaenodon obesus*	Kemp, 1974a, 1974b
	Carcharhinus menisorrah	Kemp and Park, 1974
Venom	*Synanceja verrucosa*	Saunders, 1959
	Pterois volitans, Synanceja horrida, S. verrucosa	Saunders and Taylor, 1959

Island, Middleton and Elizabeth Reefs, and Norfolk Island combined have about 12% endemism (Randall, 1976). Randall (1978a) made an approximation of 10% endemism for the fishes of the Marquesas. For the Marshall Islands the Type 3 endemism, based on species which have been named, is less than 1%. This figure will rise slightly when some new species currently known only from the Marshalls are described. However, when there has been a comparable collecting effort in the Central Pacific, and in particular the Gilbert Islands and eastern Caroline Islands (which lie near the Marshalls and include atolls), it is expected that most of the species now regarded as endemic to the Marshall Islands will be found elsewhere.

In addition to publications on the classification of fishes from the atoll, there has been a variety of nonsystematic studies dealing with the Enewetak ichthyofauna. Table 2 summarizes these and gives the references and taxa involved.

The three plates (Figs. 1, 2, and 3) of underwater photographs of fishes herein were taken by the senior author in the Marshall Islands.

Plates 1-3

Fig. 1 a, The gray reef shark, *Carcharhinus amblyrhynchos* (Bleeker), one of the three most abundant sharks at Enewetak; responsible for four attacks on man at the atoll; b, *Gymnothorax javanicus* (Bleeker), the largest moray of the Indo-Pacific region; attains a length of at least 2 m; c, *Poeciloconger fasciatus* Günther; known from only five specimens. This one emerged from the sand from the effect of ichthyocide at Enewetak; d, The squirrelfish *Sargocentron microstoma* (Günther). Photograph taken at night; e, The soldierfish *Myripristis berndti* Jordan and Evermann being "cleaned" by the wrasse *Labroides pectoralis* Randall and Springer; f, The grouper *Epinephelus microdon* (Bleeker) being cleaned by the wrasse *Labroides dimidiatus* (Valenciennes); g, The bright violet and yellow *Anthias bartlettorum* Randall and Lubbock, named in honor of Nathan and Patricia Bartlett who discovered it at Kwajalein; h, The red snapper *Lutjanus gibbus* (Forsskål). Photograph taken at night. ⟶

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Fig. 2 a, A school of the fusilier *Casio caerulaureus* Lacepède from the Kwajalein lagoon. This photo was the basis for the first Marshall Islands record; b, The nocturnal lethrinid fish *Monotaxis grandoculis* (Forsskål); has well-developed molariform for crushing mollusks, echinoids, etc; c, The black jack, *Caranx lugubris* Poey. Circumtropical in distribution; d, The goatfish *Parupeneus barberinoides* (Bleeker). Recent collections provided the first record for the Marshall Islands; e, The colorful damselfish *Pomacentrus pavo* (Bloch). Blue in life with yellow on the caudal fin; f, The anemonefish *Amphiprion chrysopterus* Cuvier. Like others of the genus, it lives symbiotically with sea anemones; g, The wrasse *Labropsis micronesica* Randall. Enewetak is the type-locality. Adults feed on coral polyps; h, The terminal male of wrasse *Halichoeres trimaculatus* (Quoy and Gaimard). A common lagoon species in sand and rubble areas around coral heads. ⟶

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Fig. 3 a, A group of the butterflyfish *Heniochus chrysostomus* Cuvier. Usually seen in pairs or small aggregations; b, The yellow angelfish *Centropyge heraldi* Woods and Schultz; named for the late Earl S. Herald, who collected most of the type specimens in the Marshall Islands in 1946; c, The goby *Amblyeleotris guttata* (Fowler) and its symbiotic partner *Alpheus ochrostiatus* Miya. The shrimp is just removing a load of sand and gravel from the burrow; d, The colorful goby *Nemateleotris helfrichi* Randall and Allen, named for Philip Helfrich, the last director of the Mid-Pacific Research Laboratory at Enewetak; e, The surgeonfish *Acanthurus nigricans* Linnaeus, distinctive in the white spot under the eye and yellow band at the base of the dorsal and anal fins; f, The filefish *Oxymonacanthus longirostris* (Bloch and Schneider); blue-green with orange spots. Feeds on coral polyps; g, The female of the triggerfish *Xanthichthys auromarginatus* (Bennett); generally found at depths greater than 30 m; h, The clown triggerfish *Balistoides conspicillum* (Bloch and Schneider). Often identified as *B. niger* (Bonnaterre), but this name is a homonym, hence invalid. ⟶

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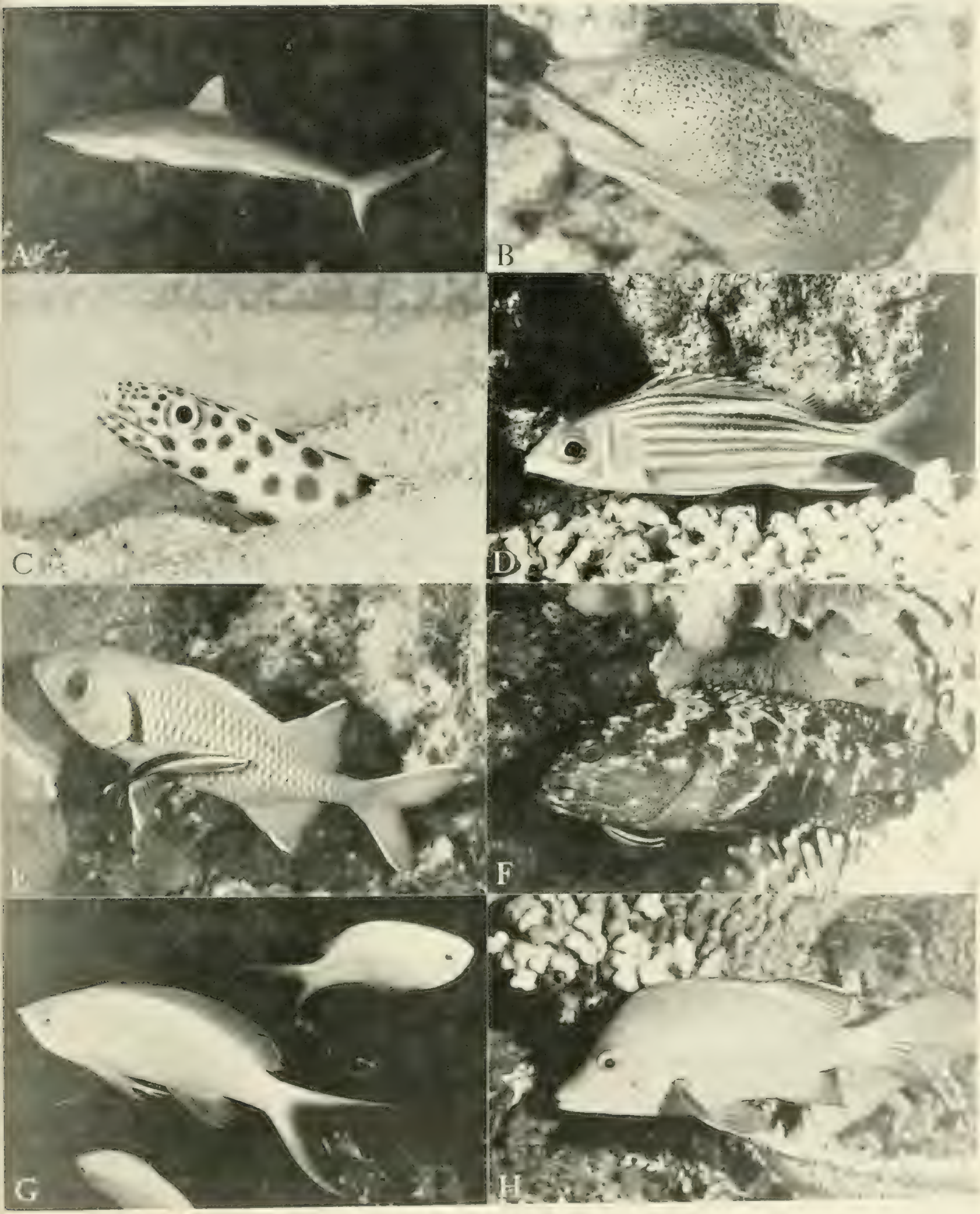

Fig. 1

Fig. 2

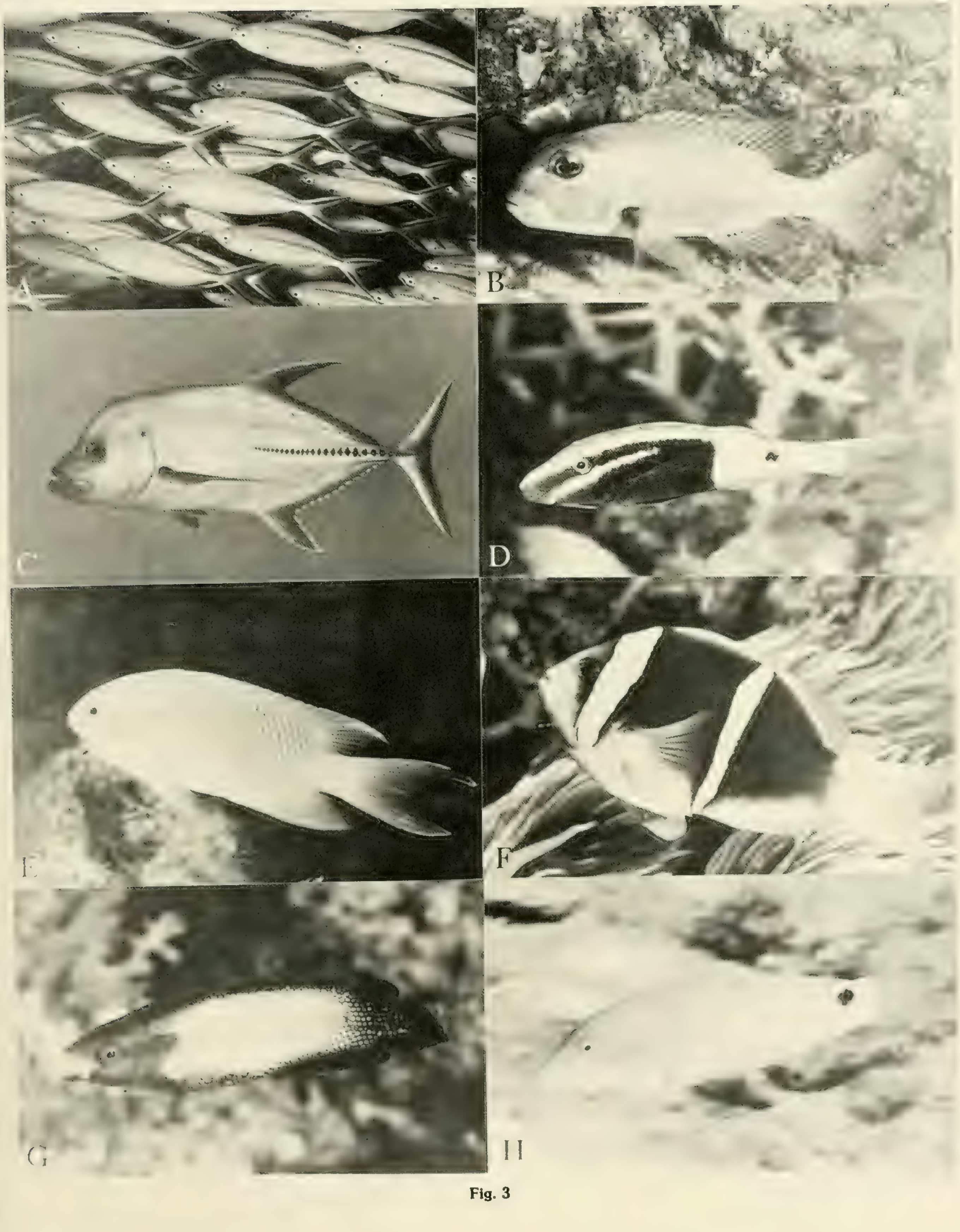

Fig. 3

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Chapter 28

Reptiles of Enewetak Atoll

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Seven species of lizards and one species of blind snake comprise the known terrestrial herpetofauna of Enewetak Atoll, based on specimens in the U. S. National Museum of Natural History, the B. P. Bishop Museum, the American Museum of Natural History, the Museum of Comparative Zoology, and the Mid-Pacific Research Laboratory collections (Table 1). Species found on nearby atolls may also be present on Enewetak; however, no additional species have been collected from there. No amphibia or sea snakes are known from Enewetak.

None of the species of reptiles known from Enewetak is endemic to Micronesia. Presumably, *Gehyra oceanica, Lipinia noctua,* and *Emoia cyanura* originated in Papua New Guinea, and *Hemiphyllodactylus typus* and *Lepidodactylus lugubris* evolved in southern Asia (Burt and Burt, 1932; Brown, 1957). All are now widely distributed among the islands of the Pacific (McCoy, 1980). *Hemidactylus frenatus* and *Ramphotyphlops bramina* are known from tropical Asia, India, and Africa and have been introduced to Central America and the islands of the Pacific and Indian Oceans, including Hawaii (Hunsaker, 1966; Hunsaker and Breese, 1967; Bustard, 1970; McKeown, 1978; McCoy, 1980). *Varanus indicus* probably originated in the Indo-Australian archipelago or Papua New Guinea and has been intentionally introduced to a number of the Mariana, Caroline, and Marshall Islands (Fisher, 1948). This species is extensively distributed on Pacific Islands, including the eastern part of the Indo-Australian archipelago, Papua New Guinea, northern Queensland, Bismarck archipelago, Solomons, Trobriands, Carolines, Marianas, and the Marshalls (R. Crombie, USNM, personal communication). Keys for identification of the reptiles of Enewetak, distribution records, notes on natural history, and excellent color illustrations may be found in booklets by McKeown (1978) and McCoy (1980).

The most often seen lizard on Enewetak is the house gecko, *Hemidactylus frenatus*, which frequents areas of human occupation. It is common on or inside buildings, especially near lights, or on windows at night where it stalks insects attracted by the light. It is also found under scrap metal, plant debris, and driftwood or other debris on the beach.

Hemidactylus frenatus is an aggressive species that may replace other resident species of geckos when it is introduced to a new area. In Hawaii it is reported to have replaced *Hemidactylus garnoti* (McKeown, 1978) and possibly also *Lepidodactylus lugubris* to some extent (Hunsaker and Breese, 1967). McKeown (1978) reports that *L. lugubris*, which also frequents areas of human habitation, is still quite abundant in Hawaii. On Enewetak Atoll, *L. lugubris* is common on Enjebi Islet but is infrequently collected relative to the collection of *H. frenatus* on Enewetak Islet (Table 1). *Hemidactylus frenatus* is highly vocal, and in encounters with other geckos, it frequently emits a series of five to six chirping call notes. If attacked, it emits a squeak. An extensive discussion of vocalization in this species is given by Marcellini (1974). The female *H. frenatus* lays two round white eggs in crevices, and the eggs or adults may be introduced to new areas as stowaways among materials or equipment moved among islands (McKeown, 1978).

The mourning gecko, *Lepidodactylus lugubris,* is found on buildings; trees and bushes; among coconut, pandanus, and other plant debris in areas occupied by people; in open forest; and among beach driftwood. This species is parthenogenic (McKeown, 1978), and its highly adhesive eggs are easily transported among goods carried by boat. This gecko has been widely distributed around the Pacific and is known from several islets on Enewetak Atoll (Table 1). Its call has been compared to the sound of two pebbles being hit together (Marshall, 1951). It sometimes emits a squeak when attacked by another gecko or captured by a collector.

The tree gecko, *Hemiphyllodactylus typus*, is represented from Enewetak by only two specimens in the USNM collection. This gecko, however, is reported to have a quick escape reaction (Oliver and Shaw, 1953) and to be wary and agile (Hunsaker and Breese, 1967). Therefore, it may be more abundant on Enewetak than indicated by the frequency of collection. In Hawaii it is found in low density in forested areas, rock and wood piles, occasionally on the sides of buildings and on tree trunks at night, and under the bases of coconut palm fronds. It is not generally

TABLE 1

Checklist of Terrestrial Reptiles of Enewetak Atoll[*]

Phylum CHORDATA	
Class REPTILIA	
Order SQUAMATA	
Suborder SAURIA (Lizards)	
Family GEKKONIDAE	
"gecko"	
BPBM–Bokombako Islet:	Dec. 30, 1950, under loose canvas, Y. Oshiro, 1 spec., 0695.
Gehyra oceanica (Lesson)	
USNM—Biken Islet:	May 25, 1946, J. P. E. Morrison, 2 spec., 124076–77;
USNM—Elugelab Islet:	1948, Draeger, 7 eggs, 128000;
USNM—Ikuren Islet:	Aug. 21, 1976, in *Pisonia* forest at night, P. B. Lamberson, 1 spec., 205527;
	Aug. 21, 1976, E. Reese, 1 spec., 205528.
BPBM—Ananij Islet:	Dec. 25, 1965, under loose bark of fallen coconut tree, K. J. Frogner, 1 spec., 4033;
BPBM—Ikuren Islet:	June 28, 1964, in chela of crab, *Geograpsus crinipes* (still alive), in coconut grove, C. Berry, 1 spec., 4028;
	Dec. 29, 1965, K. J. Frogner, 1 spec., 4034;
	Jan. 25, 1967, K. J. Frogner, 20 spec., 4273, 4279–97;
	July 15, 1967, on *Pisonia* at night, E. S. Reese, 1 spec., 4001.
MPRL—Japtan Islet:	Jan. 11, 1976, J. Lamberson, 2 eggs;
	March 7, 1976, around buildings near lagoon, F. C. Rabelais, 1 spec.
Hemidactylus frenatus Duméril and Bibron	
USNM—Enewetak Islet:	March 5, 1977, trailer park area, J. Lamberson, 1 spec., 205529;
	March 12, 1977, on lawn furniture, trailer park area, P. B. Lamberson and J. Lamberson, 2 spec., 205530–31;
	March 13, 1977, on lawn under *Coccoloba* tree, trailer park area, P. B. Lamberson, 1 spec., 205532;
	March 17, 1977, under piece of corrugated metal, J. Lamberson, 1 spec., 205533;
USNM—Medren Islet:	Aug. 1964, W. B. Jackson, 3 spec., 197841;
USNM—Runit Islet:	July 24, 1966, W. B. Jackson, 1 spec., 197842;
	Sept. 1, 1968, L. N. Huber, 2 spec., 197874.
BPBM—Enewetak Islet:	Jan. 22, 1967, K. J. Frogner, 1 spec., 4247;
BPBM—Japtan Islet:	Feb. 2, 1967, K. J. Frogner, 1 spec., 4253;
BPBM—Medren Islet:	June 22, 1964, K. J. Frogner, 2 spec., 4046–47;
	Aug. 8, 1964, K. J. Frogner, 2 spec., 4031 and 4078;
	Aug. 8, 1964, in 10 ft coconut trees at edge of lagoon beach, K. J. Frogner, 3 spec., 4048–50;
	Dec. 30, 1965, large crumpled tarp on seaward beach, K. J. Frogner, 1 spec., 4064;
	Dec. 30, 1965, K. J. Frogner, 27 spec., 4065–67, 4079–4100, 4200–01;
	Dec. 30, 1965, under pile of sheet tin on cement tent base, K. J. Frogner, 3 eggs, 6948;
	Jan. 22, 1967, K. J. Frogner, 21 spec., 4202 and 4227–46;
BPBM—Runit Islet:	July 5, 1964, in small pile of rusted sheet metal, K. J. Frogner, 1 spec., 4021;
	Aug. 29, 1964, in wood and tarp pile on seaward beach, K. J. Frogner, 1 spec., 4044;
	Aug. 29, 1964, in driftwood on seaward beach, K. J. Frogner, 1 spec., 4045.
MPRL—Enewetak Islet:	March 7, 1976, around occupied buildings, F. C. Rabelais and J. Lamberson, 2 spec.
Hemiphyllodactylus typus Bleeker	
USNM—Alembel Islet:	April 17, 1977, in "roof," P. B. Lamberson and J. Lamberson, 2 spec., 205534–35.
Lepidodactylus lugubris (Duméril and Bibron)	
USNM—Alembel Islet:	July 30, 1966, W. B. Jackson, 1 spec., 197844;
USNM—Biken Islet:	May 25, 1946, J. P. E. Morrison, 2 spec., 124078–79;
	Aug. 1, 1966, W. B. Jackson, 1 spec., 197843;
USNM—Billae Islet:	Aug. 24, 1968, L. N. Huber, 3 spec., 197876;
USNM—Boken (Irene) Islet:	Aug. 24, 1968, L. N. Huber, 2 spec. with 17 eggs, 197875;
	Feb. 28, 1977, on bunker, J. Lamberson, 3 spec., 205538–40;

[*]With collection data for specimens recorded in the collections of the U. S. National Museum of Natural History (USNM), the B. P. Bishop Museum (BPBM), the American Museum of Natural History (AMNH), and the Mid-Pacific Research Laboratory (MPRL).

(This table continued on next page.)

TABLE 1 (cont'd)

Family GEKKONIDAE (cont'd.)	
USNM—Enewetak Islet:	March 12, 1977, on lawn furniture in trailer park area, P. B. Lamberson and J. Lamberson, 1 spec., 205536;
	March 12, 1977, on palm tree in trailer park area, J. Lamberson, 1 spec., 205537;
Enjebi Islet:	Feb. 28, 1977, on LLL trailer, J. Lamberson, 2 spec., 205541–42;
	March 4, 1977, on LLL shack, P. Lamberson, 2 spec., 205543–44;
	March 11, 1977, on rain gauge, 1 spec., 205545, on tide gauge, 4 spec., 205546–49, and on LLL shack, 3 spec., 205550–52, P. B. Lamberson and J. Lamberson;
USNM—Japtan Islet:	Aug. 3, 1965, W. B. Jackson, 1 spec., 197845.
BPBM—Biken Islet:	Aug. 1964, K. J. Frogner, 3 spec., 4022–24;
	Aug. 5, 1964, in tip of coconut "boat" in tree, K. J. Frogner, 1 spec., 4043;
BPBM—Enewetak Islet:	Jan. 22, 1967, K. J. Frogner, 5 spec., 4248–52;
BPBM—Ikuren Islet:	June 24, 1964, in driftwood along beach, K. J. Frogner, 2 spec., 4029–30;
	Dec. 29, 1965, K. J. Frogner, 2 spec., 4275–76;
	Jan. 25, 1967, K. J. Frogner, 4 spec., 4274, 4277–78, 4298;
	July 15, 1967, E. S. Reese, 1 spec., 4002;
BPBM—Medren Islet:	Aug. 8, 1964, under log just above seaward beach, K. J. Frogner, 1 spec., 4027;
	Dec. 30, 1965, large crumpled tarp on seaward beach, K. J. Frogner, 3 spec., 4061–63;
	Dec. 30, 1965, K. J. Frogner, 10 spec., 4068–77;
	Dec. 30, 1965, K. J. Frogner, 6 + eggs, 6949;
	Jan. 22, 1967, K. J. Frogner, 8 spec., 4219–26;
	Jan. 23, 1967, K. J. Frogner, 4 spec., 4215–18.
AMNH—Runit Islet:	1 spec., 66570.
MPRL—Biken Islet:	March 11, 1976, in forest, J. Lamberson, 1 spec.
Family SCINCIDAE	
Emoia cyanura (Lesson)	
USNM—Billae Islet:	Aug. 25, 1968, A. B. Amerson, Jr., 2 spec., 197918;
	June 6, 1946, J. P. E. Morrison, 1 spec., 124082;
USNM—Japtan Islet:	Aug. 7, 1966, W. B. Jackson, 1 spec., 197847;
USNM—Lujor Islet:	June 2, 1946, J. P. E. Morrison, 2 spec., 124080–81;
USNM—Medren Islet:	Aug. 1, 1965, W. B. Jackson, 1 spec., 197848;
USNM—Mut Islet:	May 28, 1946, J. P. E. Morrison, 5 spec., 124071–75.
BPBM—Ikuren Islet:	Dec. 29, 1965, K. J. Frogner, 5 spec., 4036–40;
	June 24, 1964, in coconut grove, K. J. Frogner, 2 spec., 4025–26;
	Dec. 28, 1965, K. J. Frogner, 1 spec., 4035;
	Jan. 25, 1965, K. J. Frogner, 2 spec., 4271–72;
	Jan. 31, 1967, K. J. Frogner, 8 spec., 4009–16;
	Feb. 1, 1967, K. J. Frogner, 4 spec., 4261–64;
BPBM—Japtan Islet:	Feb. 2, 1967, K. J. Frogner, 4 spec., 4257–60;
BPBM—Medren Islet:	Aug. 8, 1964, under board on sand on seaward beach, K. J. Frogner, 1 spec., 4051;
	Aug. 8, 1964, K. J. Frogner, 8 spec., 4052–59;
	Dec. 30, 1965, large crumpled tarp on seaward beach, K. J. Frogner, 1 spec., 4060;
	Jan. 23, 1967, K. J. Frogner, 12 spec., 4203–14.
AMNH—Runit Islet:	4 spec., 66573–74, plus 2 untagged.
MPRL—Medren Islet:	March 29, 1977, inside redwood water tank, P. B. Lamberson, 1 spec.
Lipinia noctua (Lesson)	
USNM—Ikuren Islet:	Aug. 1964, W. B. Jackson, 1 spec., 197850;
USNM—Japtan Islet:	Aug. 7, 1966, W. B. Jackson, 1 spec., 197849.
BPBM—Ikuren Islet:	June 24, 1964, in coconut grove in pile of fallen nuts at base of tree, K. J. Frogner, 1 spec., 4032;
	Dec. 29, 1965, K. J. Frogner, 2 spec., 4041–42;
	Jan. 25, 1967, K. J. Frogner, 3 spec., 4268–70;
	Jan. 31, 1967, K. J. Frogner, 10 spec., 4003–08, 4017–20;
	Feb. 1, 1967, K. J. Frogner, 3 spec., 4265–67;
BPBM—Japtan Islet:	Feb. 2, 1967, K. J. Frogner, 3 spec., 4254–56.
AMNH—Runit Islet:	6 spec., 66571–72, plus 4 untagged.
MPRL—Japtan Islet:	March 7, 1976, among coconut debris, F. C. Rabelais, 2 spec.

(This table continued on next page.)

TABLE 1 (cont'd)

Family VARANIDAE	
Varanus indicus (Daudin)	
USNM—Japtan Islet:	June 7, 1947, J. P. E. Morrison, 2 spec., 124112–13.
AMNH—Japtan Islet:	A. A. Vincenzi, 1 spec., 78994.
MPRL—Japtan Islet:	Sept. 15, 1975, in open field, P. B. Lamberson and J. Lamberson, 1 spec.
Suborder SERPENTES (Snakes)	
Family TYPHLOPIDAE	
Ramphotyphlops bramina (Daudin)	
BPBM—Enewetak Islet:	Sept. 13, 1980, MPRL lanai at night, S. Ige, 1 spec., 6953.
MCZ—Medren Islet:	June 1954, C. Okino and A. Souza, 1 spec., MCZ 53782.
Order TESTUDINES (=CHELONIA) (Turtles)	
Suborder CRYPTODIRA	
Family CHELONIDAE	
Chelonia mydas (Linnaeus, 1758)–Green turtle.	
Eretmachelys imbricata (Linnaeus, 1766)–Hawksbill turtle.	

found in association with man (Hunsaker and Breese, 1967; Oliver and Shaw, 1953; McKeown, 1978). The female produces two eggs which adhere to surfaces (McKeown, 1978).

The large Polynesian gecko, *Gehyra oceanica,* is found in the forest on the leaves or trunks of coconut, *Pisonia*, or *Pandanus* trees or under fallen logs or other debris on the ground (Heatwole, 1975). It can be spotted at night by the way its eyes shine red when touched by light. Its call is a loud "Kraaaaaaa" (Marshall, 1951).

The blue-tailed skink, *Emoia cyanura,* is common under coconut or other plant debris, under driftwood, and among scrub vegetation at the top of island beaches, especially among the vines of the beach morning glory *Ipomoea pes-caprae* (Sachet, 1962). These skinks are reportedly poor climbers and are active primarily during the day (Moul, 1954; Marshall, 1951).

The moth skink, *Lipinia* (*Lygosoma* or *Leiolopisma*) *noctua*, is fairly common on Enewetak Atoll among leaf litter and coconut debris. It is essentially diurnal and may be partly arboreal (McCoy, 1980). Oliver and Shaw (1953) reported that they had collected *L. noctua* on Runit Islet on Enewetak Atoll on the ground among "herbaceous vegetation along the beach dunes" and that specimens they collected had "two or more incomplete digits on the feet." They speculated that the missing digits might have been sheared off by terrestrial hermit crabs which are common on the islet or by other lizards during fights. Rats are also common on Runit and may have been responsible for some of the missing digits. Missing toes among specimens of *L. noctua* in Hawaii have been attributed to the lizards' characteristic rolling escape behavior (McKeown, 1978). *Lipinia noctua* brings forth one to four young alive from eggs retained in the body (McKeown, 1978).

The largest lizard on Enewetak Atoll is the monitor lizard, *Varanus indicus*, a native of Australia and Papua New Guinea which was introduced to Guam, the Mariana, Caroline, and Marshall Islands by the Japanese for rat control or as a food source (Fisher, 1948; Marshall, 1975). This species has been collected on Enewetak Atoll only from Japtan Islet, and it apparently feeds on land crabs and some marine life. Specimens from Enewetak Atoll are commonly about 1 m in length.

The Brahminy blind snake, *Ramphotyphlops bramina* (Daudin) (*Typhlops* or *Typhlina braminus*), is a small (<20 cm), secretive burrowing snake native to the Philippines and southeast Asia. The species has been introduced into new areas in the dirt accompanying transported plants and equipment and is now widely distributed among major island groups of the Pacific and Indian Oceans. It is found in Africa, Australia, India, and Mexico (Brown, 1957; McCoy, 1980). In Micronesia it is found on Guam, Tinian, Saipan, and Enewetak (Burt and Burt, 1932; Cagle, 1946; Knight, 1984). It may have been introduced to Enewetak with plantings from Hawaii, where it was initially observed in 1930 (Slevin, 1930; Fisher, 1948; Oliver and Shaw, 1953; Hunsaker and Breese, 1967).

Blind snakes are secretive, nocturnal, and generally seen abroad only following a heavy rain. They are found in loose, moist soil in or under rotting logs and other debris and in gardens under stones, plastic cover, and potted plants (Cagle, 1946; McKeown, 1978; McCoy, 1980). Two specimens have been collected on Enewetak Atoll: one on Medren in 1954 (Knight, 1984) and one in 1980 on Enewetak Islet on the MPRL lanai at night. It remains to be seen whether any more specimens will be found on the atoll or whether the species can survive in the island's relatively dry, sandy soil. Blind snakes are parthenogenic, and the single female parent lays two to eight elongate eggs in moist soil (McKeown, 1978). A population may thus be established from a single introduced individual. Blind snakes are beneficial to man because they eat termites and other soft-bodied insects and insect larvae (McKeown, 1978; McCoy, 1980).

The relatively dry climate at Enewetak makes it a rather harsh environment for terrestrial reptiles. Some of the species found there are adapted to living where humans live and may have been transported there by man accidentally or intentionally *(Hemidactylus, Lepidodactylus, Varanus, Ramphotyphlops)*. Some species inhabit beach areas and are found among driftwood *(Lipinia, Emoia, Hemidactylus, Lepidodactylus)*. They may have been washed ashore on the atoll from other areas on floating debris or come as stowaways on the boats of early inter-island travelers. *Gehyra* and *Hemiphyllodactylus* are primarily restricted to forest areas and may have been rafted to the atoll from other islands by storm waves which sometimes wash over low-lying areas and can dislodge large trees and fallen debris.

Enewetak Atoll has few species of reptiles compared to large, high islands such as Hawaii. Due to its dry climate, lack of extensive forest area, and relative isolation, it also has fewer species than some other atolls. Systematic reports on the terrestrial reptiles of atolls are rare and often are based on chance observation (e.g., Marshall, 1951; Moul, 1954; Sachet, 1962). Specimens discussed in these reports and many of the specimens collected from Enewetak were found by chance by people working on other projects. K. J. Frogner took advantage of limited opportunities to visit the various islands of Enewetak Atoll to collect as many specimens as possible, and much of what is known about the habitat of the lizards on the atoll is based on his work. However, a more thorough search, especially on the forested islets, could reveal more species present. Based on specimens in the USNM collection from nearby Pacific islands and other atolls in the Marshall Islands, the following species of lizards possibly could be found on Enewetak Atoll (R. Crombie, USNM, personal communication):

Gehyra mutilata – widespread in Oceania
Lamprolepis smaragdina – widespread in Oceania (found on Ailuk, Arno, Jaluit, Likiep, Taka, Ujae, Ujelang, Utirik, and Wotho Atolls in the Marshall Islands)
Cryptoblepharus boutoni – widespread in Oceania (Pokak and Taongi in the Marshalls)
Emoia baudini group – spotty in Oceania, identification doubtful
E. arnoensis – Marshalls and possibly Caroline Islands (Arno, Bikini?, Lae, Jaluit, Rongerik?)
E. boettgeri orientalis – spotty (Arno, Bikini?, Rongerik?)
E. mivarti – spotty (Lae, Ujae, Wotho)
Cyrtodactylus pelagicus – spotty (Arno Atoll)
Perochirus ateles – spotty in Oceania but on Arno Atoll

According to George Balazs (personal communication), only two species of sea turtles—the green turtle, *Chelonia mydas,* and the hawksbill turtle, *Eretmachelys imbricata*—are known to Enewetak Atoll. Too few specimens have been examined to determine whether these two species belong to the subspecies *C. mydas japonica* of the western Pacific or *E. imbricata squamata* of the Indo-Pacific. At least one incidence of a possible sea turtle nesting on Ikuren Islet has been observed (P. Lamberson, personal communication and photo).

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Chapter 29

Birds of Enewetak Atoll

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In Chapter 1, Roy Tsuda wrote that "our present knowledge of the floristics and ecology of the marine benthic algae on Pacific atolls is based primarily on studies conducted on Enewetak Atoll." This has not been the case with birds: I know of no systematic studies that are based on the birds of Enewetak Atoll. Most of the seabirds that occur at Enewetak have a very wide range in the Pacific basin, and they have not been shown to demonstrate a tendency for subspeciation.

Because of its geographical location, Enewetak provides nesting habitat for some species whose primary breeding range is north of the atoll and for others whose primary breeding range is south of it. For example, species that nest on the Hawaiian Islands include the wedge-tailed shearwater *(Puffinus pacificus)*, red-tailed and white-tailed tropic birds *(Phaethon rubricauds, P. leturus)*, red-footed and brown boobies *(Sula sula rubripes, S. leucogaster)*, great frigate bird *(Fregata minor)*, gray-backed tern *(Sterna lunata)*, sooty tern *(S. fuscata)*, brown, black, and blue-gray noddies *(Anous stolidus, A. tenuirostris, Procelsterna cerulea)*, and the white tern *(Gygis alba)*. Enewetak species that also occur as breeding birds south of the equator include the sooty and slender-billed shearwaters *(Puffinus griseus, P. tenuirostris)* and the black-naped and crested terns *(Sterna sumatrana, Thalassepus bergii)*.

The reef heron *(Egretta sacra)* is a permanent resident on Enewetak Atoll and has a wide range that includes Korea, Japan, Malaysia, Australia, Melanesia, Polynesia, and Micronesia. The long-tailed cuckoo *(Eudynamis taitensis)*, a nesting bird in New Zealand, spends the nonbreeding season on Enewetak and many other Pacific Islands from the Bismarck Archipelago eastward to the Marquesas Islands. At least 17 species of shorebirds that nest in Alaska or Siberia have been recorded as winter visitants on the islets of Enewetak Atoll. Table 1 provides a checklist of Enewetak Atoll birds.

TABLE 1

Checklist of Enewetak Atoll Birds

Order PROCELLARIIFORMES
- Family PROCELLARIIDAE
  - *Puffinus pacificus* Salvin: Woodbury, 1962; Carpenter et al., 1968; Hailman, 1979.
  - *Puffinus griseus* (Gmelin): Pearson and Knudsen, 1967.
  - *Puffinus tenuirostris* (Temminck): Pearson and Knudsen, 1967.
  - *Pterodroma hypoleuca nigripennis* Salvin: Johnson and Kienholz, 1975.

Order PELICANIFORMES
- Family PHAETHONTIDAE
  - *Phaethon rubricauda* (Mathews): Carpenter et al., 1968; Amerson, 1969.
  - *Phaethon lepturus* Mathews: Carpenter et al., 1968; Amerson, 1969.
- Family SULIDAE
  - *Sula sula* Gould: Carpenter et al., 1968; Amerson, 1969.
  - *Sula leucogaster* (Forster): Woodbury, 1962; Amerson, 1969.
- Family FREGATIDAE
  - *Fregata minor* (Gmelin): Carpenter et al., 1968; Amerson, 1969.

Order CICONIIFORMES
- Family ARDEIDAE
  - *Egretta sacra* Gmelin: Pearson and Knudsen, 1967; Carpenter et al., 1968; Amerson, 1969.

(This table continued on next page.)

TABLE 1 (cont'd)

Order ANSERIFORMES
  Family ANATIDAE
    Anas acuta Linnaeus: Temme, MS; Hailman, 1979.
    Anas querquedula Linnaeus: Hailman, 1979.
Order GALLIFORMES
  Family PHASIANIDAE
    Gallus gallus (Linnaeus): Amerson, 1969.
Order CHARADRIIFORMES
  Family SCOLOPACIDAE
    Limosa lapponica baueri Naumann: Pearson and Knudsen, 1968; Carpenter et al., 1968.
    Numenius phaeopus (Scopoli): Woodbury, 1962; Pearson and Knudsen, 1967.
    Numenius tahitensis (Gmelin): Woodbury, 1962; Pearson and Knudsen, 1967.
    **Tringa glareola* Linnaeus: Hailman, 1979.
    Heteroscelus brevipes (Vieillot): Pearson and Knudsen, 1967; Carpenter et al., 1968.
    Heteroscelus incanus (Gmelin): Woodbury, 1962; Pearson and Knudsen, 1967.
    Arenaria interpres (Linnaeus): Woodbury, 1962; Pearson and Knudsen, 1967.
    Gallinago hardwickii (Gray): Hailman, 1979.
    Calidris alba (Pallas): Woodbury, 1962; Pearson and Knudsen, 1967.
    Calidris acuminata (Horsfield): Woodbury, 1962; Pearson and Knudsen, 1967.
    Calidris ruficollis (Pallas): Johnson and Kienholz, 1975.
    Tryngites subruficollis (Vieillot): Pearson and Knudsen, 1967.
    **Philomachus pugnax* (Linnaeus): Temme photograph; Hailman, 1979.
  Family CHARADRIIDAE
    Charadrius dubius curonicus Gmelin: Baker, 1951; Pearson and Knudsen, 1967.
    Charadrius mongolus Stresemann: Hailman, 1979.
    Pluvialis dominica fulva (Gmelin): Woodbury, 1962; Pearson and Knudsen, 1967.
    Pluvialis squatarola (Linnaeus): Baker, 1951; Pearson and Knudsen, 1967.
  Family LARIDAE
    Sterna paradisaea Pontoppidan: Woodbury, 1962.
    Sterna sumatrana Raffles: Woodbury, 1962; Pearson and Knudsen, 1967.
    Sterna lunata Peale: Woodbury, 1962; Amerson, 1969.
    Sterna fuscata Linnaeus: Woodbury, 1962; Pearson and Knudsen, 1967.
    Thalasseus bergii (Lichtenstein): Woodbury, 1962; Pearson and Knudsen, 1967.
    Procelsterna cerulea (Bennett): Woodbury, 1962; Pearson and Knudsen, 1967.
    Anous stolidus (Linnaeus): Woodbury, 1962; Pearson and Knudsen, 1967.
    Anous tenuirostris (Bryan): Woodbury, 1962; Pearson and Knudsen, 1967.
    Gygis alba (Sparrman): Woodbury, 1962; Pearson and Knudsen, 1967.
Order CUCULIFORMES
  Family CUCULIDAE
    Eudynamis taitensis (Sparrman): Woodbury, 1962.
Order STRIGIFORMES
  Family STRIGIDAE
    Asio flammeus (Pontoppidan): Johnson and Kienholz, 1975.

*New record for Enewetak and northern Marshall Islands.

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Chapter 30

Mammals of Enewetak Atoll

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Man is the dominant mammal of Enewetak Atoll. Humans arrived at least 2000 years ago (Craib, 1983). In all probability the Polynesian rat, *Rattus exulans*, and the domestic pig, *Sus scrofa*, accompanied him. Domestic dogs, *Canis familiaris*, and cats, *Felix catus*, most likely did not arrive until European contact in the 19th century.

The ubiquitous common house mouse, *Mus musculus*, and the roof rat, *Rattus rattus*, apparently arrived early in the 20th century when foreign contacts were more frequent. There is no evidence of the Norway rat, *Rattus norvegicus*, on Enewetak, although it occurs elsewhere in the Marshall Islands (Jackson, Vessey, and Bastian, Chapter 12 of Volume I). All of these species of rats and mice are considered as human commensals and have been spread widely throughout the world through the activities of man (Eisenberg, 1981; Nowak and Paradiso, 1983).

Domestic cats, pigs, and goats, *Capra hircus*, were left on Otdia (Wotjii) Atoll of the Ratak, or sunrise chain, by Otto von Kotzebue in 1816 and 1817. There is, however, no evidence that goats ever lived on Enewetak Atoll, which lies far to the northwest in the Ralik, or sunset chain of atolls. Kotzebue did not visit this chain until his second voyage in 1824 (Kotzebue, 1830).

Marine mammals are occasional visitors to Enewetak Atoll. Unfortunately there are only two positive identifications based on skeletal remains, beached specimens, and photographs collected by Philip Lamberson, former laboratory manager of the Mid-Pacific Marine Laboratory, 1974–1977, and sent to William F. Perrin, National Marine Fisheries Service, La Jolla, California, for identification.

The spinner dolphin, *Stenella longirostris*, is identified from photographs (Fig. 1) and by observations of its distinctive spinning breaching behavior (Perrin, 1972), while the striped dolphin, *Stenella coeruleoalba*, is identified from a skeleton. The occurrence of this species at Enewetak represents a new record for the central Pacific (Hubbs, Perrin, and Balcomb, 1973; W. F. Perrin, personal communication to P. Lamberson, 1977).

A checklist of mammals of Enewetak Atoll is provided in Table 1.

Twenty-seven species of whales, dolphins, and porpoises may be expected to occur at Enewetak Atoll (W. F. Perrin, personal communication). These are listed below in the order they are presented in Leatherwood et al. (1982), which provides a guide to their identification.

Large whales with a dorsal fin:
- Blue whale, *Balaenoptera musculus*
- Fin whale, *Balaenoptera physalus*
- Sei whale, *Balaenoptera borealis*
- Bryde's whale, *Balaenoptera edeni*
- Humpback whale, *Megaptera novaeangliae*
- Sperm whale, *Physeter macrocephalus*

Medium-sized whales with a dorsal fin:
- Minke whale, *Balaenoptera acutorostrata*
- (Southern ?) bottlenose whale, *Hyperoodon* sp.?
- Cuvier's beaked whale, *Ziphius cavirostris*
- Beaked whales of the genus *Mesoplodon*
  - Stejneger's beaked whale, *M. stejnegeri*
  - Blainville's beaked whale, *M. densirostris*
  - Ginkgo-toothed beaked whale, *M. ginkgodens*
- Killer whale, *Orcinus orca*
- False killer whale, *Pseudorca crassidens*
- Short-finned pilot whale, *Globicephala macrorhynchus*
- Risso's dolphin, *Grampus griseus*

Small whales, dolphins, and porpoises with a dorsal fin:
- Spotted dolphin, *Stenella attenuata*
- Spinner dolphin, *Stenella longirostris*
- Striped dolphin, *Stenella coeruleoalba*
- Common dolphin, *Delphinus delphis*
- Fraser's dolphin, *Lagenodelphis hosei*
- Bottlenose dolphin, *Tursiops truncatus*
- Rough-toothed dolphin, *Steno bredanensis*
- Pygmy killer whale, *Feresa attenuata*
- Melon-headed whale, *Peponocephala electra*
- Pygmy sperm whale, *Kogia breviceps*
- Dwarf sperm whale, *Kogia simus*

Other marine mammals, such as seals and sea lions, are not known to occur in the Marshall Islands.

According to Lamberson, the Marshallese recognize two kinds of porpoises. One is small and travels in large

(a)

(b)

Fig. 1 Two views of the spinner dolphin, *Stenella longirostris*, in the lagoon of Enewetak Atoll. [Photos by (a) Paul M. Allen and (b) Philip Lamberson.]

TABLE 1

Checklist of the Mammals of Enewetak Atoll*

Phylum CHORDATA
  Class MAMMALIA
    Order ARTIODACTYLA
      Family SUIDAE
        Sus scrofa Linnaeus, 1758. Domestic pig.
    Order CARNIVORA
      Family CANIDAE
        Canis familiaris Linnaeus, 1758. Domestic dog.
      Family FELIDAE
        Felis catus Linnaeus, 1758. Domestic cat.
    Order CETACEA
      Family DELPHINIDAE
        †*Stenella coeruleoalba* (Meyen), 1833. Striped dolphin.
        †*Stenella longirostris* (Gray), 1828. Spinner dolphin.
    Order PRIMATE
      Family HOMINIDAE
        Homo sapiens Linnaeus, 1758. Humans.
    Order RODENTIA
      Family MURIDAE
        Mus musculus Linnaeus, 1766. House mouse.
        Rattus exulans (Peale), 1848. Polynesian rat.
        Rattus rattus (Linnaeus), 1758. Roof rat.

*Classification modified from Nowak and Paradiso, 1983, and Tomich, 1969.

†New Enewetak record.

groups and is called "ke." It is probably *Stenella longirostris*. The other is larger and swims in smaller groups. It may be *S. coeruleoalba* or one of the other species which should occur at Enewetak. Lamberson thinks the Marshallese call the larger animal "rak." Occasionally Marshallese men harpoon dolphins for food which may explain the dolphins' wariness of boats. They are also extremely wary of swimmers and divers at Enewetak.

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Chapter 31

Miscellaneous Species Records of Enewetak Atoll

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INTRODUCTION

The preceding chapters in Volume II are compilations of species records from Enewetak Atoll. For various reasons all systematic groups could not be covered in a separate chapter. Consequently, this final chapter includes miscellaneous records from the Mid-Pacific Research Laboratory at Enewetak Atoll and from the literature.

Ideally, all Enewetak species records not contained in the previous chapters would be presented here. Unfortunately, the vastness of the biological literature and the time available would not permit such an undertaking. Therefore, the search was confined to the more obvious reference materials that might contain these records. We hope this small checklist (Table 1) will be of some help, and we apologize to those authors whose records we have missed.

Some of the previous chapters listed only geologically recent material. For this reason some fossil material and/or material from drill cores is contained herein, even though the systematic group may have been more completely discussed in previous chapters of this volume.

TABLE 1

Checklist of Miscellaneous Species of Enewetak Atoll

KINGDOM PLANTAE
Division PYRRHOPHYTA
Class DINOPHYCEAE
Order PERIDINIALES
Family HETERAULACACEAE
Gambierdiscus toxicus Adachi and Fukuyo, 1979: see Colin, Vol. I.
Division CHLOROPHYTA
Class CHLOROPHYCEAE
Order CLADOPHORALES
Family CLADOPHORACEAE
Cladophora sp.
Cladophora hemisphaerica: Bailey-Brock et al., 1980.
Order SIPHONOCLADALES
Family VALONIACEAE
Valonia trabeculata Egerod, 1952: Bailey-Brock et al., 1980.
Valonia ventricosa J. Agardh, 1887.
Valonia ventricava: Bailey-Brock et al., 1980
Order DASYCLADALES
Family DASYCLADACEAE
Acetabularia clavata Yamada, 1934: Bailey-Brock et al., 1980.
Division PHAEOPHYTA
Class PHAEOPHYCEAE
Order DICTYOTALES
Family DICTYOTACEAE
Padina japonica Yamada, 1931: Bailey-Brock et al., 1980.

(This table continued on next page.)

TABLE 1 (cont'd)

Division RHODOPHYTA
Class FLORIDEOPHYCEAE
Order RHODYMENIALES
Family RHODYMENIACEAE
Chylocladia sp.: Bailey-Brock et al., 1980.
KINGDOM ANIMALIA
Phylum SARCOMASTIGOPHORA
Subphylum SARCODINA
Class GRANULORETICULOSA
Order FORAMINIFERIDA
Suborder ROTALIINA
Superfamily GLOBIGERINOIDEA
Family GLOBIGERINIDAE
*_Globigerina_ sp. aff. _G. apertura_ Cushman, 1918: Todd, 1964.
*_Globigerina conglomerata_ Schwager, 1866: Todd, 1964.
*_Globigerina (Beella) digitata_ Brady, 1884: Todd, 1964.
*_Globigerina (Globorotaloides) hexagona_ Natland, 1938: Todd, 1964.
*_Globigerina obesa_ (Bolli, 1957): Todd, 1964.
*_Globigerina rubescens_ Hofker, 1956: Todd, 1964.
*_Globigerinella adamsi_ (Banner and Blow, 1959): Todd, 1964.
*_Globigerinella aequilateralis_ (Brady, 1884): Todd, 1964.
*_Globigerinita glutinata_ (Egger, 1893): Todd, 1964.
*_Globigerinita humilis_ (Brady, 1884): Todd, 1964.
*_Globigerinoides elongatus_ (d'Orbigny, 1826): Todd, 1964.
*_Globigerinoides sacculifer fistulosa_ (Schubert, 1910): Todd, 1964.
*_Globoquadrina altispira_ (Cushman and Jarvis, 1936): Todd, 1964.
*_Globoquadrina altispira globosa_ Bolli, 1957: Todd, 1964.
*_Orbulina bilobata_ (d'Orbigny, 1846): Todd, 1964.
*_Orbulina suturalis_ Bronnimann, 1951: Todd, 1964.
*_Sphaeroidinella disjuncta_ Finlay, 1940: Todd, 1964.
*_Sphaeroidinella kochi_ (Caudri, 1934): Todd, 1964.
Family GLOBOROTALIIDAE
*_Globorotalia (Turborotalia) acostaensis_ Blow, 1959: Todd, 1964.
*_Globorotalia fohsi robusta_ Bolli, 1950: Todd, 1964.
*_Globorotalia (Truncorotalia) punctulata_ (d'Orbigny, 1826): Todd, 1964.
Family HASTIGERINIDAE
*_Hastigerina pelagica_ (d'Orbigny, 1839): Todd, 1964.
Phylum CNIDARIA
Class SCYPHOZOA
Order CORONATAE
Family LINUCHIDAE
†_Linuche_ sp.
Class HYDROZOA
Order HYDROIDA
Suborder ANTHOMEDUSAE
Family CLAVIDAE
?_Rhizogeton_ sp.: Cooke, 1975.
Family EUDENDRIIDAE
Eudendrium ?breve Fraser, 1938: Cooke, 1975.
Eudendrium capillare Alder, 1856: Cooke, 1975.
Family HALOCORDYLIDAE
Halocordyle disticha (Goldfuss, 1820): Cooke, 1975.
Suborder LEPTOMEDUSAE
Family CAMPANULARIIDAE
Clytia hemisphaerica (Linnaeus, 1767): Cooke, 1975.
Family HALECIIDAE
Halecium beani (Johnson, 1847): Cooke, 1975.
Halecium sp.: Cooke, 1975.

*Fossil material and/or material from cores.
†Records from the Enewetak Laboratory Card Catalogue.

(This table continued on next page.)

TABLE 1 (cont'd)

Family PLUMULARIIDAE
†*Aglaophenia lophocarpa* Allman, 1877.
Aglaophenia pluma (Linnaeus, 1758): Cooke, 1975.
Halopteris diaphana (Heller, 1868): Cooke, 1975.
Plumularia halecioides Adler, 1859: Cooke, 1975.
Plumularia setacea (Linnaeus, 1758): Cooke, 1975.
Family SERTULARIIDAE
Dynamena cornicina McCrady, 1857: Cooke, 1975.
Dynamena crisioides Lamouroux, 1824: Cooke, 1975.
Sertularella miniscula Billard, 1925: Cooke, 1975.
Sertularia subtilis Fraser, 1937: Cooke, 1975.
Sertularia westindica Stechow, 1919: Cooke, 1975.
Thyroscyphus vitiensis Marktanner-Turneretscher, 1890: Cooke, 1975.
Order MILLEPORINA
Family MILLEPORIDAE
†*Millepora murrayi* Quelch, 1886.
Millepora platyphylla Hemprich and Ehrenberg, 1834: Wells, 1954.
Millepora tenera Boschma, 1949: Wittle and Wheeler, 1974; Wittle et al., 1974.
Millepora dichotoma: Middlebrook et al., 1971.
Order STYLASTERINA
Family STYLASTERIDAE
†*Distichopora coccinea* Gray, 1860.
Distichopora fisheri Broch, 1942: Wells, 1954.
†*Distichopora violacea* (Pallas, 1766).
Stylaster elegans Verrill, 1864: Wells, 1954.
Class ANTHOZOA
Subclass ALCYONARIA
Order ALCYONACEA
Family NEPHTHEIDAE
Nephthea sp.: Ciereszko et al., 1968; Schmitz et al., 1974; Vanderah et al., 1978.
Subclass ZOANTHARIA
Order CORALLIMORPHARIA
Family ACTINODISCIDAE
†*Rhodactis inchoata* Carlgren, 1943.
Order SCLERACTINIA
Suborder ASTROCOENIINA
Family ACROPORIDAE
**Dendracis pacificus* Wells, 1964.
Family ASTROCOENIIDAE
**Actinastrea minutissima* (Gerth, 1921): Wells, 1964.
Family POCILLOPORIDAE
**Seriatopora micrommata* Felix, 1921: Wells, 1964.
**Seriatopora ornata* Felix, 1921: Wells, 1964.
**Stylophora* sp. cf. *S. sokkohensis* Gerth, 1921: Wells, 1964.
**Stylophora stellata* (von Fritsch, 1875): Wells, 1964.
**Stylophora* sp.: Wells, 1964.
Suborder DENDROPHYLLIINA
Family DENDROPHYLLIIDAE
†*Rhizopsammia minuta* var. *bikiniensis* Wells, 1954.
Suborder FAVIINA
Family FAVIIDAE
**Favia* sp. cf. *F. oligophylla* (von Fritsch, 1875): Wells, 1964.
Family MUSSIDAE
**Acanthophyllia* sp.: Wells, 1964.
Family OCULINIDAE
**Galaxea* sp.: Wells, 1964.
Suborder FUNGIINA
Family AGARICIIDAE
**Leptoseris* sp. cf. *L. floriformis* Gerth, 1923: Wells, 1964.

*Fossil material and/or material from cores.
†Records from the Enewetak Laboratory Card Catalogue.

(This table continued on next page.)

TABLE 1 (cont'd)

Family FUNGIIDAE
*Discotrochus sp. cf. D. orbignyanus Milne Edwards and Haime, 1848: Wells, 1964.
Family PORITIDAE
*Alveopora polyacantha Reuss, 1867: Wells, 1964.
*Dictyaraea micrantha Reuss, 1867: Wells, 1964.
*Porites sp. cf. P. capricornis Rehberg, 1892: Wells, 1964.
Order ZOANTHIDEA
Family ZOANTHIDAE
†*Gemmaria* sp.
†*Isaurus duchassaingi* Andres, 1883.
†*Palythoa tuberculosa* (Esper, 1791).
†*Zoanthus* sp.
Subclass CERIANTIPATHARIA
Order CERIANTHARIA
‡Suborder PENICILLARIA
‡Family ARACHNACTIDAE
†*Arachnanthus australiae* Carlgren, 1937.
Phylum PLATYHELMINTHES
Class CESTODA
Subclass EUCESTODA
Order CYCLOPHYLLIDEA
Family HYMENOLEPIDIDAE
Hymenolepis diminuta (Rudolphi, 1819): see Jackson et al., Vol. I., Chapter 12.
Phylum NEMATODA
Class SECERNENTEA
Subclass SPIRURIA
Order SPIRURIDA
Suborder SPIRURINA
Superfamily SPIRUROIDEA
Family GONGYLONEMATIDAE
Gongylonema neoplasticum Fibiger and Ditlevsen, 1914: see Jackson et al., Vol. I, Chapter 12.
Phylum SIPUNCULA
Family PHASCOLOSOMATIDAE
§*Phascolosoma albolineatum* Baird, 1868.
§*Phascolosoma pacificum* Keferstein, 1866.
Family SIPUNCULIDAE
§*Siphonosoma rotumanum* (Shipley, 1898).
Phylum CHAETOGNATHA
Class SAGITTOIDEA
Order PHRAGMOPHORA
Family SPADELLIDAE
Spadella legazpichessi Alvariño, 1981.
Phylum ARTHROPODA
Subphylum CRUSTACEA
Class MALACOSTRACA
Subclass EUMALACOSTRACA
Superorder PERACARIDA
Order ISOPODA
Suborder ONISCOIDEA
Infraorder LIGIAMORPHA
Section CRINOCHETA
Superfamily ATRACHEATA
Family ONISCIDAE
§*Alloniscus oahuensis* Budde-Lund, 1885.

*Fossil material and/or material from cores.
†Records from the Enewetak Laboratory Card Catalogue.
‡See den Hartog (1977) on the systematic classification of the genus *Arachnanthus*.
§New Enewetak records.

(This table continued on next page.)

TABLE 1 (cont'd)

Superfamily PSEUDOTRACHEATA
Family PORCELLIONIDAE
Porcellionides pruinosus (Brandt, 1833).
Metapornorthrus pruinosus: Woodbury, 1962.
Suborder EPICARIDEA
Infraorder BOPYRINA
Family BOPYRIDAE
Bopyrella thomsoni Bonnier, 1900; Bourdon, 1980.
Bopyrella thomsoni muiensis Danforth, 1970.
Cancricepon garthi Danforth, 1970.
Cancricepon? knudseni (Danforth, 1970).
Merocepon knudseni Danforth, 1970.
Gigantione pratti Danforth, 1967: Danforth, 1970.
Grapsicepon sp.: Danforth, 1970.
Merocepon knudseni Danforth, 1970.
Scyracepon hawaiiensis Richardson, 1911: Danforth, 1970.
Order AMPHIPODA
Suborder GAMMARIDEA
Superfamily GAMMAROIDEA
Family GAMMARIDAE
Beaudettia palmeri Barnard, 1965.
Elasmopus pectenicrus (Bate, 1862): Barnard, 1965.
Elasmopus pseudaffinis Schellenberg, 1938: Barnard, 1965.
Elasmopus rapax Costa, 1853: Barnard, 1965.
Elasmopus spinidactylus Chevreux, 1907: Barnard, 1965.
Elasmopus sp.: Croker, 1971b.
Jerbarnia mecochira Croker, 1971a.
Maera hamigera Haswell, 1879: Barnard, 1965.
Maera inaequipes (Costa, 1851): Barnard, 1965.
Maera othonopsis Schellenberg, 1938: Barnard, 1965.
Maera pacifica Schellenberg, 1938: Barnard, 1965.
Maera quadrimana (Dana, 1853): Barnard, 1965.
Maera serrata Schellenberg, 1938: Barnard, 1965.
Mallacoota insignis (Chevreux, 1901).
Maera insignis: Barnard, 1965.
Melita celericula Croker, 1971b.
Superfamily LEUCOTHOIDEA
Family LEUCOTHOIDAE
Leucothoe hyhelia Barnard, 1965.
Superfamily TALITROIDEA
Family HYALIDAE
Hyale chevreuxi K. H. Barnard, 1916: Barnard, 1965.
Hyale dentifera Chevreux, 1907: Barnard, 1965.
Hyale honoluluensis Schellenberg, 1938: Barnard, 1965.
Hyale media (Dana, 1853): Barnard, 1965.
Talorchestia spinipalma (Dana, 1853): Barnard, 1960; Woodbury, 1962.
Superfamily COROPHIOIDEA
Family AMPITHOIDAE
Ampithoe ramondi Audouin, 1826: Barnard, 1965.
Cymadusa brevidactyla (Chevreux, 1907): Croker, 1971b.
Cymadusa filosa Savigny, 1816: Barnard, 1965.
Paragrubia vorax Chevreux, 1901: Barnard, 1965.
Family AORIDAE
Lembos aequimanus Schellenberg, 1938: Barnard, 1965.
Lembos bryopsis Barnard, 1965.
Lembos sp. cf. *L. francanni* Reid, 1951: Barnard, 1965.
Lembos sp. cf. *L. intermedius* Schellenberg, 1938: Barnard, 1965.
Microdeutopus tridens Schellenberg, 1938: Barnard, 1965.
Family ISAEIDAE
Gammaropsis atlanticus (Stebbing, 1888).
Eurystheus atlanticus: Barnard, 1965.

(This table continued on next page.)

TABLE 1 (cont'd)

Family ISAEIDAE (cont'd)
Gammaropsis digitatus Schellenberg, 1938.
Eurystheus digitatus: Barnard, 1965.
Gammaropsis pacificus Schellenberg, 1938.
Eurystheus ?pacificus: Barnard, 1965.
Megamphopus abbotti Barnard, 1965.
Suborder CAPRELLIDEA
Family CAPRELLIDAE
§*Metaprotella sandalensis* Mayer, 1903.
Phylum TARDIGRADA
Order EUTARDIGRADA
Family MACROBIOTIDAE
Hypsibius (Isohypsibius) augusti Murray, 1907.
Hypsibius (Isohypsibius) angusti: Mehlen, 1972.
Hypsibius (Calohypsibius) truncatus Thulin, 1928: Mehlen, 1972.
Macrobiotus allani Murray, 1913: Mehlen, 1972.
Macrobiotus harmsworthi Murray, 1907: Mehlen, 1972.
Macrobiotus richtersi Murray, 1911: Mehlen, 1972.
Family MILNESIIDAE
Milnesium tardigradum Doyere, 1840: Mehlen, 1972.
Phylum ECHINODERMATA
Subphylum ECHINOZOA
Class ECHINOIDEA
Subclass EUECHINOIDEA
Superorder GNATHOSTOMATA
Order CLYPEASTEROIDA
Suborder LAGANINA
Family FIBULARIIDAE
**Echinocyamus parviporus* Kier, 1964.
**Echinocyamus* cf. *parviporus* Kier, 1964.
**Echinocyamus petalus* Kier, 1964.
Phylum HEMICHORDATA
Class ENTEROPNEUSTA
Family PTYCHODERIDAE
†*Ptychodera flava* Eschscholtz, 1825.

*Fossil material and/or material from cores.
†Records from the Enewetak Laboratory Card Catalogue.
§New Enewetak records.

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Author Index

Subject Index

The reader interested in a particular group of organisms should consult the table of contents at the front of the volume and turn to the appropriate chapter. Scientific names and authors' names are not listed here as they would be redundant with the checklists included in each chapter. Vernacular names of organisms and certain scientific names used in the vernacular sense are included. Only Indo-Pacific geographic place names are included, with the exception of Enewetak Atoll and Marshall Islands, which are referred to in every chapter, and the names of islands within Enewetak Atoll.

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