MICROFOSSILS FROM THE UPPER CRETACEOUS OF ADOBE CANYON, SOUTHERN ARIZONA

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ABSTRACT

Upper Cretaceous sediments from Adobe Canyon, located in the southeastern foothills of the Santa Rita Mountains of Arizona, contain a varied microfauna and microflora. Evidence for Late Cretaceous erosion of lower Paleozoic rocks in Southern Arizona is presented.

Micro-vertebrates include teeth of *Gyrodus?*, an unidentified amioid fish, and reworked ostracoderm plate fragments. Micro-invertebrates include the mollusks *Sphaerium* sp. of cf. *S. formosum* Meek and Hayden, *corbicula* sp., *Gyraulus* sp., and *Goniobasis* sp.; an ostracode, *Cypridopsis;* an unidentified mosquito, an insect claw, problematical amber spheres; the hystrichomorphs *Leiosphaeridia* spp., *Baltisphaeridium* spp., *Veryhachium* sp. cf. *V. trispinosum* Eisenack, *Hystrichosphaeridium* spp., and *Pterospermopsis?* sp.; two reworked chitinozoans, *Sphaerochitina* sp., and *Hoegisphaera* sp.; the charophytes *Stellatochara mundula* Peck, *Aclistochara* sp. cf. *A. bransoni* Peck, and *Mesochara voluta* Peck; the palynomorphs *Punctatisporites* sp., *Cyclogranisporites* sp., *Acanthotriletes* sp., *Aequitriradites?* sp., *Monosulcites* sp., *Ginkgoretectina?* sp., *Anemiidites?* sp., and *Labiadensites?* sp., also present are remains of the fungus *Pluricellaesporites* sp. cf. *P. psilatus* Clarke.

INTRODUCTION

A stratigraphic section consisting of at least 15,000 feet of largely non-marine shales, sandstones, and a few thin, marine limestone beds exposed near the Santa Rita, Empire, and Whetstone Mountains of southern Arizona has been considered by various geologists to be either entirely a lateral equivalent of the Lower Cretaceous Bisbee Group, or partly Upper Cretaceous, or partly Cretaceous and partly Tertiary, or entirely Tertiary, or possibly partly a lateral equivalent of the Triassic and Jurassic Barranca Group of Sonora.

Miller (1964) described some Cretaceous vertebrate remains from Adobe Canyon and elsewhere in southern Arizona, and divided the largely non-marine sediments of southern Arizona into two faunal and lithologic

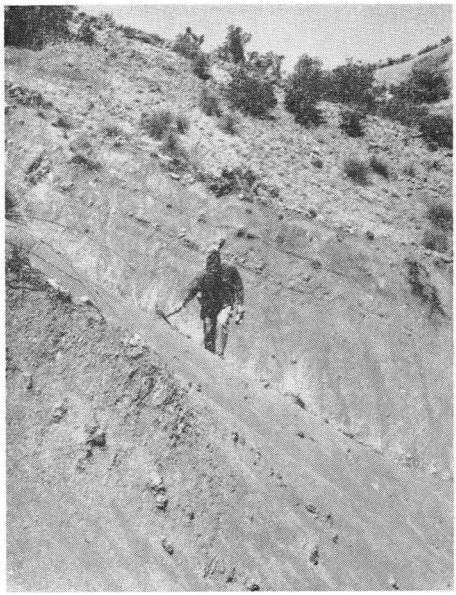

FIGURE 1. Upper Cretaceous shales exposed along East Branch of Adobe Canyon at the "Tooth Locality."

FIGURE 2. Indurated conglomeratic sandstone bed exposed along East Branch of Adobe Canyon, at the "Unionid Locality."

suites. The basal suite is Lower Cretaceous and consists of a largely sandstone section with a few thin marine limestone beds containing the pelecypods *Arctica, Gryphaea, Trigonia,* and *Ostrea.* The majority of the section is non-marine and contains silicified tree trunks, and more rarely, bones of iguanodontid dinosaurs.

The overlying suite is Upper Cretaceous and lacks marine beds and marine mollusks. The sediments are shales, siltstones, and sandstones, (Text, Fig. 1, 2) and contain abundant non-marine mollusks such as *Physa, Viviparus, Unio,* and *Protelliptio,* and fragments of amioid fish, garpike, trionychid turtles, handrosaurian and theropod dinosaurs.

Unfortunately the vertebrate macrofauna is fragmentary and not too well preserved. However, it is the best known record of a non-marine fauna from the 15,000 feet of sediments that accumulated along the southeastern slope of the Mesocordilleran Geanticline during the Cretaceous Period. Therefore identification, in so far as is possible, and description of the fossils is necessary to complete our understanding of Cretaceous life and geography. Accordingly, the authors have described the microfauna and microflora.

LOCATION

Adobe Canyon is located in the foothills of the Santa Rita Mountains, about six miles southwest of Sonoita, Arizona. Exact locations cited in

FIGURE 3. Photograph of yellow, conglomeratic, shell-hash, approximately two feet thick, from which the spore-pollen samples were taken. The location is in Adobe Canyon between the "Unionid Locality" and "First Bluff."

the text are indicated on a map previously published by Miller (1964, Fig. 2). Section, range and township numbers are unavailable as the area is unsurveyed.

REWORKED FOSSILS

Many of the microfossils found in the Upper Cretaceous sediments of Adobe Canyon have been reworked from older rocks.

The reworked microfossils include Lower Paleozoic forms such as the ostracoderm plates, and the two genera of chitinozoans. The presence of these typically Paleozoic fossils indicates that nearly Paleozoic (Devonian?) rocks along the Mesocordilleran Geanticline were exposed to erosion and contributed sediments to the Adobe Canyon area during Late Upper Cretaceous time. Furthermore, some of the hystricospheres, such as *Baltisphaeridium, Veryhachium,* and *Hystrichosphaeridium* are also most probably reworked from Lower Paleozoic rocks.

The charophytes may have been reworked from Lower Cretaceous, or even Jurassic, rocks. However, these are the first charophytes found and

described from southern Arizona, and it may be that the poorly known Upper Cretaceous charophyte flora of that region differs little from the Lower Cretaceous floras further north.

ENVIRONMENT OF DEPOSITION

The section consists of black to red shales, siltstones, and sandstones, and was deposited in shallow, fresh water-ponds and streams. The invertebrates and charophytes clearly indicate a non-marine environment.

The charophytes and mosquito puparia indicate shallow, calm, slightly brackish or non-saline water. The snail *Gonibasis* lives in many fresh water habitats, in areas with rapid currents to quiet water among water plants. *Viviparus* lives in rather quiet water on muddy bottoms. The clam *Sphaerium* lives in nearly any type of fresh water environment, from swift streams to calm ponds with sandy or clay bottoms. The larger mussels such as *Unio* and *Protelliptio* live in quiet or slowly moving water on muddy bottoms, and sandy bottoms are less frequently inhabited by the mussels. The ostracode *Cypridopsis* lives in either fresh or brackish water. The hystricospheres are marine, but they are probably reworked from Lower Paleozoic rocks.

The vertebrate fauna contains some marine remains in that Miller (1964, p. 381) reported the presence of the maxillary bone of an elopid fish from the Adobe Canyon sediments. These are marine fish that frequently enter fresh water, and the occurrence in the Adobe Canyon sediments of three fragmentary specimens does not necessarily indicate a seacoast closer than the known marine Upper Cretaceous deposits in the Deer Creek Coal Basin a hundred miles to the north. Furthermore, *Gyrodus* (Romer, 1945, p. 80) has been questionably reported from Upper Cretaceous rocks of North America, and the pycnodontid fishes are normally considered to be a marine group. However, our specimens are not yet positively identified.

The remainder of the non-reworked vertebrate fauna is compatible with a fresh water environment in that it includes such forms as garpike, amioid fish, trionychid turtles, and hadrosaurian dinosaurs.

ACKNOWLEDGMENTS

Miller received grants from the Society of the Sigma Xi and the Geochronology Laboratories of the University of Arizona in 1959 that enabled him to begin field work on the Cretaceous rocks of southern Arizona. The authors would like to acknowledge the help of Jerome Eyer with the identification of some charophytes, and H. Wesley (Wes) Peirce's help with some geologic information. Dr. Joseph Gregory aided in the identification of some vertebrate fragments. Mr. Anthony Ross helped identify the fossil insect remains.

However, the authors assume responsibility for all identifications and conclusions.

SYSTEMATIC PALEONTOLOGY

KINGDOM PLANTAE
FUNGAL SPORAE DISPERSAE
CLASS FUNGI IMPERFECTI

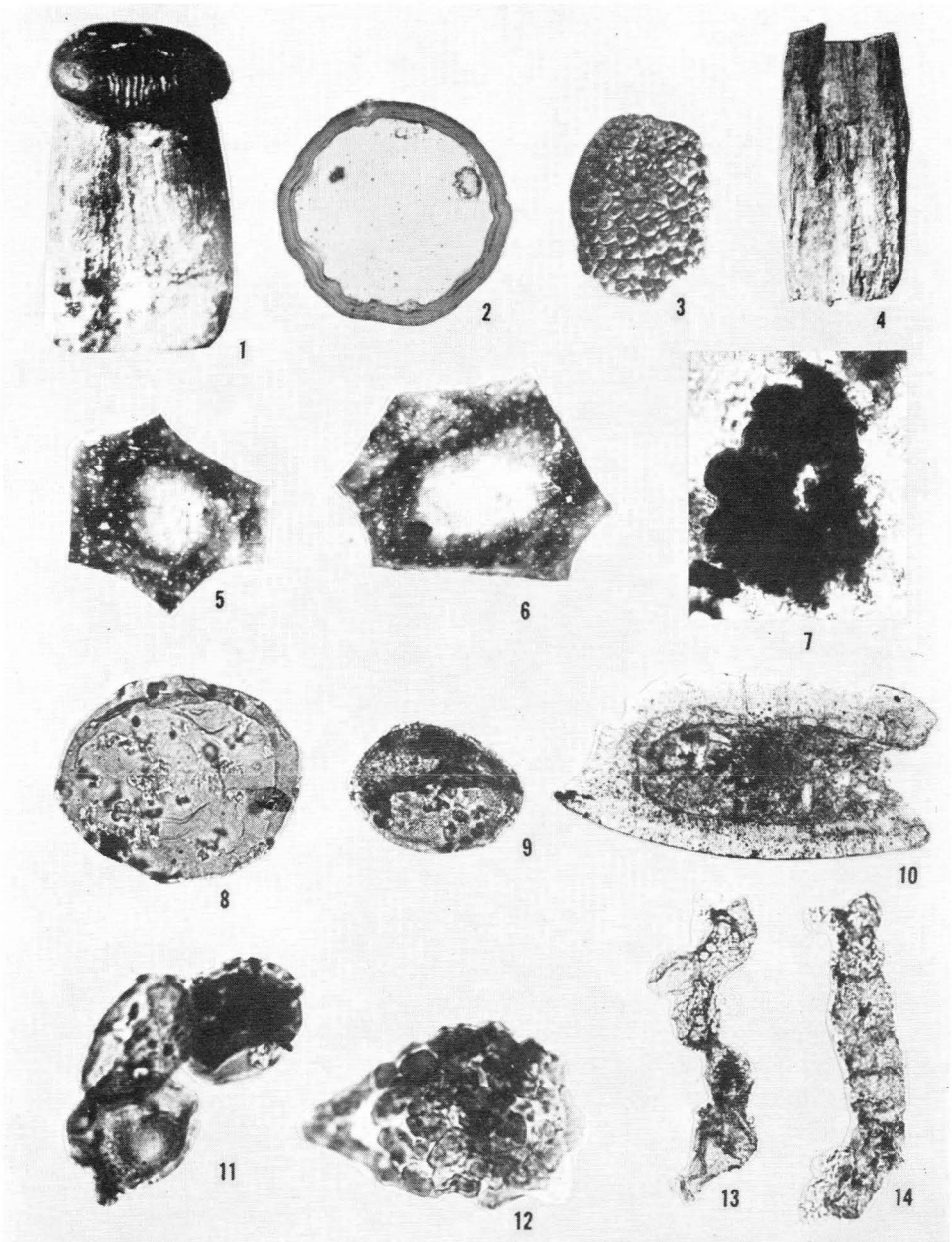

PLATE 3. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

GENUS *PLURICELLAESPORITES* van der Hammen, 1954

Type species: *Pluricellaesporites typicus* van der Hammen, 1954

Description: Uniserial fungal spores consisting of five or more cells flattened at the boundary of union. Cells connected by means of a slit-like opening through the septa; equatorial outline of individual cell, convex.

Pluricellaesporites sp. c. *P. psilatus* Clarke, 1965
Plate 3, Figs. 13 and 14

Description: Uniserial fungal sports consisting of five or more cells united and flattened at the boundary of union. Spores are 100 to 120 microns in length, 18 to 20 microns in width. The cell walls are slightly concave to nearly straight and the cells are connected by a slit-like opening through the septa. Spore wall, smooth.

Remarks: Only two poorly preserved specimens of *Pluricellaesporites* were recovered from Adobe Canyon. They appear to be similar to *P. psilatus* described by Clarke (1965) from the Vermejo Formation coal beds (Upper Cretaceous) of central Colorado.

ACID-INSOLUBLE PALYNOMORPHS

GENUS *PUNCTATISPORITES* (Ibrahim, 1933)
Emended Schopf, Wilson and Bentall, 1944

Type species: *Punctatisporites punctatus* (Ibrahim, 1933)

Description: Spores trilete, rounded to subround-subtriangular in equatorial cross-section; 25 to 120 μ in diameter, showing no preferred compressional orientation. Trilete ray generally well defined and on inconstant length. Contact area of spore may be indistinct. Spore wall 2 to 4 microns in thickness; ornamentation (smooth, granulose, minutely punctate, reticulate, etc.), varied.

Punctatisporites sp.
Plate 4, Figs. 1, 7, and 8

Description: Spores are subround in equatorial cross-section, 50 μ in diameter and have a well defined trilete mark extending to near the margin of the spore wall. Ornamentation finely granulose to smooth.

Remarks: *Punctatisporites* was abundant in the sample from Adobe Canyon.

GENUS *CYCLOGRANISPORITES* Potonié and Kremp, 1954

Type species: *Cyclogranisporites (Granulatisporites) leopoldi* (Kremp, 1952) emend. Potonié and Kremp, 1954

Description: The genus *Cyclogranisporites* includes those spores with a circular to subcircular equatorial cross-section; the trilete mark is well defined, the trilete ray usually greater than one-half the diameter of the spore radius. The exine may be sparsely to densely granulose and the spore wall is rarely folded.

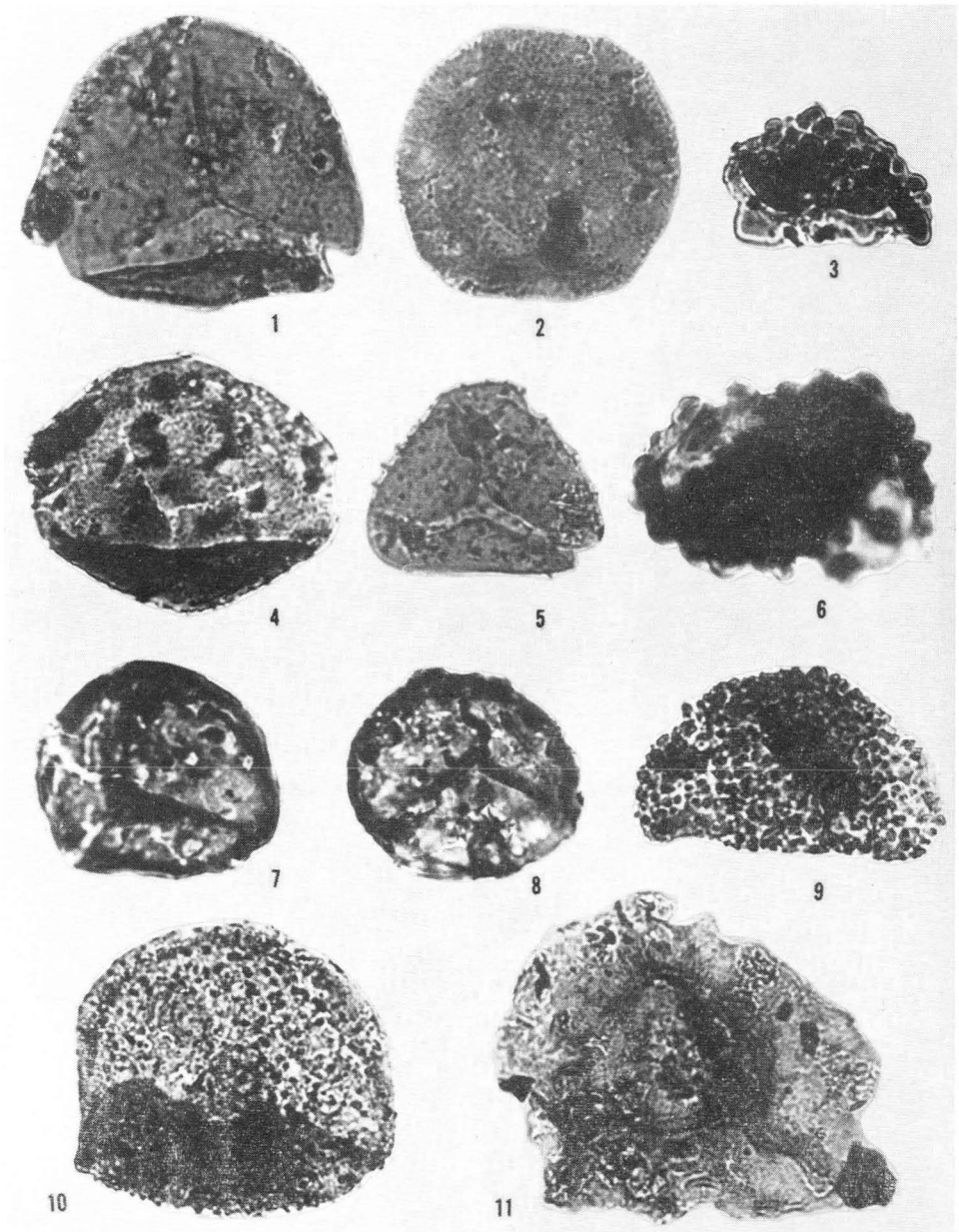

PLATE 4. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

Cyclogranisporites sp.
Plate 4, Figs. 4 and 10

Description: The spores are subround in outline, between 50 and 60 μ in diameter, with a well defined and distinct trilete mark. The trilete mark

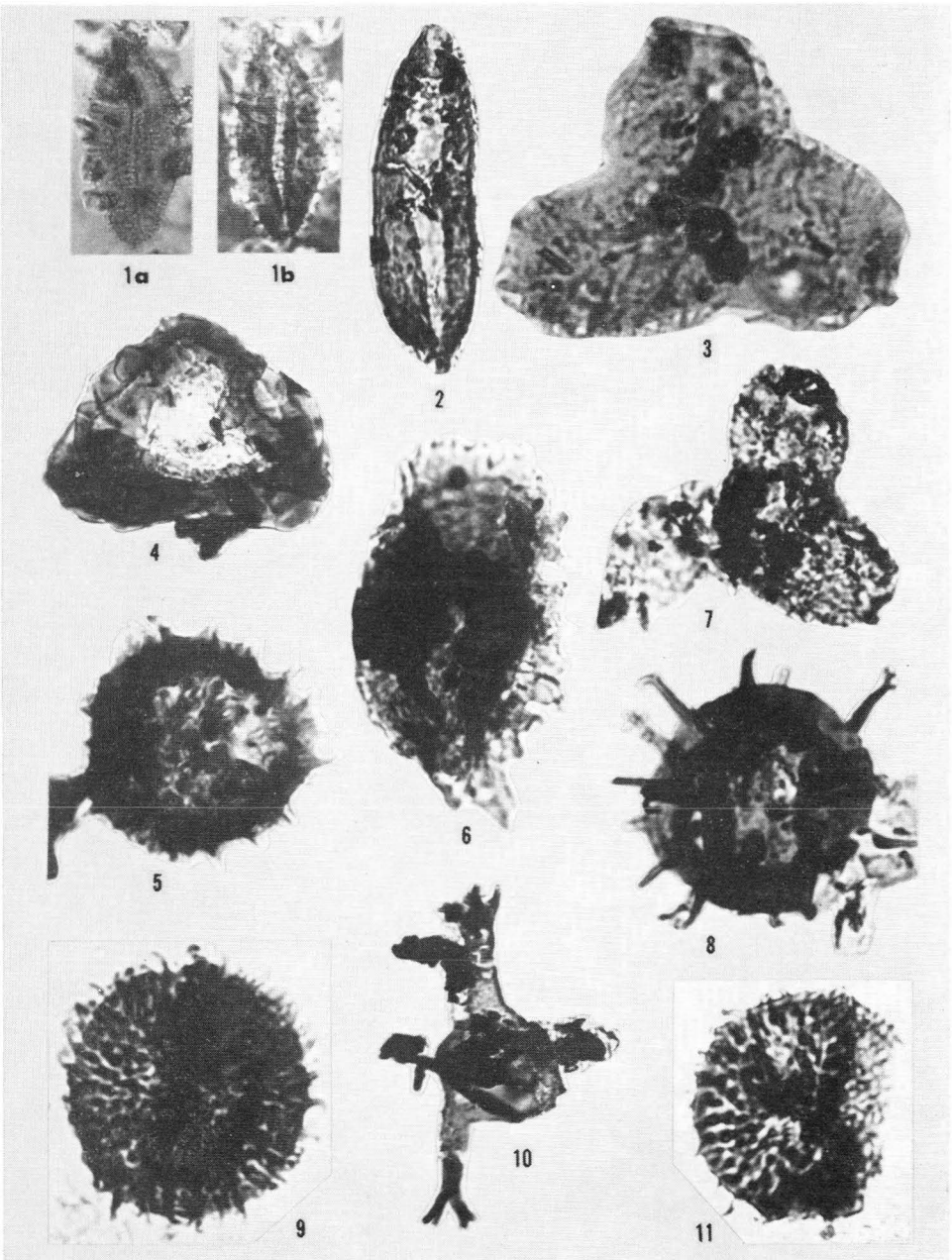

PLATE 5. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

may appear indistinct in some specimens because of poor preservation. The rays of the trilete mark are greater than one-half the diameter of the spore and the spore wall is slightly folded. Ornamentation granulose to smooth.

Remarks: The above description is based on several specimens. This genus appears to be one of the most abundant palynomorphs in the sediments from Adobe Canyon.

GENUS *ACANTHOTRILETES* (Naumova, 1937)
Emended Potonié and Kremp, 1954

Type species: *Acanthotriletes (Spinososporites) ciliatus* Knox, 1950

Description: Spores trilete, triangular to subround in equatorial cross-section. Trilete mark distinct, laesura greater than one-half the diameter of the spore. Ornamentation ciliate or spinose; the spines are sharply pointed and closely crowded.

Acanthotriletes sp.
Plate 4, Fig. 5

Description: Spore triangular in outline, with a well defined and open trilete mark. The rays of the trilete mark extend almost to the equatorial margin of the spore wall. The spore has a diameter of 36 μ; ornamentation consists of short to moderately long, coarse, spines evenly distributed over the entire spore.

Remarks: Several grains of this genus were observed in the sample from Adobe Canyon.

GENUS *AEQUITRIRADITES* (Delcourt and Sprumont)
Emended Cookson and Dettmann, 1961

Type species: *Aequitriradites dubius* (Delcourt and Sprumont, 1955)

Description: Delcourt and Sprumont (1955, p. 44, Pl. 3) proposed the genus *Aequitriradites* for spores with a large membrane enclosing a central body with well developed trilete marks extending to near the margin of the membranous covering. Cookson and Dettmann (1961) emended the genus to include: "Trilete microspores with a membraneous zone. Laesurae distinct or only faintly represented, especially toward the proximal pole. Exine entire or perforated distally. When perforated, the opening is formed as the result of a natural exinous breakdown about the distal pole. Sculptural elements various."

Aequitriradies? sp.
Plate 4, Fig. 11

Description: Spore subtriangular in equatorial cross-section, and greater than 70 μ in diameter. Central body approximately 35 μ in diameter and covered by a membrane that forms an equatorial flange. Trilete mark

indistinct; trilete rays extend from the central body to the outer margin of the equatorial flange. Ornamentation indeterminate because of poor preservation.

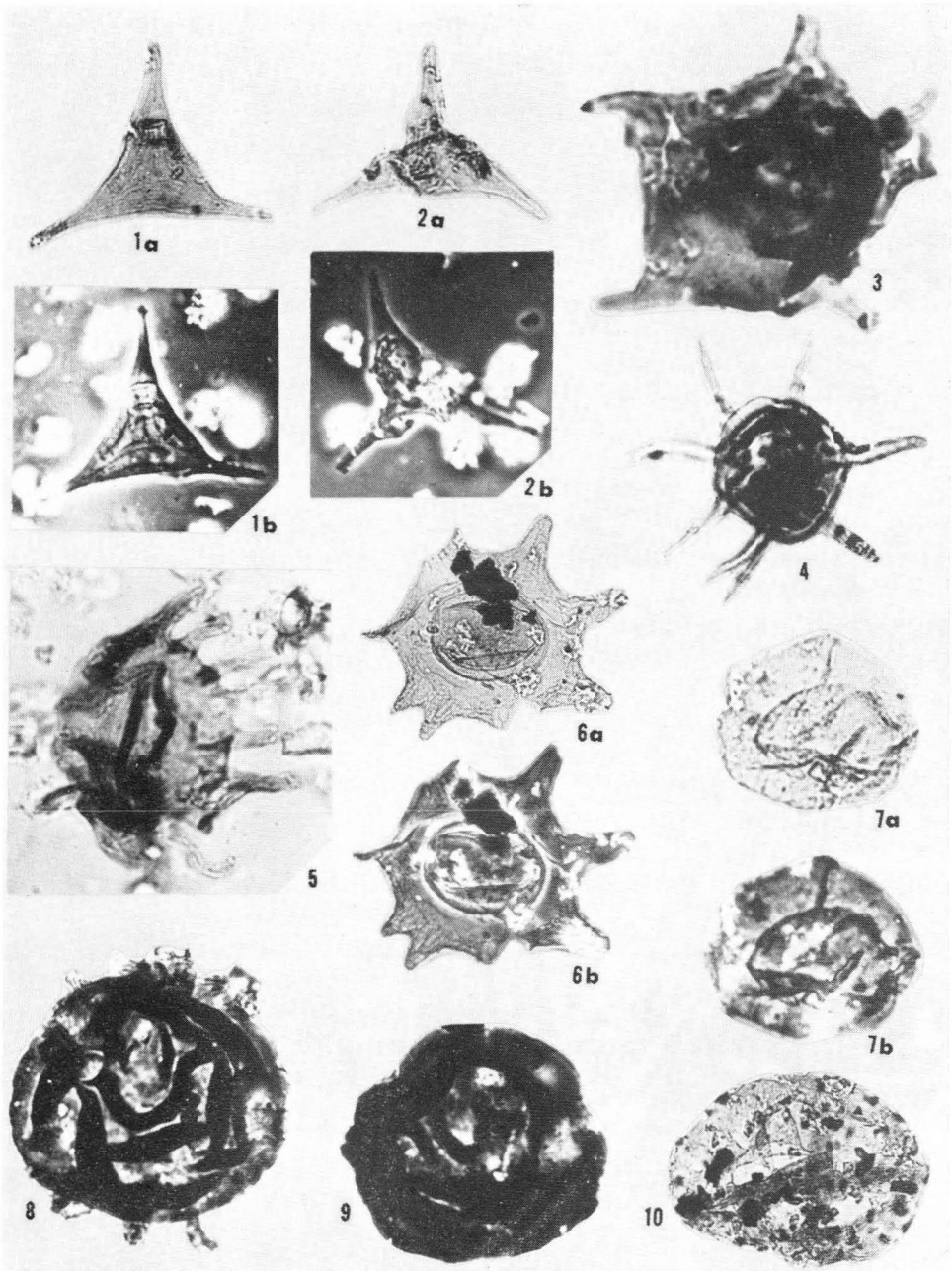

PLATE 6. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

Remarks: The illustrated specimen, because of poor preservation, is questionably assigned to the genus *Aequitriradites*. Only one specimen was found in the sample from Adobe Canyon.

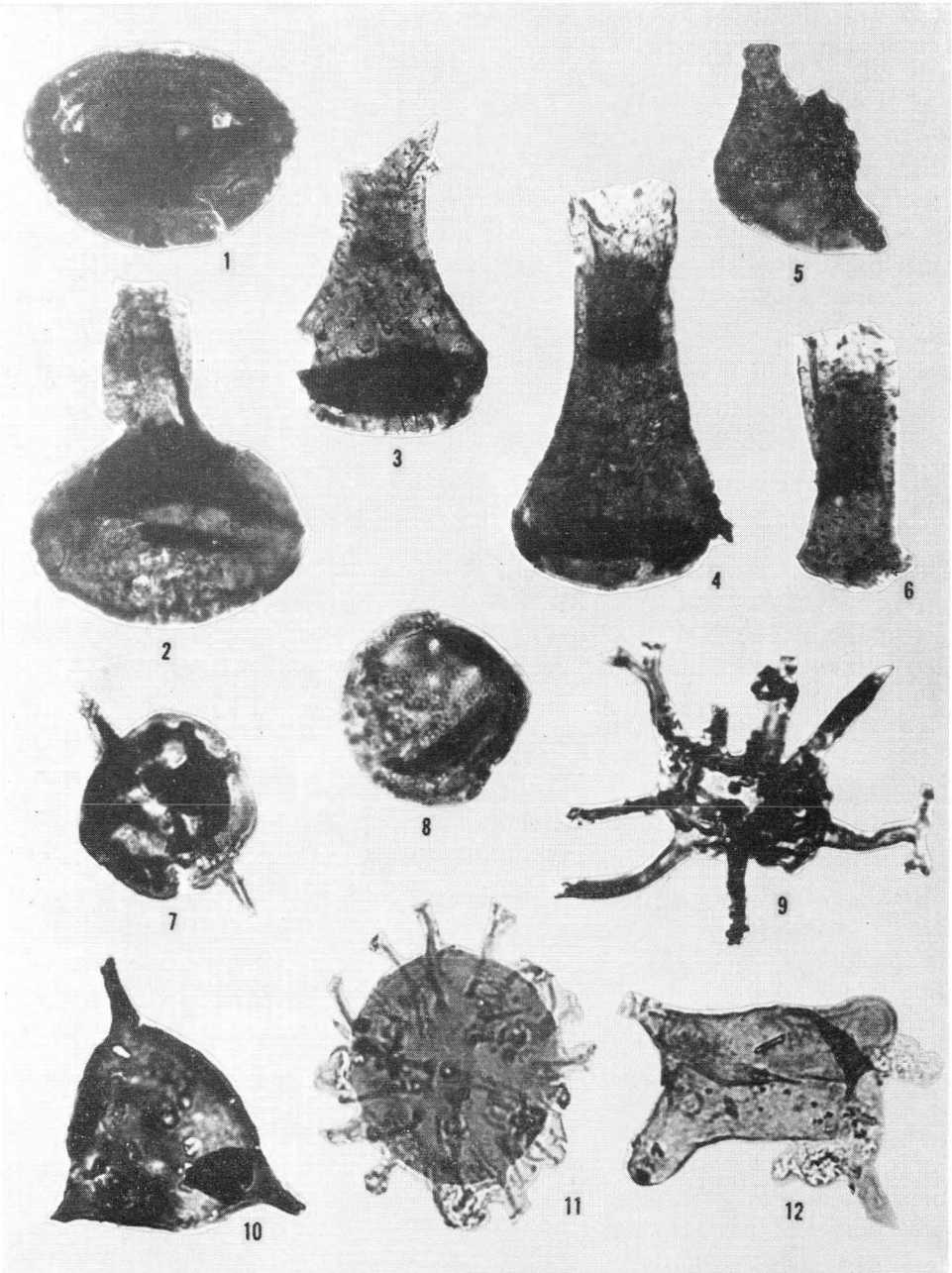

PLATE 7. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

GENUS *MONOSULCITES* Cookson, 1947

Type species: *Monosulcites minima* Cookson, 1947

Description: The genus *Monosulcites* was proposed to include pollen grains with a single furrow. Ornamentation generally smooth and may be spinose, but not reticulate.

Monosulcites sp.
Plate 5, Figs. 1a and b

Description: Pollen grain fusiform in equatorial cross-section, monosulcate, and 40 μ in length. There is a central thickening of the lips along the sulcus. Ornamentation consists of small spinose to baculate projections evenly distributed over the pollen grain except around the furrow.

Remarks: A single specimen was recovered from the Adobe Canyon material. The grain fits the definition of *Monosulcites* and is consequently assigned to that genus.

GENUS *GINKGORETECTINA* (Maliavkina 1953) Emended Potonié 1958

Type species: *Ginkgoretectina punctata* Maliavkina 1953

Description: This genus is represented by monosulcate pollen grains having an elongated fusiform equatorial outline. The exine is generally smooth to infrapunctate. Ends of grain pointed but may be surrounded by short discontinuous folds. The furrow extends to near the equatorial margin.

Ginkgoretectina? sp.
Plate 5, Fig. 2

Description: Monosulcate pollen grain, 80 μ in length; furrow terminating at equatorial margin; ends of pollen grain slightly rounded or pointed. Ornamentation smooth, this may be the result of poor preservation.

Remarks: Only one specimen was observed. The grain fits within Potonié's (1958) definition of *Ginkgoretectina* and is therefore tentatively assigned to that genus.

GENUS *ANEMIIDITES* Ross, 1949

Type species: *Anemiidites echinatus* Ross, 1949

Description: Spores radial, trilete, equatorial outline triangular, apical margins narrowly rounded, interapical margins range from concave to nearly straight. Ornamentation consists of fine and coarse spines which may obscure the trilete mark.

Remarks: The genus *Anemiidites* as described by Potonié (1956) has coarser and stouter spines than *Acanthotriletes*.

Anemiidites? sp.
Plate 5, Fig. 3

Description: Trilete spore, 40 μ in diameter, equatorial outline triangular. Interapical margins strongly concave; ornamentation consists of finely ciliate to spinose projections which obscure the trilete mark.

Remarks: Only one specimen was found in the Adobe Canyon sediment samples. It fits within Ross's (1949) definition of *Anemiidites* and is assigned to that genus.

GENUS *LABIADENSITES* Hacquebard and Barss, 1957

Type species: *Labiadensites attenatus* Hacquebard and Barss, 1957

Description: Spores rounded to sub-triangular, radial, and trilete with uniform equatorial thickening of the spore coat. The spore coat may be strongly tapered and simulate a flange or may possess an irregularly thickened margin. The central area is thinner than the equator and in well preserved specimens it is marked by a strong trilete mark with well developed lips. In poorly preserved specimens the central areas is not apparent. Species of the genus *Labiadensites* range from 70 μ to 250 μ in the greatest diameter.

Labiadensites? sp.
Plate 5, Figs. 4 and 6; Plate 6, Fig. 10

Description: Spores, subround to subtriangular in equatorial outline, and range from 64 to 86 μ in diameter. Central portion of spores usually absent; margin of spore wall folded.

Remarks: The illustrated specimens from Adobe Canyon are poorly preserved and are questionably assigned to this genus.

CLASS CHAROPHYTA
ORDER CHARALES

FAMILY POROCHARACEAE Grambast, 1962
SUBFAMILY STELLATOCHAROIDAE Grambast, 1962

GENUS *STELLATOCHARA* Horn af Rantzien, 1954

Type species: *Stellatochara sellingii* Horn af Rantzien, 1954

Stellatochara mundula (Peck)
Plate 2, Fig. 1a and d

Description: Small ovoid gyrogonites averaging approximately 430 μ in length, and about 200 μ in diameter. The gyrogonites have 8 to 12 sinistrally spiraled units. The ridges terminate apically and form a large circular pore that occupies the greater portion of the summit. A small pentagonal-shaped basal pore is also present.

Remarks: The description is based on observations and measurements of six specimens. The conspicuous truncated summit at the end of a short neck and the small basal pore, are characteristic of *Stellatochara mundula*. The illustrated specimens are from a yellow, conglomeratic shell hash exposed along the East Branch of Adobe Canyon between Miller's (1964) "Unionid Locality" and "First Bluff" (Text, Fig. 3).

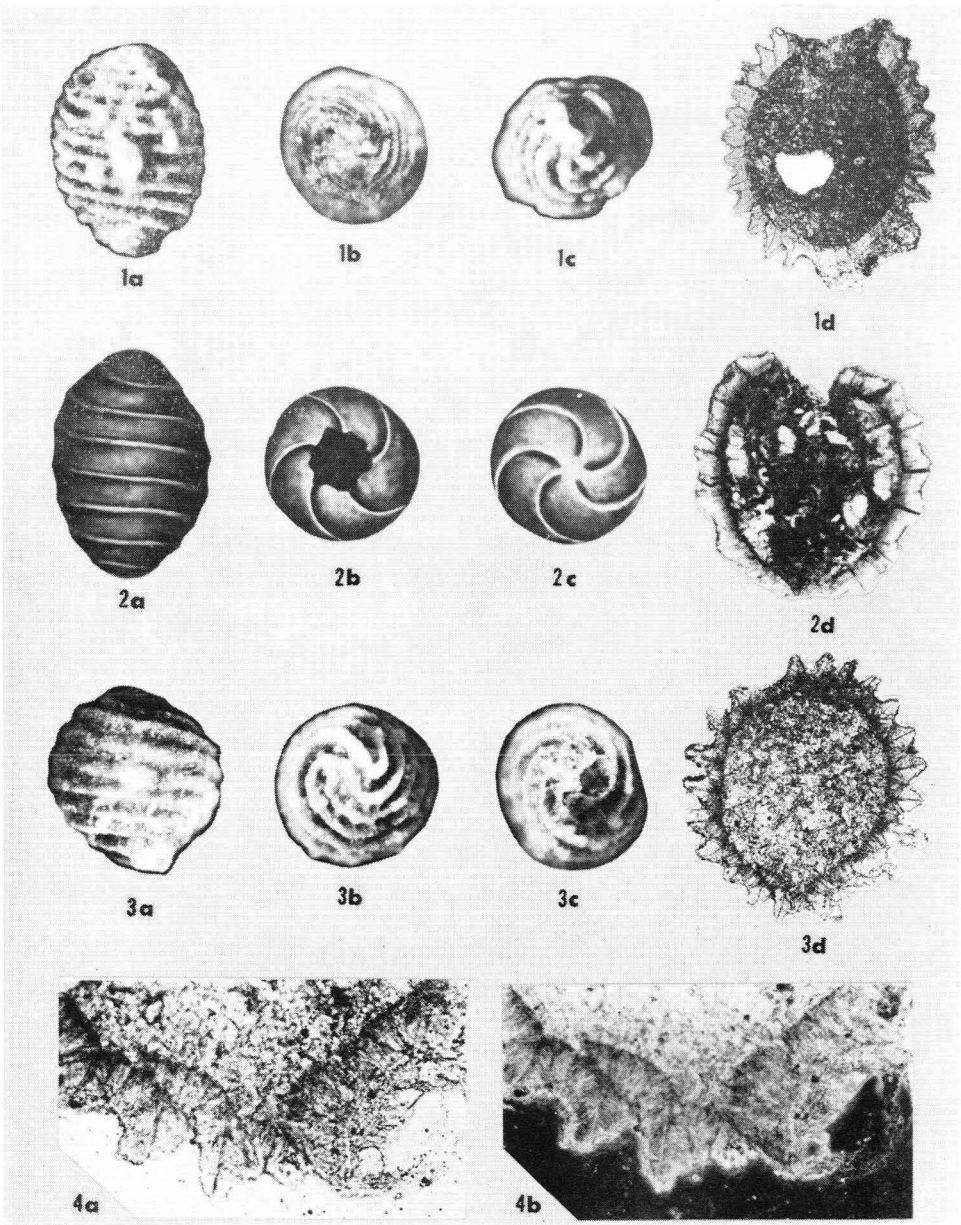

PLATE 2. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

Occurrence: Peck (1957) reported *Stellatochara mundula* to be widespread and abundant in the Albian Bear River Formation of southwestern Wyoming and in the Peterson Limestone and Draney Limestone (Aptian) of west central Montana.

Repository: UA 51b, University of Arizona paleontological collections.

FAMILY CHARACEAE
SUBFAMILY ACLISTOCHAREAE

GENUS *ACLISTOCHARA* Peck, 1937, emend. 1957

Type species: *Aclistochara bransoni* Peck, 1937

Aclistochara sp. cf. *A. bransoni* (Peck)
Plate 2, Figs. 2a and d

Description: Gyrongonite small and spheroidal. Inasmuch as the summit areas are poorly preserved, the large depression characteristic of *A. bransoni* is not visible in the specimens from Adobe Canyon. The specimens average 420 μ in length and 350 μ in width. Gyrogonites have 6 to 8 sinistrally spiraled ridges; the spiral ridges are intercellular, and interspiral sutures are visible.

Remarks: The description was based upon 13 poorly preserved specimens collected by the writers from several localities in Adobe Canyon. The specimens are similar to *Aclistochara bransoni* (Peck) and are therefore tentatively assigned to that species.

Occurrence: Peck (1957) recorded this species from the Morrison Formation (Upper Jurassic) of Wyoming. The specimens came from El Pilar Tank near Miller's (1964) "Tooth Locality" in the East Branch of Adobe Canyon.

Repository: The specimens are UA 51 in the paleontological collections of the University of Arizona.

SUBFAMILY CHAROIDEAE

GENUS *MESOCHARA* Grambast, 1962

Type species: *Mesochara (Praechara) symmetrica* (Peck) 1957

Mesochara voluta Miller and Schwab, nov. comb.
Plate 2, Figs. 3a and b, 4a and b

Description: Gyrogonites small, subround to obovoid or ellipsoid, and measure 450 μ in length and 200 μ in width. The 8 to 10 spiral ridges of the gyrogonites are sinistrally coiled. The spirals continue onto the summit without change in size and unite apically. At the base, the spirals terminate about a large pore approximately 50 μ in diameter. The wall encompasses the pore, (Plate 2, Figs 4a and b), and is shaped like an inverted cone. This feature is characteristic of *Mesochara voluta.*

Remarks: *Mesochara voluta* was formerly assigned to the genus *Praechara. Praechara,* however, is an invalid generic name proposed by Horn af Rant-

zien (1954) and the species has been assigned to various other genera by Grambast (1962). From Grambast's description it is evident that *"Praechara" voluta* should be referred to *Mesochara.*

The illustrated specimens of *Mesochara voluta* are from a yellow conglomeratic shell hash zone exposed along the East Branch of Adobe Canyon between Miller's (1964) "Unionid Locality" and "First Bluff" (Text, Fig. 3). Occurrence: Peck (1957) reported *Mesochara voluta* from the Morrison Formation (Upper Jurassic) and the Bear River Formation (Albian) of Wyoming.

Repository: UA 51c; University of Arizona paleontological collection.

Unidentified Plant Materials
Plate 3, Fig. 4

Description: Fragments of plant stems ranging from 1 through 7 cm. in length. Diameters vary from 0.5 cm. (ovoid cross-section) through 2.0 cm. elongated cross-section. The stems seem to be of two main kinds.

A smaller stem fragment (UA 56) 1 cm. long, an oval cross-section with greatest diameter of 7 mm. and least diameter of 5 mm., is marked by fine irregular, longitudinal lines on the exterior. The interior of the stem consists of a central pithy portion filled with thick-walled tubules, surrounded by an annulated zone of different texture lacking the tubules.

The larger stem fragments (UA 57) have irregular cross-sections, and a bark-like exterior appearance. The outer portion of the stem consists of a light colored area marked by fine, short lines oriented perpendicular to the exterior. This layer surrounds a darker, dense core that seems to have a faintly developed radiating structure. A few thick-walled tubules are present in the core. Annular structures are not present.

Repository: Specimens UA 56 and UA 57 in the University of Arizona paleontological collection.

KINGDOM ANIMALIA
INCERTAE SEDIS

"Egg Capsules"
Plate 1, Fig. 6; Plate 3, Fig. 2

Description: Three small (.2 mm.) spheres that resemble red or amber spheres usually found associated with conodonts in Paleozoic rocks. The spheres are hollow and easily crushed. One sphere is filled with material and has a reddish color. The walls are relatively thin and have a lamellar structure. The composition of the spheres is unknown, but the writers suspect an organic chitin-like substance.

Remarks: The spheres may have been reworked from Paleozoic rocks, as other reworked Paleozoic microfossils and fish plates occur in sediments of Adobe Canyon. Spheres similar to these have been observed by the authors in Paleozoic, Mesozoic, and Cenozoic sediments. The authors have

thin sectioned Paleozoic spheres and find that most of them are hollow and thin walled; however, some of the Paleozoic spheres seem to be solid, and are composed of calcium phosphate. It may be significant that the spheres occur in with Charophytes in that thin sections show the wall structure to

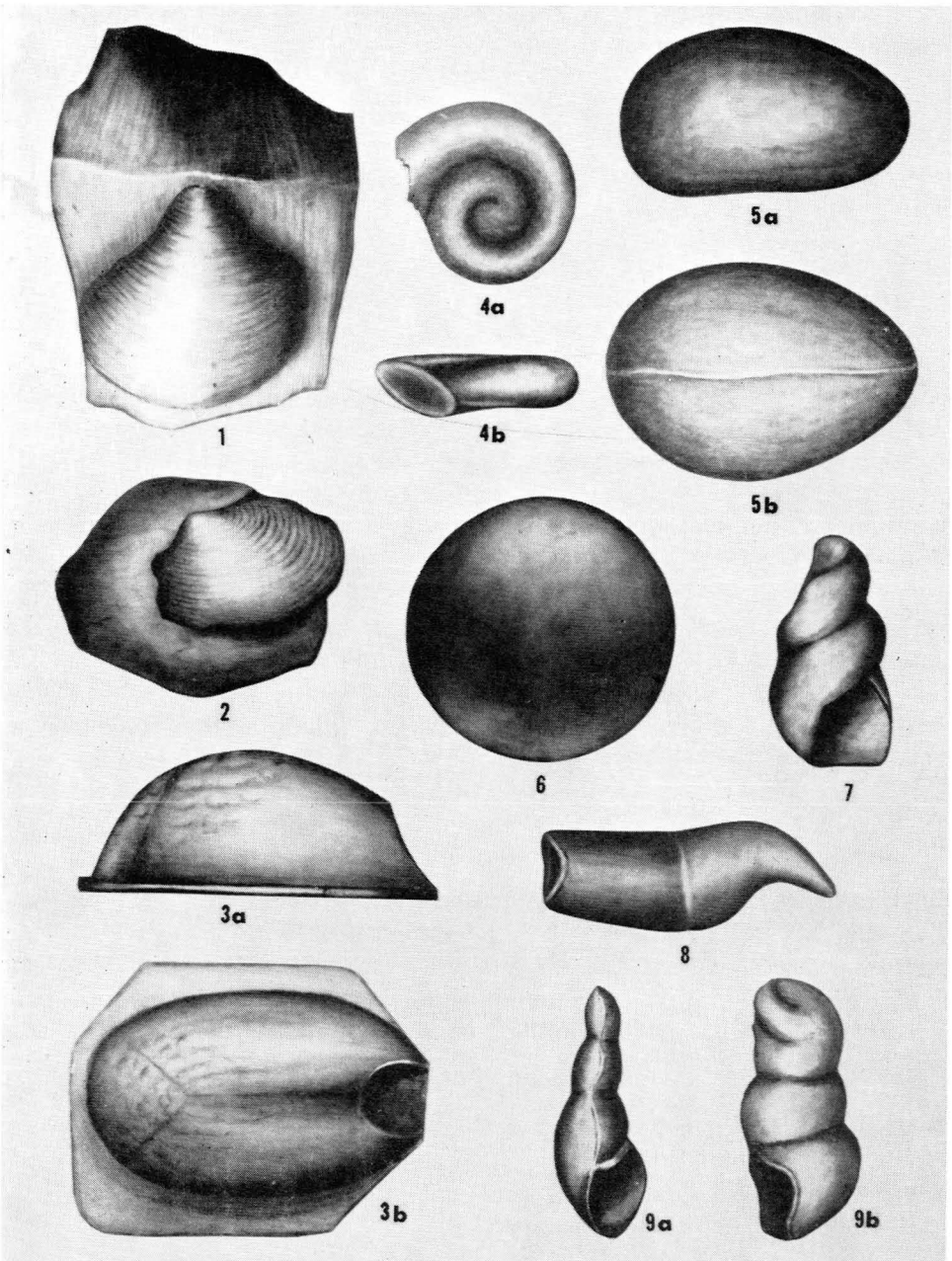

PLATE 1. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

be similar to structures observed of the oospore membrane from Recent Charophytes. They are also similar in construction and size to Recent brine shrimp egg cases.

The origin of the spheres is uncertain and to place them in a taxonomic group at this time is unfeasible, although their consistent size and structure suggest that they may be "egg capsules" of some unidentified animal.

The specimens illustrated were found near El Pilar Tank and the "Tooth Locality" in the East Branch of Adobe Canyon.

Repository: Specimen UA 55 in the University of Arizona paleontological collection.

ORDER HYSTRICHOSPHAERIDEA

GENUS *LEIOSPHAERIDIA* (Eisenack 1958) Downie and Sarjeant, 1963

Type species: *Leiosphaeridia baltica* Eisenack 1958

Description: The genus *Leiosphaeridia* includes spherical to ellipsoidal hystrichospherids without processes; the wall is usually partially collapsed or folded, and with or without pylomes. The walls are thin and may be granular, punctate or otherwise ornamented, and are without divisions into zones and without transverse or longitudinal furrows or girdles.

Remarks: The genus *Protoleiosphaeridium* Timofiev was not validly published until 1959; its type species *P. conglutinatum* was not designated until 1960. Both *Protoleiosphaeridium* and *Leiosphaeridium* have about the same size range, 20 to 30 microns and 200 to 300 microns. Downie and Sarjeant (1963) regard *Protoleiosphaeridium* as a subgenus of *Leiosphaeridia* and restrict it to thin walled forms having a diameter less than 50 microns. The writers accept this classification.

Leiosphaeridia? sp. "A"
Plate 3, Fig. 8

Description: Test round to subround in outline, approximately 80 μ in diameter. The wall unornamented and folded near the margin of the test.

Remarks: Only one specimen was observed and it is questionably assigned to this genus.

Leiosphaeridia (Protoleiosphaeridium) sp. "B"
Plate 5, Fig. 5

Description: Test round, approximately 20 μ in diameter, and has numerous spines. The spines are stout, have a thick base tapering to a sharp point. The wall is not folded and the spines are evenly distributed over the surface of the grain.

Remarks: The above description is based on several specimens, one of which is illustrated.

Leiosphaeridia (Protoleiosphaeridium) sp. "C"
Plate 5, Figs. 9 and 11

Description: Test round, 30 μ in diameter, densely covered with fine to moderately stout spines. The spines are evenly distributed over the surface of the grain, but are more crowded than those of species "B".

Remarks: This species is the most abundant species of *Leiosphaeridia.*

Leiosphaeridia sp. "D"
Plate 6, Figs. 8 and 9

Description: Tests are round, approximately 50 μ in diameter, have smooth walls which are folded so that the grain has an irregular outline.

Remarks: One specimen appears to be either broken or possess spines (Plate 6, Fig. 8). If the projections are spines and not features due to preservation, then the specimen does not belong with the *Leiosphaeridia* and may possibly be a basal view of a chitinozoan similar to *Ancyrochitina.*

Leiosphaeridia? sp. "E"
Plate 7, Fig. 8

Description: Test is small, rounded, and approximately 26 μ in greatest diameter. The walls appear to be partly smooth and partly granulose and are folded.

Remarks: Only one specimen was observed and is tentatively placed in this genus.

GROUP ACRITARCHA EVITT, 1963

GENUS *BALTISPHAERIDIUM* (Eisenack 1958) Downie and Sarjeant, 1963

Type species: *Baltisphaeridium longispinosum* (Eisenack 1931) Eisenack 1958

Description: Downie and Sarjeant (1963) emended Eisenack's original description of the genus *Baltisphaeridium* to include hystrichospheres with spherical to ovoid tests that are not divided into zones or plates and bear a few or many processes (spines, etc.) The processes may be simple, branching or ramifying, hollow to partly solid, and with closed tips that do not unite distally. An outer test is not present. The processes are generally of one basic type; however, more than one type may be present. The average diameter of the test (body) is greater than 20 microns.

Baltisphaeridium sp. "A"
Plate 5, Fig. 8

Description: Test round, bearing numerous, hollow processes with closed tips. The processes bifurcate and sometimes trifurcate distally. The test is 24 microns in diameter, the processes are 6 microns long, and terminate about 1 or 2 microns after branching.

Remarks: Only one specimen was observed in the residue from Adobe Canyon.

Baltisphaeridium sp. "B"
Plate 5, Fig. 10; Plate 7, Fig. 9

Description: Tests subround to oval, approximately 25 microns in diameter with 3 to 8 long, hollow processes with closed tips. The processes are generally 18 to 20 microns in length and bifurcate into four smaller processes distally (Plate 5, Fig. 10). The spines are too large for the test and give the specimen an unproportionate appearance.

Remarks: Several specimens were observed in the sample, and two of the best preserved specimens are illustrated.

Baltisphaeridium sp. "C"
Plate 6, Fig. 4

Description: Test round, 22 microns in diameter with 6 to 10 processes 14 microns long. The processes are evenly distributed over the test, appear to be hollow for the greatest portion of their length, and become solid distally.

Remarks: Several specimens were observed in the sample from Adobe Canyon and one well preserved specimen was illustrated.

GENUS *VERYHACHIUM* (Denuff) Downie and Sarjeant, 1963

Type species: *Veryhachium trisulcum* Denuff, (1954) 1959

Description: Downie and Sarjeant (1963) define the genus *Veryhachium* as those hystrichospheres with a globular, ovoid, triangular, convexly trigonal, polygonal or subpolygonal tests, normally with three or four, although as many as 8 may be present, simple, broad-based, tapered spines or appendages. The spines may be curved on some species. The appendages are hollow with closed tips and are connected with the central body. The diameter size range of the tests is 10 to 40 μ.

Remarks: The phylemic affinities of this genus are not clear. Denuff (1959) and others believe that it may belong to the Family Hystrichosphaeridae. Baschnagel (1942) believed it to be an alga and to belong to the Class Chlorophyceae. Evitt (1961) considers it to be a non-dinoflagellate protozoan cyst.

Veryhachium sp. cf. *V. trispinosum* (Eisenack, 1938) Denuff, 1954
Plate 7, Fig. 10

Description: Triangular to subtriangular test; central body 30 to 35 μ in diameter, bearing 3 appendages exceeding 10 μ in length. Surface ornamentation smooth to laevigate.

Remarks: The illustrated specimen from Adobe Canyon closely resembles *Veryhachium trispinosum* (Eisenack) Denuff, in that the sides of the central body or vesicle are almost straight. For this reason it has been tentatively placed in the above species.

Veryhachium sp. "A"
Plate 6, Figs. 1 and 2

Description: Outline triangular with concave margins. Three broad-based, hollow appendages with closed tips are connected with and derived from the central body. The two specimens from Adobe Canyon measured 30 μ in diameter. The central body is marked by a series of striate or plicate ridges which form a pattern similar to the outline of the specimen.

Veryhachium sp. "B"
Plate 6, Fig. 3

Description: Outline triangular to globular. Five or six appendages are connected with the central body. The illustrated specimen measured 30 μ in diameter; the appendages are hollow with closed tips and are 8 μ long.

GENUS *HYSTRICHOSPHAERIDIUM* Deflandre, 1937

Type species: *Hystrichosphaeridium tubiferum* (Ehrenberg) Deflandre, 1934

Description: Body spherical to polyhedral, elongate, greater than 30 μ in diameter; ornamentation generally consists of spinose appendages that may attain a length of 150 μ and have modified tips.

Hystrichosphaeridium sp. "A"
Plate 5, Fig. 8

Description: Body spherical, 40 μ in diameter, and bears 8 to 12 spinose appendages which bifurcate at the tips. The wall of the specimen is smooth.

Remarks: Only one nearly complete specimen was found. Fragments similar to described species were observed but poor preservation made positive identification impossible.

Hystrichosphaeridium sp. "B"
Plate 6, Fig. 5

Description: Specimen 36 μ in diameter, wall smooth, bearing 12 to 14 appendages. The appendages are derived from the central body, are thick, and appear to be hollow with rounded, closed tips. The appendages appear to be absent from the central portion of the test and are restricted to the equator of the grain.

Remarks: The illustrated specimen is folded; consequently, it is difficult to observe all the appendages. Only one specimen was found.

Hystrichosphaeridium? sp. "C"
Plate 6, Figs. 6a and b

Description: Test spherical to globular in shape with a central body 40 μ in diameter covered by a thin, usually folded, perium-like structure. The diameter of the illustrated specimen is 82 μ.

Remarks: One specimen was observed and tentatively identified as belonging to this genus.

GENUS *PTEROSPERMOPSIS* Wetzel 1952

Type species: *Pterospermopsis danica* Wetzel, 1952

Description: The genus Pterospermopsis was erected by Wetzel (1952, p. 411) for forms with a central capsule covered by a soft membrane of unvarying width of separation from the central body. The cross-section is elliptical to round. Fossil species lack the girdle band present in the modern species of *Pterosperma.*

Pterospermopsis? sp.
Plate 6, Figs. 7a and b

Description: Hystrichomorphs 31 μ in greatest diameter; central capsule approximately 20 μ in diameter. The central capsule is covered by a thin membrane that appears to fold readily.

Remarks: Wetzel's (1952) description of *Pterospermopsis* is broad and it allows a number of different genera to be placed within its bounds. The writers are questionably assigning the illustrated specimen to *Pterospermopsis.*

PHYLUM PROTOZOA?

ORDER CHITINOZOA Eisenack, 1931

FAMILY CONOCHITINIDAE Eisenack, 1931

GENUS *SPHAEROCHITINA* Eisenack, 1955

Type species: *Lagenochitina sphaerocephala* Eisenack, 1932
Plate 7, Figs. 2 and 6

Description: The genus Sphaerochitina was proposed for those forms having a con or flask-shaped body chamber and a moderately long subcylindrical neck, the oral end of which is terminated by a thin translucent collar surrounding the aperture. The base of the test is subround to convex. Ornamentation in most species consists of short, thick, erect spinules, while in others the test may be smooth, granular, or finely nodose. The dimensions of the illustrated specimens range from 80 to 140 μ from the apex of the collar to the base of the bowl, and from 50 to 80 μ across the body chamber. The average length is 123 μ and the average width 80 μ.

Occurrence: *Sphaerochitina sphaerocephala* was first reported by Eisenack (1932, p. 271, Pl. 12, Figs. 14-15) from the Silurian Beryichienkalk of the Baltic region. Dunn (1959) reported *Sphaerochitina* from the upper portion of the Solon Member and the Rapid Member of the Cedar Valley Formation (Middle Devonian) of Iowa. The genus *Sphaerochitina* is considered to range from the Middle Ordovician through the Devonian.

FAMILY DESMOCHITINIDAE Eisenack, 1931

GENUS *HOEGISPHAERA* Staplin, 1961

Type species: *Hoegisphaera glabra* Staplin, 1961
Plate 7, Fig. 1

Description: Chitinozoans with spherical shape, surface laevigate, and dark amber-brown. The color, however, may vary depending upon the degree of oxidation resulting from maceration. When viewed orally *Hoegisphaera* appears as a thick circular ring, or series of rings, surrounding a central operculum which may be partially or entirely removed. The illustrated specimen is 94 μ in diameter, the operculum measures 42 μ in diameter.

Remarks: The genus *Hoegisphaera* appears to be closely related to those chitinozoans belonging to the Family Desmochitinidae. The Desmochitinidae when viewed laterally seem to be composed of a series of small circular flask-shaped tests with a short, thick neck attached to the base of the preceding test in a chainlike fashion. When observed from an oral position, they seem to be a round test with a circular aperture which may or may not be occupied by an operculum. It is highly possible that the genus *Hoegisphaera* is a broken segment of a chainlike chitinozoan. For this reason the writers have tentatively placed the genus *Hoegisphaera* in the Family Desmochitinidae.

Occurrence: Staplin (1961, p. 419) reports *Hoegisphaera* from the Sylvan Shale (Ordovician) and Tuplip Crek Formation (Ordovician) of Oklahoma. It is probable that the geologic range of *Hoegisphaera* extends into the Upper Devonian.

PHYLUM MOLLUSCA
CLASS PELECYPODA

FAMILY SPHAERIIDAE

Sphaerium sp. cf. *S. formosum* Meek and Hayden
Plate 1, Fig. 1

Description: Two small specimens from El Pilar Tank in Adobe Canyon. The smaller specimen measures 3.5 mm. in greatest height and 4 mm. in greatest width. The larger specimen measures 4.7 mm. in greatest height and 4.5 mm. in greatest width. Both the specimens are slightly distorted.

The shells are of approximately equal width and height, and are marked by fine, regular growth lines. Concentric undulations parallel the growth lines but are less abundant than the growth lines. Nine undulations were counted on the one complete specimen. The hinge line is short and straight; the beak is prominent.

Remarks: The specimens resemble closely Meek and Hayden's figures and description of *S. formosum* and are referred to that species. The shells are well preserved, but appear to have been replaced. The specimens were found near El Pilar Tank and in the *Corbicula* shell bed in the East Branch of Adobe Canyon.

Repository: Specimens are numbered UA 44 and are in the University of Arizona paleontological collection.

Corbicula sp.
Plate 1, Fig. 2

Description: Several poorly preserved specimens in a rock sample from a shell bed. Three nearly complete specimens were measured as: greatest height 5 mm. and greatest width 6 mm.; greatest height 7 mm. and greatest width 8 mm.; greatest height 8 mm. and greatest width 9 mm. The shell is ovoid, the beak is prominent and slightly to the anterior, the surface is marked by fine, regular concentric lines. Some specimens have two or three strong concentric furrows. Hinge line features are not discernible.

Remarks: The specimens are smaller than most described species of *Corbicula,* however, they fall within the range of variation of that genus. The shell bed is exposed in the lower portion of the East Branch of Adobe Canyon (Text, Fig. 3).

Repository: Specimen number UA 54 in the University of Arizona paleontological collection.

CLASS GASTROPODA
FAMILY PLANORBIDAE

Gyraulus sp.
Plate 1, Figs. 4a and b

Description: Four fragmentary specimens; greatest diameter of the smallest specimen is 1 mm., greatest diameter of the largest specimen is 2 mm. The largest specimen consists of two whorls. The aperture is ovoid and the shell is planispirally coiled. The exterior of the shell is smooth.

Remarks: The specimens are immature and too poorly preserved to warrant further description and closer identification. Specimens have been found near the El Pilar Tank and the "Tooth Locality" in the East Branch of Adobe Canyon.

Repository: Four specimens numbered UA 52 in the University of Arizona paleontological collection.

FAMILY PLEUROCERATIDAE

Goniobasis sp.

Plate 1, Figs. 7, 9a, and 9b

Description: Two incomplete internal casts. The larger specimen (UA 41) consists of three volutions, has a greatest height of 14 mm., and a greatest width of 7.5 mm. No external ornamentation can be discerned.

The smaller specimen (UA 42) has a greatest height of 11.5 mm., and the greatest width is probably 4 mm. The specimen is flattened. Small fragments of shell material adhering to the cast show growth lines.

The casts are high spired, the tips are broken away, and the aperture appears to be ovoid.

Remarks: The specimens are too incomplete and too poorly preserved for positive identification.

Repository: Specimens UA 41 and UA 42, University of Arizona paleontological collection.

PHYLUM ARTHROPODA

SUBCLASS OSTRACODA

ORDER PODOCOPIDA

FAMILY CYPRIDAE

Cypridopsis sp.

Plate 1, Figs. 5a and b

Description: Internal cast .5 mm. in greatest length. Valves inflated, kidney shaped, nearly equal in size, thickest in postmedian, muscle scars not apparent.

Remarks: Only a single whole ostracode has been discovered by the authors thus far. The specimen seems to resemble *Cypridopsis* closely, and we refer it to that genus. Fragments of ostracodes have come from El Pilar Tank and the "Tooth Locality" in the East Branch of Adobe Canyon.

Repository: The figured specimen is UA 47, University of Arizona paleontological collections.

CLASS INSECTA

ORDER DIPTERA

FAMILY CULICIDAE

Unidentified Mosquito

Plate 1, Figs 3a and b; Plate 3, Fig. 10

Description: Specimens consist of several calcified puparia and a fragmentary adult. The adult (not illustrated) specimen's wings are broken away, and the specimen consists of a calcified abdomen, thorax, and cephalon. Portions of the legs are present. The puparia are also calcified, and are filled with calcareous silt. A thin sectioned puparium (UA 50) is 9.0 mm. long, the walls are 0.1 mm. thick and are composed of two calcified layers, the central cavity is 0.2 mm. wide and 0.7 mm. deep.

Remarks: The remains were picked out of fresh matrix, and showed evidence of fossilization. The writers are confident they are not Recent contaminants. The specimens were identified by Mr. Anthony Ross of the University of Arizona Zoology Department. Because the adult specimen lacks wings and the puparia are incomplete, identification below familial level was not feasible.

Mosquito puparia are composed of nearly indestructable chitin, which may or may not be calcified, and should be abundant in none-marine sediments.

The insect containing sediments were collected from the shales exposed near El Pilar Tank and the "Tooth Locality" in the East Branch of Adobe Canyon.

Repository: The adult is UA 48, the illustrated puparium is UA 49, and a thin section of another puparium is UA 50 in the University of Arizona paleontological collections.

Unidentified Insect Claw
Plate 1, Fig. 8

Description: Small insect claw (pretarsus) 0.35 mm. in greatest length, and 0.12 mm. in greatest width. The claw is dark in color and seems to be composed of chitin, and may not be calcified.

Remarks: Mr. Anthony Ross of the University of Arizona Zoology Department examined the claw and identified it as the pretarsus of a larval insect. Further identification could not be accurately made as the pretarsus of larvae are not distinctive. The claw came from near El Pilar Tank and was extracted from matrix.

Repository: Specimen UA 53 in the University of Arizona paleontological collection.

CLASS AGNATHA

Ostracoderm Plates
Plate 3, Figs. 5 and 6

Description: Small bony plates, 1 to 2 mm. in diameter. The plates are constructed of two units: an outer amber to amber-black, highly porous, glassy surface, 50 μ thick and an inner white, less porous, bony layer, 100 μ thick. The surface of the plates are marked by elongated pits approximately .5 to 1.0 mm. in diameter. The pit extends through the outer glassy unit and terminates in the bony layer as a shallow depression.

Remarks: The specimens from Adobe Canyon are identical to those described by Schwab (1965) from the Catheys' Limestone (Middle Ordovician) of Davidson County, Tennessee. In order to illustrate the morphologic features, well preserved specimens from the Catheys Limestone were used in place of the poorly preserved plates from Adobe Canyon.

Repository: USNM 145595.

CLASS OSTEICHTHYES
FAMILY PYCNODONTIDAE

Gyrodus? sp.
Plate 3, Fig. 1

Description: Two nearly flat crowned, thick rooted fish teeth. Specimen UA 45 is the most complete, the crown measures 6 mm. in greatest diameter and 4 mm. in least diameter. The crown is 1 mm. thick. The root is massive,

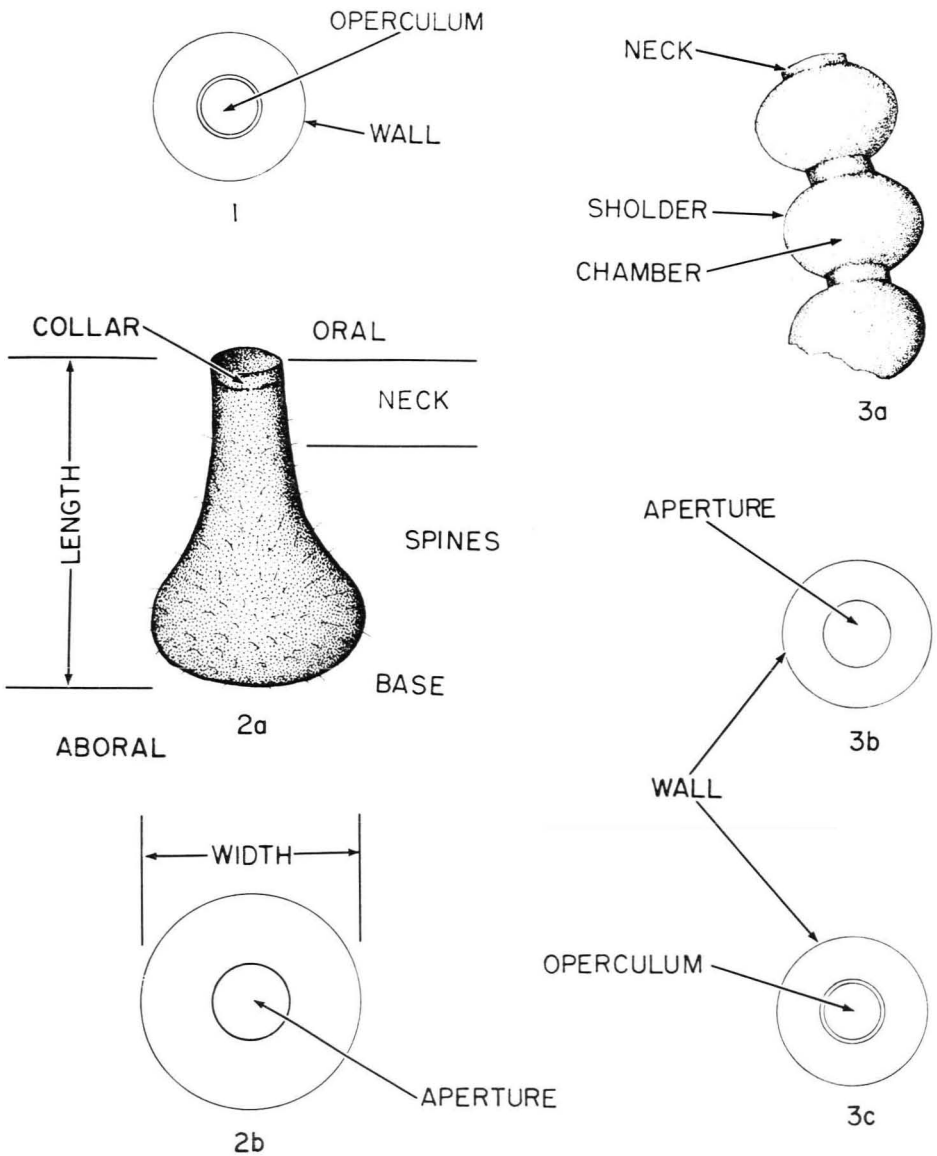

FIGURE 4. Microfossils from the Upper Cretaceous of Adobe Canyon, Southern Arizona.

9 mm. in greatest length, 7 mm. in greatest width, and 4 mm. in least width (near the base of the crown). The least width is measured perpendicular to the greatest width as the root is rectangular. The root is inclined to the surface of the crown at an angle of 45°. The edges of the crown are rounded and convex, except on the side toward which the root is inclined, that side is slightly concave and is marked by 12 vertical ridges. The ridges do not extend onto the crown, nor below the edge of the cap. They do not extend to the lower edge of the enamel. The root has a vertically striated sulcus directly below the concave edge of the crown, the striations extend out from the sulcus around the sides of the root.

Specimen UA 46 consists of a large crown, greatest diameter approximately 11 mm., and least diameter 8.5 mm. The enamelled cap is 4 mm. thick. The root is broken away, and the specimen is partly covered by a calcareous concretion. The exposed portion of the tooth resembles specimen UA 45.

Remarks: Cretaceous non-marine fish are imperfectly known and the teeth herein identified as *Gyrodus?* may not be pycnodontid teeth, but the teeth of another fresh water fish that mimicked their eating habits and consequently acquired their tooth type.

Romer (1945, p. 80) questionably reported *Gyrodus* from Upper Cretaceous rocks of North America.

Specimen UA 45 is from the "Tooth Locality" in the East Branch of Adobe Canyon and specimen UA 46 is from "First Bluff" in Adobe Canyon.

Repository: Specimens UA 45 and UA 46 in the University of Arizona paleontological collections.

FAMILY AMMIIDAE
AMIOID FISH

Unidentified Amioid Fish
Plate 3, Fig. 3

Description: Greatest dimensions 25 by 19 mm., ovoid palatal bone fragment, with edges broken away on all sides, except along a 20 mm. distance where markings indicating a suture may be discerned. The upper surface is covered by rounded, pebble-like teeth, ranging from less than 1 to 3 mm. in greatest diameter. The teeth are crowded together, are distorted and range from nearly circular, through ovoid and flat sided, to triangular in outline. The individual teeth are rounded and smooth on the top, if unworn. Worn teeth show a circular depression with a central, circular pap like projection, and fine furrows radiate outward from the edge of the depression.

The underside of the bone fragment is marked with a thumbprint-like pattern of fine ridges.

Remarks: A well preserved fragment of a crushing or grinding plate from an unknown amioid fish. The palatal fragment is unusually large, and may be related to the amioid vertebra reported by Miller (1964, p. 382). Dr.

Donald Baird, personal communication, stated that the vertebra is that of *Protamia*. The bone came from near El Pilar Tank in Adobe Canyon. Repository: Specimen UA 43 in the University of Arizona paleontological collection.

REFERENCES

Baschnagel, R. A.
1942 Some microfossils from the Onondaga Chert of Central New York: Bull. Buffalo, Soc. Nat. Sci., v. 17, p. 1-18.

Clarke, Robert T.
1965 Fungal Spores From Vermejo Formation Coal Beds (Upper Cretaceous) of Central Colorado: The Mountain Geologist, v. 2, n. 2, p. 85-93, 1 pl. Rocky Mtn. Assn. of Geologists, Denver, Colo.

Cookson, I. C.
1947 Plant Microfossils from the Lignites of Kergueler Archipelago: B. A. N. Z. A. R. E. Antarctic Research Expedition 1929-31, Reports-Series A, v. 2, p. 127-142, Table 13-17.

Cookson, I. C., and M. E. Dettmann
1961 Reappraisal of the Mesozoic microspore genus *Aequitriradites:* Paleontology, v. 4, pt. 3, p. 425-427, pl. 52.

Deflandre, Georges
1934 Sur les microfossiles d'origine planctonique conserves a'l'etat de matiere organique dans les silex de la craie: Acad. Sci. Paris, Comptes rendus, v. 199, p. 966-968, 11 figs.
Microfossiles des silex crétacés: Part 2, Flagellés Incertae Sidis. Hystrichosphaeridée. Sarcodinés. Organismes divers: Annales de paléontologie, v. 26.

Delcourt, A., and G. Sprumont
1955 Les Spores Et Grains De Pollen Du Wealdien Du Hainaut: Memories De La Société Belge De Géologie De Paléontologie Et D'Hydrologie, Nouvelle Serie in no. 4-5, p. 1-73, pl. 1-4.

Denuff, J.
1954 *Veryhachium*, genre nouveau d'Hystrichosphères du Primaire: Compt. Rend. Soc. Géeol. France, 13, p. 305-307.
1959 Microorganismes planctoniques du Primaire Armoricain I. Ordovicion du Veryhach.: Bull. Soc. Géol. et Min. de Bretagne (N. S.), Fasc. 2, p. 1-41, pl. 12.

Downie, C., and W. A. S. Sarjeant
1963 On the Interpretation and Status of Some Tystrichosphere Genera: Paleontology, v. 6, pt. 1, p. 83-96, University Press, Oxford, England.

Dunn, David L.
1959 Devonian chitinozoans from the Cedar Valley formation in Iowa: Jour. Paleontology, v. 33, n. 6, p. 1001-1017, pls. 125-127, 2 figs.

Eisenack, Alfred
1931 Neue Mikrofossilien des baltischen Silurs, I: Palaeont. Zeitschr., v. 13, p. 74-118, 5 figs., 5 pls. (in German).
1932 Neues Mikrofossilies des baltischen Silurs, II: Paleontologische Zeitschrift, Bd. 14, p. 257-277, pls. 11-12, 13 figs.
1938 Hystrichosphaerideen und verwandte Formen im baltischen Silur: Z. Geschiebeforsch. u. Flachlandsgeol. 14, p. 1-30, pls. 4.
1955 Chitinozoen, Hystrichosphären und andere Mikrofossilien aus dem Beyrichiakayk: Senkenbergiana lethaca, Bd. 36, p. 311-319.
1958a *Tasmanites* Newton 1875 und *Leiosphaeridia* n. g. als Gattungen der Hystrichosphaeridea: Paleontographica, pt. A, v. 110, no. 1-3, p. 1-19, figs. 1, 3, pls. 1, 2.
1958b Mikroplankton aus dem norddentschen Apt. nebst einigen Bemerkungen Über fossile Dinoéagellaten: Neues Jahrb. Mineralogie, Geologie, Paläontologie, v. 106, no. 3, p. 383-422, 10 figs., pls. 21-27.

Evitt, W. R.
1961 Observations on the morphology of fossil dinoéagellates: Micropaleontology, v. 7, n. 4, p. 385-420.
1963 A Discussion and Proposal Concerning Fossil Dinoéagellates, Hystrichospheres, and Acritarchs II: Proc. Nat. Acad. Sci., v. 49, no. 3, p. 298-302.

Grambast, Louis
1962 Classification de l'Embranchement des charophytes: Nataralia Monspeliensia, serie Botanique, fascicule 14, p. 63-86.

Hacquebard, P. A., and M. S. Barss
1957 A Carboniferous Spore Assemblage, In Coal From The South Nahanni River Area, Northwest Territories: Geol. Survey of Canada, Bull. 40, p. 1-50, pls. 1-6.

Hammen, Thomas van der
1954 El desarrollo de la éora Colombiana en los periodos geologicas: Boletín Geológico, v. 2, n. 1, p. 49-106.

Horn af Rantzien, Henning
1954 Middle Triassic Charophyta of South Sweden: Opera Botanica, v. 1:2, p. 5-83, 7 pls.

Ibrahim, A. C.
1933 Sporenformen des Aeqirhorizonts des Ruhr-Reviers: Dissertation, Berlin; privately pub. by Konrad Triltsch, Wurzburg, 47 p.

Knox, E. M.
1950 The spores of Lycopodium, Phylloglossum, Selaginella and their value in the study of microfossils of Paleozoic age. Trans. bot. Soc. Edinb., v. 35, p. 207-257.

Malyawkina, W. S.
1953 Upper Triassic, Lower Jurassic and Middle Jurassic spore-pollen assemblages from the eastern and western Pre-Urals: Leningrad and Moscow, V. N. I. G. R. I. Trad., N. S., 75, p. 93-147 (in Russian).

Miller, H. W.
1964 Cretaceous Dinosaurian Remains From Southern Arizona: Jour. Paleontology, v. 38, no. 2, p. 378-384, pls. 61-62.

Naumova, S. N.
1937 The Spores and Pollen of the Coals of the U.S.S.R.: Internat. Geol. Congr., 17th (U.S.S.R.), Abstr. Papers, p. 60-61, 2 pls.

Peck, Raymond E.
1937 Morrison Charophyta from Wyoming: Jour. Paleontology, v. 11, p. 83-90, pl. 14.
1957 North American Mesozoic Charophyta: U. S. Geological Survey, Professional Paper 294-A, U. S. Gov. Print. Office, Washington: 8 pls., 44 p.

Potonié, R.
1956 Synopsis der Gattungen der Sporae dispersae: Beihefte zum Geologischen Jahrbuch, Heft 23, I. Teil: Sporites, S. 103, Taf. 11.

1958 Synopsis der Gattungen der Sporae dispersae: Beihefte zum Geologischen Jarbuch, Heft 31, II. Teil: Sporites (Nachträge), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpites, v. 31, S. 114, Taf. 11.

Potonié, R., and G. Kremp

1954 Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie: Geol. Jahrb., 69, p. 111-194, pls. 4-20, text-figs. 1-5.

Romer, A. S.

1945 Vertebrate Paleontology: Univ. Chicago Press, Chicago, 687 p.

Ross, N. E.

1949 Investigations of the Senonian of the Kristianstad District, South Sweden. I. On a Cretaceous pollen- and spore-bearing clay deposit of Scania: Bull. Geol. Inst. Uppsala, v. 34, p. 25-44.

Schopf, J. M., L. R. Wilson, and Ray Bentall

1044 An annotated synopsis of Paleozoic fossil spores and the definition of generic groups: Illinois Geol. Survey Rept. Inv. 91, 72 p.

Schwab, Karl W.

1965 Microstructure of Some Middle Ordovician Conodonts: Jour. Paleontology, v. 39, no. 4, p. 590-593, pls. 69-70.

Staplin, F. L.

1961 Reef-controlled Distribution of Devonian Microplankton in Alberta: Paleontology, v. 4, pt. 3, p. 392-424, pls. 48-51, 9 figs., London.

Wetzel, W.

1952 Beitrag zur Kenntnis des dan-zeitlichen Meeresplanktons: Geologisches Jahrbuch, Band 66, S. 822, Taf. 6.