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Patterns of indigenous timber extraction from Moluccan rain forest fringes*

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ABSTRACT. Using ethnographic and historical data, this paper tries to show the effects of different patterns of demand and extraction on the condition of rain forest fringes in the Moluccan islands of eastern Indonesia. The first part examines contemporary folk perceptions and use, with particular reference to the Nuaulu of south central Seram. It covers the impact of gathering forest products, swiddening, timber extraction and forestry practice, together with the cultural uses for wood in construction and manufacturing, and for fuel. The second part ranges more widely, and looks historically at production of forest commodities for exchange, the demands of boat-building, clearance for spice plantations and, finally, modern commercial logging. Traditional modes of extraction had a considerable impact on Moluccan forests prior to the intrusion and effects of occidental capitalism, and an attempt is made to outline a scheme of historical periodization which might serve as a hypothetical framework for future palaeobotanical and archaeological research.

Introduction

Few studies exist of the character and organization of timber extraction among the indigenous peoples of insular southeast Asia. There are, it is true, many lists of useful trees, the occasionally relevant ethnographic account of subsistence, a growing ethnobotanical literature, and a few general summaries (see e.g. Heyne, 1927; Freeman, 1970; Friedberg, 1970; Cobban, 1968). The main exceptions to this otherwise rather uneven coverage have been investigations connected with ascertaining the effects of swiddening on the rain forest. Harold Conklin's notable report on Hanunoo agriculture in the Philippines (1957) was even published as an FAO Forestry Development Paper. It is, however, significant that this important work does not extend to a consideration of other aspects of forest and timber use.

A partial effect of this neglect is the pernicious but nonetheless persisting assumption that there is a sharp break between so-called 'traditional'† patterns of extraction and modern ones; that prior to the intrusion of

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† The word is ubiquitous in the literature on local economies throughout the region and became translated as dogma of a kind in J. H. Boeke's economic dualism. More often still it is simply implicit. For a convenient outline of this theory and of the criticisms levelled at it see Koentjaraningrat (1980). As applied to patterns of forest extraction the assumption underlies, for example, Cobban (1968).

occidental capitalism methods of extraction were uniform and, for the most part, of little consequence. While there have undoubtedly been major changes in recent times, and while the level of timber extraction has risen at an exponential rate in the last few decades, the antithesis as it is sometimes drawn will not sustain much serious examination. There have been precious few attempts to embark upon a proper study of the historic changes in forest use in the context of local economic systems, and there can be little doubt that the prospect may seem daunting. Dunn (1975) is an important exception.

In this paper I look at the interaction between people and forest in the Moluccas as a set of dynamic relations: variable in any short-term ethnographic analysis, shifting from place to place and between one historical epoch and the next, depending on the uses to which the forest is put and the technical means of extracting its resources. I begin with an examination of the local scene on the island of Seram. Between 1969 and the present, much of my own research in this area has focussed on the ecology and ethnobiology of the Nuaulu, a small, ethnically distinct, group of some 500 individuals mainly located in five hamlets in the south central part of the island, and whose economy rests predominantly upon the extraction of sago, swiddening, hunting and gathering (Ellen, 1978). I shall draw upon this fieldwork to illustrate many points concerning inland and highland patterns of extraction. I shall also refer to the wider literature and to my own more recent work at a number of scattered locations around the circumference of the Banda sea. These latter data furnish evidence for modes of settlement and forest use linked to maritime and trading lifestyles.

The natural history of Seramese forests*

The woodland biotopes of Seram share many features in common with rain forest in other parts of insular southeast Asia. However, in at least two important respects they differ. The first is in terms of their position within the eastern part of the Malesian floristic division (Steenis, 1950; Balgooy, 1971), in a zone of transition between the southeast Asian and Australian biogeographic regions. The second is topographic: the islands are smaller, more mountainous for their size, with few big rivers and all of them fast-flowing.

In the south central part of the island there are four basic forest formations, overlying coastal Quaternary deposits of alluvium containing conglomerates and outcrops of coralline limestone, and further inland phyllitic rocks. These formations are: tropical wet evergreen forest, which stretches from sea level mountainwards (mostly on low hills); montane rain forest, generally above 1000 m; *Metroxylon* swamp forest; and patches of semi-evergreen associations. Although no detailed studies exist, there is undoubtedly considerable variation in profiles from place to place, with perhaps as many as 200 different tree species per hectare (Jones, 1976; 59). Canopy height is generally 30–40 m. The typical dominant of the more inland and highland areas (above 300 m), *Agathis* (kamane), is replaced towards the coast by *Shorea* spp. (onie), *Canarium sylvestre, Canarium vulgare* (iane), species of *Terminalia* (kaiane, nosate), *Calophyllum* (ahutaune), *Myristica* (asaherane), and hardwoods such as *Pterocarpus* (kinai), and *Diospyros* (ai yarine). According to Jones (1976: 59), up to 50% of the volume over 35 cm diameter are Dipterocarps. In favourable localities (especially in the semi-evergreen and more open grassland areas on Buru and the Huamoal peninsula of Seram) the giant *Melaleuca cajuputi* (= *leucodendra*) (sakaputi), and *Melastoma* (*Malabathricum?*) are common. In riverine areas, stands of *Ficus* (nunu) and *Casuarina* (neune) are frequent. These same lowland zones contain both seasonal and permanent swamp forest, composed almost exclusively of natural sago palm, *Metroxylon sagu*.

There has probably been a human impact on the forests of Seram for many thousands of years. In virtually all coastal areas primary forest has been replaced by cultivated corridors of swiddens, groves and permanent dry fields together with anthropogenic secondary forest the width of which varies depending on topo-

*For some background, see Ellen (1978: 212–219). Wallace (1869), Warburg (1893) and Rant (1934) provide some general descriptions of central Moluccan forest vegetation and inventories of tree species. Local names provided are those used by the Nuaulu, unless otherwise indicated.

graphy. Where the hills descend sharply to the sea, the corridor may be no more than 1 km wide; elsewhere the cultivated areas may penetrate several kilometres inland, especially in the rich alluvial areas around the mouths of the larger rivers and creeks. This is the situation, for example, around the estuaries of the rivers Kawa, Eti in the vicinity of Kairatu in

FIG. 1. Recently planted swidden cut from mature forest (in background). Usa river area, south Seram: 22 August 1981. (Neg. 75-5-18.)

west Seram, around the mouth of the Ruatan on Elpaputih Bay, along the course of the river Bobot and for much of the moth coast from Seleman Bay as far as the river Masiwang. Some of this has been encroached upon for gardens and has succeeded to grassland. Other areas are too swampy and remain largely uncultivated, but are a valuable source of naturally-propagated sago palms.

In the western highlands patches of cultivated land encircle hamlets, and in the more densely-populated interior some lie so close together that they are not separated by any forest at all. Large parts of the highlands, particularly in central and east Seram, were heavily depopulated from the end of the nineteenth century (Ellen, 1978: 9–10). However, the sites of these old villages (and some even older) are still detectable in the composition of their vegetation. In many cases they are still visited to collect fruits. A low human population density (0.07 per hectare) has meant that there has been little succession to grassland, although what there is appears to be the result of human impact. The adjacent islands of Ambon, Haruku, Saparua and Nusalaut, where population densities are considerably greater, have extensive tracts of grassland and little rain forest (Ellen, 1978: 6–7). Level coastal land is heavily cultivated with a considerable proportion devoted to coconut and clove plantations. The land rapidly steepens away from the shoreline and even coastal settlements are forced to find gardens on the steep valley walls of the short rivers descending to the sea.

The current distribution of forest in the Nuaulu area has been indicated elsewhere (Ellen, 1978: map 8). Nevertheless, it is helpful to note here that its distribution permits a convenient twofold division: (a) the bulk of forest stretching from a very minimum of around 100 m from the coast northwards and mountainwards (Fig. 1), and (b) isolated patches and pseudopodia apart from the major block of forest and forming barriers between cultivated areas. This latter residual distribution tends to be along ridges and around steep knolls (Fig. 2), unsuitable for cultivation under normal circumstances. As a result, these (together with the margins of the main forest block) are within easy access of the village, and are a principal source of construction timbers and other products. Their use for these purposes leads to gradual thinning and denudation.

In the Nuaulu area, secondary growth is of four kinds:

FIG. 2. Characteristic young groveland (mainly *Eugenia aromatica*) with residual depleted primary growth on ridge. Samna ukuna valley near Ruhuwa, south central Seram: 8 August 1973. (Neg. 73-2-17.)

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(1) Young growth: recently deserted clearings with rapidly growing herbs, shrubs and small trees of a relatively few number of genera – for example, *Trema orientalis* (sapane), *Euphorbia hirta* and *Omalanthus populneus.*

(2) Medium secondary growth: 1–10 years, with small trees gradually becoming dominant: *Aleurites moluccana, Melastoma malabathricum.*

(3) Mature secondary forest: large variety of small and medium-sized trees, shrubs and vines in areas with more than 10 years secondary growth.

(4) Bamboo thicket, also found in combination with the above three associations.

Despite the overwhelming evidence, it is still sometimes thought that so-called 'traditional' modes of extraction and interaction have had little effect on the rain forest of southeast Asia. This is a curious argument. On the one hand it is obviously true in respect of the large tracts of rainforest of Sumatra, parts of the Malay peninsula and Borneo, since the density of human population is so low. On the other hand, there is now palynological evidence (Flenley, 1979; Maloney, 1985) from Sumatra and New Guinea indicating human alteration along forest margins by 5000 B.P. Elsewhere (e.g. Java and Bali) the rain forest has been decimated with the advance of permanent agriculture. So while Cobban (1968: 23) is correct in asserting that the 'grazing, charcoal-making, lumbering and the spread of settlement which resulted in extensive removal of forest vegetation in many parts of the world did not take place to the same extent in southeast Asia', such a statement is misleading, and accurate only in a geographically relative sense. Much more interesting have been the historical modfications taking place between these two extremes: the development of grassland patches in forest areas, of marginal ecotones resulting from partial clearance and selective extraction, and different kinds and degrees of secondary regrowth. In this respect we must also consider the indirect effects of human activity, such as those which introduced animals have on the regeneration of forest species (Walker, 1980: 28). In the Moluccan context, some measure of the genetic impact of human interference can be gained by reviewing the evidence for species introduction.

Rumphius reports that during the time he spent in Ambon during the latter half of the seventeenth century, *Tectona grandis* was beginning to be planted, while *Toona sureni* was being grown for its wood (van Slooten, 1959: 326–327). Both of these are currently important sources of timber. Rumphius was writing at a time when many new species where being introduced into the region for the first time: fruit trees such as *Carica papaya, Psidium guajava, Annona muricata, Averrhoa bilimbi* and *Tamarindus indica*; providers of dyes such as *Bixa orellana,* sources of beverages and stimulants including *Coffea arabica,* and technologically useful species such as *Crescentia cujete.* Of the total number of tree species named by the Nuaulu, many probably represent historic and prehistoric introductions (e.g. *Citrus aurantifolia, C. hystrix,* and *C. grandis*) and at least ten have been introduced since 1500, some quite recently. For example, the ornamental *Delonix regia* cannot have been planted on Seram before the middle of the nineteenth century. Together, these form a significant proportion of all domesticated tree species, some now also occurring in completely undomesticated settings. The presentation employed by Fox (1952) in his monograph on the Pinutabu Negritos of Mindoro gives a clear picture of just how extensive the number of introduced trees can be, even for apparently non-cultivars.

Indigenous perceptions of the forest

As with many traditional peoples, the Nuaulu often conceptualize the forest as a total experience. Thus, vegetation may be (although this is not to say always) classified in terms of two contrasting categories, on the basis of whether or not it has been affected by humans. On the one hand there is forest (wesie) in which no land rights are held; and on the other there is land that is or has once been cultivated and in which certain rights are vested (wasi). In some contexts wesie also contrasts with niane (village). Within an area of 4 km around the study village of Ruhuwa (1971 population: 180), 70 ha were devoted to newly-cleared gardens (nisi honwe), 410 ha to garden land after the first year (nisi monai), and 360 ha to discarded gardens and secondary growth (nisi ahue). Primary growth and advanced secondary forest (wesie) constituted 1410 ha, and 180 ha dwelling area (Ellen, 1978: 22). What is remarkable about these figures is the small amount for new gardens (3% of the land area, compared with 58% forest).

The greater part of the Nuaulu non-domesticated environment consists of mature forest. Wesie is focally conceived of in these terms, the principal distinguishing feature understandably being the size of the trees of which it is composed. Almost synonymous with the wesie : wasi distinction is ai yonata : ai yana wasi, 'great trees':'trees of the forest'. Not only is this a simple dual classifcication of types of tree, of mature and secondary forest associations, it also has far-reaching ecological and cultural implications. Wesie has all the characteristics of ai yonata and more, for the vegetal component of the Nuaulu environment consists of three basic categories: ai, trees and woody shrubs; wane, lianas and trailers, and rahue, herbs and shrubby plants. All these are found in a particular combination to give wesie. There are also zonal variations within wesie areas, which the Nuaulu recognize but, as they are of no practical utility, these are an unimportant aspect of their environmental model. Each separate and specific component of the flora has qualities which the Nuaulu recognize and utilize on different occasions, but the forest as a whole is a phenomenological entity which divulges its own peculiarities. It has noises: the shriek of birds, falling trees and boughs, game animals, the perpetual drone of cicadas and other insects, the resonance caused by felling timber and the huge buttress roots being beaten. But the reason why such noises are so marked is because of the never-ending and all-pervading background of silence on which they are only superimposed incidents. It is said, 'there is no wind in the forest, it is evil' (Ellen, 1978: 65–66).

Nuaulu venture into the forest frequently, but always with diffidence, taking both practical and magical precautions. Travel is largely by established major and minor paths, using well-known landmarks for direction-finding, such as rocks and prominent trees, together with artificial markers. Habitual paths (illustrated in Ellen, 1978: map 6) are subject to many of the rules of upkeep which apply to regular thoroughfares between villages and gardens. At some strategic points are found huts (numa wanane), halting places for long-distance treks. However, the only occasions on which montane zones are traversed are during journeys to the north coast, or on larger hunting trips to the headwaters of the Nua. Ruatan, Kawa or Lata, or in collecting *Agathis* resin.

Although the Nuaulu recognize over 700 distinguishable plant species, and theirs is far from being an exhaustive inventory, my concern here is with 'timber' or 'wood', terms which can be broadly encompassed by the Nuaulu world ai, which in turn is roughly equivalent to the Malay kayu. Although I will necessarily mention them, I am not primarily concerned with other components of the forest ecosystem, such as rattans, bamboos and palms. On the other hand, pandans are included. During the course of some 24 months of fieldwork spread over a decade I have elicited 238 words designating terminal categories which most Nuaulu would agree to be kinds of ai. If we add palms, then the number rises to 272 (Table 1). Not all Nuaulu would share all these names, no more than they share all the knowledge concerning species which can be glossed as ai. I would estimate, however, that well over 250 of the terms are shared by most adult males and females. A further characteristic which is worth noting here is that terms for domesticated forms tend to correspond closely with phylogenetic species, or even to subdivide them. Although there are certain salient non-domesticated trees which can be identified to the level of individual species, most apply to phylogenetic genera. This is not because the Nuaulu fail to recognize even the most subtle differences, but because any finer differentiation is of little practical interest to them. Substitution among conspecifics is common.

Of all the Nuaulu labels for terminal categories of tree, 212 (that is 78%) were specified by informants as having particular uses. Four categories are mone (sacred) to individual clans, and are not used on that account. Some other species (fewer than the twenty-nine categories indicated), although used for ritual purposes, are not available for ordinary use.

TABLE 1. Types of tree named by Nuaulu informants and their customary uses. Terminal Nuaulu categories (approximate number of equivalent phylogenetic species in parentheses).

Category of usage	Prime example	Total	Present in non anthropogenic biotopes	Present in anthropogenic secondary associations	Present in domesticated biotopes
Palmae					
All named palms		34 (14+)	12 (2)	23 (12)	24 (4)
Named, but with no indicated uses		4 (4+)	4 (4+)	4 (4+)	–
Named, with indicated uses		30 (10)	11 (1)	30 (10)	24 (4)
Building materials	*Metroxylon sagu* Rottb.	13 (2)	13 (2)	13 (2)	13 (2)
Primary food source	*Metroxylon sagu* Rottb.	16 (2)	11 (1)	16 (2)	16 (2)
Secondary food source	*Licuala rumphii* Blume	6 (5)	–	6 (5)	2 (1)
Medical uses	*Cocos nucifera* L.	16 (2)	11 (1)	16 (2)	16 (2)
Stimulants and beverages	*Areca catechu* L.	7 (2)	–	7 (2)	6 (1)
Ornamentation	*Nypa fruticans* Wurmb.	6 (2)	–	6 (2)	5 (1)
Ritual	*Livistona rotundifolia* (Lam.) Mart.	13 (4)	–	7 (3)	11 (2)
Sundry supplies, e.g. wrappers	*Orania moluccana* Becc.	24 (5)	11 (1)	24 (5)	22 (3)
Manufacture of tools and other small objects	*Caryota rumphiana* Mart.	27 (7)	11 (1)	27 (7)	24 (4)
All other families					
All named types		238 (185)	125 (109+)	104 (78)	63 (35+)
Named, but with no indicated uses		56 (52)	38 (35)	19 (16)	–
Named, with indicated uses		182 (133)	87 (74+)	85 (62+)	63 (35+)
Building materials	*Vitex cofassus* Reinw. ex Bl.	21 (18+)	19 (15)	1 (1)	–
Clothing	*Ficus benjamina* L.	5 (5)	4 (4)	1 (1)	1 (1)
Primary food source	*Carica papaya* L.	24 (14)	8 (1)	11 (2)	14 (4)
Secondary food source	*Gnetum gnemon* L.	62 (46+)	22 (20)	20 (17)	27 (22)
Medical uses (including poisons)	*Melaleuca leucadendron* L.	17 (11)	11 (6)	10 (8)	5 (2)
Stimulants and beverages	*Coffea arabica* L.	3 (2+)	–	1 (1)	2 (1+)
Ornamentation	*Cananga odorata* (Lmk.) Hook. f. & Thoms.	4 (4)	2 (2)	1 (1)	1 (1)
Ritual	*Pithecellobium clyp* Benth.	16 (11)	14 (9)	4 (3)	2 (1)
Sundry supplies, e.g. wrappers	*Xerospermum* sp.	6 (5)	4 (3)	3 (3)	–
Resin	*Agathis dammara* (Lamb.) L. C. Rich	14 (4)	12 (2)	10 (3)	8 (1)
Firewood	*Premna corymbosa* (Burm. f.) Rottl. & Willd.	3+ (3+)	3+ (3+)	1+ (1+)	–
Manufacture of tools and other small objects	*Calophyllum inophyllum* L.	82 (58+)	34 (21)	28 (15)	13 (4)
Colouring matter, scents, cosmetics	*Pongamia pinnata* (L.) Merr.	19 (11+)	4 (3)	16 (9)	4 (2)
Sources of cash	*Syzygium aromaticum* (L.) Merr. & Perry	6 (3)	–	–	6 (3)
Trees with more than one indicated use		70 (39)	44 (26)	28 (17)	24 (1+)
Trees with more than two indicated uses		23 (11)	16 (6)	18 (7)	16 (7)

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Indeed, many of the species subsumed in Table 1 are used only intermittently. Inclusion in the list therefore indicates anything from large-scale consumption on a regular basis to limited and occasional use. The condition for inclusion is that a species, subspecies or group of species has a shared local name and that it has a reputation for being appropriate for a particular purpose, vindicated by use. Contrariwise, many species not mentioned may periodically be employed but have no established reputation which might indicate that they are preferred. Some named species may have no known use but are cognitively salient because of their visual prominence or other botanical peculiarities, or because of their ecological association. Note also that many species may be found either in domesticated or non-domesticated settings. Many of the latter are in fact domesticated (often introduced) species which have run wild. They are commonly found at the sites of deserted villages.

A great deal has been said in some quarters of indigenous attitudes to forest providing effective conservation measures (e.g. Rappaport, 1968: 3). Certainly, there are many examples of indigenous forestry conservation and artificial reafforestation, but too much can be made of this. The Nuaulu have sacred groves. There are also ritual restrictions on harvesting certain forest products at particular times (sasi); fruit trees are protected and sago palms replanted from suckers. However, all this applies to trees with quite specific, usually food, uses. It does not in the normal way apply to trees used for timber or to the forest itself, although I have already noted that certain species are not cut for ritual reasons. But none of this is sufficient to entertain elaborate feedback models of ritually controlled conservation.

Gathering forest products

The interior peoples of Seram were much more dependent upon the extraction of non-domesticated resources in the past than they are now (Ellen, 1978). Even at the present time the reliance of some groups – including the Nuaulu (Ellen, 1975) – on gathering is considerable, whether this is measured in terms of published lists of different forest products used (Conklin, 1954a; Fox, 1952), or in terms of time and motion and bioenergetic studies (Ellen, 1975; cf. Colfer, 1983: 6). It is characteristic of tropical forests that although the total bulk of vegetation is large, its food conversion value is low. Fauna is consequently sparsely distributed and small in body size. Little will be said here of hunting, although sustained predation must clearly have some impact on the demographic levels of deer, pig and cassowary which forage on forest litter and young saplings. It must therefore have some effect on regeneration. If left to increase naturally, animal populations might reasonably be thought to affect the replacement rates of mature forest. The main damage done to forests which does not involve the felling of timber or clearance for cultivation is through sustained extraction of sago. This, however, is strictly limited. Sago is the Nuaulu starch staple and each household probably destroys the equivalent of twelve mature sago palms every year. A small proportion of these are cultivated palms, but most are felled in the extensive swamp forests of the Ruatan and Nua confluence. As supply remains far in excess of demand, the sago forest is able to replace itself effectively over a 15 year cycle. The effect on the swamp forest as a whole and associated biotopes is for this reason limited. There is even scope for modest commercial extraction without damaging the environment or competing with local requirements.

Forest trees are harvested for a variety of purposes without destroying them: for resin, fruits, leaves, flowers, bark and branches. Table 1 summarizes some key information about them. It is important to stress that Nuaulu extraction of forest resources does not occur evenly over the 900 km^2 which they habitually traverse, either in space or in time (Ellen, 1978: 61–64, Table 12). The forest is not homogeneous but rather might be seen as a combination of merging biotopes, unevenly distributed and predated upon by humans (cf. Hyndman, 1982). Timber is more commonly extracted in some areas, rattan in others. What localities are under pressure is determined in part by the availability of the desired species, and partially by problems of access (e.g. distance from village, proximity to existing trails, and the general limiting character of the topography and vegetation). Interaction between the population of Ruhuwa and different parts of the forest varies over time: seasonally, annually and in terms of longer cycles as determined by factors such as periodic demand for and availability of various resources.

Mature forest and other non-domesticated biotopes are the source of a wide range of non-edible products. The most important of these are timber for construction purposes and kamane resin from the conifer *Agathis*. Most timber comes from within a radius of 3–4 km of the village, and usually from land bordering the gardens. Good kamane resin is much more difficult to come by. Accordingly, Nuaulu may travel considerably further to obtain it, sometimes 18–20 km to the higher montane regions renowned for its abundance and quality, such as the headwaters of the river Kawa, Satu and Lasa (Ellen, 1978: maps 2 and 6). Rattan of high quality is also regarded as worth the effort of travelling substantial distances to obtain, and areas frequented in this respect include Hatuhahu, Lahati and Sama (Ellen, 1978: map 6). Other non-edible forest products include bark for bow strings, loin-cloths and waistbands; varieties of herbs, climbers and roots for dyes and poisons; and woods for the manufacture of utensils and other objects. Apart from timber and bamboo, the most important source of house-building materials comes from the sago palm, of which the woody leafstalks are used for walling and the fronds for thatch. Firewood is generally bamboo. A wide range of types of bamboo (Ellen, 1973: 450–459) are also in great demand as raw materials for building, manufacture of utensils and basketry. The constant cutting of bamboo from areas near the village tends to transform thickets into more open areas, with a greater diversity of shrubs, grasses, herbs and tree seedlings. This is despite a fast rate of bamboo regeneration.

Most products, with the obvious exceptions of rattan and resin, tend to be obtained within a fairly short radius of the village, in secondary and denuded forest, rarely exceeding the boundaries of the most distant gardens (Ellen, 1975). This tendency to forage as near the village as possible leads to the depletion of stable primary associations of forest the nearer one gets to the main loci of settlement. Consequently, when mature forest is cut for gardens it has almost always been considerably modified and may contain species more typical of regenerated secondary growth. Such denuded primary growth, like open secondary associations, may become subject to marginal cultivation as well as complete clearance (Ellen, 1978: 76). Those areas which have been subjected to selected felling for the purposes of obtaining timber, have been termed by Richards (1952: 379, 400) depleted forest.

The impact of swiddening on the forest*

Most Nuaulu forest-cutting activities arise (in the first place) from their involvement in forest-fallow swiddening or 'agroforestry'. I have indicated elsewhere that most contemporary Nuaulu swiddens are cut from secondary forest (typically bamboo scrub), and if they are cut from primary forest then this has generally already been severely depleted. Fires seldom get out of hand and valuable timber is rarely gratuitously destroyed. Conklin (1954b: 141–142) has reported the same findings for the Hanunoo of Mindanao, and it is clearly also the case for large numbers of southeast Asian horticulturalists (Spencer, 1966: 41). All of this is consistent with the relatively sedentary character of Seramese hill people, in contrast, say, to the pioneering Iban (Freeman, 1970: 144–151). On the other hand, swiddening in forest areas is easier; the soils tend to be looser and richer. During 1969–70 and 1970–71 Nuaulu new gardens derived from mature forest represented 30–36% of the total area cut, although of all land under cultivation of some description during the same period, only 6% had been cut from primary growth. This is high and probably relates not only to the advantageous properties of the soils but also recent population growth. A percentage figure is also slightly misleading since the amount of land under population per head is somewhat lower among the Nuaulu

* For the recent history of Nuaulu forest clearing activities see Ellen (1978: 81–83). Jones (1976: 59) has estimated that swiddening is responsible for the destruction of 0.75 million m^3 of timber on 7000 ha of primary forest land on Seram. For reasons which will be apparent from the following section, I believe this figure to be misleading, if not inaccurate.

than, say, the Iban, Nuaulu diet being heavily subsidized by food from non-domesticated sources. Clearly, different patterns of swiddening have different effects on the forest (Kunstadter & Chapman, 1978; Pelzer, 1978) and the comparative study of their ecology has only just begun.

Forest is cut as close to a watercourse as possible to provide easy access, and adjacent existing cleared plots. This usually takes place in December or January, allowing sufficient time for clearing, firing and planting before the heavy rains begin in April and May. Work begins at the centre of a projected plot. This is so that timber can fall uphill, permitting downhill clearance unhampered by fallen stands and trash. Undergrowth, saplings and small trees are cleared first, followed by stands of medium size. Time and labour inputs for forest clearance vary. On one occasion it took fifteen males 2 days to clear a 75 m^2 patch, working 4.5 h each day. The largest trees may each take half a day to fell. Felling is arranged so as to maximize treefall with a minimum of effort. Careful and experienced judgement permits the simultaneous downing of whole portions of forest. During cutting wood is sometimes taken back to the village for construction purposes or for fuel, but generally only in small amounts. Although wood or other products may be salvaged during clearing a garden plot, much secondary growth is destroyed.

Particular sections of forest, on account of trunk size or location in areas posing problems of access, represent limiting conditions. Similarly, the presence of particular trees, such as *Canarium vulgare*, *Sterculia* sp., *Diospyros ebenaster* and *D. elliptifolia*, pose such formidable difficulties, or are seen as providing such valuable concentrations of resources, that they too limit the total amount of forest available for cultivation.

As long as it is accessible, most forest may be cut for swiddens; it is only preserved on inferior land and on cemeteries. Small groves and individual trees may also be left for ritual reasons, because they are technically difficult to fell, or because they serve as prominent and collectively-agreed landmarks and boundary indicators. Uncut forest cannot be said to be 'owned' in the conventional sense, though historical association of particular clans with particular tracts may generally be acknowledged, and provide certain minimal rights. Nuaulu swiddening effectively clears the ground of all existing vegetation, leaving only boles and the largest trunks. Once brought into cultivation, it seldom returns to fallow for more than a few years, with little opportunity of returing to climax forest. This only happens in deserted villages.

The extraction of timber and Nuaulu forestry practices

Timber (meaning the woody stands of most coniferous or broad-leafed trees) has been removed from the forests of Seram for as long as there has been the available technology, and all along it has been techniques which have constrained and determined the extent of extraction. However, the demand for timber in pre-colonial societies was always strictly limited, and where other materials would suffice they have been used. Where wood has been obtainable without felling stands this has been done. The most important timber producing trees in the Nuaulu area are *Intsia bijuga*, *Diospyros* spp., *Calophyllum inophyllum*, *Pterocarpus indicus*, certain species of *Eugenia*, and *Vitex coffasus*. Dipterocarps, so important in west Malesia, are relatively unimportant on Seram. The characteristics of individual woods are well understood by the Nuaulu, in terms of hardness, strength, susceptability to disease and rot, elasticity, resilience, ability to split, and their qualities as fuel. However, woods are often used for their accessibility or availability as much as for their structural properties.

The techniques of Nuaulu timber extraction can be discussed under the following headings: selection, cutting, preparation, transport and storage.

Nuaulu forest-cutting activities are entirely male but vary in the number of persons involved. Some swidden sites covered in secondary growth may be cut by single individuals or pairs. Larger parties, divided along genealogical lines, may be assembled for special purposes (such as the cutting of timber for ritual houses). In some cases (such as the cutting of sacred shields) participation is more a ritual and social obligation than a physical necessity.

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The largest groups formed at any one time are for the cutting of timber for ritual houses (suane) and in the clearing of ground for government-sponsored groves. On such occasions the entire adult male population of a village may be involved. However, despite the large numbers of persons who sometimes cooperate for forest-cutting activities, it must be said that Nuaulu forest felling is predominantly an individual activity or for pairs of kinsmen. There is no specialization, and a craftsman may perform all operations from felling to finishing an object.

Some trees are selected because they already approximate to the outline of the desired finished product. This strategy minimizes overall effort, the number of distinct technical operations and the proportion of waste. This is in contrast to modern methods, where wood is dismembered to a basic supply and then reconstructed. In order to find a tree of the correct size, it is common to use a measuring stick (otoi otu otua; otoi ukii) cut to the required length, sometimes notched to give lesser dimensions. This is not only employed in selecting the right tree, but is generally on hand throughout the operation of felling and reducing logs in order periodically to check that measurements are correct.

Most trees are made available through the cutting of single stands. However, in the course of clearing swiddens, the felling of a single large tree may bring down with it a number of surrounding smaller trees which may be used for timber. Belting (the removal of bark and cambium) and controlled burning do not appear to be used.

If not taken from swiddens in the course of clearing, most timber cut by the Nuaulu comes from portions of forest directly adjacent to gardens. This leads to 'depleted' forest through irregular coppicing. It has the effect of preserving woodland and permitting rapid and effective regrowth in some cases. In others (perhaps the majority) it makes the job of subsequent clearance for swiddens much easier. Where depleted forest is preserved over long periods it may yield a steady supply of small timber and protect existing swiddens from wind, erosion and heat damage.

For secondary bush and small stands (sometimes with boles up to 30 or 50 cm diameter) the main cutting and trimming tool is the longbladed parang (tunuwe, tunu nawe, tunu nure). For stands over 15 cm a steel felling axe (turmane, tuma maiinai) is generally employed. Iron blades have probably been in general use in the area for more than 500 years, and before this neolithic stone blades. Experimental work and observations based on Melanesian ethnography and artefacts suggest that these would have been between 2 and 4 times less efficient than steel blades. For Townsend (1969) stone axes take 4.4 times as long; for Godelier & Garanger (1973) 1.5–2 times as long and 3–4.5 times as long when the circumference of the tree is more than 1 m; and for Steensberg (1980: 24–40), 3–4 times as long. Such evidence suggests that the arrival of iron tools in the Moluccas led to an overall increase in the volume of timber cut, and in particular to the regular use of larger pieces in the construction of dwellings and boats. We might also reasonably infer an increase in the acceptable wastage factor following the introduction of iron tools. Unfortunately, there are no appropriate data available on the relative performance of bronze blades compared with both stone and iron, or of parangs compared with axes.

Trees may be cut either by using level notches on opposite sides, or split-level notches, depending on the size and complexity of the operation. If a tree is in danger of falling in the wrong direction it will be corrected by pushing with a long pole-like trunk of a young tree: a kakataputi (iruruhi tau kakataputi, iruhi rem nohoi: lit. 'to push with a kakataputi, to push in the right direction'). Depending on the size of the tree, the number and size of kakataputi will vary. The same result may be obtained by the use of small wedges hammered in to the axed notches. Trees without buttress roots or with minimal buttressing are usually cut at waist height, about 92 cm. In felling the larger trees, which are left till last, the slope on which they are often growing and the presence of massive buttresses* necessitates the erection of scaffolding from the debris of already fallen trees (hanakane). These are

* Buttressing is common with many tree species on Seram, the greatest proportion being for trees over 30 m in height. Since the wood of buttresses is often harder than that of the trunk, erection of platforms also serve to give access to wood that is more manageable for a limited lumbering technology.

FIG. 3. Felling a large tree with aid of scaffolding at new village garden (nisi niane) site. Usa river area, south Seram: 31 January 1971. (Neg. 71-18-35.)

usually sturdy structures, but seldom secured by much binding. They are constructed to give either a near flat area surrounding the tree from which it can be effectively hewn or, in the cases of the largest trees (sometimes between 165 and 184 cm diameter), to minimize effort by cutting the trunk at the point where the buttresses merge with the trunk. Platforms may often be around 3 or 4 m in height, and sometimes lashed to nearby trees (Fig. 3).

Once felled, stands intended for building, or large objects such as canoes, are shrouded. The branches are cut off at the spars at the top of the trunk. If large enough, these branches may be used as timber or, failing that, fuel. The butt is then barked. Initial shaping and facing-up (particularly of larger items) usually takes place at the point of felling, or if inconvenient, at a more open space not too distant (Fig. 4). If there is no conveniently located flat ground then an artificial horizon-

FIG. 4. Trimming cut lengths for ritual shields (anyawe mone) from *Albizzia falcata* wood, near Ruhuwa, south Seram: 2 April 1970. (Neg. 70-4-17.)

tal surface, a form of trestle, is prepared from timber (kanakate). This prevents logs slipping while being reduced and also permits easy manipulation. Some stands must be split or cleaved longitudinally at this stage and this is done with the use of wooden wedges (kalaita) rammed into cracks. A felled log is first marked longitudinally with a parang or axe to indicate the desired lines for splitting. A crack is then opened up at one end of the line sufficiently large to accept the blade of the first wooden wedge which is driven in with a hammer log (tumanaune), or occasionally a large stone. A person stands on or over the log astride the crack and bisects the log along the line of strain opened up by the wedge. Progressively larger wedges are inserted at convenient intervals as the split opens further, and are gradually driven in deeper to prise the two halves apart. The wedges are generally inserted by a second, and sometimes even a third, person. Two men with a hammer log will generally operate alternately, while another may be employed in making wedges by trimming one side of a small log. This technical division of labour by process may increase the efficiency of the operation severalfold. Wedges usually need only be inserted for half the length of the butt for it to split, as beyond the mid-point the tension is generally sufficient for the remainder to divide under its own stress. An opened split will then be prised apart with wooden or steel crowbars (kahoate) which are also used as levers to shift logs. While one or two individuals wield the crowbars a third cuts the remaining wood connecting the halves with a parang or axe. Sometimes the process may be speeded up by inserting wedges from both ends simultaneously. If the log has not split right through the diameter, it will be rolled over and the same procedure repeated for the other side. From this description it will be clear that the efficient preparation of large timbers using this technology requires teamwork. By comparison, reducing logs by sawing is labour intensive rather than extensive, requiring no more than two individuals engaged in the expenditure of roughly equivalent effort. Cleaving is generally only used for quartering or halving butts. It is anyway rare and used mainly in the making of such items as doors or wall boards. Most timber is selected with an aim to its intended use. Thus stands cut for houseposts need only be trimmed, barked, cut into the correct lengths and shaped at the base. Entire timbers are then dried in this condition.

Transport of timber is almost entirely manual, being carried mainly on the shoulder by individual or pairs of males. Larger logs may be dragged, or even occasionally floated along larger rivers or the coast. Females may

FIG. 5. Timber store (heute), end view. Ruhuwa, south Seram: 18 February 1970. (Neg. 70-27-8.)

carry small amounts of wood (especially firewood) and other products in back baskets or on the head. Timber is occasionally stored temporarily, awaiting collection and drying, outside the village, characteristically along the edges of paths. A rudimentary structure known as a kamrenta is used for this purpose, consisting of two pieces of wood, usually bamboo, stuck upright in the ground, against which the wood (generally faggots of firewood) is piled. Such stacks may also be provided with sago thatch roofs. Seasoning varies depending on intended use and available time. A certain amount occurs in swiddens when cut timbers are left for several months or longer without being destroyed or removed. Wood for smaller items, such as shields, is generally rough-cut and stored in houses, garden huts or a timber store until needed. Wood used in boat-building is seasoned during the course of construction.

Particular attention is paid to the seasoning and storage of the main timbers used in constructing pile dwellings and suane ritual houses. Timber for new clan section houses may be collected many months, or even years, before it is actually used. The timbers are cut, trimmed and prepared (for example, with widened bases for the parts of uprights to be immersed in soil), and stored in covered timber stores (heute). The ratio of heute to existing ritual houses is approximately 1:2,* and each belongs to a particular clan or clan section. In the case of a heu(te) suane the structure is in the guardianship of the clan Matoke or its functional equivalent. The length and number of timbers stored in a heute will depend on the purposes for which they are intended. The longest may be over 10 m and contain more than thirty timbers. It is a rigid structure with a sago palm thatch, in which timber is stacked to allow air fully to circulate (Fig. 5). Almost as much care goes in to its construction as goes into the ritual houses themselves. This is not altogether surprising, given their expected lifespan and the sacred character of the house-timbers stored in them. In a very real sense they too are sacred.

The main Nuaulu use for timber is for the

*The actual figures for heute (number of ritual houses in parentheses) for the hamlets investigated are as follows: Ruhuwa 5(10), Aihisuru 4(9), Watane 1(6), Hahuwalan 1(3) and Bunara 5(11). See Ellen (1978: map 6 and Fig. 3) for original data.

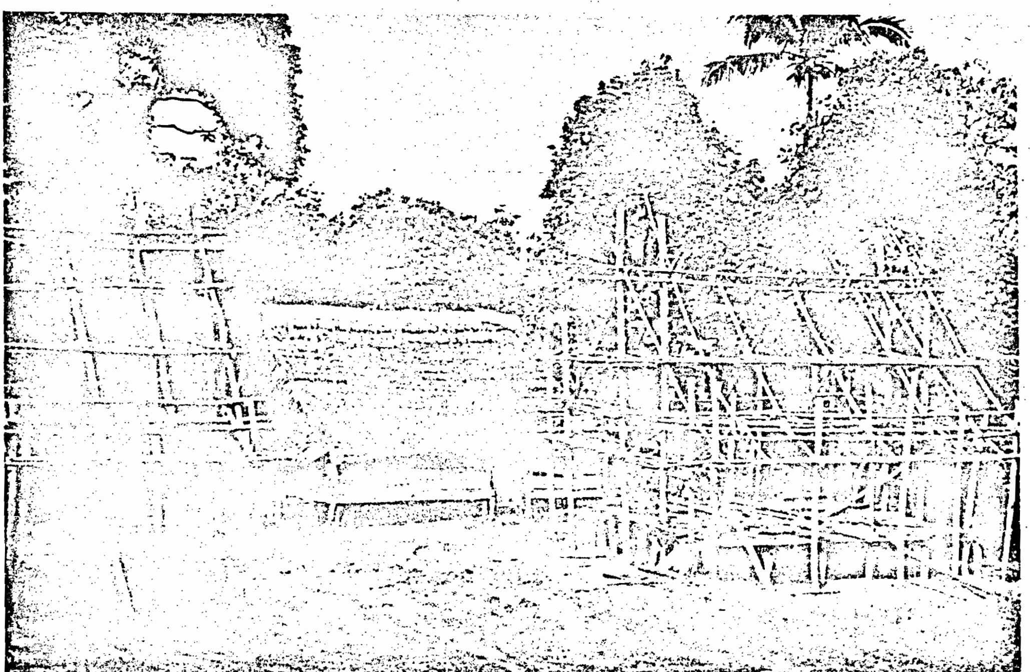

FIG. 6. Houses at varying stages of completion. Aihisusu, south Seram: 16 August 1973. (Neg. 73-4-31.)

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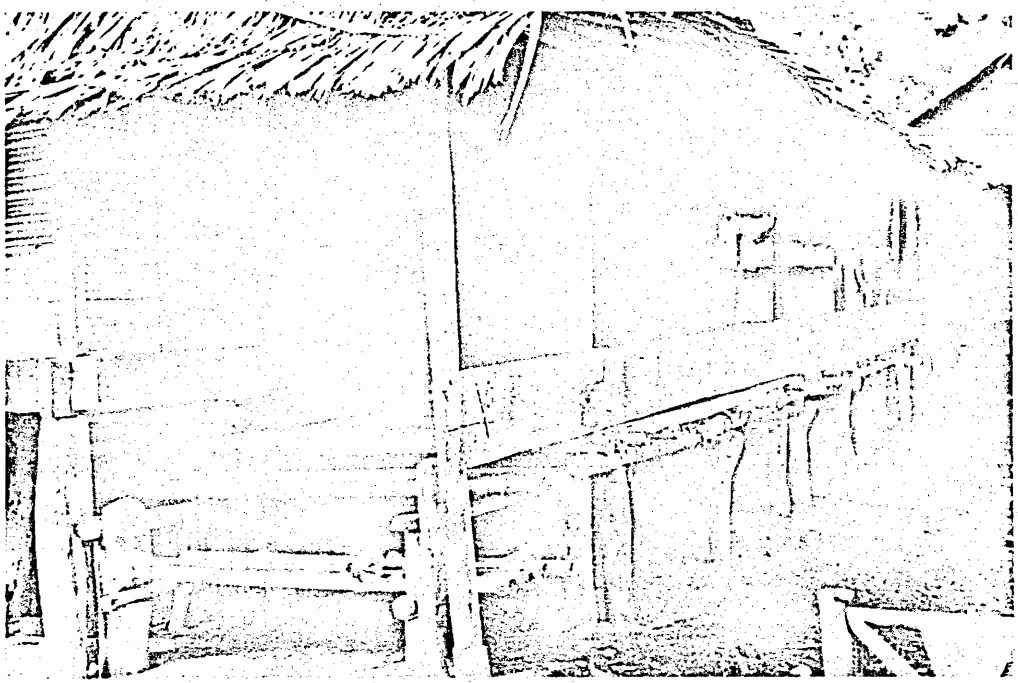

FIG. 7. Front verandah of house, showing sakanai boards. Ruhuwa, south Seram: 7 August 1975. (Neg. 75-4-31.)

house frame (Fig. 6). Wood used in house construction is generically labelled tien, or sometimes hini. The uprights (hini, in its more usual sense; p. hiniu) are preferably made from *Vitex cofassus* (pasane), although a number of other species are frequently used. Most of the timbers are trimmed and shaped from trees of much the same size, producing little waste in the main trunk wood. The only exceptions are sakanai base boards along walls, and (in some houses and other structures) wooden steps and doors. Each pile house has four or five sakanai, one along the base of each wall and sometimes one along the edge of the exterior sitting platform (Fig. 7). Sakanai may therefore be up to 10.30 m long, but are generally between 7.6 and 8.95 m. They are essentially planks of 16–22 cm width by 6–7 cm thick, and must be reduced by the splitting of trees with a diameter of at least 20 cm and of the necessary height. These are then the largest (though not the longest) timbers used in Nuaulu housebuilding and their production inevitably involves a greater proportion of waste. In reducing trees to timber of the right dimensions for making such objects there is, unavoidably given the available technology, a fair amount of unusable material. Without an adze or saw, planks are extracted by first notching on either side to the required depth and length and then removing the plank and shaping with a parang. It took twenty-five persons 5 days to collect all the wood required for the main frame of a ritual house.

Timber is also required for timber stores, drying platforms, stages for male initiation ceremonies, village ritual houses, menstruation huts, copra drying huts and ground level houses. In Table 2 I have tried to estimate timber requirements (and by extension number of trees) for various kinds of common Nuaulu structure. The greatest demand is clearly for housing. Although the village ritual house requires a total length of 646.9 m of timber (Fig. 8), there is only one in each village generally containing between sixteen and thirty-two dwellings. The figures for tree equivalents are unreliable when reconstructed from crude lengths and volumes. All major house timbers are trimmed entire stands cut into sections of appropriate length; they are

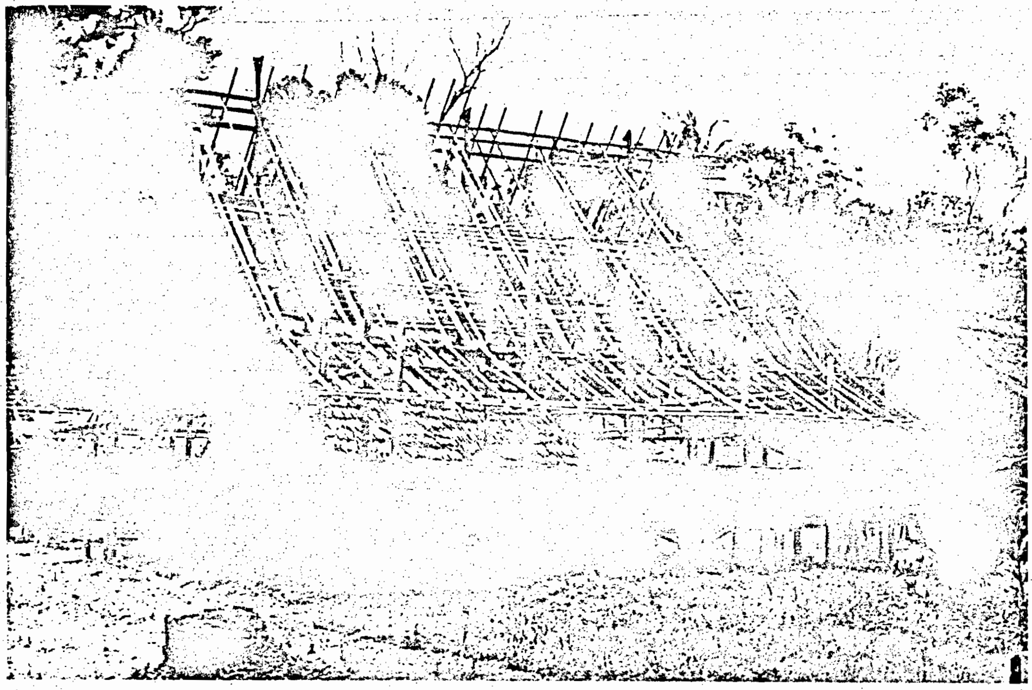

FIG. 8. Village ritual house (suane) during construction, showing complete frame. Bunara, south Seram: 16 August 1973. (Neg. 73-4-34.)

not split off or sawn, except in the case of modern frame houses. Trees are chosen precisely because they are judged to be of the right height, circumference and degree of staightness. Since the diameter of the thickest Nuaulu housepost does not exceed 18 cm, the trees used are relatively small by tropical forest standards. Under these technological conditions, therefore, trees are extracted young and tend to be shorter than the average forest stand. Consequently, in order to obtain a realistic picture of numbers of trees felled, the figures in the penultimate column have been adjusted by a crude variable factor depending on the kind of stands used. The figures provided in the final column are likely to be extremely conservative.

Among movable objects, timber is used in the manufacture of domestic utensils, spear shafts, stakes, bows, arrows, shields, hooks and other technological paraphernalia. Softwoods are used for short-life cooking utensils, and hardwood for heavy-duty objects such as barkcloth beaters and mortars. Since moving to the coast, it has also been used in the construction of outrigger and large dugout canoes. The most bulky pieces of wood used for any purpose by the Nuaulu are exceptional, and significantly both are for sacred items: these are the large drums (tihane) of the suane ritual houses (between 78 and 130 cm in length and 39–52 cm in diameter), and the doors of clan section houses made from *Alstonia scholaris* (ito). A door piece of 105 x 201 x 6 cm took five men to carry to the village. After this come canoes, about which more will be said below. In both cases, however, wood is rarely cut specially for the purpose by the Nuaulu, rather it tends to be the spoils of swiddening. Large boles, which are the most suitable, are ordinarily only attempted during clearance for cultivation.

Finally, timber is used as firewood. Most of this, measured in terms of bulk collected, consists of dead bamboo. In addition, a great deal of vegetable trash (old thatch, sago leafstalk, and so on) is burned. It is collected by women (sometimes with the assistance of old men) in the village area, on its immediate periphery, around the edges of nearby gardens, in unowned tracts of secondary growth and in interstitial and marginal bamboo thickets.

TABLE 2. Approximate quantities of timber used for different construction purposes in the Nuaulu area. Calculations based on field measurements and estimates made from photographs.

Structure	Pieces of timber	Total length of timber used (m)	No. of 35 m tree equivalents	Adjusted figure for actual no. of trees
1. Clan section house (numa mone)	65–86	328–379	9–11	>15
2. Ground-level house (numa)	42–51	121–149	3.5–4	6
3. Ritual birth house (numa nuhuwe)	17	47.15	<1	<1
4. Standard Seramese house of sawn timber	64	191.18	5.5	–
5. Copra-drying hut	15	39.3	<1	<1
6. Timber store (heute)	27	93.9	3	3
7. Ritual platform for male puberty rites (han tetane)	26	74.2	2.5	13
8. Village ritual house (suane)	115	646.9	18.5	>25

This of course is all fastburning material and does not serve all cooking purposes. Firewood may be taken from a large number of timber species, although some are avoided, e.g. hardwoods such as *Minusops elengi* and *Alstonia scholaris*. Species reckoned to provide good fuel include *Canarium vulgare, Eugenia syzygium* (ai nona), *Durio zibethinus, Dysoxylum cauliflorum* and *Annona reticulate,* as well as several others which I have not yet been able to identify. The best is considered to be *Vitex coffasus* (pasane). Domestic hearths are ideally kept burning continuously, and much depends on whether slowburning (e.g. night-time) or fast-burning (e.g. day-time) fuels are required. One thing is clear, although large quantities of wood are consumed as fuel, and volumetrically this is perhaps the greatest consumer of wood, it involves little cutting of timber. Most comes from either non-timber sources, dead wood or swidden trash*.

Now, if we summarize patterns of timber use and methods of extraction several things become apparent:

1. Many objects are made from vegetable materials other than wood: particularly bamboo, bark, palm leafstalk and leaves. These are used for items of all descriptions. In fact, Nuaulu material culture is dominated by basketry containers, bamboo and sago palm derived products. Compared with timber-producing trees these are relatively fast-growing, and replace themselves naturally.

2. Occasionally, fallen stands are used in preference to cutting fresh wood. This is not necessarily enlightened conservation, but simply a question of saving time. Fallen stands, branches or boles have also often had time to season, and anyway clutter-up valuable swidden plots. Most timber is, however, cut from living trees.

3. Small amounts of timber may be cut without killing a tree: for example, uprights for the complex system of bamboo conduits bringing water into Nuaulu villages and the flexible laths required in constructing the apparatus used to extract sago flour.

4. The constraints of traditional technology mean that stands of small and medium girth are cut, in preference to larger trees. The concentration on trees of small girth, while economically efficient, prevents natural replacement.

5. Major house-timbers are reused again and again, and sometimes mended.

6. Most wood is cut from denuded and secondary forest near villages, which is then transformed into cultivated plots. Local concentration on patches of forest for extractive purposes in this way prevents natural replacement, and denuded growth seldom has an opportunity under contemporary conditions to return to mature forest.

7. The greatest volume of firewood comes from non-timber producing species, and after

*Compare this situation with, say, high altitude Gurungs of Nepal, where 504 m^3 of wood are used per 100 houses for fuel compared with 15.5 m^3 used for all other purposes (Macfarlane, 1976: 43), or even the highly denuded upland woodland of central Java (see below).

that from dead or already felled wood. Live timber is rarely cut solely for fuel.

We have, then, a combination of factors, some preserving forest resources, and others tending to inhibit preservation. There are examples of extravagance and waste: some trees are felled in order to obtain only their bark, large trunks are left to rot in swiddens, and a restricted technology means that certain methods of reducing logs are extravagant. However, in aggregate this amounts to a reasonably economical strategy of timber extraction which, at the best of times, requires considerable effort and human resources. Though not uniformly ecologically efficient, a low population density and rate of extraction ensure that the techniques minimize forest damage.

Extraction of forest products for exchange

For many hundreds of years Moluccan forest products have been collected not only for home-consumption, but also for exchange: either for local circulation (Ellen, 1979: 51; 1984) or, more importantly, for long-distance trade. This pattern holds good for the forest regions of insular southeast Asia as a whole (Dunn, 1975; Cobban, 1968). The locally-traded products have included resin, sago, rattan, kayuputih oil* and timber. Timber has been an item of trade in the Moluccas for many hundreds of years. Meilink-Roelofsz (1962: 160) notes that wood was paid by client villages to Hitu on Ambon island as part of their tribute.

The kinds of products involved, the level and the manner of their extraction was largely such that little long-term damage was done to the resource base, except perhaps in particular localities. In other words, extraction was at a sustainable level. Moreover, most of the interest was not so much in timber but in non-timber products. Only where timber was cut on an excessive scale did this do long-term ecological damage. A striking example from eastern Indonesia, and prior to the European period, was in the destruction of Timorese forests through the trade in sandalwood (*Santalum album*), although this was admittedly combined with destruction through swiddening (Ormeling, 1957: 171–173). The effects of the sandalwood trade were not due to a sudden rise in the rate of extraction but were the result of sustained extraction at a moderately high level over a period of many centuries for medicinal, pharmaceutical, ornamental and cosmetic uses.

Once forest has been heavily depleted, either through sustained extraction at a low level for many decades or through dramatic short-term clearances, it becomes more vulnerable to predatory activities which would otherwise not be expected to have much effect, e.g. firewood collection or for fencing. Both of these have become critical in contemporary Timor, where 135 000 m^3 of forest are destroyed a year for fuel (based on a Javanese figure of 0.3 m^2 per capita; population of Timor 430 000) (Ormeling, 1957: 208–209). The Timor model of deforestation can be applied cautiously to the smaller islands of the Moluccas, e.g. Banda, Ternate, Tidore, Ambon, Haruku, Saparua and Nusalaut. The development of small islands as political and trading centres throughout the historical, and no doubt also during the protohistoric period, led to population growth beyond a level which the timber resources of the islands themselves could sustain. Wood had to be brought in. For the most part this meant large timber required for major construction purposes, including boats. In a few, but nevertheless notable, cases virtually all wood had to be imported. Thus, the historically important islands of Geser, Kiltai and Keffing off the southeast corner of Seram imported all their firewood from settlements in the adjacent mainland mangrove swamps. Mangrove wood is of restricted manufacturing use, but it does make excellent fuel, including charcoal. It is heavy, dense and hard, with a high calorific value which, when burned, creates little smoke. It will ignite even when only partially dry, and its projection of an even heat when burning allows users to reckon their requirements with some degree of accuracy (Cobban, 1968: 15).

*Kayuputih oil is extracted from *Melaleuca cajuputi* which is found abundantly on Buru, the Hoamoal peninsula and in the more open areas of West Seram. Forbes (1885) reports that in 1881 96 000 bottles, worth £9200, were shipped out of the port of Kajeli alone.

Boat-building

Prior to the emergence of modern commercial logging, and next to swiddening, boat-building has had the most significant human impact on Moluccan forests. The effects of this have frequently been shown for European woodland,* but seldom for tropical forests. Cobban (1968) makes no mention of boat-building in his essay, and this must surely be an oversight rather than a deliberate omission. Indeed, its affect on the vastness of tropical forests might seem to be minimal. In the Moluccas, with its small islands, and historical involvement in maritime trade, it has been critical.

* The expansion of the British navy and mercantile marine from the middle of the seventeenth century onwards led to a demand for timber that could only be met with difficulty from existing sources, and gave rise to John Evelyn's (1664) celebrated appeal to people to plant trees. There is no evidence that timber has been planted in Indonesia for the specific purpose of securing good boat-building timber, and neither is there evidence for the bending and pinning of trees to produce suitable curved and angled pieces, as was common in Europe (Albion, 1926: 8–9). As we have seen, however, trees were introduced into the Moluccas from other parts of Indonesia with the express purpose of growing them for timber.

Certain settlements specialize in boat-building and this may have particular effects on forest reserves. Hudson (1972: 36) quotes a touring Dutch civil administrator on one such specialist canoe-making district on the Barito river of central Kalimantan in 1857 'Through their industry the canoe makers have denuded the whole territory of heavy timber so that at the present time it is only by renting forest tracts from their neighbours that they are able to continue their profession'. Coastal villages in the Moluccas must have been constructing small outrigger craft and other dugout canoes for some thousands of years with much the same effects. Traditional dug-out canoes are of two main types: a small double outrigger canoe used mainly for fishing, and a larger canoe (only occasionally fitted with outriggers) used for transport and ferrying (Fig. 9). The amount of timber required for such vessels is given in Table 3. Although such craft are sometimes made from fallen stands, it is more usual to make them from stands which have been purposefully felled. Indeed, stands are selected not only on the basis of the species but on the girth of the trunk, straightness, absence of knots and other physical features. Because of the limitations of

TABLE 3. Crude estimates of timber requirements for building different kinds of Moluccan boat hulls

Type of craft	No. measured	Mean length[1]	Mean height[1]	Mean width[1]	Cubic metres volume (gross tonnage)	Approximate no. of trees required[8]
1. Small outrigger canoe (sampan)[2]	16	4.36	0.49	0.5	1.07 (0.38)	<1
2. Large canoe (koli-koli)[3]	12	8.61	0.69	0.69	4.1 (1.4)	1
3. Small planked boat (orembai)[4]	2	7.5	0.75	1	5.63 (2)	2
4. Lambo[5]	3	10.9–12.2	4.56–8	3.5–3.65	17.5–28.6 (20–100)	7–>14
5. Pinisi[6]	–	4.56 (keel)	–	–	28.7 (100)	>11
6. Average British warship of of the line, 1650–1800[7]	–	–	–	–	–	1000–3600 stands of English oak

[1]Measured in metres.

[2]Source of data: Ellen, 1969–81 (fieldnotes): Ambon, Masohi, Sepa and Ruhuwa (South Seram); Warus-warus [illegible] Seram).

[3]Source of data: Ellen, 1969–81 (fieldnotes): Sepa and Ruhuwa (South Seram); Elat (Kei Islands).

[4]Source of data: Ellen, 1981 (fieldnotes): Piru (West Seram) and Geser (Southeast Seram).

[5]Source of data: Ellen, 1981 (fieldnotes): Kelu (Southeast Seram) and Banda; Horridge (1979b: 25).

[6]Source of data: Horridge (1979a: 13) (124 pieces of timber including eleven urats (roughly, 'layers') of planks).

[7]Albion (1926: 20, 93). 'The average oak of timber size contained about a "load" of timber and made nearly [illegible] of shipping. It weighed about a ton and a quarter' (p. 9). One 'load' was equivalent to 50 ft^3.

[8]When comparing these figures with those provided in the final column of Table 2 it is important to note that [illegible] average girth of trees felled for boat-building is considerably greater than those felled for house-building purposes.

FIG. 9. Finishing interior of dugout canoe (koli-koli) with small-shafted adze (conkol). Butonese settlement near Ruhuwa, south Seram: 2 February 1981. (Neg. 81-4-28.) Note debris in middle- and background resulting from local lumbering operations.

traditional technology, however, for a long time larger craft had to be assembled from smaller pieces. Wood for small craft must be as light and as durable as possible. The woods generally used for canoes are *Toona sureni, Litsea stickmanni, Gmelina moluccana* (kayu titi), *Diospyros ebenaster* (loria) and *Pterocarpus indicus* (lengua). However, the best woods are not always available, and I have seen canoes made from *Durio zibethinus* (durian), *Canarium vulgare* (kenari), *Artocarpus* (kayu suku) and *Mangifera* (mangga). In 1981 canoes on the south coast of Seram were being made from *Shorea* (meranti) due to the availability of large waste pieces in connection with Filipino lumbering ventures. But canoes made from *Durio* or *Mangifera* are generally derelict after 10 and 4 years respectively. By comparison, canoes made from *Pterocarpus* may last up to 20 years. Some canoes may be built from particular species for sacred reasons: for example, a Nuaulu canoe built of *Albizia falcataria* wood by a clan head in Ruhuwa.

The growth of trade with Java, Sulawesi and places further afield during the period prior to 1500 led to the introduction of larger

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planked boats. There had been a local boat-building tradition for a long time (Horridge, 1978), and Moluccan craft are known to have reached Malacca. But most long-distance trade was conducted by Malay, Javanese and Chinese vessels in the pre-European period. The largest vessel native to the Moluccas at this time, the kora-kora, was designed for warfare not trade. The expansion of spice production brought with it an increasing number of vessels of western Indonesian origin, and throughout the sixteenth century contact with various European craft was on an increasingly regular basis. The boats themselves were built elsewhere and, to begin with, would only have been repaired on Moluccan beaches. With the migration of entire trading communities they began to be built as well. The building of larger planked boats, with its more advanced technology, saw a major increase in the rate of destruction of Moluccan rain forest, and in places a shortage of suitable timber species.

Contemporary Moluccan boat-building (Figs. 10–12) is largely in the hands of settlers

TABLE 4. Preferred Moluccan woods used in indigenous boat-building. Data from Van Slooten (1969: 330–331) (whose information is in part derived from Rumphius), and Ellen, 1981 (unpublished fieldnotes).

Species	Properties	Uses
Anthocephalus macrophyllus (Roxb.) Hov.		Hull, below water-line
Artocarpus sp.		Canoes
Bruguiera spp.	Very hard	Interior ribs
Caesalpinia sappan L.		Pins
Calophyllum soulattri Burm.	Tough and pliable	Masts
Canarium vulgare L.		Canoes
Canarium indicum L.	Suitable but not as strong as *Calophyllum*	Masts
Cordia dichotoma Forst f.	Sea-water resistant; does not split or burst	Ideal rib and knee timber
Dehaasia media Bl.	Gnarled and durable	Oars and paddles
Diospyros ebenaster Retz.		Canoes
Gmelina moluccana (Bl.) Backer	Sea-water resistant; easy to hollow-out	Canoes
Heritiera littoralis Ait.	Sea-water resistant; does not crack or split; can be planed and sawn	Timbering small craft
Hernandia spp.	Not water resistant	Small craft carving; superstructures only
Homalium faetidum (Roxb.) Bth.	Very durable in sea water	Larger vessels
Intsia bijuga (Colebr.)		Rudders, sternposts; hull above water-line and super-structure; deck, ribs
Litsea stickmanni Merr.	Light and durable in sea water	Small craft
Melaleuca leuco dendra L.		Hulls
Mimusops elengi L.	When properly dried more durable than *Caesalpinia sappan*	Pins, keels
Pometia pinnata Forst.	Must be thoroughly dried and smoked; sinks in water but soon dries again	Oars and paddles
Premna corymbosa (Burm. f.) Rottl. & Willd.	Long-fibred, dry and fine	Oars and paddles
Pterocarpus indicus Willd.		Canoes
Rhizophora apiculata Bl.	Exceptionally sea-water resistant; hard thick root wood	Anchors

TABLE 4 (*continued*)

Species	Properties	Uses
Shorea spp.		Hull, below water-line
Sonneratia spp.	Sea-water resistant, does not split or burst	Ideal rib and knee timber
Toona sureni (Bl.) Merr.	Light and durable in sea water	Small craft
Vitex cofassus Reinw. ex Bl.	Very durable in sea water; commonest and second-to-none boat-building timber; heavy	Small craft; keels, sides and timbers below water-line generally
Arenga pinnata (Wurmb.) Merr.	Bark pounded to paste	Caulking
Canarium acutifolium (DC.) Merr.	Resin mixed with coconut oil	Tarring sloops and sampans
Canarium decumanum Gaertn.	Resin diluted in coconut oil	Caulking
Melaleuca leucodendra L.	Bark swells when moistened by sea water	Caulking
Parinari glaberrimum (Hassk.) Hassk.	Half-ripened seeds pounded to paste	Caulking
Ricinus communis L.	Oil pressed from seeds and mixed with slaked lime; becomes as hard as glass	Caulking
Shorea selanica (Bl.) Bl.	Resin diluted in coconut oil; gets harder in sea water	Caulking

of Butonese descent, Kei Islanders and some Ambonese (though often controlled by local ethnic Chinese capital). The preferred woods are indicated in Table 4, but as with dugout canoes and smaller fishing craft such as the orembai, these are not always available. For example, *Vitex cofassus* (gufasa) is not found on Gorom, or at least not in sufficient quantities of the right size. It either has to be imported or substituted with other woods, for example *Diospyros* or *Gmelina moluccana*. *Gmelina* has a shorter life than *Vitex*, although I have seen it used at Piru in west Seram for the construction of motorized prahus. Likewise, *Calophyllum* (kayu bintangor), generally regarded as quite unsuitable, was being used in 1981 for sterns and planking above the water-line. The problem of finding suitable timbers for marine work at the present time is also mentioned by Horridge (1979a: 9), who reports on the extensive use of *Canarium* (a wood not usually recommended) in the construction of Butonese lambos on Bandaneira.

Large sailing boats require planks, which can only be made efficiently from large diameter trees, and which had to be cut with axes and adzes. Most planks and timbers are carved from the solid hardwood with an adze (Horridge, 1979a: 16, 1979b), given the shapes required. This is clear from an inspection of Fig. 2. Some woods can be cleft into moderately thin planking, and tractable grains allow the splitting of a number of parallel-sided planks, although I have no evidence for the latter in the Indonesian context. While the saw must have been present from a fairly early period, it was probably not used much in boat-building. At the present time, thin sawn planks may be used on the hulls of the larger boats (Fig. 12), for superstructures (e.g. the deck house roof) and fittings*.

In Table 3 I have tried to estimate the amounts of timber required for the construction of different kinds of vessel of various sizes. It is a hazardous undertaking. It is not always easy to interpret figures given in the literature

*This is in contrast to European wooden boat-building techniques during the period 1600–1850. Timber for British naval vessels was cut in sawpits using two-man 5 ft frame saws, although sometimes trestles were used. Only some of the more irregular pieces were converted with an adze (Albion, 1926: 70). Sawn planks used on contemporary Moluccan boats are generally prepared from quarter-sawn logs using pits and a two-man cross-cut saw. The technique was presumably acquired from the Dutch (Horridge, 1979a: 10).

FIG. 10. Butonese lambo on stocks undergoing routine repairs, Gortei Selatan, Gunung Api, Banda Islands: 8 March 1981. (Neg. 81-9-16.)

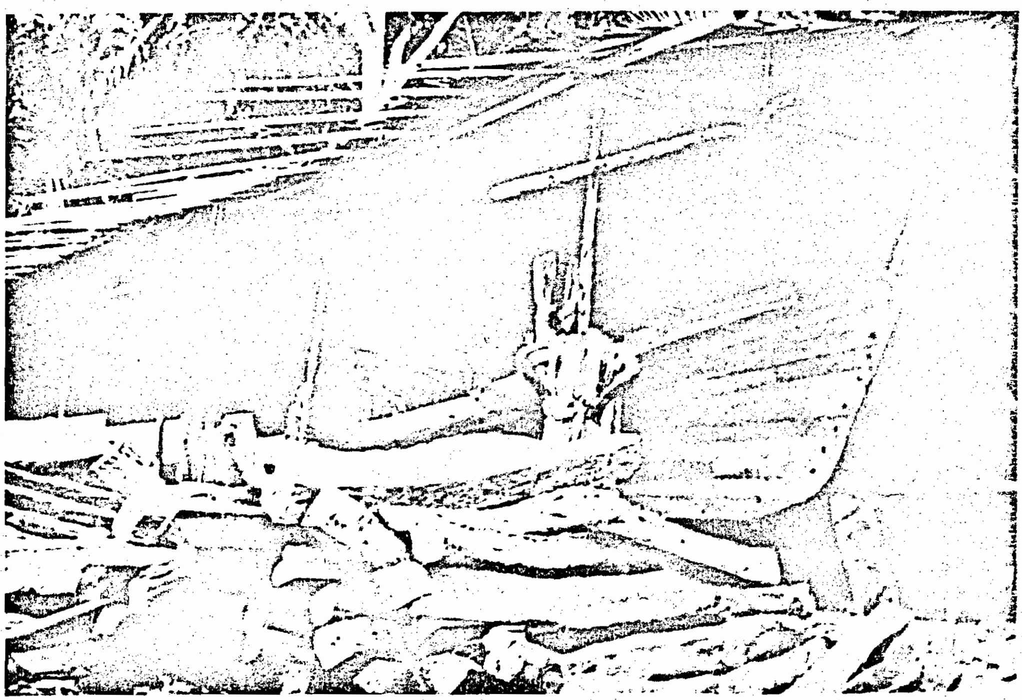

FIG. 11. Passenger ferry (motor penumpang) being built by Asilulu shipwrights for a Chinese merchant in Tulehu, Waairutan, Ambon: 26 March 1981. (Neg. 81-12-20.)

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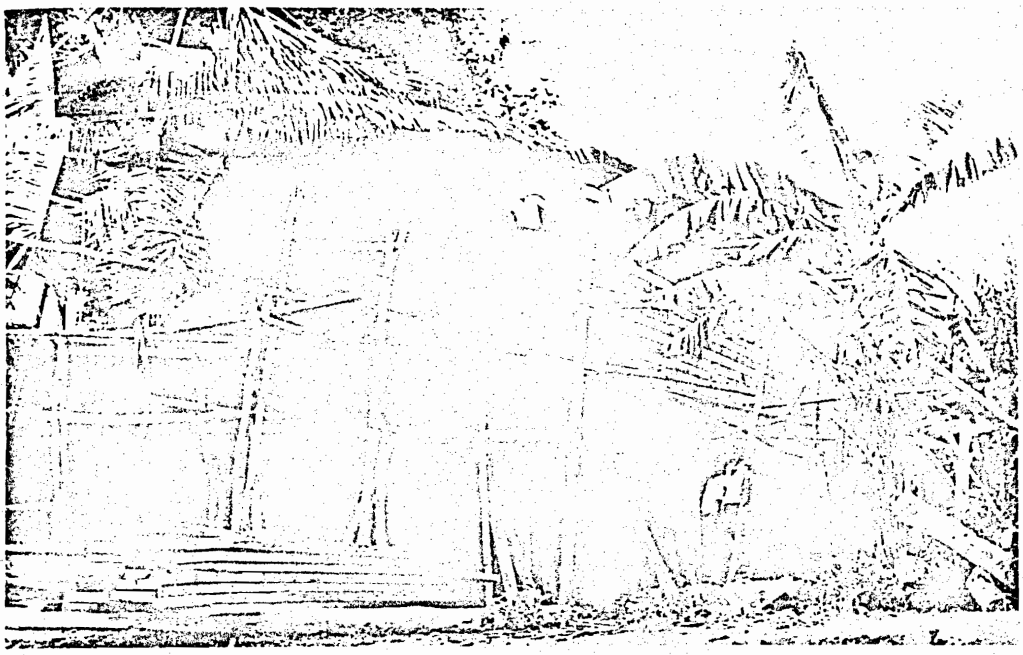

FIG. 12. Hull of large motor-vessel (perahu motor) under construction at Raroreng, near Elat, Kei Besar: 15 March 1981. (Neg. 81-11-23.) Note extensive use of sawn planks.

for tonnages and few detailed measurements are readily available. Moreover, it is clear that documented capacities of inter-island vessels vary almost continuously between 20 and 200 tons, depending on the year in which the keel was laid, the trade for which it was designed and local circumstances. Wallace (1869: 321) estimated that the larger Kei boats of 20–30 tons 'burthen' required an entire tree to make each pair of planks. Trees were hewn longitudinally into two equal portions, each of which formed a plank after it had been trimmed down to the required uniform size. Thus the technique employed is much the same as used by the Nuaulu in making sakanai (see above), plank thickness being about 5–8 cm. More efficient means of timber conversion have been possible using modern methods, but requirements remain considerable. Most Moluccan coastal villages of any size have at least one lambo, and villages of Butonese settlers, trading and administrative centres frequently have several for whom it is an operating base. Although there is a tendency for the life of older vessels to be prolonged by periodic repair, the annual effects on Moluccan timber resources remain substantial.

Historically, the greater demands of boat builders coincided with the increased planting of spices, which between them led early to the virtual deforestation of certain small islands, either through blanket or selective felling. This was especially the case in such important centres as the Banda islands, Seram Laut, Gorom, Ternate, Tidore and Ambon. The population of Banda in the seventeenth century was 15 000 on only 40 square miles. Even the larger island of Kei Besar, which Wallace reports (1869: 321) as having a plentiful supply, and which had a strong boat-building tradition, had little rain forest remaining by the middle of the twentieth century. With the decline of the rain forest on the smaller islands, increasingly boats were built with timber from Seram and Halmahera, and sometimes even New Guinea. In 1981 I came across imported Seramese boat-building timber on Kelu, Geser and Banda; while on Kei Besar I found timber from Aru and Kei Kecil; on Banda I also found timber from Irian (particularly from Pulau Karas). In some cases the wood was shipped to trading centres, in others boats were built on the Seramese coast within reach of suitable timber.

Boat-building expanded from the early seventeenth century until about 1850, despite European attempts to control inter-island trade and boat construction. The size, type and number of boats has changed during this period to match the pattern of trade (Dick, 1975), with considerable European influences on design and construction methods (Horridge, 1979a: 8–9). With the introduction of steamships and the establishment of the Koninklijke Pakketvaart Maatschappij in 1891 sailing boats got progressively smaller and were restricted to local trade. (Only the depression saw a slight increase in perahu trade.) It is perhaps ironic that a decline in the building of wooden boats should have come at a time when the forests were being destroyed at an accelerated rate in other ways.

TABLE 5. Annual output of Moluccan timber (sources: Indonesia, 1979, 1980)

Year	Cubic metres
1969–70	111 993.71
1970–71	758 354.14
1971–72	1 049 616.26
1972–73	1 476 305.83
1973–74	1 528 367.95
1974–75	1 059 685.65*
1975–76	737 190.81
1976–77	877 064.11
1977–78	985 501.01
1978–79	971 440.02

* Cf. Jones (1976: 59), who provides a figure of 50 000 m^3 for coastal Moluccas.

The colonial timber trade and modern commercial logging

The colonial influence brought with it new uses for planked timber, especially for house-building, bridges, landing stages and fortifications. Prior to the colonial period, the products of Moluccan forests had been collected for sale to outside traders (cf. Dunn, 1975). This now intensified and was accompanied by the introduction of sawing on a large scale. Until the arrival of mechanical band and circular saws, pit saws (free-bladed and frame saws) were virtually the only means of producing wide planking. At the present time pits are used in preference to trestles, and each saw requires two persons.* Rough-sawn butts are cut into planks and then stacked to allow ventilation. In 1856 Jordens recommended the establishment of a factory at Amahai to extract timber from the rich lowland forests of south Seram. Indeed, the land around Amahai is now heavily denuded. By the late nineteenth century Moluccan timbers had been surveyed, exhibited and extolled in Europe (Sturler, 1867; Campen, 1883), and by the early years of the present century their economic potential was beginning to be realized (Endert, 1929; K., 1981). In 1908, a forest administration was set up for the Outer Provinces and, by 1936, 1.7% of the surface area of the Moluccas had been designated forest reserve (Koppel, 1945: 217–219). However, in recent years new technology, particularly the chain saw, has had a decisive impact on forest clearance activities. Large trees which were once left standing, and would provide the seed and shade and water retention properties necessary for eventual effective forest regeneration are now cut, while the efficiency of forest clearance activities has increased immeasurably (cf. Colfer, 1983: 15–16). It also brought with it commercial logging for export on a quite unprecedented scale. Some recent government figures are set out in Table 5. In 1979, almost 100 000 m^3 of timber were exported from the Moluccas as a whole, to the value of US$96 635 584. Most of this came from the forests of Halmahera and Seram with over 80% destined for Japan. The most important species being handled by the thirty timber firms operating out of Ambon were *Shorea* (meranti), *Intsia bijuga* (besi), *Durio*, *Pterocarpus indica* and *Anthocephalus* (samama) (Indonesia, 1979, 1980).

All this has brought only marginal benefits to native Moluccans: a little short-term employment as loggers and access to some new technology. The Nuaulu can now take advantage of discarded cut timber, the deserted buildings and rubbish of logging camps. Ironically, the

*On European two-person frame-saws of the kind routinely used in pits see Goodman (1964: 131–142). Pit-sawing was common in England and Denmark from the eighteenth centrury onwards, but trestles were mainly used before that. Presumably it spread to Indonesia via the Dutch, although there are Chinese records of using this technique.

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driving of causeways through the forest has opened up new areas to hunters and foragers, while the gaps in the forest are used for driving game. The long-term reality is that this itself threatens to destroy the very fauna on which the Nuaulu depend.

The damage done by mechanized logging teams is well documented. Vayda (1981: 10) reports that 50% of standing trees were damaged in the mechanized logging areas which he observed in East Kalimantan, 41% in terms of crown and branch damage alone. This is far in excess of damage done even by indigenous low-technology teams of cash-loggers. 30% of the mechanically logged areas were made bare by skid trails, haul roads and log yards. As in Kalimantan, desirable woody species grow only with difficulty in such areas and the rate of recolonization is generally slow. Compacting of soils by tractors and other heavy machinery does further environmental damage. As in Kalimantan, selective logging is professed but seldom practised, combining logging with conservation. Specifications regarding the minimum size of trees to be cut, their number and spacing, have rarely been heeded in practice (Kartawinata, 1978). According to Ashton (1980: 46–48) there is no ecological evidence to suggest that such a system would work anyway. Although Moluccan timber extraction is about 3–4% of total Indonesian production, its local ecological and sociological impact is significant in view of the smallness of the land masses and forest areas involved. Therefore extensive logging, combined with increased clearance through swiddening, transmigratory settlement from Java and elsewhere, government plantations and road-building, seems likely to destroy much lowland rain forest of Seram. The less accessible highland forests have been accorded some degree of protection through the establishment of a series of reserves, the Batas Hutan Tutupan, and more recently the Way Nua and Way Mual nature reserves (Amir & Wind, 1978). Sadly, even these are now being encroached upon.

Conclusion

I have tried to show in this paper the effects of different patterns of demand and timber extraction on the condition of Moluccan forest fringes. I have used ethnographic, experimental and historical data. It is conceivable that palaeobotanical and archaeological means of reconstructing the changing face of forests may in time serve to refute the hypotheses presented here. If we now summarize what is known from the literature, and retroject some of the patterns I have identified for the modern period, a chronology begins to emerge for the history of human impact on Moluccan forests. It is only tentative, but may help us begin to think about, if not fully understand, the changing human impact on the forest fringe over the last millenium.

Throughout the period of human habitation in the Moluccas, it is clear that there has been a continuous gathering of forest products and timber for home consumption. Indeed, the interior peoples of Seram were for a long time essentially sago-extractors, foragers and hunters (Ellen, 1979). The rate of extraction entailed in such activities has risen with population growth, improved technologies and expanded inventories of material culture. It has only decreased locally in the modern period with the substitution of local products with items acquired through trade.

The protohistoric period in the Moluccas, which might be said to have ended around AD 1400 with regular trading and political contacts with Java, the arrival of Islam and the compilation of the first local chronologies, must for a long time have been characterized by a predominantly lithic and vegetable-based technology, with iron tools only generally available in trading centres such as Gorom, Banda and Ternate. This same period was marked by an expansion in forest clearnace for swiddening in coastal areas, in the Asian trade in forest products, and in the use of iron blades.

Trade in nutmeg and cloves has a demonstrably ancient pedigree, but there is evidence for a sharp increase in trade from about AD 1400 and of the spread of cultivated spice groves throughout the sixteenth century. This must have been accompanied by further population growth and forest clearance in selected areas, encouraged by the introduction of cultigens such as *Zea meys*, *Xanthosoma* and *Ipomoea batatas*, as well as the planting of long-term cash crops. With increased trade, and especially following the establishment of

Javanese, Buginese, and much later Butonese, settlements, there was also an increase in the local building of large planked boats. This was facilitated by the introduction of new European hulls, rigging, accessories, tools and techniques. The exhaustion of valued timber producing species in particular areas led to a growth in local inter-island trade in wood. From the late nineteenth century the demand for timber for traditional purposes declined, but only to be obscured by the dramatic expansion of the colonial export of timber and latterly modern intensive commercial logging. The difference between modern logging and all earlier patterns of extraction is that the latter involves, for the most part, a gradual denudation of primary forest and the selective (but not exhaustive) extraction of a variety of species to cater for a wide range of essentially local uses. Modern methods involve either the selective extraction of just a few species to exhaustion, or the total destruction of forest in a short period to cater for a narrow range of non-local uses.

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