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Fishing, Turtle Hunting, and Mammal Exploitation at Fa'ahia, Huahine, French Polynesia.

B. F. LEACH¹, M. INTOH²,
J. W. G. SMITH³

INTRODUCTION.

Fa'ahia and Vaito'otia are two small land divisions on the north-west corner of Huahine in the Society Islands (See Figure 1). An important waterlogged site was discovered at Vaito'otia in 1972, during dredging associated with construction of the Bali Hai hotel. The land immediately to the north is known as Fa'ahia, and the archaeological deposits are now known to extend into this land division too.

Excavations have been carried out under Sinoto's direction periodically since 1973 (Christensen 1981; Sinoto 1974, 1979, 1982, 1983a, 1983b; Sinoto and Han 1981; Sinoto and McCoy 1975). There are two main cultural horizons — a lower one (Layer V) which is waterlogged, and an upper one (surface of Layer IV) thought to be recent occupational debris. There are six radiocarbon determinations for the early deposit in the range of AD 850 to 1 200, and the material culture may be ascribed to 'Archaic East Polynesian', with affinities to early Marquesan and New Zealand cultures. These waterlogged deposits have produced significant wooden items — parts of outrigger canoes, paddle helms, tapa beaters, and wooden hand clubs (*patu*), as well as a rich assemblage of whalebone, shell and stone artefacts. The excavations have produced abundant osteological material, including fishbone, mammalian fauna, and bird bone. The assemblage was

sent to the Otago Archaeological Laboratories for analysis. This paper reports the identifications of all except the bird bones, which are still being examined.

The bulk of the material derives from section 3, Zone A at Fa'ahia (Sinoto, 1979). This section may have been a stream bed (Sinoto, 1982), and the entire area investigated at Fa'ahia appears to have been a depression in the ground surface, which may have contained a pond or swamp. Any flooding, such as that resulting from tidal waves, may have accumulated in this area. The present high ground water table probably accounts for the excellent state of preservation of the faunal remains. A smaller quantity of bone material was recovered from Section 5, Zone A at Fa'ahia, about 30 m south-east of Section 3.

In the field, all material retained by a one quarter inch mesh (6.35 mm) wet sieve was kept for analysis. In order to obtain as complete a picture of faunal exploitation as possible, recognisable material which passed through the sieves, and material of uncertain or mixed provenance was also collected (Sinoto, pers. comm. 1984).

ENVIRONMENTAL SETTING.

The waterlogged nature of these deposits indicates that the nearby environment may have changed at some time in the past.

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Although this matter is largely beyond the scope of this paper, the question arises as to whether the local marine setting was sufficiently unlike today to have to take this into account in evaluating the character of marine exploitation from these faunal remains. The cause(s) of the waterlogging is the crucial point. This matter is still under study. Possible contributing factors which have been suggested are as follows :

1. Tilting of the north-western part of Huahine (Kitagawa, pers. comm. to Sinoto, 1983a : 586).
2. A lowering of sea level relative to land of 3 m suggested for the Tuamotu archipelago (Salvat, 1970 ; Sinoto, 1983a : 586-7).
3. Tidal waves (*tsunami*) in the Fa'ahia district (Kitagawa, pers. comm. to Sinoto, 1983a : 587).

A noteworthy feature of Huahine, evident on the available French topographic map of the island, is the steep terrain near the sea in the south, and the presence of an elevated reef platform in the north. The combination of these two features certainly suggests some tilting process for the island as a whole, with the south sinking and the north rising. The archaeological site is located on part of this elevated reef flat (See Figure 1). In a situation like this, numerous purely local pheno-

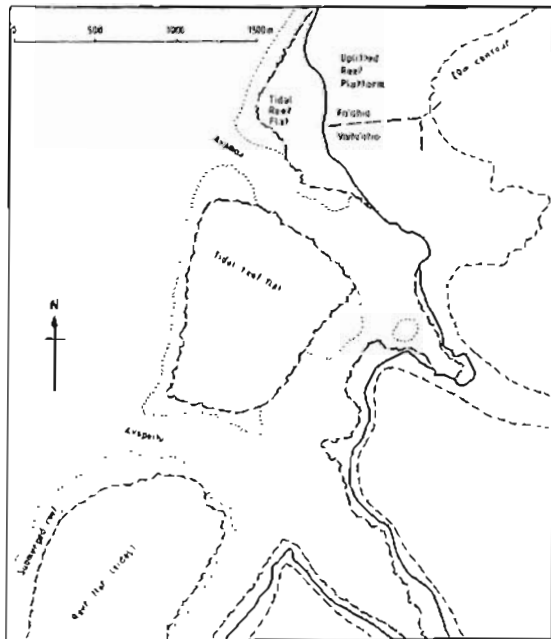


FIG. 1. — North-west Huahine showing the location of the Vaito'otia and Fa'ahia land divisions and the nearby terrestrial and marine environment. Note that the excavation are situated on an uplifted reef platform. A larger scale map is given by Sinoto (1983a).

mena could be invoked to explain the waterlogged nature of the deposits (J. N. Jennings, 1983 : pers. comm.). For instance, local depressions in an uplifted sandy reef platform could remain waterlogged for long periods, despite their elevation above sea level, because of inability of water run-off to seep away quickly from the generally flat terrain. In addition, any storm ridges which might form subsequent to the uplift would further inhibit run-off, and thereby increase the tendency to form swampy land. Habitation sites, initially established on relatively dry land, could easily become waterlogged in the course of time, in a terrain with these features. Tidal waves do occur in French Polynesia, on average about once every ten years (Tallandier, 1980 : 613), and this certainly could be an additional factor. The effects of such events are well described by Davies, following just such an incident in Tahiti in 1805 :

in the evening, an unexpected and uncommon rising of the sea took place, the low lands were overflowed and much damage done to taro plantations & c. This uncommon phenomenon excited fears, but they were soon somewhat removed, by the water quickly falling again. It was found afterwards that damage was done to trees and plantations in various districts of Tahiti, and also at Eimeo (Davies, 1961 : 79).

A possible complication in this matter is the recorded presence on Huahine of pole-houses, built out over the water (for example, see Anon., 1943 II : 171 ; Russell, 1935 : 139). These seem to have been common in the Maeva area on the north-east of Huahine, but Emory has noted that they were not present in 1818 (Emory, 1933 : 127). It may also be noted that an early 19th century woodcut of the village of Fare, near Fa'ahia and Vaito'otia, shows houses on the ground, not elevated (see Ellis, 1969). Handy reviewed this question carefully and concluded that " the sleeping house on posts or piles is a modern innovation, but there existed anciently, in Huahine at least, a counterpart of the old Polynesian *tapu* house on posts " (1932 : 7). The sole example of the latter cited by Handy was a specialised house near a marae.

Given that pole-houses over water were not present in the prehistoric period, we can assume that this land was reasonably dry when first inhabited ; thus, the uplifted reef platform in this area must have been elevated some time before occupation, and the waterlogging must relate to some other phenome-

non. Some very local e off, seems the most significant marine enviro be ruled out for the r main present-day featur being similar to those w the period of prehistoric

PRELIMINARY ANALYSIS C RIAL.

Bags of material were trays and sorted into m as follows :

1. Fish
2. Bird
3. Turtle
4. Sea Mammal
5. Pig
6. Dog
7. Bovine

The clean and well-pr bone material obviated clean the collection. was entered into the data base accession sys an appropriate accessio is used as a cross refe notes on the bags. T bagged at this stage in each was recorded the a abbreviated provenance as follows :

- AC429 Accession Num
- FA Fa'ahia
- 3 Section
- L3 Layer informat

Additional abbreviatic

- Square ?? = no inform
- » Pit = a large p
- Layer 3 = Layer III
- » 4 = Layer IV
- » 5 = Layer V
- » 9 = no Layer
- » 10 = Fill mater (ging)
- » 11 = Overburd.
- » 12 = Bulk

These designations are paper, and their slightly those used by Sinoto (19

tain the water. N. Jennings, instance, local reef platform long periods, ve sea level, un-off to seep rally flat ter- ridges which > uplift would hereby increase land. Habitu- l on relatively waterlogged in with these fea n French Poly every ten year this certainly The effects of by Davies, fol t in Tahiti is and uncommon low lands were ie to taro plants nomenon excited hat removed, by It was found ne to trees and Tahiti, and also this matter is ahine of pole- er (for example, Russell, 1935: een common in ast of Huahine. y were not pre- 127). It may y 19th century e, near Fa'ahia on the ground. Handy review and concluded posts or piles there existed t, a counterpart ouse on posts le of the latter lised house near water were not period, we can reasonably th he uplifted nee ve been elevated, and the water- other phenomena

non. Some very local effect, inhibiting run-off, seems the most likely cause. If so, significant marine environmental change can be ruled out for the nearby area, and the main present-day features can be assumed as being similar to those which prevailed during the period of prehistoric marine exploitation.

PRELIMINARY ANALYSIS OF THE FAUNAL MATERIAL.

Bags of material were spread out on plastic trays and sorted into major faunal categories as follows :

- 1. Fish
- 2. Bird
- 3. Turtle
- 4. Sea Mammal
- 5. Pig
- 6. Dog
- 7. Bovine

The clean and well-preserved nature of the bone material obviated any need to steam-clean the collection. All provenance data was entered into the Laboratory computer data base accession system, which generates an appropriate accession number and which is used as a cross reference to all detailed notes on the bags. The material was re-bagged at this stage in plastic bags, and on each was recorded the accession number, and abbreviated provenance information, typically as follows :

- AC429 Accession Number
- FA Fa'ahia
- S Section
- L3 Layer information

- Additional abbreviations are :
- Square ?? = no information
 - " Pit = a large pit feature
 - Layer 3 = Layer III
 - " 4 = Layer IV
 - " 5 = Layer V
 - " 9 = no Layer given
 - " 10 = Fill material (from pond dredging)
 - " 11 = Overburden
 - " 12 = Baulk

These designations are used throughout this paper, and their slightly different character to those used by Sinoto (1983a) should be noted.

Analysis of turtle and mammalian fauna.

The material was identified using reference collections at the Otago Archaeological Laboratories, the Auckland University Anthropology Department, and the Auckland Institute and Museum.

Minimum numbers of individuals were calculated for each species or class of fauna (depending on level of identification) by counting the most commonly occurring anatomical element. Timetables of tooth eruption and epiphyseal fusion in modern pigs and dogs (Silver, 1969) were used to estimate the age at death for these groups of animals. However, as the extent to which such data are applicable to prehistoric populations in the Pacific is not known, the reported ages should be treated as approximations only. The sub-specific affinities of the pigs (see Groves, 1983 ; n.d.) could not be assessed because of the juvenile state of the dentition. Similarly, the fragmentary nature of the dog remains prevented osteometric comparisons with other collections of prehistoric dogs (for example Wood Jones, 1931 ; Allo, 1970, 1971 ; Smith, n.d.a.).

The most abundant remains in this assemblage were those of marine turtles (Table 1). A minimum number of 25 individuals were identified from Section 3 (Table 2). The species to which these belong could not be established because of the lack of suitable reference material (Figure 2). However, clear differences in mandibular morphology indicate the presence of at least two species. On distributional grounds, these are most likely to

Animal	Section 3	Section 5
Turtle	25	1
Dolphin	5	
Large cetacean	1	
Pig	3	1
Dog	3	
Bovine	1	

TABLE 1 Fa'ahia reptile and mammal minimum numbers

Element	Left	Right	Minimum Number
Cranium			7
Mandible	6	7	7
Preopercoid	11	4	11
Coracoid	24	11	24
Humerus	25	25	25
Radius	3	6	6
Ulna	2	6	6
Pelvis	4	10	10
Femur	4	4	4
Fibula	3	3	3
Tibia	3	3	3
Extremities	2	1	2

TABLE 2 Fa'ahia Section 3, Turtle minimum numbers for each skeletal element. Note no attempt was made to quantify fragments of carapace or plastron. Extremities = Carpals, tarsals, metacarpals, Metatarsals, and phalanges.

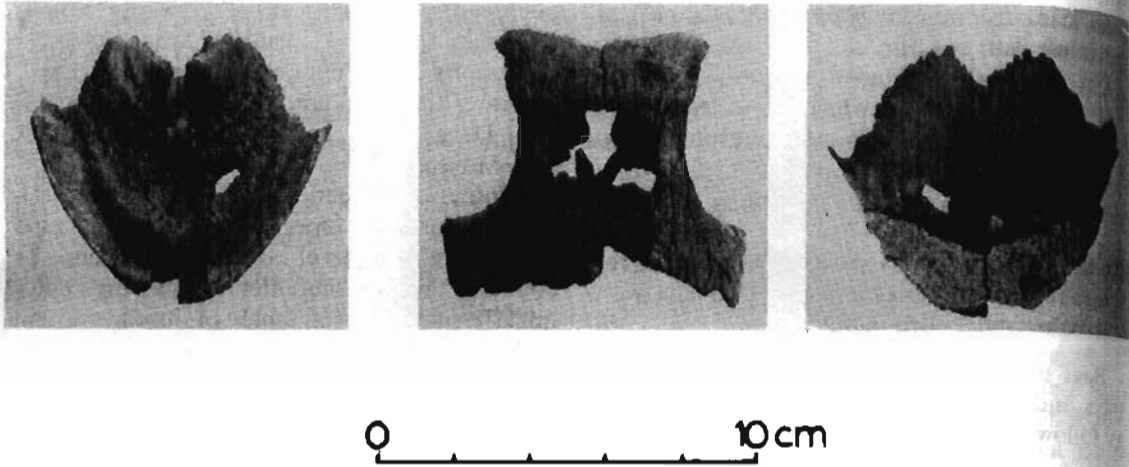


FIG. 2. — The maxilla of one of the turtle specimens from Fa'ahia (species uncertain).

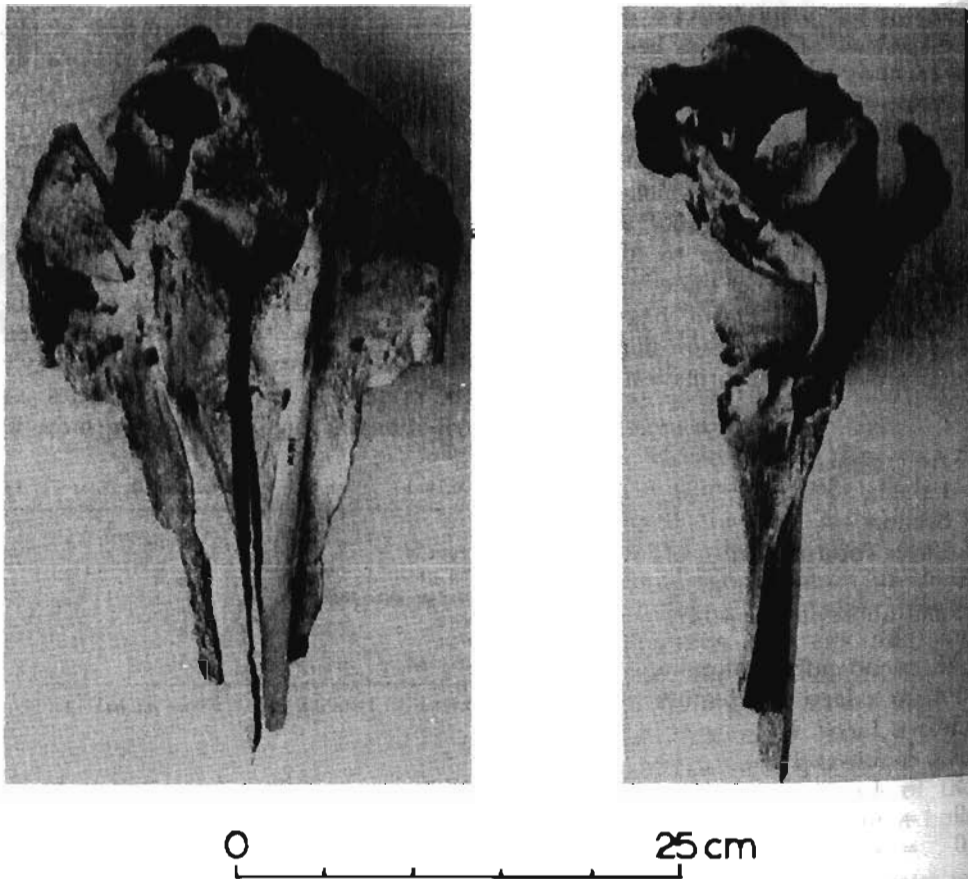


FIG. 3. — A complete dolphin cranium recovered from Fa'ahia (species uncertain).

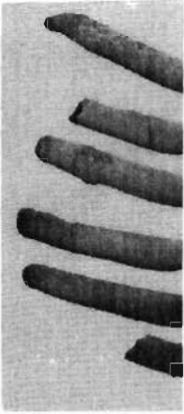


FIG. 4. — Many of the dolphin vertebrae of the transverse process.

be the Green Turtle (*Chelonia mydas*) or the Hawksbill (*Eretmochelys imbricata*). Two species reported from today (Anon., 1980 : 8). (1975 : 176) suggested that turtle remains were probably from two species, although some were tentatively identified by the Green Turtle (*Dermochelys coriacea*). Modern evidence of the presence of the Green Turtle in the part of the Pacific (Anon., 1980) is that it is a wide-ranging pelagic species with wide population numbers and historically low levels (Bustard, 1975). It is well known that it may well have occurred on the Pacific coast during the prehistoric period.

The Fa'ahia turtle remains are of a wide size range, indicating that they were not concentrated upon a single species. However, in view of the difficulty of establishing the species, it is not possible to assess the value of the information reliably.

Sea mammals are the second most common class of animal in the archaeological record. Five dolphins are represented by vertebrae, although only one complete cranium was also recovered. Again, positive identification was not possible. At least

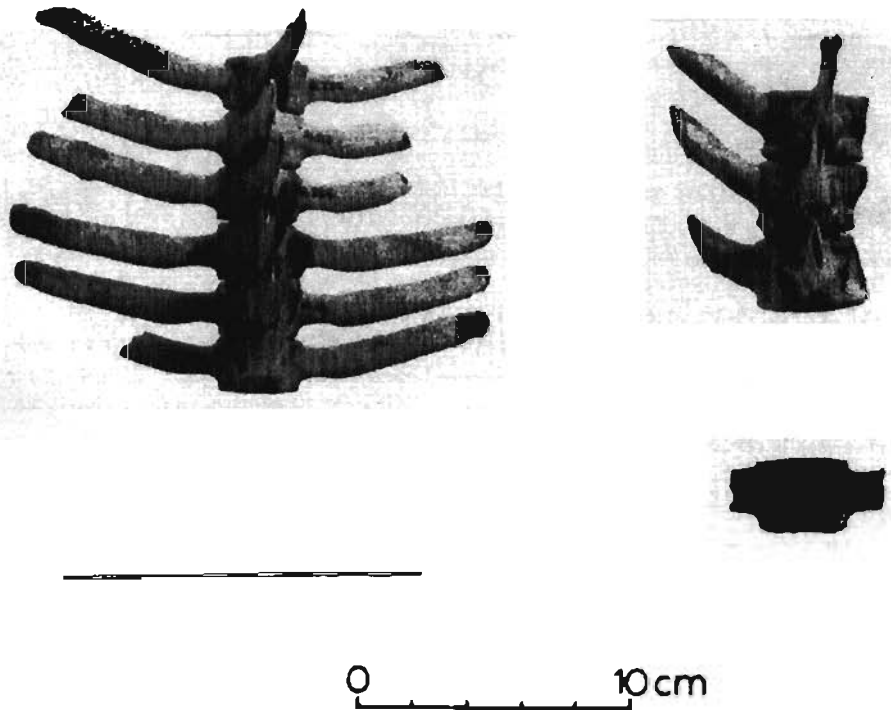


FIG. 4. — Many of the dolphin vertebrae exhibit butchering marks as shown here, predominantly on the dorsal surfaces of the transverse processes, such as would accompany removing dorsal muscles.

be the Green Turtle (*Chelonia mydas*) and the Hawksbill (*Eretmochelys imbricata*), which are two species reported from French Polynesia today (Anon., 1980 : 8). Sinoto and McCoy (1975 : 176) suggested that the Vaito'otia turtle remains were probably from these two species, although some limb fragments are tentatively identified by them as Leatherback Turtle (*Dermochelys coriacea*). There is no modern evidence of the Leatherback in this part of the Pacific (Anon., 1980 : 8), but as it is a wide-ranging pelagic species with world wide population numbers now reduced to critically low levels (Bustard, 1972 : 35), it may well have occurred on Huahine during the prehistoric period.

The Fa'ahia turtle remains included a wide size range, indicating that exploitation was not concentrated upon a restricted age class. However, in view of the difficulty in accurately establishing the species present, it is not possible to assess the implications of this information reliably.

Sea mammals are the second most common class of animal in the assemblage (Table 1). Five dolphins are represented, predominantly by vertebrae, although one virtually complete cranium was also recovered (Figure 3). Once again, positive identification to species level was not possible. At least eight species of

dolphin occur in the tropical Pacific, but three of these seem to be confined to deep off-shore waters (Watson, 1981), reducing the likelihood that they were the prey of prehistoric hunters. Three of the remaining species — the Spinner dolphin (*Stenella longirostris*), the Striped dolphin (*S. coeruleoalba*), and the Bridled dolphin (*S. attenuata*) — feed upon, and are frequently found about, schools of tuna (Watson, 1981 : 262, 265, 267). As will be seen below, tuna were abundant amongst the fish in the assemblage, and these three species therefore may be considered the most likely prey. The Common dolphin (*Delphinus delphis*), and the Bottlenose dolphin (*Tursiops truncatus*) appear to have somewhat different feeding habits (Watson, 1981 : 272, 274), but as they occur in coastal waters throughout the tropical Pacific, they too could have been hunted. There are no historic ethnographic records of dolphin hunting in the Society Islands which could give guidance on this matter.

Many of the dolphin vertebrae exhibit butchering marks, predominantly on the dorsal surfaces of the transverse processes (Figure 4). These marks would have been made during removal of the musculature along the dorsal surface of the vertebral column. This form of butchering has been noticed before in New

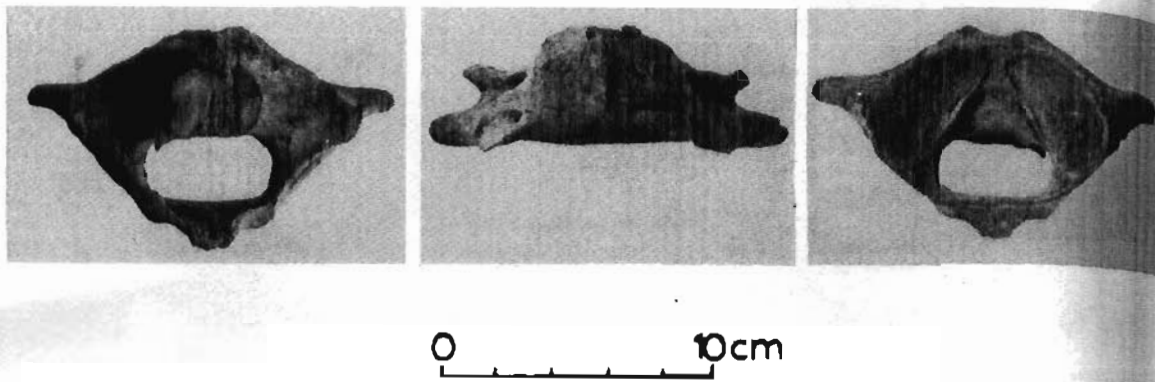


FIG. 5. — This dolphin cervical vertebra shows considerable butchering marks, presumably during the severing of the head from the trunk.

Zealand on pilot whales (*Globicephala* sp.), and in that instance, it appears that stone adzes were used for the butchering (Smith, 1979 : 221). However, in the Huahine case, the butchering marks are sharp fine cuts in the bone, suggesting a very sharp implement such as a stone flake, or perhaps a shell or bamboo knife. Flake tools made from an andesitic material are abundant in the site (Sinoto and McCoy, 1975 : 170-173), but these may not have been sharp enough to produce the observed cuts. This difference in technique of butchering dolphins and pilot whales may reflect the size difference between the two animals. Numerous fine butchering marks also occurred on the first cervical vertebrae of a large dolphin (Figure 5), presumably resulting from the severing of the head from the vertebral column.

Intervertebral plates and fragments of vertebrae from a much larger cetacean are also present in the assemblage. These would appear to be from an animal of the size of a large pilot whale (*Globicephala* sp.), or a small Sperm Whale (*Physeter macrocephalus*). In view of the abundant use of whale bone for the manufacture of artefacts at both Vaito'otia (Sinoto and McCoy, 1975), and Fa'ahia (Sinoto, 1979) these remains may be industrial raw materials collected from beach-wrecked animals, rather than food remains.

Remains of three pigs (*Sus scrofa*) were recovered from Section 3 (Table 3), with one further fragment from Section 5. Consideration of the epiphyseal fusion and tooth eruption indicates that all three animals from Section 3 were less than one year old at death, with at least one of these less than six months in age. No estimate of age was possible for the individual from Section 5.

Three dogs were also represented in Section

Element	Left	Right	Minimum Number
Cranium			1
Teeth	1	1	1
Mandible	1	1	1
Scapula	2	1	3
Humerus	3	3	3
Radius	1	1	1
Ulna	1	1	1
Carpus	1	1	1
Metacarpus		1	1
Phalanx (fore)	3	2	3
Pelvis	2	2	2
Femur	2	2	2
Tibia	3	3	3
Tarsus	1	1	1
Metatarsus	1	1	1
Phalanx (hind)	7	7	7
Vertebrae			3
Ribs	7	7	7

TABLE 3 Fa'ahia Section 3, Pig minimum numbers for each skeletal element.

Element	Left	Right	Minimum Number
Cranium			3
Teeth	1	2	3
Mandible	1	1	1
Scapula	1	1	1
Humerus	1	1	1
Ulna		1	1
Metacarpus	2	2	1
Pelvis	7	7	1
Tibia	1	1	1
Tarsus	1	1	1
Metatarsus	1	1	1
Vertebrae			1
Ribs	7	7	1

TABLE 4 Fa'ahia Section 3, Dog minimum numbers for each skeletal element.

3 (Table 4). All of these animals were young. On the basis of tooth eruption, two individuals appeared to be approximately four to six months at death, and the third was less than three and a half months old. The unfused state of the long bone epiphyses, and the small size of the cranial remains is consistent with these estimates.

The Fa'ahia assemblage also included a number of bones and teeth of cattle, probably belonging to one individual. These remains are considered further below.

Discussion of turtle and mammalian fauna.

The reptilian and mammalian fauna from Fa'ahia are indicative of a broad range of subsistence pursuits. The turtles and dol-

phins in the assemblage su hunting was an important economy. While there are variations of the hunting method, probable methods can be inferred. The majority of turtles are most likely to have been taken when emerging from their nest or breed, though some may have been caught in fishing. It should be noted that a hook baited harpoon has been claimed to be a method applied to turtles (Coffin, 1975), though whether this is relevant to the assemblage is uncertain. Diving methods have been described for the Pacific (Emory, 1975 : 216-217), and it is probable that hunting was probably undertaken in the sea with the aid of harpoon. Complete harpoons have been recovered from Fa'ahia or Vaito'otia, which may be a harpoon recovered at Vaito'otia (Sinoto, 1975 : 169, Figure 7s), and a fragment has been found at Fa'ahia (Sinoto, 1975 : 590). Harpoons occur in other assemblages from the Pacific (Sinoto and McCoy, 1975 : 170-173), and both these are evidence of dolphin hunting (Sinoto, n.d.b.). In addition, wooden clubs have been recovered from the site, and could have been used for hunting dolphins rather than, or in addition to, as fighting weapons. This does not rule out this possibility. These artefacts are thought to have been used in the Chatham Islands (Sutton and Marshall, 1980), and are invariably so (see Sutton, 1980). On the other hand, dolphins may be killed outright with a *patu* (Sutton, 1980). The exploitation of dolphins was clearly also an important part of the economy. Dogs appear to have been used within the first year of life, with only three pigs occur, these are all less than three years old. It is difficult to interpret this. In other European societies engaged in selective culling of both young (months) and old individuals (years) was practised (see Sinoto, 1975 : 135), leaving the breeding stock. There is little guidance on the age of dolphins in the ethnographic literature on the Pacific. However, Rappaport (1967) has shown that in the highlands of Papua New Guinea, between one and two years is the most common age for pig trade and exchange. Evidence from the Pacific, e-

Figure 6, following Munro's classification (Munro, 1967). The diversity index, Shannon's H statistic, given in this Table and elsewhere in this paper is a statistic which has found wide application in problems of classification and pattern recognition (see for

Layer	3	4	5	9	10	11	12	Total (%)
1 Thunnidae/Katsuwonidae	7	32	31	3				73 (19.6)
2 Carangidae	8	25	32	3				68 (18.2)
3 Scaridae	1	7	22	17	3	1		51 (13.7)
4 Epinephelidae	1	7	9	11	4		1	33 (8.8)
5 Lutjanidae	1	11	9	5	2		1	29 (7.8)
6 Serranidae	2	11	5	1		1		20 (5.4)
7 Balistidae	3	4	6	4	1			18 (4.8)
8 Molocentridae	1	1	6	2	1			11 (2.9)
9 Belontiidae	2	1	4	2				9 (2.4)
10 Nemipteridae	1	3	2	1				6 (1.6)
11 Mullidae		3	2	1				6 (1.6)
12 Anguilliformes								7 (1.9)
Anguillidae	1	1	1					3 (0.8)
Muraenidae	1	1	2					4 (1.1)
13 Labridae	1	1	3	1				6 (1.6)
14 Sphyraenidae		2	1	1	1	1		6 (1.6)
15 Elasmobranchia	1	2	1	1				5 (1.3)
16 Diodontidae	1	1	1	1	1			5 (1.3)
17 Acanthuridae	1	2	1					4 (1.1)
18 Ostraciidae	1	1	1	1				4 (1.1)
19 Tetrodontidae	1	1	1	1				4 (1.1)
20 Megalopidae			2					2 (0.5)
21 Scolecidae		1						1 (0.3)
22 Exocoetidae			1					1 (0.3)
23 Chanidae		1						1 (0.3)
24 Hemiramphidae			1					1 (0.3)
25 Mugilidae				1				1 (0.3)
Totals	4	57	128	135	32	5	2	373

TABLE 5 Minimum numbers for Fa'ahia fish remains, arranged in order of decreasing abundance. The family numbers indicated here are used throughout this paper.

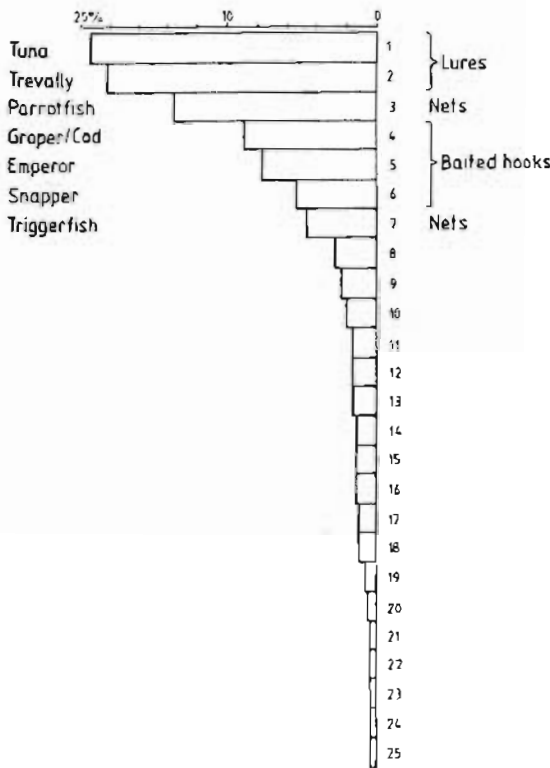


FIG. 6. — Fall-off abundance curve for fish from the Fa'ahia site. The family numbers follow Table 1. Common names and likely catch methods are indicated for the more important types of fish. Shannon's H statistic = 3.62. This indicates the disproportionate reliance on some types of fish. Note that the two most important families are both pelagic game fish.

example Watanabe, 1972 : 562), and in ecological studies where species diversity is measured against environmental stress. It has also been used as an index of environmental quality (and lack of it) in areas of high pollution such as American estuaries (Headrich, 1975). When biomass units are employed instead of numbers the index has been used to measure the complexity of energy pathways in communities (Wilhm, 1968). The statistic has equally diverse applications in archaeology, particularly in studying the effects of human predation on resources (see Leach, 1978). It is calculated as follows :

$$H = - \sum_{i=1}^q (p_i \cdot \log_2 p_i)$$

Where q = the number of families represented ;
 p_i = the proportion of the ith family ;
 NB : by using base 2 logarithms, H is given in binary digits (bits).

Fish from 26 families were caught by these Huahine people. This is a comparable range to that of other known prehistoric Pacific fishermen. Only seven of these, however, could be said to have been major components in the catch (greater than 4 % of the total). This may be compared with 10 major types on both Nukuoro and Kapingamarangi (Leach and Davidson, n.d.), and nine on Palau (Masse, n.d.). This shows that the Huahine people were specialised in their approach to marine harvesting, and this is further indicated by the low value for Shannon's H statistic (see Table 6).

Assemblage	Shannon's H	Characteristics
Nukuoro	3.83	More generalised fishermen, though netting dominates.
Huahine	3.62	Specialised pelagic fishermen.
Kapingamarangi	3.61	Specialised baited hook fishermen.
Palau	3.45	Highly specialised net fishermen.

TABLE 6 Shannon's H statistic for Huahine (pooled estimate) and other major fish bone collections in the Pacific.

Foremost in importance are fish of the Thunnidae/Katsuwonidae families, closely followed by the Carangidae. It will be seen from Figure 1 that the site is only 1 km from the open sea, and there is an entrance through the reef, known as *avamoa*, with its main channel passing close to Vaito'otia and Fa'ahia. The site is therefore ideally sited to take advantage of pelagic fish coming through the reef entrance in search of prey inside the reef. Tuna certainly come through reefs in

this way, though the resident inside the reef are attracted by a trap have been the main

It is thought that (Kapingamarangi and Davidson, n.d.), caught on one-piece archaeological occurrence shanks on the tuna with long line a been described for the 1974 : 297). However were also found in t and lure fishing is t catch method for the lure shanks have Vaito'otia and Fa'ahia and no points have pers. comm. 1984). ten, however, that a can be caught in net: people were certainly and given the locatio a reef entrance, some have been caught in proportion were nett lures is an open que:

Next in importance scarids or parrotfish. herbivorous, though and coral are also ea ted hook and line fis many of these fish. today, including Hu dominant form of fis easily taken in this n coralline location in This form of fishing been greatly assisted l eed by Europeans.

times is unlikely to b as productive as to confined to shallow kets. It is therefore

rids were principally Scarids are followe families of fish which feeders, and which waters — Epinephe Lutjanidae. The onl these fish is by use c and in particular in outside the reef.

Finally, the Balistic for just over 4 % of ged to have been t: general foraging aro The relative import

62), and in ecology is measured. It has also been used to measure environmental quality of high pollution (Headrich, 1975). It is employed instead of the usual methods used to measure environmental quality in commercial fisheries. The statistic has been used in archaeology, to measure the effects of human activity (Leach, 1978). It

log₂ pi) of families representation of the 10 most abundant species. The 2 logarithms, H and h, are in binary digits.

are caught by these methods. The comparable range of species in prehistoric Pacific fisheries, however, is much smaller. The 4 major components of the catch are 4% of the total, and the 10 major types are 10% of the total. Kapingamarangi (Leach and Davidson, n.d.), and nine other sites show that the fishery is specialised in their fishing, and this is why the value for Shannon's H is 6).

Slits: 1) specialised fishermen, 2) generalist fishermen, 3) pelagic fishermen, 4) baited hook fishermen, 5) specialised net fishermen.

are (pooled estimate) and are in the Pacific.

are fish of the families, closely related. It will be seen that the site is only 1 km from the reef. There is an entrance to the lagoon, with its name *avamo*, with its entrance to Vaito'otia and is therefore ideally sited for fish coming through the lagoon of prey inside the reef through reefs in

this way, though the carangids may have been resident inside the reef. Both forms of fish are attracted by a trolling lure, and this may have been the main method of capture.

It is thought that on some Pacific islands (Kapingamarangi and Nukuoro, see Leach and Davidson, n.d.), pelagic fish were largely caught on one-piece bait hooks, despite the archaeological occurrence of a few trolling lure shanks on these islands. Fishing for tuna with long line and baited hook has also been described for the Society Islands (Oliver, 1974 : 297). However, trolling lure shanks were also found in the Huahine excavations, and lure fishing is therefore the most likely catch method for these fish. A number of lure shanks have been found at both Vaito'otia and Fa'ahia, but all are unfinished, and no points have yet been found (Sinoto, pers. comm. 1984). It should not be forgotten, however, that any fish, including tuna, can be caught in nets too. These prehistoric people were certainly using nets (see below), and given the location of the settlement near a reef entrance, some pelagic fish are sure to have been caught in these nets. Just what proportion were netted and what taken with lures is an open question.

Next in importance in the fish catch are the scarids or parrotfish. These fish are largely herbivorous, though invertebrates, molluscs and coral are also eaten by them. Thus, baited hook and line fishing is unlikely to catch many of these fish. In many Pacific islands today, including Huahine, spearing is the dominant form of fishing, and scarids may be easily taken in this manner in just about any coralline location in fairly shallow water. This form of fishing is very efficient, but has been greatly assisted by small goggles introduced by Europeans. Spearing in prehistoric times is unlikely to have been anywhere near as productive as today, and was probably confined to shallow water around coral thickets. It is therefore suggested that these scarids were principally taken in nets.

Scarids are followed in abundance by three families of fish which are demersal or bottom feeders, and which largely live in deeper waters — Epinephelidae, Lethrinidae, and Lutjanidae. The only effective way of taking these fish is by use of baited hook and line, and in particular in deeper lagoon waters or outside the reef.

Finally, the Balistidae (Triggerfish) account for just over 4% of the catch, and are judged to have been taken in nets, or during general foraging around coral thickets.

The relative importance of netting and bai-

ted line fishing may be assessed by comparing the number of scarids with those of the Epinephelidae family. This is presented in Table 7, with some other prehistoric catches as a guideline. This highlights the importance of netting for these Huahine people, though nowhere near as much so as for the fishermen on Palau. The figures are comparable to those for Nukuoro, where ethnographic data also attest the importance of communally owned nets. Of course this comparison takes no account of environmental differences between the islands, something which requires detailed local marine biological information, unfortunately not available. Even so, this comparison should show the approximate relative importance of these two catching methods, as fish of both families are abundant throughout the Pacific.

Assemblage	Groper/Cod	Parrotfish	Ratio	Characteristics
Kapingamarangi	231	231	1.00	Baited hook oriented
Huahine	31	51	0.65	Net oriented
Nukuoro	67	95	0.65	Net oriented
Palau	134	817	0.16	Net oriented

TABLE 7 Comparison of relative numbers of groper/cod and parrotfish for Huahine (pooled estimate) and several other major fish bone collections in the Pacific. This indicates the relative importance of baited hook fishing against netting.

It is difficult to be too precise about prehistoric catching methods (for a detailed discussion on this, see Leach and Davidson, n.d. and Masse, n.d.). Nevertheless, it is useful to group the fish catch into three categories as follow :

- 1) Pelagic predatory game fishes which are known to be attracted by lures, though they may have been taken by other techniques also (Families 1, 2, 9, 14).
- 2) Demersal fishes which feed in deeper water on the bottom, and which would be largely taken with baited hooks (Families 4, 5, 6, 10, 11).
- 3) Lagoon fish which can be taken by netting, spearing and general foraging in shallow water. In this category are also placed those fish thought to have been taken as opportunity arises, rather than as actual target species — for example, scorpion fish, and fish which are only minor components in the overall catch, such as flying fish, sharks and rays (Families 3, 7, 8, 12, 13, 15-25).

This grouping is presented in Table 8 and Figure 7. It will be seen from these that fishing for pelagic species was the major pre-occupation of these Huahine fisherman. This characteristic of the assemblage is remar-

Assemblage	Pelagic	Demersal	Foraging
Huahine	155 (41.6)	97 (26.8)	171 (32.4)
Nukuoro	132 (19.3)	197 (28.8)	354 (51.8)
Kapingamarangi	149 (12.3)	408 (33.6)	657 (54.1)
Palau	97 (4.0)	643 (26.8)	1583 (69.2)

TABLE 2. Huahine fish remains (pooled estimate) grouped into three main catching methods, with other assemblages for comparison. Minimum numbers are given and percentages in brackets. See text for the list of families involved in each category for Huahine. See also Figure 7.

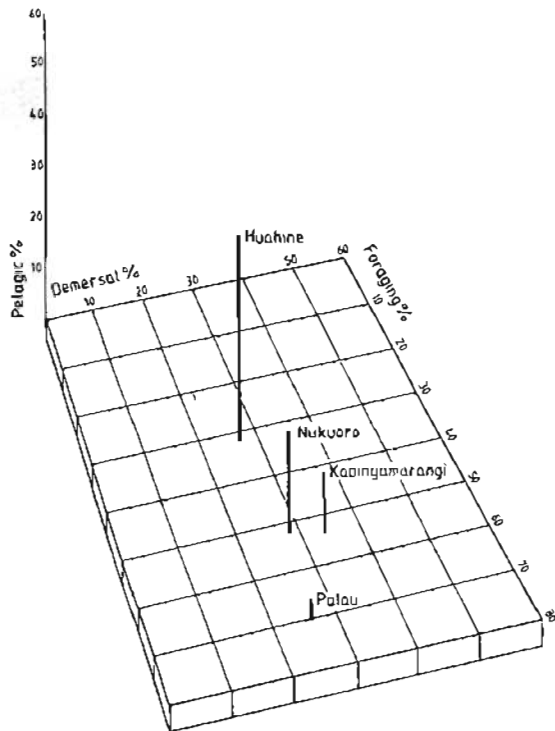


FIG. 7. — The three main fish catching methods for the Fa'ahia assemblage compared with several others from Pacific islands. Note the dominance of pelagic game fishes on Huahine.

kable compared with other known prehistoric fish catches in the Pacific. It is a pity that comparable information is not yet available for other parts of East Polynesia, the area most notable in the Pacific for its highly developed fishing technology. It therefore remains to be seen whether this bias on Huahine is unique or not. At present, it appears so.

Another interesting point is whether such a bias could be sustained over any period of time in a specific locality on an island. Given that tuna and barracouta come into lagoons from the surrounding ocean, and inshore stocks can therefore be replenished from a virtually limitless supply, these fish should not be depleted so rapidly by sustained inshore catching. On the other hand, many types of fish are known to quickly learn to avoid humans by adjusting their behaviour. The absence of wahoo, which

may be primarily caught outside the reef in the open sea, supports the idea that many of the pelagic fish were taken inside the reef by the Huahine people. Wahoo certainly occurs in other Pacific fish assemblages. On the other hand, ethnographic records for the Society Islands in the 19th century and later are rich with descriptions of tuna fishing outside the reef with trolling lures (see Oliver, 1974 : 299-303 for a survey of these descriptions). Although tuna and barracouta stocks may be relatively unaffected by human predation, fish of the Carangidae and Belonidae families may be. These fish are somewhat lower down the food chain, and are more frequently seen inside reef areas. Sustained exploitation of this more restricted resource may therefore eventually result in some depletion of stocks. The point should also be made that whereas catching tuna, barracouta, wahoo, and carangids is subject to a 'serendipity effect' whereby advantage must be taken of unpredictable opportunities as the fish shoal into hunting packs, the same is not so for the Belonidae. Although these fish are not especially important in the Huahine assemblage (2.4 % of the total catch), some additional observations about these fish may be worthwhile, to highlight their distinctiveness in the pelagic category. In the 19th century, these fish were captured on Huahine by a highly specialised technique (Oliver, 1974 : 286-7), whereby a series of raft structures were used, and the fish frightened out of the water on to these by slapping the water with long sticks. Thus, these fish could be said to be targets of a deliberate hunting activity, with a reasonably predictable return for effort. Similarly, on modern Taumako, in the Solomon Islands, the Belonidae are caught at quite specific times of the day when they feed. Thus, expeditions are mounted for a short period in the early morning and at dusk over quiet waters in the lagoon to catch them while feeding. Two most effective techniques are employed :

- 1) A man stands in the front of a canoe with a long multipronged throwing spear, while the canoe is quietly manoeuvred by a small boy seated in the rear. When a fish is seen it is speared, sometimes some distance from the canoe.
- 2) Special lures (*levele*) are made by carefully wrapping strands of tough web from the banana spider into a lure made of a short length of soft bark fibre (*ape*) which is very strong. These lures are attached either to cordage strung between two

moving canoes, or dab use of a kite. The fish the spider web entangle sharp teeth of the fish fibre also becomes entangled allowing the fish to be

In the case of Belonidae their regular feeding habit hunting can be suggested of catching method was particular prehistoric group. Hunting the other a deliberate strategy is used because of their unpredictable. In some other Pacific has been suggested that subjects of avoidance by Davidson, n.d.). Fish with this role are ridae), puffer fish (Diodontidae), and the Huahine collection, might be made for avoidance eels, and this is only tent four such eels were found (1.1 %) does seem very rangi = 8.6 %, Nukuoro avoidance is thought to Palau = 2.5 %). They taken in very shallow water rubble, and they are plentiful of the site today (Sinoto, perhaps the few specimens not food items, but curios for the other relevant fish low, but these fish are not important food items and of elasmobranchs are few expected, but differential factor here. Unfortunately distinguish between shark the main anatomical characters found. Ethnographic records islands (Oliver, 1974 : 2 main suggestions of fish 19th century.

One fishbone was found (Figure 8). This Pacific archaeological bone is a left quadrate (phyraenidae (barracouta) the species is uncertain it and may be Agrioposporus as with the butchering methods these are fine cuts, such sharp implement, such There are at least 15 cut are parallel, and occur on

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 the spider web entangles the numerous
 sharp teeth of the fish. The strong ape
 fibre also becomes entangled in the teeth,
 allowing the fish to be easily pulled in.

In the case of Belonidae, therefore, with
 their regular feeding habits, deliberate target
 hunting can be suggested, though what kind
 of catching method was employed by any
 particular prehistoric group is open to ques-
 tion. Hunting the other game fishes by such
 a deliberate strategy is much more difficult,
 because of their unpredictable occurrence.

In some other Pacific faunal collections it
 has been suggested that some fish species were
 subjects of avoidance behaviour (Leach and
 Davidson, n.d.). Fish which have been iden-
 tified with this role are moray eels (Muraeni-
 dae), puffer fish (Diodontidae), porcupine
 fish (Tetrodontidae), and sharks. Amongst
 the Huahine collection, the only case which
 might be made for avoidance is for moray
 eels, and this is only tentative, since bones of
 four such eels were found. Four moray eels
 (1.1 %) does seem very few (cf. Kapingama-
 rangi = 8.6 %, Nukuoro = 0.0 (deliberate
 avoidance is thought to have occurred here),
 Palau = 2.5 %). These animals can be
 taken in very shallow water amongst coral
 rubble, and they are plentiful in the vicinity
 of the site today (Sinoto, pers. comm. 1984),
 so perhaps the few specimens identified were
 not food items, but curiosities. The numbers
 for the other relevant families are similarly
 low, but these fish are not normally especially
 important food items anyway. The remains
 of elasmobranchs are fewer than might be
 expected, but differential survival may be a
 factor here. Unfortunately, it is not easy to
 distinguish between shark and ray vertebrae,
 the main anatomical component normally
 found. Ethnographic records for the Society
 Islands (Oliver, 1974 : 281-314) do not con-
 tain suggestions of fish avoidance in the
 19th century.

One fishbone was found with signs of but-
 chering (Figure 8). This is a rare find in
 Pacific archaeological assemblages. The
 bone is a left quadrate of a member of the
 Agrioposphyraenidae (barracouta) family. Though
 the species is uncertain it is a large individual,
 and may be *Agrioposphyraena barracuda*.
 As with the butchering marks on the dolphin,
 these are fine cuts, suggesting some very
 sharp implement, such as a stone flake.
 There are at least 15 cuts on this bone ; all
 are parallel, and occur on the lateral surface ;



FIG. 8. — A left quadrate of a barracouta, showing but-
 chering marks. About 15 parallel cuts are evident.
 These were made with a sharp implement, possibly a
 stone flake, and are parallel with the long axis of the
 fish. Deliberate cutting of the jaw muscles is indica-
 ted, possibly to open the fish's mouth to remove a
 trolling lure.

one is about 2 mm in depth, and this shows
 that the implement used was quite strong.
 The angle of the cuts is parallel to the long
 axis of the body, and they were forward of
 the operculum (gill cover). If the purpose of
 these cuts was to remove the head, they are
 in a very strange position and angle. The
 simplest way of removing a fish head is to
 cut behind the operculum and through the
 spine. Some species of fish have a substan-
 tial cheek musculature (such as the groper
 family), and this meat is considered a delicacy
 in some societies, and is removed separately.
 The cuts on this quadrate could be inter-
 preted as an indication of cheek muscle re-
 moval ; however, the authors know of no ethno-
 graphic evidence supporting this interpretation
 in the case of barracouta. These muscles are
 the principal ones which close the dentary,
 and the preferred interpretation is that these
 muscles were cut to release the bite of a living
 animal. This might have been done to
 remove an especially valuable lure hook with
 safety from these vicious animals, which can
 strongly bite even when they have been out of
 the water for some time. Alternatively, this
 would be an effective way of rendering the
 fish harmless to bare feet in the confined
 space of a canoe.

Bovine remains.

The excavation produced quite a few teeth and bones of adult cattle, distributed through several layers of the site. If it is assumed that stratigraphic mixing has occurred, only one animal would be represented by the bones. If the stratigraphic provenances are secure, the presence of bones of this European animal would seriously question the supposed antiquity of the main part of the site. Cattle were introduced into the Society Islands by Captain Cook in 1769 (along with sheep, ducks, geese, turkeys and peacocks). Whether descendants of this stock survived into the 19th century or not is questionable (see conflicting reports in Bligh, 1937 : 58, 378, 406); in any event, cattle were again introduced in 1817 from New South Wales (see Ellis, 1969 II : 198). Thus, the cattle bones in the archaeological site have to be later than 1769 in age. To try and shed some light on this matter, nuclear microprobe analysis was carried out on a tooth specimen to observe the fluorine uptake in the tooth as a test of temporal association with the remainder of the site. As a comparison, teeth of a dog and pig, more plausibly part of the prehistoric assemblage, were also examined. The fluorine and calcium profiles are shown in Figure 9. This clearly shows that the dog and pig have far more fluorine in them than the bovine tooth, suggesting that the cattle bones belong to a more recent period. Thus, the bovine remains may be assumed to be intrusive, and the antiquity of the main part of the site is confirmed.

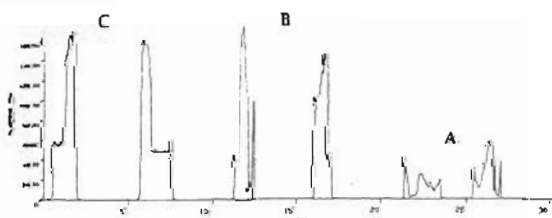


FIG. 9. — Calcium and fluorine profiles for a bovine tooth (A), dog (B), and pig (C). The much lower fluorine content in the bovine tooth demonstrates its more recent age. Even so, the fluorine content is very high, and the remains may be very early Historic period.

Disturbances by which cattle bones could have entered the site include large vertical land crab holes and small recent garbage pits. A few cattle were kept in the vicinity of the site by the landowners, before the land was

leased to the hotel (Sinoto, pers. comm. 1984). The fluorine concentration in the teeth is significantly higher than would be expected for modern teeth. It is tempting to think that these remains may represent animals left on Huahine by Captain Cook, though this would be difficult to prove.

DISCUSSION AND CONCLUSIONS.

Before reviewing the main conclusions arising from this study, a comment is needed about the approach adopted towards historical records on fishing in this region. The first point which needs to be made is that analysis of ethnographic information from historical records in purely economic terms is extremely difficult. For one thing, miscellaneous and unstructured observations about economic behaviour tend to be concentrated on the more spectacular activities of people, ignoring the mundane, but possibly more important, as far as household economics is concerned. It is simply not possible to accept such historical records at face value, and use them to reconstruct a 19th century household food energy budget with any reliability. Historical records on economic matters frequently describe what people believed to be important, rather than what people actually ate most of the time. This disjunction between belief and action is a gulf well known to anthropologists studying modern communities, and was especially clear in a recent study of ancient fishing on Kapingamarangi and Nukuoro. The species most talked about and most sought after when historical observations were made, were simply insignificant in the actual food energy budget. The relationship between field observation of living communities, and what is entombed in their archaeological sites is a complex one; and archaeologists should not be surprised if this gulf emerges from analysis of material for which relevant historical information exists. What would be more surprising would be a case when no gulf appears after a comparative study. The Huahine archaeological assemblage provides such a case. Historical records from the Society Islands stress the importance of marine hunting for tuna and turtle, and these activities were also important economically to the ancient inhabitants. What we do not know is whether this hunting approach to marine resources was genuinely of comparable economic significance in later times and would be revealed by analysis

of 19th century archæology. A suspicion is that excavation would reveal the disjunction between belief and action. Moreover (Oliver, 1974 : 291, 293) the importance of hunting for *Phaena equisetus* and other fish were of no apparent value to the prehistoric people. It is likely that stocks of turtles especially dolphins and tuna, were depleted by a millennium or more by an ever increasing population on Huahine. Until some information is available from archaeology going to the 19th century, we must ignore the ethnographic records as far as possible, as potentially very different; and concentrate on the ancient archaeological regional environmental changes which were deposited by a single group. This approach is supported by the paper, with only passing reference to historical sources which arrived at below light.

The people at Fa'ahua group, highly successful in exploiting marine resources, and in particular targeting large species, demand a 'targeted' approach to their fishing. 90% of all fish taken were young when killed, and to this figure can be added a number of at least two examples of dolphin, which were young when killed. The selective hunting of few mature animals is an established horticultural practice in the Pacific. Even the dog was killed when young.

As well as the hunting of fish and mammals, the use of nets in shallow water and fishing in deeper areas with specialised equipment. For a group of animals which were in a single category, where there were opportunities which were specific hunting to the many fish in the area, and stranded pilot whales.

The suggested hunting approach to marine resources was genuinely of comparable economic significance in later times and would be revealed by analysis

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of 19th century archaeological sites. Our suspicion is that excavation of such sites would reveal the disjunction between belief and action. Moreover, historical records (see Oliver, 1974 : 291, 293-4, 295) also stress the importance of hunting for dolphin fish (*Coryphaena equisetus* and *C. hippurus*), but these fish were of no apparent significance to the prehistoric people. It is hard to credit that stocks of turtles especially, and probably also dolphins and tuna, would not be profoundly depleted by a millennium of intensive hunting by an ever increasing human population on Huahine. Until some economic information is available from archaeological sites belonging to the 19th century, it would be wise to ignore the ethnographic descriptions as much as possible, as potentially misleading or irrelevant; and concentrate on trying to understand the ancient archeological data in its regional environmental setting, and as if it were deposited by an anonymous cultural group. This approach has been taken in this paper, with only passing comments drawn from historical sources, and the main conclusions arrived at below should be seen in this light.

The people at Fa'ahia were an adventurous group, highly successful at harvesting marine resources, and in particular the fast swimming larger species, demanding a specialised 'hunting' approach to their environment. Nearly 42% of all fish taken are pelagic predators, and to this figure can be added the sizeable number of at least two species of turtle, and examples of dolphin. The pigs represented were young when killed, which might suggest selective hunting of feral animals, rather than killing of mature animals fattened in pens, as established horticultural settlements in the Pacific. Even the dogs were selectively killed when young.

As well as the hunting of game fish, reptiles and mammals, there is clear evidence for use of nets in shallow waters, and baited line fishing in deeper areas, again requiring specialised equipment. Finally, there is a large group of animals which belong to the foraging category, where people take advantage of opportunities which periodically arise during specific hunting/fishing expeditions. To the many fish in this category can be added stranded pilot whales and/or sperm whales.

The suggested hunting mentality of these people is an unusual adaptation for a tropical Pacific island, and more akin to that of the inhabitants of temperate areas of the Pacific,

such as New Zealand, where horticulture was either marginal or impossible. It may be that this approach to the environment was part of an initial exploitation strategy on an island only recently settled, perhaps without established gardens. It would be useful to examine archaeological evidence from a later period on Huahine, preferably from a nearby locality, where horticulture can more firmly be assumed and population was greater, to see if this hunting approach survived for any length of time. In the meantime, we are left with an isolated glimpse of what appears to be a most unusual group of people, more attuned to game animals than any previously observed in the tropical Pacific.

ACKNOWLEDGEMENTS.

Yosihiko Sinoto provided consumable laboratory costs involved in this research, together with an airline fare for Smith to use the Otago Archaeological Laboratory comparative collection; Ms J. Sullivan assisted with sorting and identification of the reptile remains; Dr Graeme Coote gave access to a nuclear microprobe for the fluorine analysis; valuable advice on historical records for Huahine was given by R. Langdon, and on Huahine geomorphological matters by Dr J. N. Jennings. We would like to express our thanks for this assistance.

RÉSUMÉ

Le site de Fa'ahia et Vaito'otia est bien connu pour livrer des matériaux d'une culture semblable sous de nombreux aspects à ceux des occupations préhistoriques anciennes de Nouvelle-Zélande et à ceux des sites archaïques de Polynésie orientale. Au cours des fouilles, une vaste série ostéologique a été recueillie. Le poisson y prédomine avec des quantités significatives de tortues et de mammifères marins, suivis en quantités moindres d'espèces rapportées telles que cochon, chien et bovin. Les analyses à la fluorine indiquent que ce dernier est intrus.

Cet article présente les analyses des reconstitutions ostéologiques. Une forte présence des espèces pélagiques rapides est montrée, ce qui est en contraste marqué avec les autres reconstitutions du Pacifique. L'importante quantité de plusieurs espèces de tortues et de mammifères marins permettent d'élaborer l'image d'un groupe de gens dynamiques exploitant bien la récolte des ressources marines. Les chiens et les cochons étaient tués avant l'âge d'un an, suggérant une ponction sélective. Le

caractère inhabituel des résultats du remontage peut rendre compte du caractère original de l'occupation particulière sur cette île, et en conséquence de l'exploitation du milieu marin d'antan. Même ainsi, ces gens méritent d'être appelés « chasseurs de mer » plutôt que « collecteurs de mer ».

ABSTRACT

The Fa'ahia and Vaito'otia site is well known for producing cultural material similar in a number of respects to that from early prehistoric settlement in New Zealand, and to Archaic East Polynesian sites. A large osteological collection was recovered in the excavations. Fish predominates in this, with significant quantities of turtle and sea mammals, followed by lesser quantities of adventive species such as pig, dog and bovine. The latter is shown by fluorine analysis to be intrusive.

The analysis of the osteological assemblage is presented in this paper. A heavy reliance on the fast swimming pelagic fishes is shown, and is in marked contrast to other known archaeological fish-bone assemblages in the Pacific. The considerable quantities of several species of turtle and sea mammals combine to yield a picture of an adventurous group of people, who were highly successful at harvesting marine resources. The dogs and pigs were killed before one year of age, suggesting selective culling. The unusual character of the assemblage may reflect the early nature of this particular settlement on this island, and therefore the harvesting of a pristine marine environment. Even so, these people deserve the appellation 'Marine Hunters' rather than 'Marine Foragers'.

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