The Quest for the Rainbow Runner: Prehistoric Fishing on Kapingamarangi and Nukuoro Atolls, Micronesia

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Abstract—The rainbow runner, *Elegatus bipinnulatus,* is a fast swimming pelagic predator known as *te kina* on these two Polynesian outliers in the Caroline Islands. The main method for catching these fish on Kapingamarangi involves the use of a thick plain rope held on the surface to encircle a school. The fish are finally captured with a net. On Nukuoro, a special one-piece rotating bait hook was used for capturing the fish. These catching methods are unusual—surface predators are generally thought to have been taken in the Pacific by trolling lure hooks. In both islands, *te kina* is the subject of much discussion and many chants, along with other pelagic fish. It is clearly a worthy adversary for the expert fisherman.

Archaeological evidence on these two islands, however, suggests that at least during the prehistoric period, far more of these fish were probably caught in the men's house than ever in a canoe. Of nearly 2000 fish recovered from eleven archaeological sites spanning a millennium of prehistory on the islands, less than 15% were fast swimming pelagic predators, including varieties of tuna, barracouta, and jack mackerel, together with the rainbow runner.

This paper reviews the changing character of prehistoric fish catches and likely fishing methods on Kapingamarangi and Nukuoro. A wide gap is found between fishy folk lore and economic reality.

Predatory Pelagic Fish and Fishing Lore

Pitting one's wits against the sea and the fish it contains is still of foremost importance to all men on Kapingamarangi and Nukuoro today. Endless hours are spent discussing the whys and wherefores of different kinds of fish, their habits, and how to catch them. In this respect, these Polynesian fishermen are little different to their counterparts in modern European society. Above all other types of fish, the most worthy adversary is the fast-swimming, predatory pelagic fish, which in the Pacific is thought to have been generally taken by trolling a lure in the surface of the sea over deep water.

This type of fish is a voracious carnivore, feeding on small fish which it drives to the surface and then seizes from beneath. Frequently, fish of this kind work in schools to drive smaller fish together. Such schools are easily recognized either from the birds which follow them about or by the surface turbulence caused by small fish darting to and fro at-

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tempting to escape. If a fisherman manages to be in the right position at the right time, an abundant catch is assured, because the predatory fish in their feeding frenzy will simply attack anything moving in the water. In addition, predatory pelagic fishes can be encouraged together from a distance, to some extent, by trolling a lure through the water. Its action disturbs the calm, and emulates a small struggling fish. The lure is therefore an irresistible attraction.

The presence of lure hooks in archaeological sites is usually taken as an indication that these pelagic fish must have figured prominently in the fish component of prehistoric subsistence economics in the Pacific and their absence as an indication that these fish were unimportant in household economics without taking much notice of what species of fish bones are present (for example Emory *et al.* 1959: 39; cf. Takayama and Takasugi, 1987: 37). The question of how people caught different kinds of fish, including predatory pelagic fishes, is difficult to answer accurately. For instance, while a groper, with its large mouth, may be frequently caught with a large baited hook, it will also take a small baited hook. In New Zealand, modern fishermen know that a lure trolled deep in the water may sometimes catch a groper too. Cultural factors intervene to complicate the matter further. Some Pacific islanders, such as the Kapingamarangi people, specialized in baited trap fishing, and no doubt the bulk of eels were caught in this manner, at least in the period from which ethnographic information is available (Buck, 1950). Other people, including those on Nukuoro, employed nets to a great extent (Kubary, 1900), and others again had a long tradition of using baited hooks for fishing. Spearing fishes, on the other hand, almost universally the most important method nowadays in the Pacific, may have been insignificant before the arrival of Europeans, bringing with them glass goggles for efficient underwater hunting. Like all other types of fish, the surface-feeding predators can be caught by a number of alternative methods, in addition to trolling with a lure. In view of these complications, the archaeologist must use a fair degree of caution in interpreting fishing methods from archaeological evidence of fish catches or inferring fish catches from type of hooks found in excavations.

The ethno-archaeologist or anthropologist, examining oral traditions and folk lore, should also keep clearly in mind the role of the 'fishy story' before using verbal information to infer subsistence economics. On Kapingamarangi, there are numerous chants about the catching of *te kina,* the rainbow runner. To the casual observer, this fish would appear to be the most sought, and perhaps the most frequently caught. This is also true of Nukuoro. The thesis of this paper is that even if a man broadcasts his intention of putting to sea to catch only these fish, he will almost certainly return to the village with something else. This is not because these fishermen are not expert; quite the contrary. It is because these types of prey roam widely and predicting where they are at any one time is very difficult. This is analogous to the phrase describing another much sought after commodity—'gold is where you find it'—and can be described as a *serendipity effect* because for the most part it is a happy and unexpected accident when these predatory pelagic fishes are encountered and caught. They may be stalked with guile and cunning in much the same way that fast footed game animals are in hunting societies on the land, and they may be the subject of much discussion amongst fishermen and land hunters alike, but they may only infrequently figure in the actual harvest.

In the late 19th century, the German ethnographer, Kubary observed of Nukuoro (1900: 110):

> Fishing which is done by the men is in general more highly developed than in the Carolines, and is done by hooks, nets and spears. The fishhooks of mother-of-pearl are very solid and well made, and the fishlines of coconut or hibiscus fibres are the strongest and most beautiful of the archipelago.

Archaeological excavations on this island in 1965 (Davidson, 1971) confirmed the importance of line fishing with pearl shell hooks. It should also be remembered, however, that net fishing was a major community activity in Kubary's time, and according to him, the principal fishing was done with a communally owned net, the *upenga tonu*. Surprisingly, in 1965 when the first archaeology was carried out on Nukuoro, informants stressed the traditional use of one-piece fish hooks for catching pelagic fish, large hooks for tuna, smaller ones for rainbow runner. Thus, the Type VII hook (see Davidson, 1967), known as *gadenibidi,* was said to have been specifically used for catching *gina,* the rainbow runner, inside the lagoon (*kina* is rendered *gina* in Nukuoro orthography). This type of hook came to prominence after about AD 1700. Similarly with the other two main types of hook, Types I and V, large specimens were said to have been for catching tuna and other large fish, sometimes in the open sea, and small ones for *gina,* caught inside the lagoon. An elongated specialized form of Type I was said to have been for catching fish with long snouts and sharp teeth, such as *daodao* and *sulei. Daodao* is tentatively identified as the wahoo, *Acanthocybium solandri,* another important pelagic predator (V. Carroll, pers. comm.). Although there is no certain identification for *sulei,* it is suspected that this is also a pelagic predator.

These observations profoundly question an item of faith amongst archaeologists that predatory pelagic fish were caught with trolling lures throughout the Pacific region. The ethnographic information on Nukuoro alone surely indicates that this rule has exceptions. It must be concluded that the relationship between fishing technology and fish catches in the Pacific is a highly variable one, and generalizations should be avoided. To emphasize this point, it can be noted that trolling lures were apparently not important for catching pelagic predatory fish on Kapingamarangi either. The main method for catching the rainbow runner on Kapingamarangi today is a remarkable technique whereby a group of fishermen hold a thick plain rope on the surface and slowly encircle a school. The fish simply will not pass under the rope, perhaps mistaking it for a large surface predator. When the fish are contained in a tight area, they are scooped out with a net in large numbers. It is not known how long ago this technique was developed. Archaeological evidence indicates the rainbow runner was only infrequently caught in the prehistoric period. The fish is well named—catching it is like finding the pot of gold at the end of the rainbow.

In addition to the rainbow runner, the other surface predators which figure prominently in discussions amongst fishermen are as follows:

Barracouta	*Agrioposphyraena barracuda*
Wahoo, Jack Mackerel	*Acanthocybium solandri*

Yellowfin Tuna	*Thunnus albacares*
	syn. *Neothunnus macropterus*
Skipjack, Striped Tuna	*Katsuwonus pelamis*

These fish are known as *ono, mala, takua* and *atu,* names which are almost universal in Polynesia today, and which can be reconstructed as terms in the 3000 year old language, Proto-Polynesian. In the Kapingamarangi language, special terms exist which relate to small variations in size and characteristics, clearly showing the central importance of these fish. It is hardly surprising that during fishing for a modern osteological comparative collection on Kapingamarangi, the first two species of over 100 eventually collected were yellow fin tuna and wahoo. It is an indication of the difficulty of catching the rainbow runner, that this fish did not turn up until nearly the end of fieldwork. As far as the modern fishermen on these two islands are concerned, to find out anything useful or interesting about the prehistory of fishing on these two atolls is to illustrate the varying prowess of their ancestors in catching these types of fish. As will be shown below, the evidence is that while much dreaming of these fish may have taken place in the past, far more were probably caught in the men's house than ever in a canoe.

This discrepancy between the spectacular bonito or tuna fishing activities described for a number of areas of the Pacific in the historic period, and the pattern of prehistoric catches as reflected by minimum numbers of individuals (MNI) in the archaeological record is notable. A similar discrepancy can be seen in the temperate waters of New Zealand. Here, bonito or tuna fishing was not really feasible, but a counterpart fish was the *kahawai, Arripis trutta.* Special lures for taking these fish figure prominently in 19th century ethnographic collections of the New Zealand Maori. Yet both the hooks and the fishes are extremely rare in archaeological sites (Davidson, 1984: 65–67, 138). Lure hooks and bones of predatory pelagic fishes are similarly rare in archaeological sites on both Kapingamarangi and Nukuoro. The various fish which could be taken with lure hooks form only a small proportion of the total catch reflected in the archaeological record (12.3% for Kapingamarangi, and 19.3% on Nukuoro—see Tables 1 and 2). It would be interesting to know just how frequently these fish are actually caught today. Our suspicion is that the true situation is like that of the Pygmy elephant hunters in Africa. There is much talk of elephants, and there is a specialized vocabulary about elephants, but the diet largely consists of items other than elephants. It would be a mistake, therefore, to use this dearth of predatory pelagic fish in the archaeological record to argue that the prehistoric fishermen of these two islands were less skilled than their modern descendants.

When Peter Buck visited Kapingamarangi in 1947, one of his ambitions was to go "on a fishing expedition the purpose of which was to view the method of fishing for tuna" (Buck, 1950: 219); but during several days away from Touhou islet, when many fish other than tuna were caught, he failed to observe this activity at first hand. He commented that "fish seemed to be scarce" (ibid.: 248), and was told that "the day was wrong (*huaaitu*) because it was too bright and the fish were not swimming near the bottom" (ibid.: 249). Eventually, rather sadly, they paddled through the reef channel and four miles back to Touhou. He added "we had another demonstration of the value of direct observation" (ibid.: 249), which barely disguises the disappointment he must have felt. Buck concluded

Table 1. Kapingamarangi fish remains (MNI) arranged in order of decreasing abundance. NB: the family numbers indicated here are used in other Figures and Tables in this paper (see Table 2 for families 25–27).

	I		II		III		IV		Total	
Level	No	%	No	%	No	%	No	%	No	%
1 Epinephelidae	3	7.7	75	16.0	63	19.8	90	23.3	231	19.0
2 Scaridae	9	23.1	81	17.3	60	18.8	81	20.9	231	19.0
3 Anguilliformes	1	2.6	48	10.2	38	11.9	31	8.0	118	9.7
4 Balistidae	3	7.7	41	8.7	19	6.0	30	7.8	93	7.7
5 Carangidae	2	5.1	27	5.8	26	8.2	23	5.9	78	6.4
6 Nemipteridae	1	2.6	27	5.8	15	4.7	30	7.8	73	6.0
7 Lutjanidae	1	2.6	29	6.2	17	5.3	17	4.4	64	5.3
8 Holocentridae	9	23.1	34	7.3	9	2.8	10	2.6	62	5.1
9 Thunnidae/ Katsuwonidae	2	5.1	29	6.2	19	6.0	11	0.3	61	5.0
10 Elasmobranchii	3	7.7	20	4.3	19	6.0	10	2.6	52	4.3
11 Lethrinidae	1	2.6	16	3.4	9	2.8	9	2.3	35	2.9
12 Coridae	1	2.6	13	2.8	8	2.5	11	2.8	33	2.7
13 Diodontidae	2	5.1	11	2.4	5	1.6	8	2.1	26	2.1
14 Acanthuridae			6	1.3	4	1.3	12	3.1	22	1.8
15 Tetrodontidae			2	0.4	2	0.6	9	2.3	13	1.1
16 Belonidae	1	2.6	5	1.1			1	0.3	7	0.6
17 Mullidae			2	0.4	1	0.3	2	0.5	5	0.4
18 Sphyraenidae					1	0.3	1	0.3	2	0.2
19 Kyphosidae			1	0.2			1	0.3	2	0.2
20 Siganidae					2	0.6			2	0.2
21 Scorpaenidae			1	0.2					1	0.1
22 Exocoetidae			1	0.2					1	0.1
23 Acanthocybiidae					1	0.3			1	0.1
24 Caesiodidae					1	0.3			1	0.1
Total	39		469		319		387		1214	
Shannon's H	3.30		3.65		3.53		3.46		3.61	

that "bonito fishing by trolling with a lure appears to be on the wane on Kapingamarangi" (ibid.: 237).

This experience can be viewed another way altogether. Catching pelagic fish is largely a matter of seizing the opportunity if and when it arises. These fish are rather unpredictable in their occurrence, and travel far and wide. They can be easily taken whenever they are actually present, either outside or inside the reef, but one must be close at hand, or better still actually in position, when the opportunity arises. The phrase 'serendipity effect' is thus very appropriate. To go out specifically to catch only these fish is to invite an empty stomach in the evening. As every modern fisherman knows, European and Polynesian alike, when fishing for the common and mundane fish, it pays to have a lure either permanently trolling along behind or immediately to hand, in order to catch pelagic fish when they turn up. When a flock of birds is seen, one hurriedly pulls up the baited

Table 2. Nukuoro fish remains (MNI) arranged in order of decreasing abundance. NB: family numbers follow Table 1 (families 25–27 are additions).

	I		II		III		Total	
Level	No	%	No	%	No	%	No	%
4 Balistidae	7	8.0	24	12.8	69	16.9	100	14.6
2 Scaridae	8	9.1	22	11.8	65	15.9	95	13.9
10 Elasmobranchii	16	18.2	24	12.8	22	5.4	62	9.0
1 Epinephelidae	4	4.5	16	8.6	42	10.3	62	9.0
9 Thunnidae/ Katsuwonidae	11	12.5	19	10.2	20	4.9	50	7.3
7 Lutjanidae	8	9.1	11	5.9	29	7.2	48	7.0
11 Lethrinidae	3	3.4	17	9.1	26	6.4	46	6.7
5 Carangidae	6	6.8	13	7.0	25	6.1	44	6.4
6 Nemipteridae	5	5.7	9	4.8	24	5.9	38	5.6
13 Diodontidae	4	4.5	8	4.3	15	3.7	27	4.0
8 Holocentridae	2	2.3	5	2.7	18	4.4	25	3.7
12 Coridae	4	4.5	6	3.2	13	3.2	23	3.4
18 Sphyraenidae	4	4.5	4	2.1	9	2.2	17	2.5
16 Belonidae	4	4.5	1	0.5	6	1.5	11	1.6
23 Acanthocybiidae	1	1.1	3	1.6	6	1.5	10	1.5
14 Acanthuridae			2	1.1	7	1.7	9	1.3
17 Mullidae			1	0.5	2	0.5	3	0.4
21 Scorpaenidae			1	0.5	2	0.5	3	0.4
25 Ostraciidae					2	0.5	2	0.3
3 Anguillidae					1	0.2	1	0.1
26 Pempheridae					1	0.2	1	0.1
19 Kyphosidae	1	1.1					1	0.1
27 ? Family			1	0.5	4	1.0	5	0.7
Total	88		187		408		683	
Shannon's H	3.69		3.73		3.80		3.83	

lines and dashes to the vicinity of the birds to try and catch some of the school of fish beneath. More often than not, the school disappears as quickly as it made its presence known, and baited hooks are dropped again to carry on the main, but less exciting, fishing activity. Thus, the catch of even the most expert fisherman will largely comprise something other than pelagic fish. This is precisely what Buck observed, and exactly what the archaeological record demonstrates.

Archaeological excavations on these two North Pacific atolls produced abundant fish remains from which the relationship between fact and fancy can be tested.

Archaeological Background

Nukuoro is a small atoll in the Eastern Carolines, 215 km north of Kapingamarangi and 394 km south of Ponape (Figure 1). It has an almost circular lagoon of 28.5 km^2, with 46 islets, totaling less than 2 km^2 in area, around the perimeter. The lagoon is one of the deepest in the Pacific (108 m at its deepest point) and has only one navigable pass. The people are Polynesian linguistically and culturally, and their position far outside the Polynesian triangle is the reason for their designation as a 'Polynesian outlier' (Bayard, 1975).

Excavations on Nukuoro in 1965 (Davidson, 1971) tested eight different locations in and near the modern village on the principal islet of Nukuoro, from which to atoll takes its name. Stratified deposits up to 3m deep were found. One of these locations was traditionally the site of a men's house or *hada,* and from this excavation a large quantity of pearl shell fish hooks and evidence of their manufacture was recovered. Fish hooks were found in smaller numbers in all other excavations. These fish hook assemblages have been previously described (Davidson, 1967). All excavated material was sieved using a one quarter inch (6.35 mm) mesh, and all bone material in the sieve was kept. Fish bone was separated from other categories (bird, rat, dog, human, cetacean, turtle), but the lack of comparative material at the time precluded all but the most tentative analysis (Davidson, 1971: 93–94). Although the various locations tested were supposed by modern informants to have been used for different activities, the range of material recovered, both

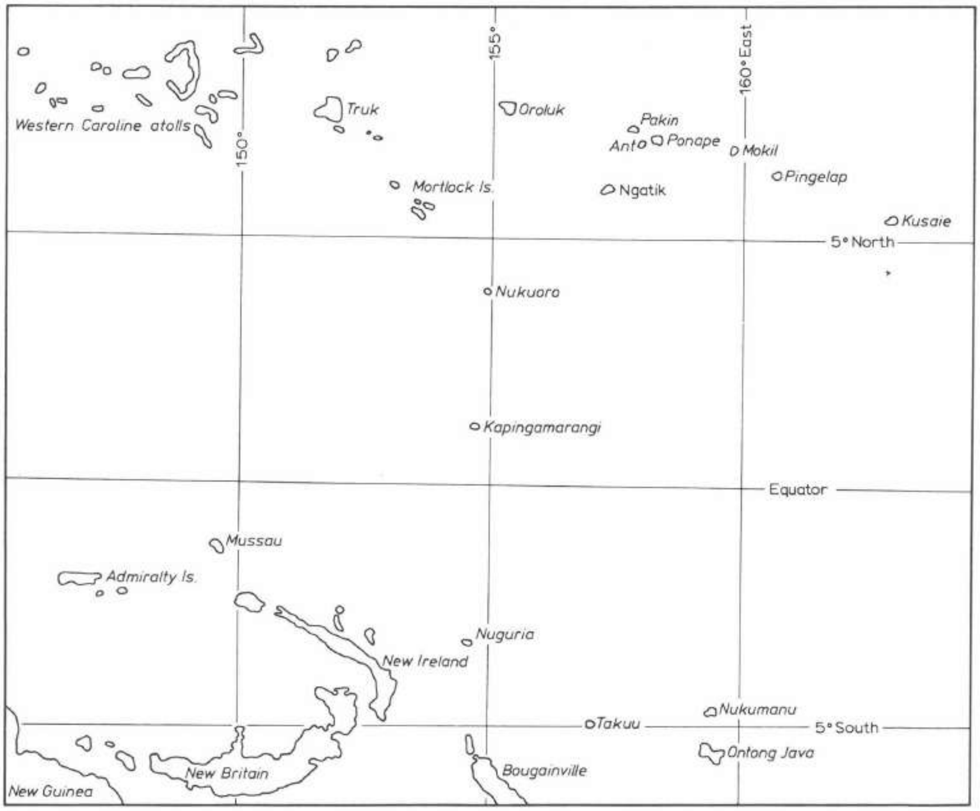

Figure 1: Location map of Kapingamarangi and Nukuoro atolls, Micronesia.

faunal and artefactual, was similar in all cases. The only clear evidence of specialized activity was the large quantity of fish hooks and manufacturing debris from the *hada* site.

In order to examine trends through time in the Nukuoro assemblages, the deposits have been grouped into three Periods, based on certain archaeological markers. The conflicting nature of some of the radiocarbon dates makes it difficult to be too precise about the age of these three divisions, but the following is suggested:

Level III	0–250 B.P. (1950)
Level II	250–450
Level I	450–650

Level I on Nukuoro was not represented at the *hada* site, and consequently there are only 12 items of fishing gear from this period—nine fragments of one-piece hooks of early types and three large trolling lure points. Level II yielded 168 one-piece hooks and fragments and only one possible fragment of a lure shank. Level III yielded 464 one-piece hooks, parts of four small trolling lure shanks, and one lure point. This last point from near the surface of the *hada* was probably intended as part of a modern souvenir, a lure attached to a model canoe. Of the 638 items of fishing gear assigned to Levels II and III, only 49 came from sites other than the *hada*. Fishbones were recovered from seven of the eight excavations.

The Nukuoro fishing kit in the ethnographic period consisted of three main types of one-piece pearl shell hook and several other less common forms, some of wood and coconut shell. The development of this kit can be seen in the archaeological record, beginning during Level II and reaching its final form in Level III. Only one type of hook is found in all three Levels.

Trolling lures therefore were only a minor component of these archaeological assemblages. Some form of large trolling lure with a 'West Polynesian' point and shank of unknown form was present in Level I. Most of the shanks from Level III, however, are very small, and while they may have been able to catch rainbow runners, they would probably have been unsuitable for bonito. In this connection it is interesting to note that Nukuoro informants asserted that large pelagic fish could be caught on the largest and strongest examples of two of the three main types of one-piece hook. The two main types of hook at different periods are summarized below:

	One-piece hooks	Lures (shanks and points)
Level III	464	5
Level II	168	1
Level I	9	3
Totals	641	9

Kapingamarangi is about 100 km north of the equator. The atoll is roughly egg-shaped, with a maximum dimension of about 12 km. The total area is just over 82 km^2, of which the reef and land account for a mere 20.4 km^2. The lagoon reaches a depth of about 80 m in places. Land area on Kapingamarangi totals about 112 hectares, and the 32 islets range in size from 2.1 km in length (Hare) to only 30 m long (Matukerekere). More than half of the population of about 300 live on Touhou islet, which is about 300 × 150 m in size, covering 3.72 hectares. Like Nukuoro, Kapingamarangi is a 'Polynesian Outlier'.

Excavations on Kapingamarangi (Leach and Ward, 1981) were carried out at four localities on Touhou, the main islet inhabited today. Stratified deposits reached nearly 5 m in places, and approximately 54 m^3 of material were excavated. The sites excavated are known as Tiroki, Muri-Harau, Putau, and Ngeiho-Hereu. It is not believed that the modern settlement pattern has much relevance to what this islet was like in earlier periods. For one thing, at three of these locations 700 years ago, the islet had not yet been built up above sea level.

The site selection strategy and methods of layout, excavation, and recovery were precisely the same as those employed on Nukuoro 14 years earlier. The material recovered, therefore, was very comparable so far as any sampling bias is concerned.

The deposits have been grouped together, for purposes of analysis of the rich fishbone material recovered, on the basis of radiocarbon dates and other features of sediment history as follows:

Level IV	0–100 B.P. (1950)
Level III	100–300
Level II	300–700
Level I	700–1000

In contrast to Nukuoro, very few items of material culture were found in these excavations. This is largely due to the absence or extreme rarity of pearl shell (*Pinctada* spp.) and black mussel (*Atrina vexillum*) in the lagoon. Why these two nearby atolls should be so different in this respect is somewhat mysterious. Ethnographic records (Eilers, 1934: 73ff) suggest that fish hooks were made of coconut shell, turtle shell, and wood, although passing mention is also made of pearl shell and black mussel. One interesting specimen (Leach and Ward, 1981: Figure 39D) was recovered by an old man while digging a grave. He was unequivocal in his name for the hook—*matau kina*—the hook for the rainbow runner. This has a strongly incurved point and is similar to those identified on Nukuoro as being for rainbow runner. Two metal hooks were found in Level IV, two bone hooks in Level II, and one pearl shell hook in Level II. Four trolling lure shanks were recovered. Three of these (unfortunately not from controlled excavations) were made from a dense white shell, either *Tridacna* sp. or *Spondylus varians*. The fourth, of pearl shell, was from Level II. None of these necessarily functioned as fish hooks though, because these same shanks have been observed as units in a necklace in the ethnographic period (Buck, 1950: 273ff; see also Leach and Ward, 1981: 74).

Fish Bone Analysis

The fish bone recovered from excavations was sorted and identified according to a method fully described elsewhere (Leach, 1976; Leach and Davidson, 1977; Leach, 1979; Leach and Ward, 1981: 114ff) using the Otago Archaeological Laboratory comparative collection which includes about 300 tropical Pacific species.

In brief, select paired cranial bones (dentary, premaxilla, maxilla, articular, and quadrate) and certain 'special bones' (other bones which are diagnostic of particular species or families) are separated for identification. This method was developed for analysis of New Zealand fish bone in 1971 (Leach, 1976), and experience since then has consistently indicated that the bulk of information is obtained from the analysis of only the dentary, premaxilla, and special bones (Leach and Anderson, 1979). Identifications are always made to the most specific level possible, but very few tropical Pacific fish bones can be reliably identified to species or even genus. Fortunately, almost all bones in the anatomical groups referred to above can be identified to family level. This restriction is not as serious as it may first appear. The bulk of information relating to habitat, fishing zones, and fishing methods can be obtained from Pacific fish bone identifications when organised into families. The initial tabulation of results for assemblages, when organised by the most specific identifications that can be made, are very long lists with only a few MNI in each. This frustrates attempts to carry out statistical analysis aimed at revealing time-trends or significant differences from one site to another. Fruitful analysis is normally only possible when the information is synthesized into families.

There is a wealth of confused and ever-changing literature on the subject of fish taxonomy in the Pacific. It is advisable for archaeologists to use comparable nomenclature so that results of fish bone analyses can be compared from one part of the Pacific to another. The text by Munro (1967) is well known and highly regarded, and for this reason his nomenclature and taxonomic ordering are most frequently used by Oceanic archaeologists. They are used throughout this paper.

The large size of these two assemblages made it unnecessary to identify all six bone categories to obtain reliable MNI. It has been found that except for small assemblages little extra information is added from spending long periods struggling with increasingly difficult bones, maxilla, articular, and quadrate respectively (Leach, 1986). Bones identified in these present collections were as follows:

	Kapingamarangi	Nukuoro
Dentary	Yes	Yes
Articular	—	—
Quadrate	—	—
Maxilla	Yes	—
Premaxilla	Yes	Yes
Special bones	Yes	Yes

An advance on earlier work involved the use of an interactive computer program during the identification process. This places all information, cross-referenced to bag numbers, on a computer file, and minimum numbers of individuals (MNI) are calculated automatically from stratigraphic information. There is a large and interesting literature on the subject of MNI, both generally and for the field of Pacific fish bone analysis in particular (see, for example, Wild and Nichol 1983a, 1983b; Allen and Guy, 1984). This is not the place to review the advantages and disadvantages of the alternative approaches which could be adopted. The method used for this present study is outlined by Leach and Ward (1981), and more fully described and evaluated by Leach (1986). However, it may be mentioned in passing that the MNIs are not inflated by pair matching or adjusted by other transformations which have been suggested.

The main data file (copies of which can be obtained from the senior author on request) frequently contains identifications at a generic or species level, but only summary family level information is given here. This book-keeping system has the advantage that any identification errors or alterations can be easily made on both the bag and the main data file, and minimum numbers recalculated automatically. It is also a permanent and closely documented record of every single bone identified, ensuring that others who may wish to check the work or extend the study, for example with bone measurements for particular species, may do so easily.

The information on the MNI for different families and periods is given in Tables 1 and 2. In the Tables use is made of Shannon's H statistic as an index of diversity. Its method of calculation and details of the range of uses of the statistic in archaeology are described elsewhere (Leach 1978, 1986; Haedrich 1975; Watanabe 1972; Wilhm 1968; and Rao 1984).

Relative Abundance in Fish Catches and Likely Catching Methods

From the foregoing it will be recalled that one must be careful about trying to infer catching methods from fish remains recovered archaeologically. Even with this cautionary note in mind, it is possible nevertheless to group different kinds of fish according to general fishing categories based on their natural habitats and behavioural characteristics. The justification for these categories of catching method is fully described by Leach *et al.* (1988).

Two abundance fall-off curves are presented in Figures 2 and 3. For Kapingamarangi (Figure 2), the two dominant groups are the groper/cod family (bottom feeding carnivores with large mouth), thought to have been caught primarily with baited hook, and the parrotfish (largely herbivorous in habit, though they eat invertebrates too) which would be primarily taken with nets. By contrast, the groper/cod family were much less frequently taken on Nukuoro.

Next in importance on Kapingamarangi are moray eels (nearly 10% of all fish identified), for which specialized traps were used in the historic period. However, these fish frequent the shallows between islets and may also be caught by general foraging. Not one bone of a moray eel was recovered on Nukuoro. The only remains of the Order Anguilliformes were in fact of freshwater eels!

Triggerfish are next in importance. These fish are solitary in habit and are feeble swimmers. When threatened they generally hide in coral thickets and crevices. It is possible that most were caught by netting, although in view of their habits, spearing and general foraging in coral thickets could also be the main catch method. These fish are adept at removing bait from hooks, and on Satawal are caught with bottom lines (Akimichi, 1987: 280). However, this is unusual, because they have very small mouths, and generally speaking few fish of this family would be caught by baited hook. It will be noticed from Figure 2 that on Nukuoro these fish were a far more dominant component of fish catches.

Next in importance are the carangids. Most of these fish are fast-swimming predators that will take a lure or baited hook. The rainbow runner belongs to this family.

There are two main features of the fall-off curve from Kapingamarangi which can be noted. Firstly, of the 24 families represented, only about 10 can be considered to have been of economic importance (greater than 4% of the total). This is a large number of

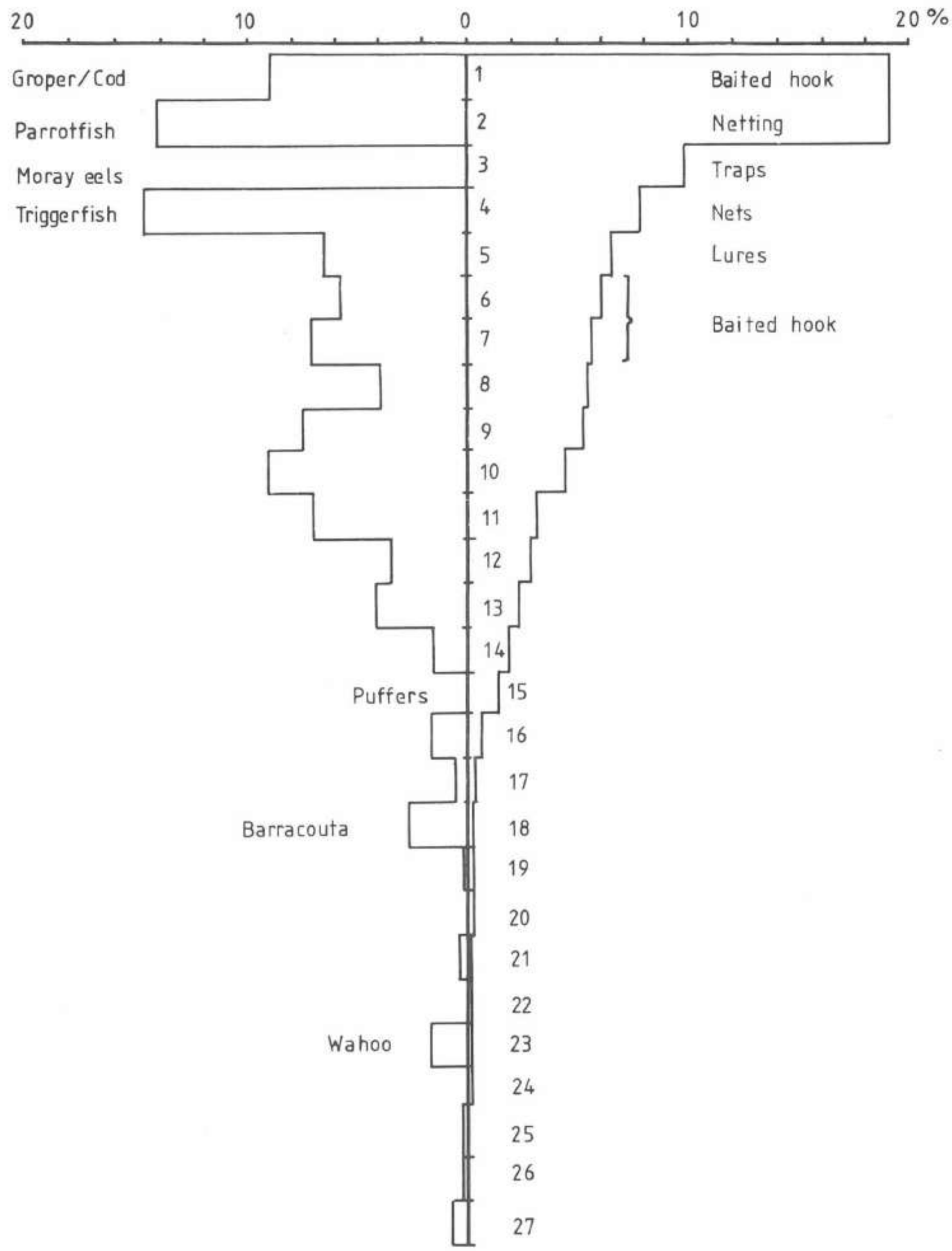

Figure 2: Kapingamarangi fall-off abundance curve (right) compared with Nukuoro (left). Family numbers follow Tables 1 & 2. Common names and likely catch methods are indicated for the more important types of fish. Shannon's H statistic for Kapingamarangi = 3.61, which indicates a large number of dominant fishes, although two are much more frequent.

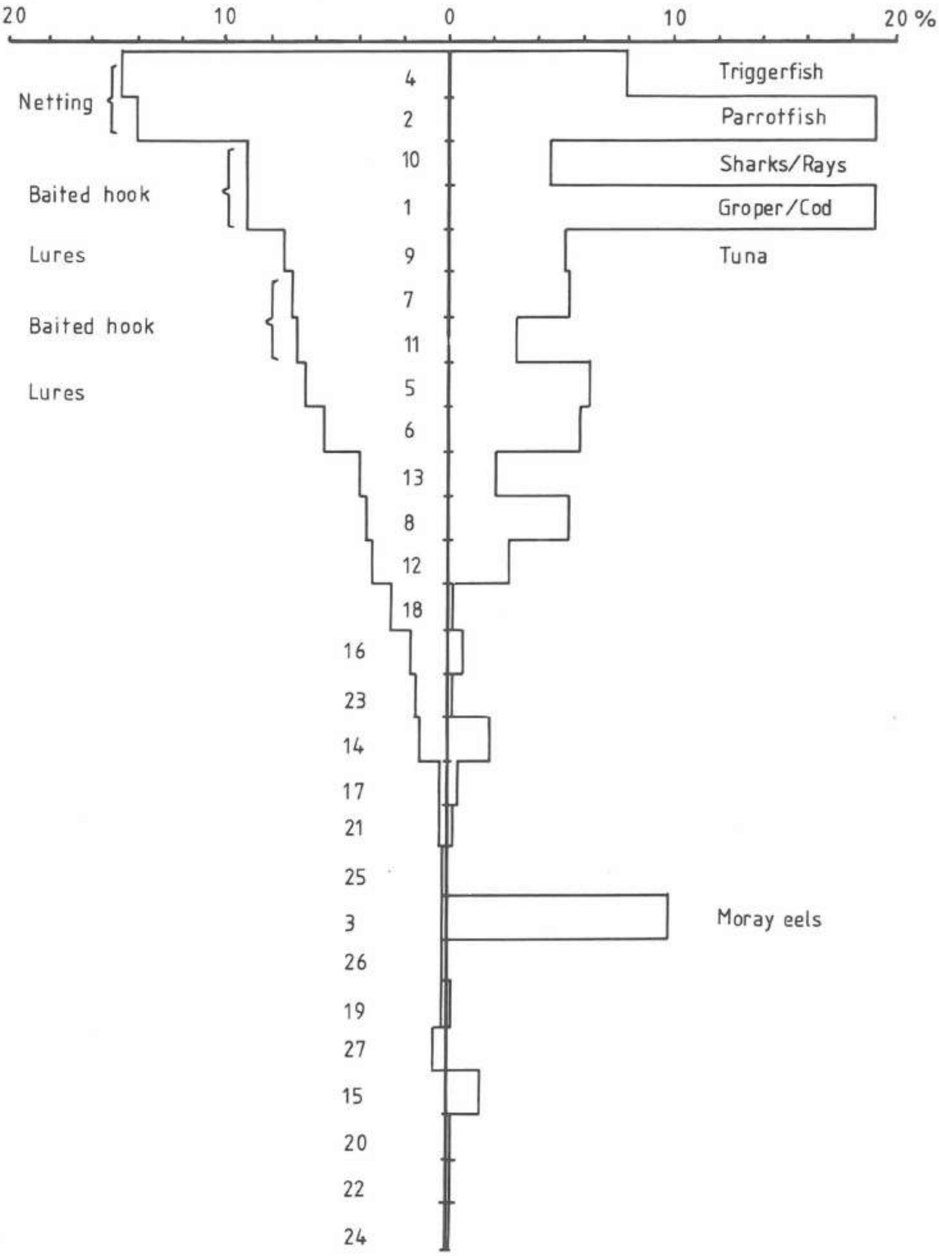

Figure 3: Nukuoro fall-off abundance curve (left) compared with Kapingamarangi (right). Family numbers follow Tables 1 & 2. Common names and likely catch methods are indicated for the more important types of fish. Shannon's H statistic for Nukuoro = 3.83. This again indicates a large number of dominant fishes, but with more even emphasis on all compared with Kapingamarangi.

dominant fish types, and it indicates a diverse approach to fishing. Secondly, of the dominant fishes, two types clearly dominate. This, in contrast, is a good indication of specialized fishing activity.

The shape of this fall-off curve may be summarized with Shannon's H statistic, a mathematical concept borrowed from cybernetics and frequently used by tropical marine ecologists to indicate the degree of diversity or environmental stress. The value $H = 3.61$ for Kapingamarangi is relatively high, reflecting the general lack of steepness in the fall-off curve. Note that Nukuoro has an even higher value of 3.83.

When the information is reorganized with the fall-off curve appropriate to Nukuoro, the significance of this different H value is somewhat clearer. Again, about 10 families could be said to have been of economic importance, although somewhat more equal emphasis is given to each category than is the case on Kapingamarangi. Thus, the Nukuoro fall-off curve displays even less steepness, and this is reflected in the higher H value.

The dominant fishes in the archaeological collection from Nukuoro were triggerfish and parrotfish, which we judge to have been mainly taken by netting. Historical records attest the importance of netting.

Fish which, in our view, are most likely to have been caught with baited hook come next in popularity. It is notable that sharks and rays are much more in evidence on Nukuoro than Kapingamarangi. It is interesting that on Kapingamarangi today, fishermen have a playful and derisory attitude towards sharks. They are certainly not considered to be food, although some sharks are cooked and fed to the taro gardens as manure! Vertebrae from the archaeological sites have been identified from X-rays as *Carcharhinus melanopterus* and *Triaenodon obesus,* the common black-tipped and white-tipped sharks (Piper, 1984: 20).

Next on the list of frequently caught fish are members of the tuna families. These would have been attracted by the lure properties of pearl shell, even though on Nukuoro it appears that the type of hook used was primarily a one-piece form, rather than the classic trolling bonito lure of East Polynesia.

A notable difference can be seen in the moray eel figures. No ecological reason can be advanced to explain this difference between the two islands. Moray eels are as abundant on Nukuoro as on other tropical Pacific islands, and some kind of avoidance behaviour is suspected. On Tikopia, a Polynesian Outlier in the Solomon Islands, both eels and porcupine fish are tapu, and not thought of as food today. This avoidance behaviour can be clearly seen in the archaeological record of the late sites there, going back to about AD 1700. Before that, both eels and porcupine fish were commonly taken as food (Kirch and Yen, 1982: 292). The reasons why certain foods become subjects of prehistoric avoidance behaviour can only be guessed at because some isolated historical event could trigger avoidance, for example, a chief becoming sick or dying after eating a species which carries ciguatera toxin. Morays are known to accumulate the toxin (Bagnis, 1973: 37). Other less tangible causes must be involved too because freshwater eels are one of the commonest objects of food avoidance in the Pacific, and they are not known to carry poison. The Tikopian case shows that specific objects of food avoidance can wax and wane over centuries. Something similar to this must be suggested for Nukuoro also, although in this case the avoidance behaviour has somewhat more antiquity. By contrast, porcupine fish

Table 3. Fish avoidance behaviour on Kapingamarangi and Nukuoro. Minimum numbers are given for each category, together with the percentage of the total. Avoidance behaviour occurs on modern Kapingamarangi towards sharks, which are quite numerous in the atoll.

Fish Family	Kapingamarangi	Nukuoro
Sharks/Rays (Elasmobranchii)	52 (4.3%)	62 (9.0%)
Moray eels (Muraenidae)	104 (8.6%)	0 Avoidance
Other eels (Anguilliformes)	14 (1.1%)	1 (0.1%)
Porcupine fish (Diodontidae)	26 (2.1%)	27 (4.0%)
Puffer fish (Tetrodontidae)	13 (1.1%)	0 Avoidance
Total all fish	1214	683

represent 4.0% of the fish identified on Nukuoro, and 2.1% on Kapingamarangi. However, a similar fish, the unspined puffer fish (Tetrodontidae), is absent on Nukuoro but represented by 1.1% of identifications on Kapingamarangi. Although the evidence is less clear, this may indicate that on Nukuoro the puffer fish filled a similar avoidance role to the porcupine fish on Tikopia. With the possible exception of sharks, no such prohibitions are indicated by the archaeological record from Kapingamarangi. These observations are summarized in Table 3.

Changes in Catching Methods Through Time

Over the last millennium on these two islands one might expect some reasonably obvious changes in the character of fish catches, given the well documented changes in fishing technology, at least for Nukuoro, where many fish hooks were found (Davidson, 1967, 1971). There are changes, but they are rather subtle. It should also be noted that the earliest assemblage on Kapingamarangi is only a small one (MNI of 39 fish). Consequently, there is an element of unreliability for this period.

The fish identified have been grouped into three main types of catch. Firstly, those which we consider to have been taken by nets, traps, and general foraging activities such as diving; secondly, demersal fish, judged to have been taken by baited hook; and finally the pelagic fishes, attracted by a lure. These groupings are given in Tables 4 and 5, and Figure 4. From Figure 4 it can be seen that on Nukuoro there is a consistent increase in the importance of netted and other foraged fish species, an increase in baited hook fishing, and a decline in pelagic fish. On Kapingamarangi, on the other hand (without paying much attention to the small early sample), the changes are not quite so marked. There is a slight decrease in general foraging activities, an increase in baited hook fishing, and no consistent change in pelagic fishing.

These trends can be rather more clearly observed by calculating the Shannon's H statistic for the different periods (Figure 5 and Table 1 and 2). Again, Nukuoro can be seen to have consistently changed in the course of time towards more generalised fishing strategies (more even emphasis on a large number of dominant fish). The people on Ka-

Table 4. Kapingamarangi fish grouped into likely catching methods. NB: the family members in each category follow Table 1.

Level	I		II		III		IV		Total	
	No	%	No	%	No	%	No	%	No	%
A: Foraging Activities Families: 2, 3, 4, 8, 10, 12, 13, 14, 15, 19, 20, 21, 22, 24	28	71.8	259	55.2	167	52.4	203	52.5	657	54.1
B: Demersal fish (baited hook) Families: 1, 6, 7, 11, 17	6	15.4	149	31.8	105	32.9	148	38.2	408	33.6
C: Pelagic fish (lures) Families: 5, 9, 16, 18, 23	5	12.8	61	13.0	47	14.7	36	9.3	149	12.3
Totals	39		469		319		387		1214	

Table 5. Nukuoro fish grouped into likely catching methods. NB: the family numbers in each category follow Table 2.

Level	I		II		III		Total	
	No	%	No	%	No	%	No	%
A: Foraging activities Families: 2, 3, 4, 8, 10, 12, 13, 14, 19, 21, 25, 26, 27	42	47.7	93	49.7	219	53.7	354	51.8
B: Demersal fish (baited hook) Families: 1, 6, 7, 11, 17	20	22.7	54	28.9	123	30.1	197	28.8
C: Pelagic fish (lures) Families: 5, 9, 16, 18, 23	26	29.5	40	21.4	66	16.2	132	19.3
Totals	88		187		408		683	

pingamarangi, on the other hand, have gone in the opposite direction. Unfortunately, the early sample is only small (MNI of 39 fish), and little reliance can be placed on this statistic for this period. In the three later periods, however, the diversity index clearly differs away from the pattern on Nukuoro. At the close of the prehistoric period, the Kapingamarangi fishermen were more specialized in their approach to marine resources than their neighbors to the north (greater emphasis on a smaller number of dominant fish).

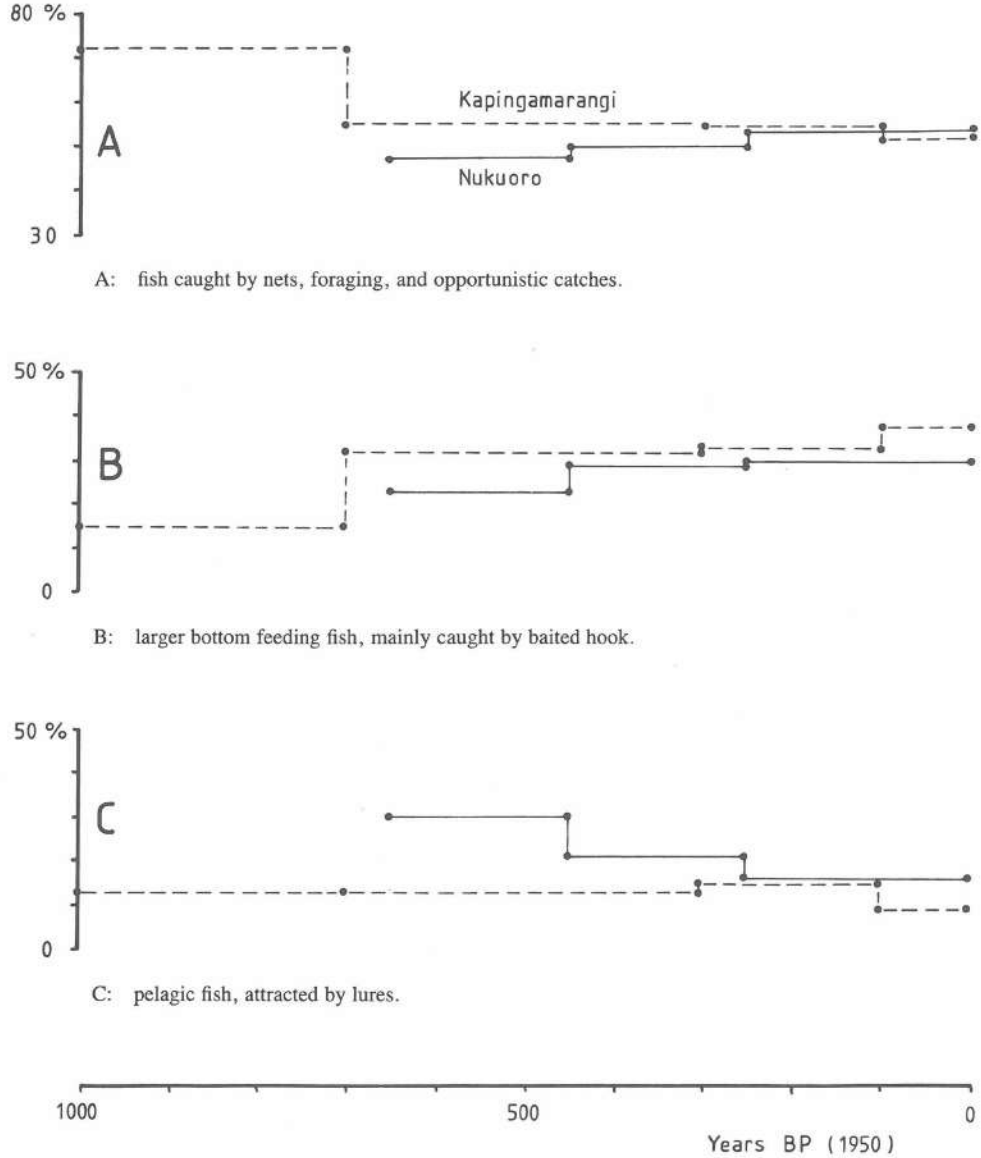

Figure 4: Comparison of the three main fish catching methods on Kapingamarangi and Nukuoro through the prehistoric period. NB: the earliest information from Kapingamarangi is not necessarily very reliable, because of the small sample involved (MNI of 39 fish).

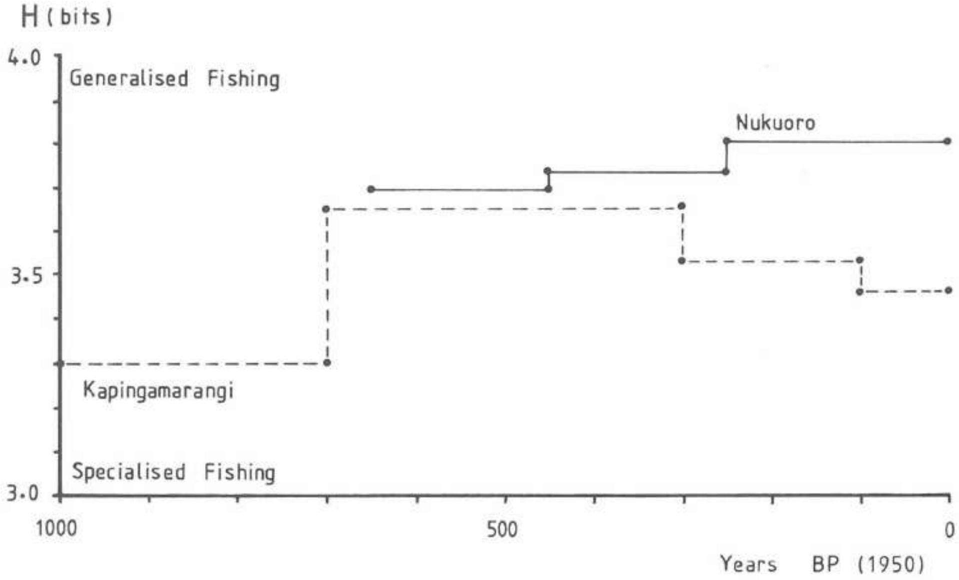

Figure 5: Shannon's H statistic for the different periods on Kapingamarangi and Nukuoro. NB: the earliest information from Kapingamarangi is not necessarily very reliable, because of the small sample involved (MNI of 39 fish). Discounting this early sample, the Kapingamarangi people appear to have become increasingly specialized in the course of time, while those on Nukuoro have adopted an increasingly generalised fishing strategy.

Discussion

It will be clear from this survey of archaeological fish remains from these two islands, that those most talked about on the land are far from the most significant in terms of household economics. What then can be said about the main body of the catch in the prehistoric period? Probably the most interesting aspect of this is the changing abundance of the parrotfish at different periods compared with members of the groper/cod family. In the tropical Pacific region the Scaridae or parrotfish fill a similar role to that of Labridae fish in more temperate waters. That is, they are abundant and easy to catch. For this very reason they are not especially sought after, and in fact may be considered inconsequential or even despised by the expert fisherman. It is ironical, but hardly surprising, that labrids formed the mainstay of prehistoric fish diet amongst many communities of early New Zealand, and scarids form the basis of fish diet for many people in tropical Oceania. Some lines of evidence suggest that in times of economic or environmental stress, labrids offer economic security and are more commonly caught (Leach and Anderson, 1979). A similar hypothesis can be advanced for scarids too, and this has been thoroughly researched on prehistoric Pacific communities by Fleming (1986). Scarids are primarily herbivores, and as such do not normally take a baited hook. They are therefore likely to have been mainly taken by netting in the past, and many may be taken in this way in relatively shallow water near coral thickets. Catching this type of fish is a 'safe activity', guaranteed to succeed.

On the other hand, baited line fishing, such as is appropriate to the groper/cod family, requires somewhat more initiative and skill in deeper water, is less secure, is more adventurous, and is not always guaranteed to produce a lot of fish. A suitable index of the skill of prehistoric fishermen, therefore, is not how frequently pelagic fish are taken, but the relative quantities of groper/cod as compared with parrotfish. The relevant figures are given in Table 6. For Kapingamarangi, there is a uniform rise in the relative importance of groper/cod in the last millennium, which suggests an improvement in fishing technology and skill. With the virtual absence of suitable shells to manufacture one-piece hooks for baited line fishing, this change shows just how effective bait hooks made from coconut shell and perhaps wood and turtle shell can be.

The ratios for Nukuoro show that netting must always have been very important for these fishermen, despite the abundance of pearl shell bait hooks in the archaeological sites. This conclusion is in keeping with Kubary's (1900) observation cited earlier that the principal fishing on Nukuoro was carried out with communally owned nets.

Returning briefly now to the initial theme of this paper—fishermen throughout the European world are well known for their elaborate fishy yarns about the fish that got away, and especially those larger examples of rarer species. It seems to us that Pacific island fishermen are no exception to this rule. The most memorable event in a week's fishing is bound to have been that time when the adrenalin was flowing while hoards of rainbow runner or tuna ripped their way across the water while chasing their prey near one's canoe. When the sea boils with this herding activity, there is great excitement amongst fishermen for a few brief minutes until calm is restored. A skilled fisherman can catch a number of these fish with almost anything dangling in the water which possesses lure qualities and a sharp point. Although these memorable events were frozen into folk lore and chants, they were relatively insignificant in keeping bellies content. This function fell to a large number of species which are relatively easy to catch in the rich marine environment of these atoll lagoons.

On the other hand, prehistoric people no less than their descendants did not catch fish according to their relative abundance in nature. We argue that the people on these two atolls were faced with essentially the same marine environments, yet they clearly diverged

Table 6. Time trends in the ratio of groper/cod to parrotfish on Kapingamarangi and Nukuoro. This clearly shows that netting was always very important on Nukuoro, far more so than on Kapingamarangi.

Kapingamarangi	Groper/Cod	Parrotfish	Ratio
0– 100 B.P. (1950)	90	81	1.11
100– 300	63	60	1.05
300– 700	75	81	0.93
700–1000	3	9	0.33
Nukuoro	**Groper/Cod**	**Parrotfish**	**Ratio**
0–250	42	65	0.65
250–450	16	22	0.73
450–650	4	8	0.50

in the fish they caught. Part of the reason is of course technology. Pearl shell and black mussel were present on one island but not the other. Even throwing in this additional natural factor, though, we can still see human cultural practices such as avoidance behaviour playing a significant role in subsistence economics—the prehistoric avoidance of moray eels and puffer fish being good examples.

Archaeologists should be careful not to assume that a marine biological survey or a survey of fish-hook types will necessarily tell them very much about what species prehistoric people may have taken as food. Humans, and particularly fishermen, are subject to strong and complex cultural prejudices. The somewhat odd behaviour towards specific types of fish, which, despite good nutritional value, may be regarded as suspicious or even downright disgusting to eat, should not be confused with totemic or religious observance. Fish avoidance seems almost universal amongst human cultures, more so perhaps among European societies than others. The Labrid family of fish, for example, is very common in inshore tropical and temperate waters around the world (Leach, 1979: 1; Rognes, 1973: 7), and is perfectly acceptable as food. Yet try to buy some at a fish market in New Zealand or Australia, and you will be disappointed. They are certainly sold in urban markets of Pacific Island countries.

Conclusions

This analysis of prehistoric fish catches on these two islands and comparison with ethnographic information has revealed a number of striking contrasts between observed and expected behaviour. Despite Firth's clear demonstration (1959: 341–2) that belief and action are two categories which perform different functions in human society and frequently do not coincide, ethnographers and social anthropologists are prone to explore and describe human behaviour by asking informants what they do, thereby creating a picture based on human values and beliefs, and seldom follow this up with a contrasting analysis of what people really do in practice. In the area of fishing activities it is desirable not only to observe the day's catch proudly displayed on mats (the prestigious fish) and ask the fishermen about their day's activity, but also to go and look in the bottom of the nearby canoe where the bulk of the fish catch will normally be found. Archaeologists observe the products of human behaviour and obtain only rare glimpses of the beliefs and values which held that behaviour together into a functioning social and cultural system. They are likely to find more by positively looking for the signs.

Why should archaeologists (and especially those interested in applying modern scientific techniques in the aid of archaeology) be concerned with this kind of problem? For the most part, archaeologists interpret prehistoric evidence without the benefits of independent checks and balances provided by ethnographic studies of the same people. This is one reason why archaeology is not considered a 'Science'; interpretations are difficult to check. The Pacific region, however, is somewhat exceptional in this respect. Archaeologists here have a rich legacy of ethnographic evidence relating to the immediate descendants of the very people they are studying, extending from the 18th century to the present. Archaeologists simply cannot and do not ignore this evidence, but in practice they frequently draw on this information to assist with interpretation (the Direct Historical Approach), rather than using it to check interpretations.

This study of ancient fishing on these two islands has revealed that the two forms of evidence do not easily marry together, and the discrepancy must be explained. On the one hand we have attempted to do this by blaming ethnographers for largely observing the superficial expression of human behaviour (beliefs and values) and more or less ignoring the tangible results of behaviour. On the other hand we claim that archaeologists are also to be blamed for giving only superficial attention to the bones in the ground (products of human action) and seldom attempting to detect the beliefs and values which were important motivating forces for the behaviour in the first place. No matter how thorough and sophisticated the analysis of such bones is in scientific terms, failure to be watchful for this less tangible evidence will result in an impoverished and inaccurate picture of past human societies.

In this paper, we have attempted to throw into sharp relief the disjunction between the ethnographic and archaeological evidence in as many areas as possible, hoping that if they are clearly in the open, future studies may be more penetrating. Some of these disjunctions may be summarized as follows:

1: Catching pelagic game fishes is subject to a serendipity effect in the Pacific islands; and while these fish have great socio-cultural importance to fishermen today on the two islands examined, their economic role was relatively insignificant over the last thousand years. The fishes most sought by fishermen are therefore not necessarily the most frequently caught.

2: The contrast between prehistoric fish catches on these two islands suggests that some species, such as moray eels and perhaps pufferfish, were subjects of avoidance behaviour on Nukuoro. Cultural prejudices can therefore be a significant determinant of prehistoric household economics.

3: Nukuoro is well known for fine ethnographic and archaeological specimens of pearl shell fish hooks, and on Kapingamarangi the bulk of fish hooks were made from non durable materials like coconut and turtle shell. In spite of this important difference in technology, baited hook fishing was surprisingly productive on Kapingamarangi, while on Nukuoro, netting seems to have been the most effective method of harvesting the sea. In addition, the main method for catching pelagic fish on these two Polynesian Outliers was not with trolling lures. Artefactual evidence is therefore a poor guide to the character of prehistoric fish catches.

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