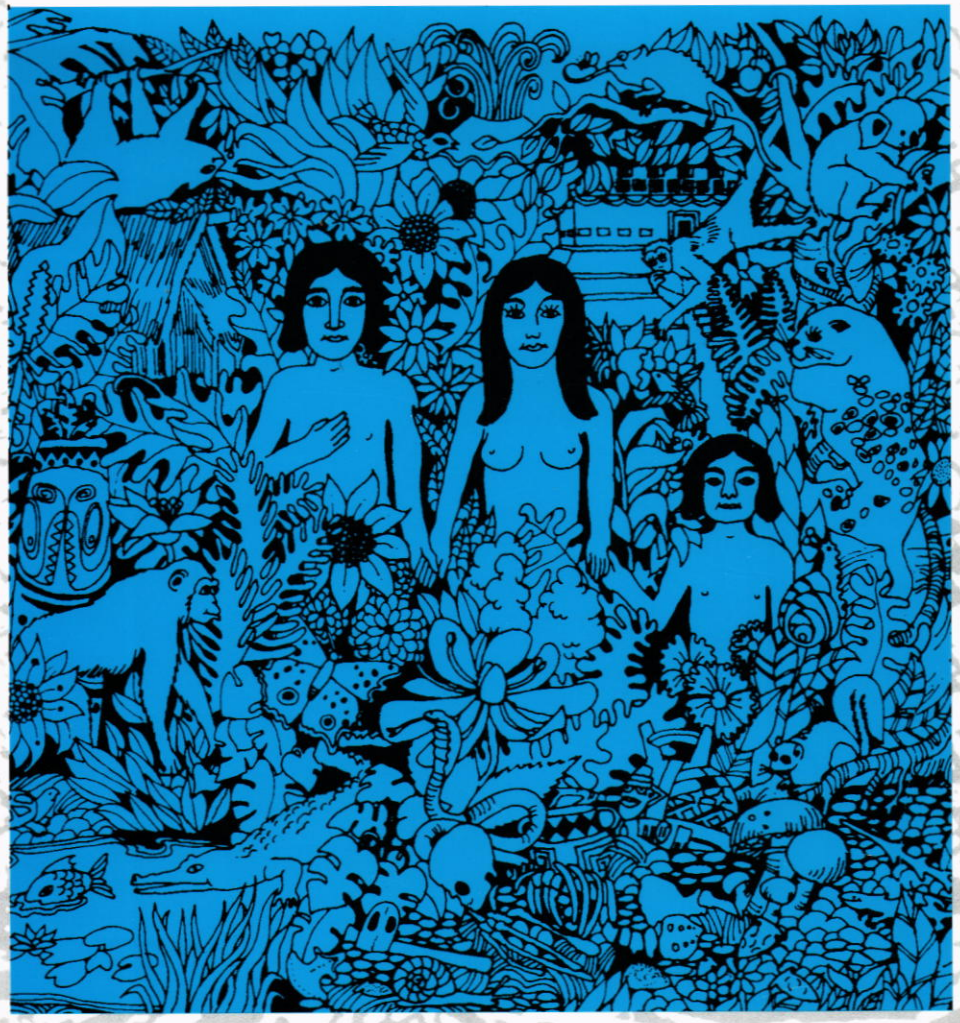
NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION MONOGRAPH 25:
Stuart Bedford, Christophe Sand and David Burley (eds), *Fifty Years in the Field: Essays in Honour and Celebration of Richard Shutler Jr's Archaeological Career*



FIFTY YEARS IN THE FIELD. ESSAYS IN HONOUR AND CELEBRATION OF RICHARD SHUTLER JR'S ARCHAEOLOGICAL CAREER

Edited by Stuart Bedford, Christophe Sand and David Burley

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NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION MONOGRAPH

THREE THOUSAND YEARS OF FISHING IN NEW CALEDONIA AND THE LOYALTY ISLANDS

Janet Davidson, Foss Leach and Christophe Sand

Fifty years ago, Gifford and Shutler recovered fish remains and items of fishing gear from their pioneering excavations in 11 archaeological sites in New Caledonia. They remarked on the relatively small amount of fishbone and its distribution, commenting that "The problem of the protein constituents in the aboriginal diet is puzzling, what with the uneven distribution of fish remains in the middens and the absence of domestic animals, except chicken, before European contact" (Gifford and Shutler 1956:28). They concluded that molluscs and decapods rather than fish must have been the main sources of protein.

This paper reviews archaeological evidence for fishing from recent excavations in several regions of New Caledonia itself and the adjacent Loyalty Islands. Faunal analyses have provided the basis for a better initial understanding of the character of pre-European fishing in New Caledonia, while the excavations have also expanded the sample of fishing gear known from the archipelago.

THE ARCHAEOLOGICAL INVESTIGATIONS

Since the beginning of the 1990s, the local Department of Archaeology has carried out archaeological studies of New Caledonia's prehistory in various parts of the archipelago. As part of a global focus on better collection of archaeological material in the field, as well as an expansion of research topics to subjects other than ceramic chronology, efforts were made to develop more efficient field recovery techniques. All sediments were water-sieved using 3mm mesh and fine sorting of material was carried out in the laboratory. Although this was often very time-consuming (it took a year to sort nearly 3 tons of sediments from the large excavation of Site 13 at Lapita), the procedure has allowed the identification of previously unknown prehistoric remains such as beads and other very small shell ornaments. But the most numerous items recovered were very small fish remains, which have been studied at the Archaeozoology Laboratory of the Museum of New Zealand Te Papa Tongarewa.

The fish remains studied came from both open habitation sites and rock shelters. Many of the sites have relatively deep stratigraphy with cultural material spanning most of New Caledonia's 3000 years of prehistory. Ten of the sites were excavated by Christophe Sand and his colleagues of the local Department of Archaeology. The eleventh, the rockshelter of Tiwi, was excavated by Jean-Christophe Galipaud of ORSTOM. The sites have yielded NISP (Number of Identified Specimens) ranging from 40 to 962 and MNI (Minimum Number of Individuals) from 34 to 418. Six sites have MNI of 130 or more. Although this is still a small sample for a relatively large archipelago, it is considerably better than what is so far available for many parts of the Pacific.

THE MARINE ENVIRONMENTS

The New Caledonian archipelago, the southernmost island group of the Melanesian chain, is characterised by a variety of geological and natural environments. The Grande Terre, a continental landmass about 450km long, is of Gondwana origin and has a long history. This island and adjacent smaller islands are surrounded by a coral reef over 1200km in total length. There are marked differences between the west coast where the reef is unbroken, and the east coast where the reef is discontinuous, resulting in more exposed shores.

The Loyalty Islands in the east of the archipelago have a different geological origin. They consist of volcanic cores over which coral formations have developed. Tectonic uplift and sea level changes have created large uplifted coral islands and islets, with some small lagoons. Mostly, however, coral cliffs fall directly into the sea. Only Ouvea, the northernmost island of the Loyalties, has a very large lagoon.

The excavations were conducted in a variety of natural environments. In this paper, the sites are grouped into four categories, taking into account land formations, coastal formations and sea characteristics (Table 1 and Figure 1).

Group 1. Sheltered lagoon environments

The smaller islands of the New Caledonian archipelago are mostly of coral formation, sometimes with a core of

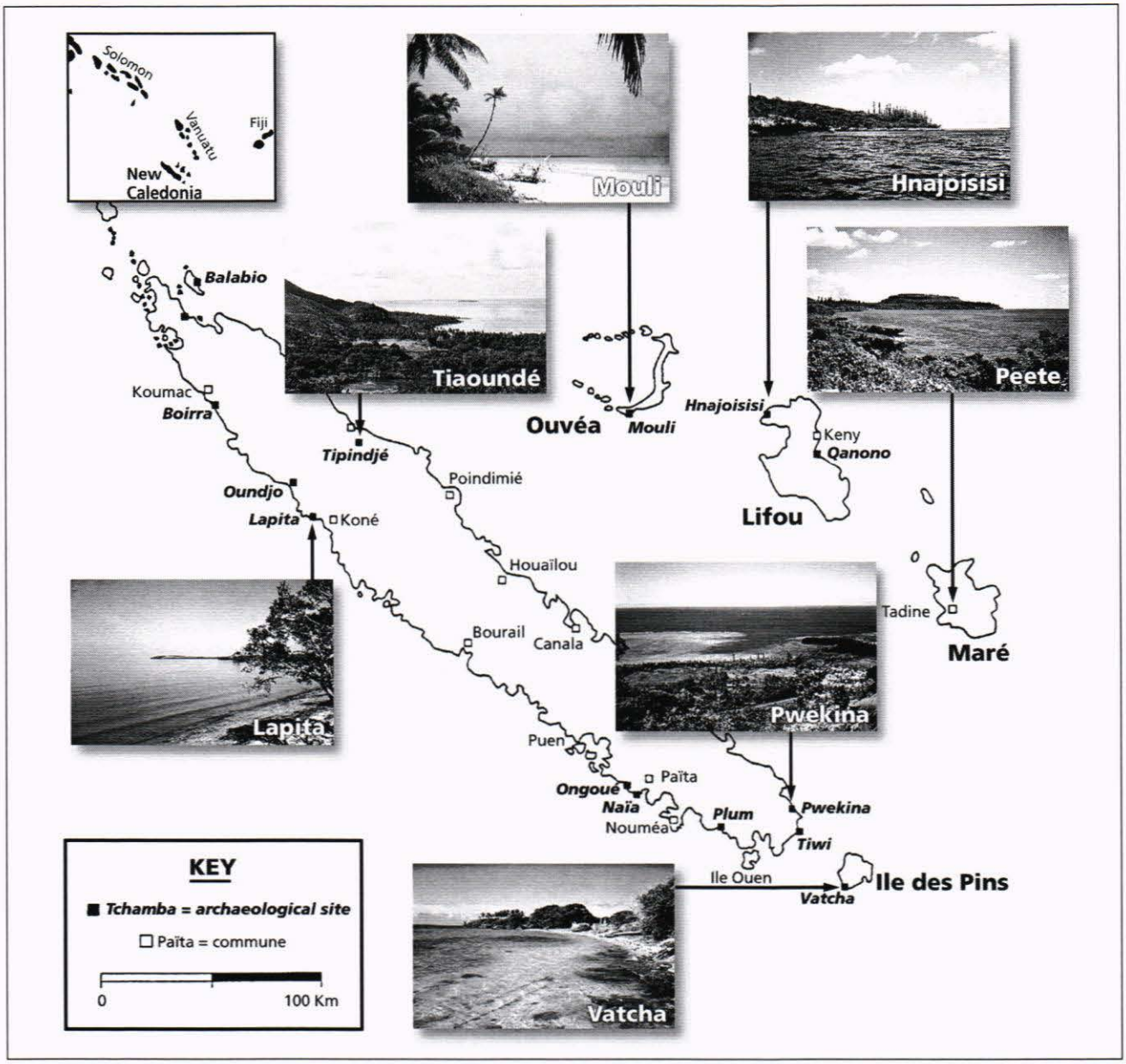

FIGURE 1. New Caledonia, showing the archaeological sites from which fish remains have been identified.

basaltic or metamorphic rocks. However, the coasts consist of uplifted coral cliffs and sandy beaches.

The Île des Pins, about 20km long, is located on a continental plateau forming the southern tip of the Grande Terre. It is totally surrounded by an old uplifted coral formation, ranging between 5m and 10m high. Numerous sheltered bays with sandy beaches at their heads permit easy landing and offer protection from the prevailing winds. The site of St Maurice-Vatcha is situated on a quaternary dune formation at the south of the island, opposite one of the major passes in the reef and near the best protected bays of the island, Gou to the east and Upi to the north. Site KVO003, occupied by Lapita colonists about 3000 years ago (Sand 1999), is now adjacent to an area of lagoon composed mostly of sandy and muddy flats with seagrasses at depths not exceeding 15m. Numerous coral outcrops in the near vicinity and extending out to the reef, about 3km to the south, provide shelter for fish species.

The geological situation of Ouvea is different. This island at the northwest end of the Loyalties chain is a semi-atoll of triangular form. The eastern part is an uplifted coral formation, reaching heights of 40m at its exposed eastern

Site	NISP	MNI
1. Small island, large lagoon		
Mouli B	962	376
Mouli A	270	160
Vatcha	215	82
2. West coast of Grande Terre, large lagoon, infilling		
Lapita	651	313
3. East coast of Grand Terre, little coral, mangroves		
Tiouandé 5	631	348
Tiouandé 14	110	67
Pwekina	45	37
Tiwi	852	418
4. Mare and Lifou, Loyalty Islands, no lagoon		
Hnajoisisi	257	133
Hnenigec	57	37
Peete	40	34

TABLE 1. New Caledonian archaeological sites from which fish remains have been identified. (NISP = Number of Identified Specimens; MNI = Minimum Number of Individuals).

side and forming a low plateau to the west, which ends in a series of sand dunes by the lagoon shore. At the southern and northern tips, small marshy inner lagoons between the islets have areas of mangroves or coral and sandy bottoms. Rich marine resources are found in the wide lagoon forming the western part of Ouvea, which is protected from the deep sea by a set of reefs ending in the pass of Anemata. This lagoon has a sandy bottom reaching 30m in depth and partly covered by sea-grasses. There are extensive coral outcrops around small islets. The lagoon attracts large deep-sea fishes as well as the typical inshore lagoonal fishes. The rockshelters of Mouli (Sand 1998a) are strategically positioned between the large lagoon and the small Fayawa swampy lagoon.

Faunal assemblages have been studied from St Maurice-Vatcha (KVO003; Leach *et al.* 1997a) and two rockshelters, Mouli A (LUV029) and Mouli B (LUV030), on Ouvea (Leach *et al.* 1998b).

Group 2. The large lagoon on the west coast of the Grande Terre

The large lagoon enclosed by the continuous barrier reef on the west coast of the Grande Terre forms a kind of inner sea along the dry side of the island, which is characterised by large valleys with extensive plains. The edge of the reef varies from about 5km to more than 15km from the land. The shore is mostly lined with large swampy mangrove areas, both in the river mouths and along the coastal flats. Regular deposition of clay soils as well as acid peridotic soils during wet periods has led to the formation of soil-rich substrata around the coast, and the development of mostly grassy bottoms with their related biota.

Coral formations are sometimes totally absent from the turbid waters of the inshore zone at the mouths of the largest river valleys on the west coast. The nearest examples may be several kilometres out into the lagoon. This is now the case at the Foué Peninsula, near Koné, where the eponymous site WKO013A of Lapita, one of the oldest known sites of the archipelago, has been excavated (Sand 1998b). Lapita is located opposite the large reef pass of Koné about 14km to the west, and faces an open beach bordered by mangroves. Immediately behind it is the Koné River mouth where mangroves extend for more than 4km. The geomorphological history of the Foué peninsula is complex and the marine environment now may be quite different from that at the time the site was first occupied.

The only faunal assemblage from the west coast in this study is from Lapita itself. Only preliminary results are available for this assemblage, which is still being analysed (Leach *et al.* n.d.). Gifford and Shutler's largest fishbone assemblage came from Site 26 (WKO026, Oundjo) nearby, although their own excavations at Lapita itself returned very few fish remains. However, long term retention of the original faunal assemblage from Oundjo has provided an opportunity for a recent study of fish otoliths (Weisler, this volume).

Group 3. The east coast

The wet east side of the Grande Terre has much smaller flat areas at the mouths of its deep valleys. In some regions, the mountains fall directly into the sea. A different tectonic history has resulted in poorer development or preservation of the coral reef on this side of the island. Although it is still continuous in the northern and southern tips, the reef is mostly broken in between, over a distance of more than 300km, with patches of coral irregularly scattered in the sea. The shores are much less protected, and the sea bottoms are more typical of open coasts than lagoonal ones. Massive fresh water flow down the rivers prevents coral growth in some areas. Coral is present mainly where fringing reefs have been able to form. The sea floors rapidly reach depths of over 40-50m, allowing the capture of deep-sea fishes near the coast, as well as a range of fishes in the extensive marshy areas forming the estuaries of some rivers. This is the case at Tiouandé in the northeast part of the east coast, where rock-shelters EHI013 and EHI022 have been excavated adjacent to the large mangrove swamp that developed at the mouth of the river (Sand 2001a).

Faunal assemblages have been studied from Tiwi (Galipaud 1992) and Pwekina (Sand and Ouetcho 1994) in the south (Leach *et al.* 1997b, 1998a) and Tiouandé in the north (Leach *et al.* 2000).

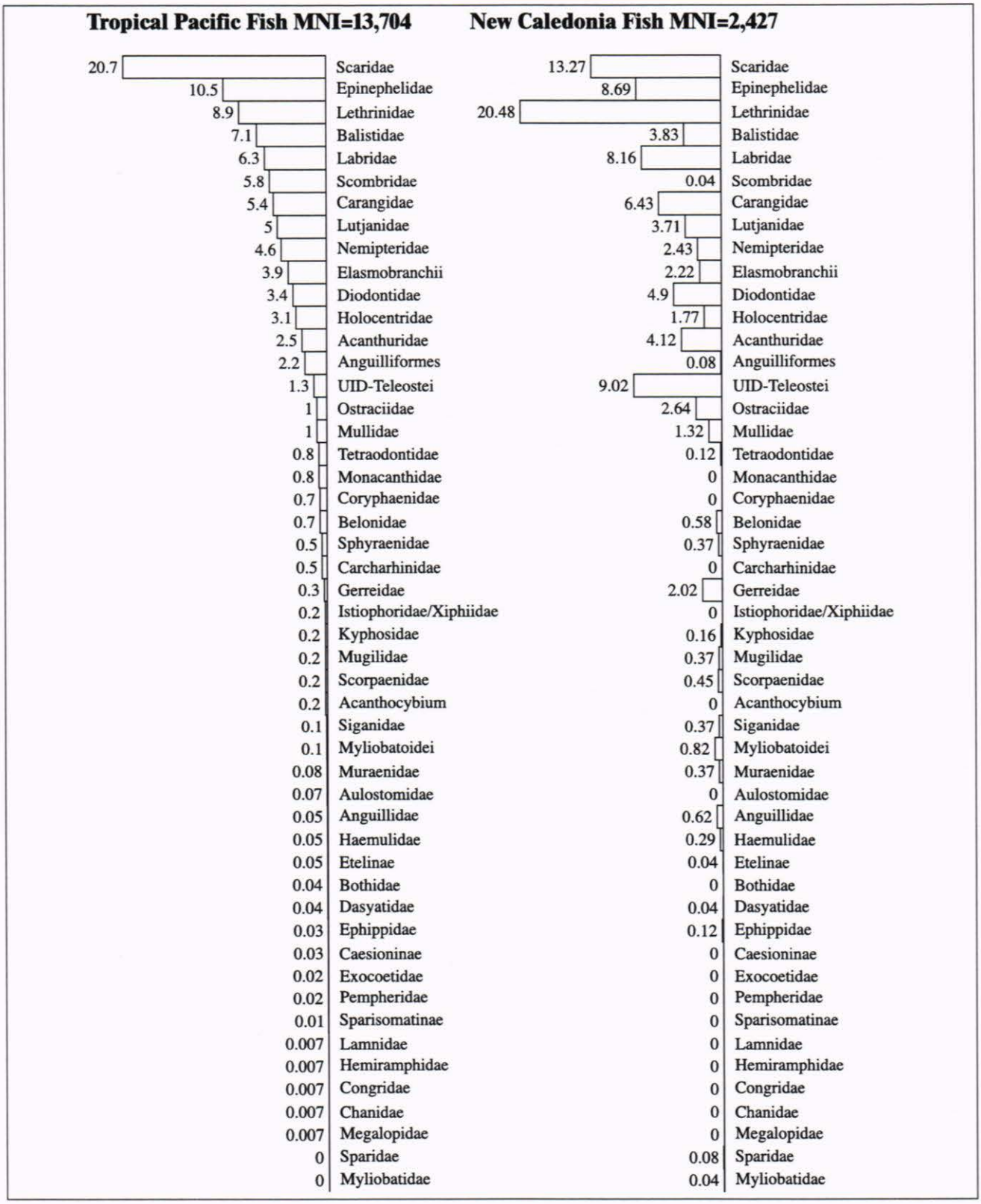

FIGURE 2. The relative abundance of fish families in the combined New Caledonian assemblages, compared with a larger Pacific sample.

Environmental Group	Site	% Lethrinidae	% Scaridae	% UID Teleostei spp.
1	Mouli B	9.84	5.05	10.11
1	Mouli A	15.00	9.38	7.50
1	Vatcha	73.00	4.88	
2	Lapita	59.42	2.88	
3	Tiouandé 5	8.62	10.92	24.43
3	Tiouandé 14	10.45	5.97	14.93
3	Pwekina	10.87	32.40	2.70
3	Tiwi	25.91	11.00	0.23
4	Hnajoisisi	9.02	25.56	4.51
4	Hnenigec		18.92	5.41
4	Peete	11.76	11.76	5.88

TABLE 2. Relative abundance of Lethrinidae, Scaridae, and Unidentified Teleostei in New Caledonian archaeological sites.

Group 4. Loyalty Islands without lagoon

In contrast to Ouvea, the large islands of Lifou and Maré in the Loyalties have very restricted lagoonal environments. Most of the coasts are formed by uplifted coral plateaus, which fall directly into the deep sea. This is the case at Hnajoisisi in Lifou and at the bay of Tadine in Maré, where the sites of Hnenigec and Peete are located (Sand 1998a). The coast in these two bays is formed by an uplifted coral formation between 3m and 5m high, with some very narrow shelters enclosing some sand beaches. Sea depth reaches 10m very rapidly, with coral outcrops around which the fishes congregate, but mostly flat bottoms without grasses, before falling to depths of over 50m. In these bays, no calm and sheltered environments can be expected.

Small faunal assemblages have been studied from site LWT008 at Hnajoisisi, LTA037 at Hnenigec and LTA042 at Peete (Leach *et al.* 1998b).

GENERAL CHARACTER OF NEW CALEDONIAN FISHING

As a general guide to the character of fishing in New Caledonia, the combined MNI (Minimum Number of Individuals) from the 11 sites analysed can be compared with the combined total MNI from a number of tropical Pacific assemblages in the data base at the Museum of New Zealand Te Papa Tongarewa (Figure 2). In many respects, the New Caledonian sample is similar to the larger sample, although there are some notable differences.

The first point to note is that New Caledonian fishing, like fishing in many parts of the Pacific, focused almost exclusively on the inshore zone. Although some of the marine environments described above offer opportunities to capture large pelagic fishes, pre-European fishers in New Caledonia apparently did not exploit such opportunities.

The next point to note is that all the families represented in the large sample by 1% MNI or more also contribute more than 1% in New Caledonia, except for Scombridae or tunas, which are a pelagic family. Anguilliformes include the more precisely identified Anguillidae and Muraenidae, and when these are added, the New Caledonia Anguilliformes contribute just over 1% of total MNI. The only family below the 1% mark in the larger Pacific sample that scores above it in New Caledonia is Gerreidae or silver biddies, which are mentioned again below.

Among the minor families not represented at all in New Caledonia are many of the seldom identified families that occur in the data base sample at less than 0.1%, and the big game fish such as Coryphaenidae, Carcharhinidae, Istiophoridae/Xiphiidae, and *Acanthocybium* (Scombridae). These would be absent from many other island groups as well.

When we look more closely at the families above the 1% point, there are, not surprisingly, variations between the New Caledonian sample and the larger Pacific sample. Some families are less abundant than expected and some are higher than expected. Many of these differences are not significant when the error of the percentage is taken into account.

The most striking features of the combined undifferentiated New Caledonian assemblage are the high proportions of Lethrinidae and unidentified (UID) Teleostei, and the low proportion of Scaridae (Table 2). Lethrinidae or Emperor fishes are a moderate-sized fish, inhabiting shallow waters around rocky and coral reefs, although some species are known to go into tidal estuaries. They are carnivorous and are normally taken on a baited hook, although some are likely to have been taken by netting. We have argued that small examples of these and other fish may have been taken by poisoning at Nan Madol on Pohnpei (Leach *et al.* 1996). Lethrinidae are the most abundant family in three sites in New Caledonia: Vatcha, Lapita, and Tiwi. They are completely absent from the small assemblage from Hnenigec, and are represented in all other sites at 9% to 15%.

Scaridae or parrotfish are usually the most common fish in Pacific archaeological sites. They are colourful reef dwellers, which feed on vegetable matter and invertebrates.

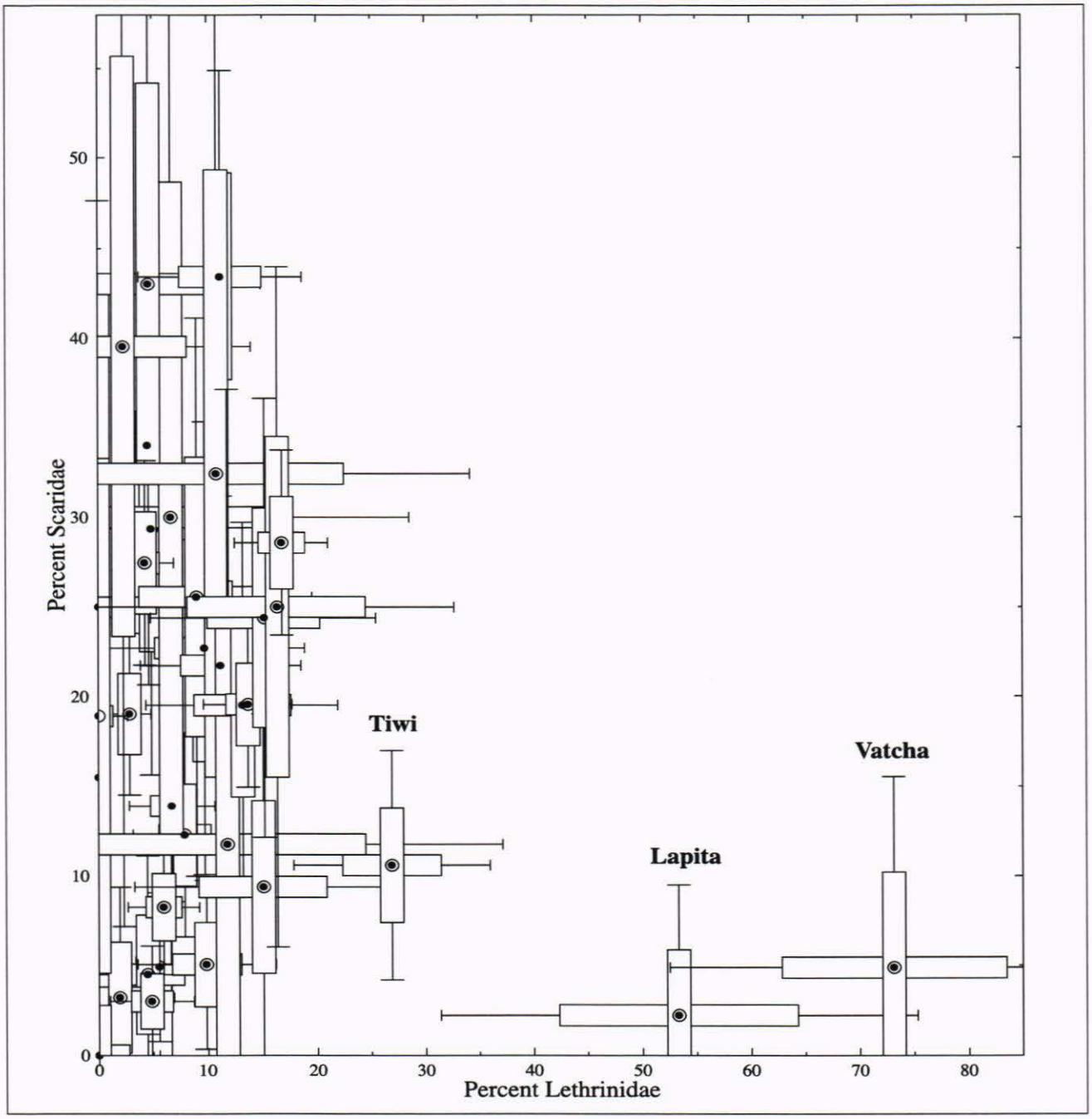

FIGURE 3. The percentage of Lethrinidae plotted against the percentage of Scaridae in 34 Pacific archaeological sites. The error bars indicate the standard error of the percentage at 68% and 95% probability.

They are most frequently taken in shallow inshore waters. Because of their diet, they cannot usually be taken on hooks. Although they are commonly speared today by divers using goggles, netting was probably the usual method for catching them in pre-European times. In New Caledonia, Scaridae are dominant only in three small assemblages – Pwekina, Hnajoisisi and Hnenigec. They are present in all the other sites, but in proportions ranging from 2.9% at Lapita to 11.8% at Peete. This is much lower than would normally be expected in assemblages deriving from the inshore zone.

Another way of looking at the importance of Lethrinidae in New Caledonia is to plot the percent

Environmental Group	Site	Dominant family
1	Mouli B	Carangidae
1	Mouli A	Epinephelidae
1	Vatcha	Lethrinidae
2	Lapita	Lethrinidae
3	Tiouandé 5	UID Teleostei
3	Tiouandé 14	Lutjanidae
3	Pwekina	Scaridae
3	Tiwi	Lethrinidae
4	Hnajoisisi	Scaridae
4	Hnenigec	Scaridae
4	Peete	Balistidae

TABLE 3. The dominant fish families in New Caledonian archaeological sites.

Lethrinidae against the percent Scaridae (Figure 3). In this diagram, 34 Pacific Island assemblages are depicted in this way. The unusual nature of the assemblages from Vatcha and Lapita, and to a lesser extent Tiwi, is obvious.

The category of UID Teleostei includes a variety of fish that are not represented in the comparative collection at the Archaeozoology Laboratory of the Museum of New Zealand Te Papa Tongarewa. The proportion of unidentifiable specimens in the New Caledonian assemblages is embarrassingly high, and includes as many as five or six separate unidentifiable species in some assemblages. Many of these fish are very small, a point we return to below. But there are also one or more species which strongly resemble Sparidae or the closely related Nemipteridae. Extensive inquiries among ichthyologists have so far failed to produce suggestions as to what species these fish might be. It is interesting to note that Fowler listed "Sparus" in five of the eight sites excavated by Gifford and Shutler from which he identified fish remains (Gifford and Shutler 1956: 29).

The category of UID Teleostei is dominant at Tiouandé 5 (EHI013). They are not represented at all at Vatcha and are very rare at Tiwi and Pwekina. These are the three southernmost sites studied to date in New Caledonia. Elsewhere, UID Teleostei range from 4.5% at Hnajoisisi to nearly 18% at Lapita.

There is another unusual feature about the New Caledonian assemblages, namely the high proportion of very small fish. We have observed this elsewhere at some Micronesian sites and at Cikobia in Fiji. At Nan Madol on Pohnpei and at Cikobia we have suggested that it may be due to fish poisoning as a regular method of capture. Poisoning is a likely method of capture of Gerreidae which, as noted above, are more abundant in the New Caledonian sample than in the larger Pacific sample. It must be pointed out that comments about high proportions of small fish are simply impressions. The only detailed work on fish size reconstruction in the tropical Pacific that we are aware of are the definitive studies by Fleming (1986) on Scaridae and Fraser (1998) on tuna. There are many problems in carrying out the necessary basic work on any Pacific fish family to provide a sound basis for size reconstructions, but until such work is done, statements about relative sizes will remain subjective only.

VARIATIONS IN SPACE

Another notable feature of the fish remains from New Caledonia is the variability from site to site. We thought that this might be due to variations in the marine environment. However, at our present level of analysis we have been unable to identify any strong correlation between relative abundance of fish families and local marine environment. This aspect of New Caledonian fishing is well illustrated by the variability in dominant species (Table 3). Some of these fish families have not so far been mentioned.

Carangidae are fast swimming predators, which congregate in schools in inshore waters, even moving into fresh water on occasion. The group is anatomically quite variable and some can be identified to species. Although they are often a prime target for trolling lures, it so happens that most of the fish of this family in the New Caledonian assemblages can be identified as *Selar boops*, which is an unusually small carangid, unlikely to have been taken by lure or hook.

Epinephelidae (Serranidae) are carnivorous, bottom-dwelling species, normally taken by angling. In this case, they are dominant in a site containing mostly very small fish, so other methods of capture need to be considered. The same can be said of the Lutjanidae, which are dominant at Tiouandé 14 (EHI022), where fish are again mostly very small.

Balistidae or trigger fish inhabit shallow inshore waters. They have very small mouths, so are hard to catch with baited hook and were probably mostly taken by netting. The sample from Peete is very small, and therefore not very reliable.

The variability within New Caledonia can also be illustrated by comparing the relative abundance of families in closely adjacent sites that share the same marine environment. Tiouandé and Mouli illustrate this point (Figures 4 and 5). The two rockshelters at Tiouandé are in the same part of the northeast of the Grande Terre and their deposits seem to cover a similar lengthy period of time, with

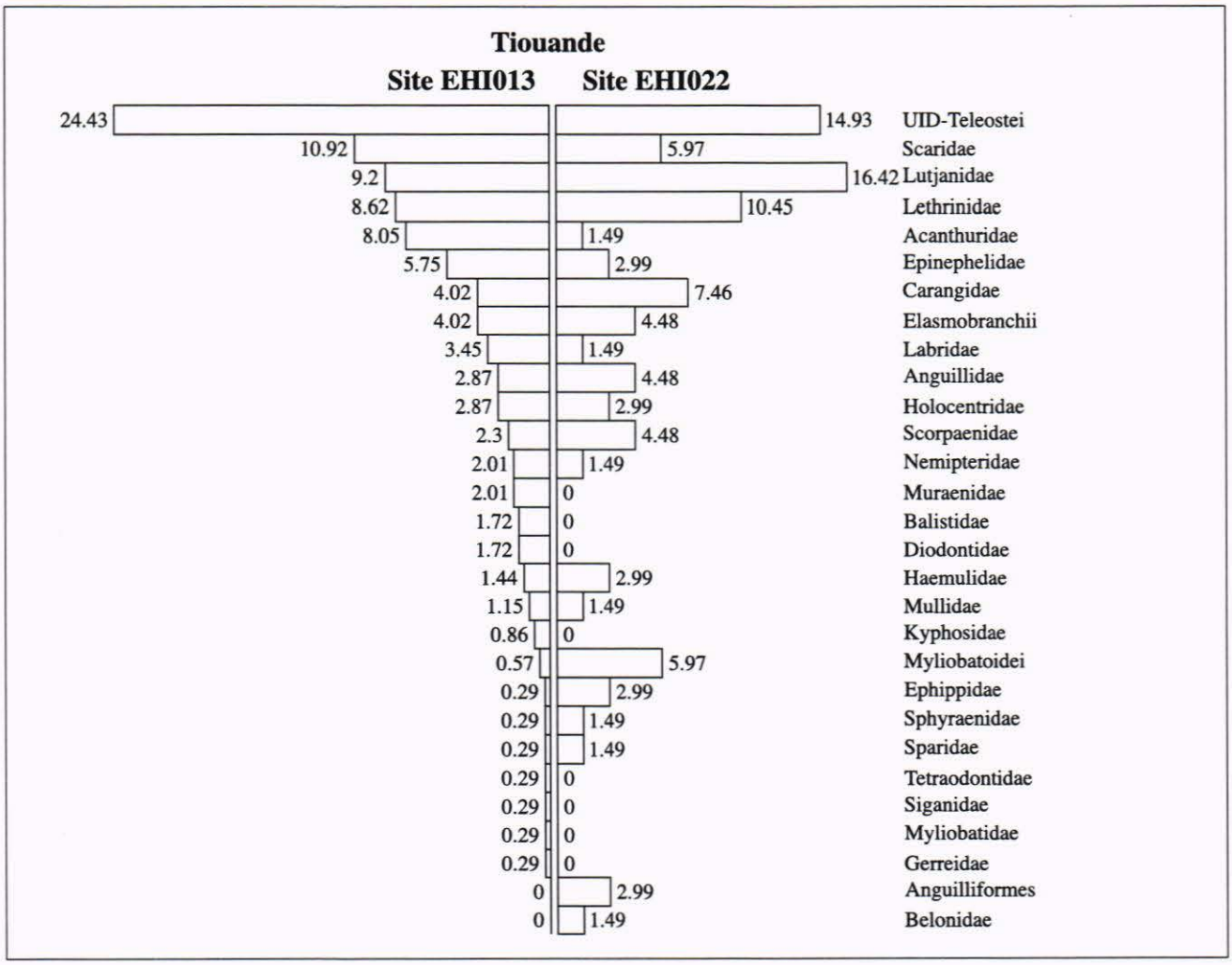

FIGURE 4. The relative abundance of fish families in two adjacent sites at Tiouandé, New Caledonia.

the exception that the earliest layers are represented only at Tiouandé 5. There was no definite evidence of chronological change at either site. Similarly, the two sites at Mouli on Ouvea in the Loyalties are very close together. Both are deep stratified sites with no evidence of chronological change.

VARIATIONS IN TIME

As noted above, many of these New Caledonian sites cover a long period. Wherever possible, we looked for evidence of change through time. Unfortunately, in most cases each site yielded a large number of very small assemblages from a series of layers in relatively small excavation squares. This makes it very difficult to identify changes that are statistically significant.

There was no evidence of chronological change in fish abundance at most of the sites. At three, there appeared to be some change, but the numbers in each case are very small and not much reliance can be placed on any trend. In all three sites there seemed to be a decline in Scaridae through time. At Pwekina, UID Teleostei were present only in the late assemblage. At Tiwi there was an increase in Lethrinidae. At Hnajoisisi the decline in Scaridae was accompanied by a slight increase in several other families.

There are too few fish bones from the bottom layers of sites such as Tiwi and Tiouandé 5 and 14 to characterise the fishing behaviour of the earliest period of New Caledonian prehistory. However, the two very early sites of Lapita and Vatcha are also the two sites with the highest abundance of Lethrinidae. On the other hand, the majority of the deposits at Tiwi, where there was an increase in Lethrinidae through time, are much more recent than the early layers at Lapita and Vatcha. Thus there appears to be no consistently clear pattern of chronological change in these New Caledonian assemblages.

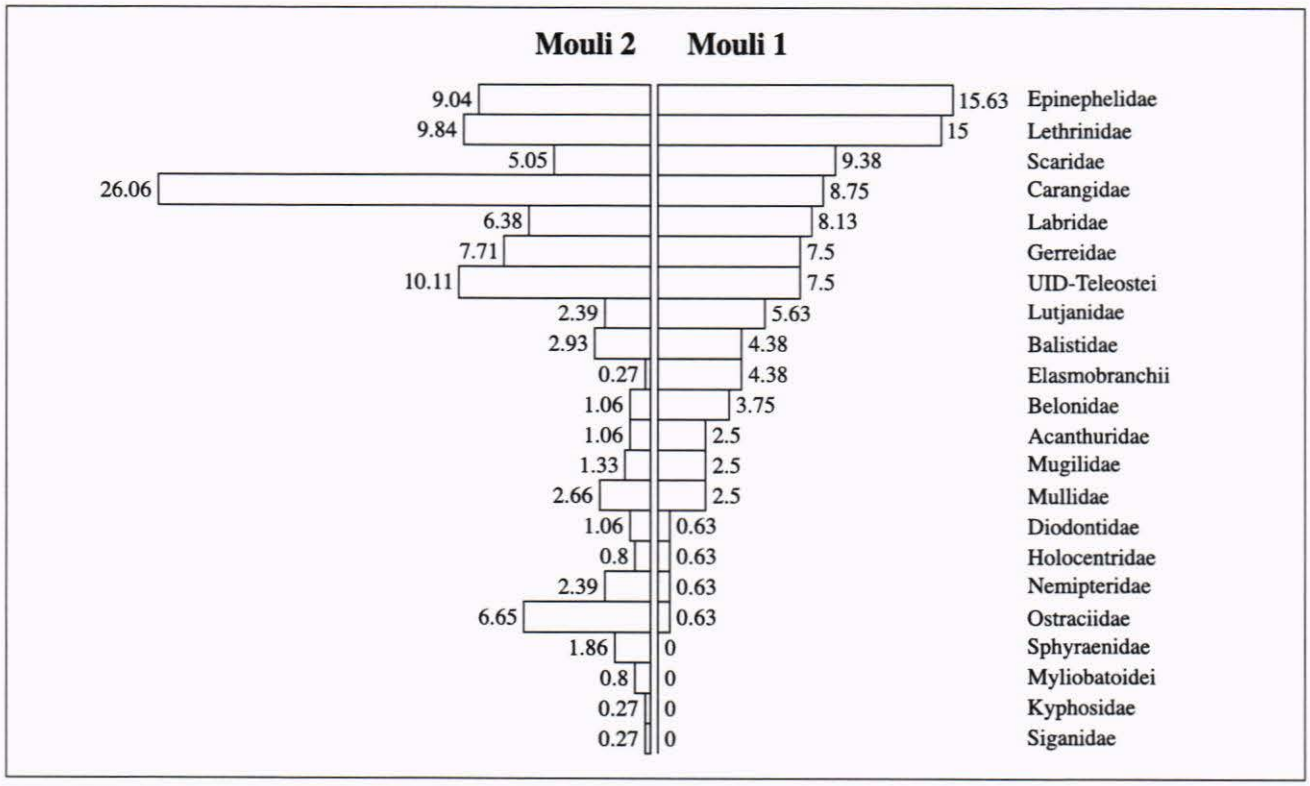

FIGURE 5. The relative abundance of fish families in two adjacent sites at Mouli, Ouvea, New Caledonia.

FISHING GEAR

Until the last decade, archaeological evidence of fishing gear was rare in New Caledonian archaeological sites (Sand 1995:89). Gifford and Shutler (1956:63) reported the recovery of 10 fishhooks similar to examples from the Loyalty Islands and Îles des Pins described by Sarasin (1917:241), which were made from the lip of the large land snail *Placostylus*. Gifford and Shutler did not illustrate their finds and those illustrated by Sarasin are not convincing. In recent years, however, things have changed markedly, with the discovery of numerous shell hooks and net sinkers.

Shell fishhooks have been found in most of the stratified coastal sites excavated on the Grande Terre and in the Loyalty islands (Figure 6). They are more numerous in the Loyalty Islands, probably because of the nature of the sites excavated, which are mostly small rockshelters. About 40 hooks are now listed in the archaeological record (Sand 2001b). Most are relatively small, ranging from less than 1.5cm to around 3cm in length (Sand 1998a:207). They are rotating hooks, often with a slight knob for line attachment. They are usually made from turbo or pearl shell. A single quite different example made from trochus shell was found at site WKO013A at Lapita. This is a 7cm long shank leg, grooved for line attachment (Sand 1996:48). It shows some similarities to specimens from other Island Melanesian Lapita sites (e.g. Kirch 1997:201). No definite examples of composite trolling hooks have yet been identified.

A specialised lure for octopus fishing has been recorded from a number of Pacific Island groups, including the Loyalty Islands (Beasley 1921; Leach 1979). It usually consists of cowrie shell plates or a whole cowrie shell attached to a stone sinker. Cut cowrie shells have been found in sites throughout New Caledonia and the Loyalty Islands, suggesting that this technique was known throughout the prehistoric sequence.

In New Caledonia (as elsewhere in the Pacific) the identification of perforated bivalves, usually *Anadara* sp., as net sinkers remains controversial. Gifford and Shutler (1956:63) identified as net weights 976 perforated bivalves (the vast majority of which they described as *Arca* rather than *Anadara* shells), despite a lack of supporting ethnographic evidence. Others consider that most of the pierced *Anadara* shells are natural. Here we consider only net sinkers of material other than shell (Sand 2001b). The type of net sinkers varies according to environment. In the Loyalty Islands, where no stones are

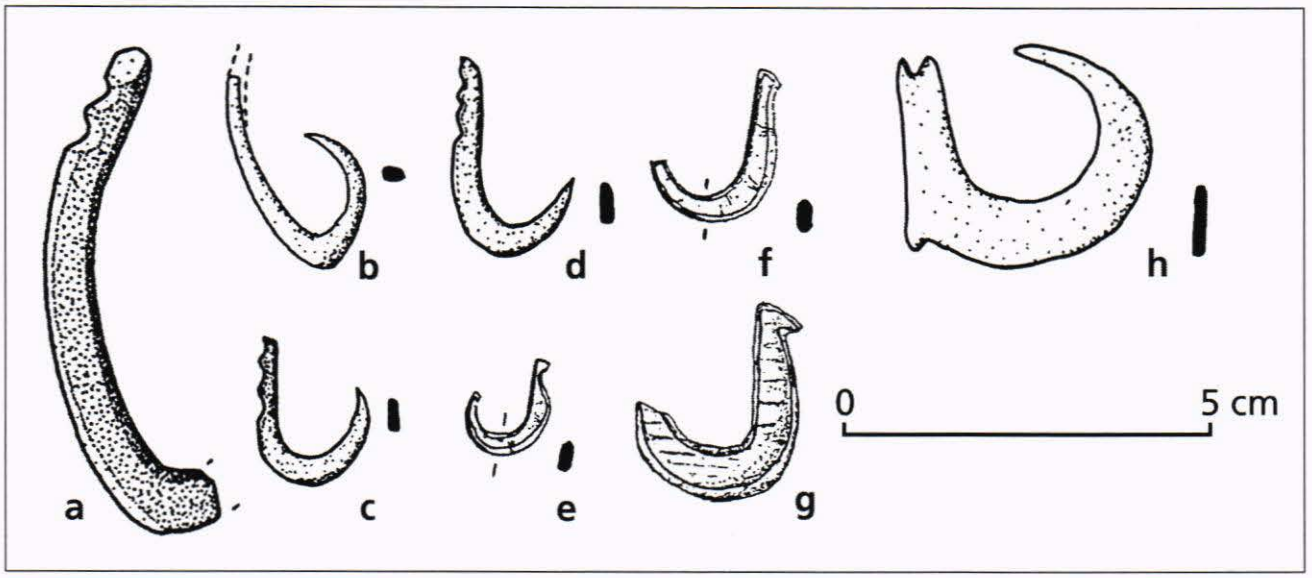

FIGURE 6. Items of fishing gear from recent excavations in New Caledonia.

present, heavy sinkers were made in the form of oval-shaped calcite blocks grooved in the centre. On the Grande Terre, flat rocks were drilled or grooved for attachment to smaller nets.

As we have argued elsewhere (Davidson and Leach 1996; Leach and Davidson 1988), it is by no means easy to infer fish catches from surviving examples of fishing gear. Our findings challenge widely held views about which types of hooks catch which kinds of fish. Faunal remains are generally a much surer indication of what people were actually catching. In our present state of knowledge, we can say only that predominantly small fishhooks now appear to have been part of the fishing technology in New Caledonia, along with nets and other methods not represented by durable portable remains.

DISCUSSION AND CONCLUSIONS

We do not find evidence to support Gifford's and Shutler's comments about a puzzling paucity of fish remains. However, it is likely that their predominant use of half-inch (12.7mm) sieves meant that they failed to recover many of the small bones that are so characteristic of these sites.

This study suggests that pre-European New Caledonian fishing is typical of much Pacific fishing in that it reflects an exclusive concentration on the inshore zone, and on most of the same families that were widely captured elsewhere in the Pacific. However, it is unusual in its relatively low proportion of Scaridae and high proportion of Lethrinidae and of species not represented in the comparative collection. This may be partly explained by New Caledonia's southern latitude, and perhaps by general aspects of its marine environments, although at present we have no information on fish distribution to support this idea.

New Caledonian fishing also appears unusual in the apparently high numbers of very small fish. Good excavation and recovery methods are undoubtedly partly responsible, but this feature of the assemblages is also likely to be due to fishing methods such as the use of small nets and possibly poison (Béarez 1998). Our results in this respect are comparable to those of an earlier study of fish remains from the Lapita site of Nessadiou in the centre of the west coast of the Grande Terre, only briefly summarised by Frimigacci (1980:9). Identification of fish otoliths from this site suggested that the occupants were concentrating their efforts on capturing very small fish and gathering shellfish from the immediate foreshore and the mangrove zone nearby. The recent study of otoliths from Oundjo (Weisler, this volume) also suggests a focus on species that frequent turbid inshore waters, mangroves, and river mouths.

Ethnographic data on fishing in New Caledonia is limited. Techniques illustrated by Leenhardt (1980:Pls. XII and XIV) include the use of the fish spear by men, the use of small fine-meshed nets apparently by both men and women, and general foraging with a basket and short hand-held "harpoon" by women. Some of these images were posed for commercial postcards, but the equipment would have been genuine, even if the exact context was

not. Fish traps on the fringing reef have also been reported (Sand 1995:190). All these techniques are typical of the inshore zone and compatible with the faunal remains recovered in the sites.

New Caledonia is also unusual in our experience in the variability in relative abundance of the major fish families, not merely between sites in what appear to be rather different marine environments, but between closely adjacent sites. We have one example of significant variability within one large site in the Society Islands (Davidson *et al.* 1998). This appears to be due to differences in site function and in the preparation and distribution of the catch among people of different status. Elsewhere, both intra-site variability and inter-site variability within an island or island group are generally lower than in New Caledonia.

There is abundant evidence in New Caledonia of significant impacts on the terrestrial environment during the period of human occupation and of corresponding changes to the coastal environment (Sand 1995:134-137). Although the broad categories of marine environment described above are of long duration, there have been some dramatic changes to specific local marine environments, such as the infilling of some former mangrove swamps and the development of new mangrove swamps as a result of forest clearance and erosion. It therefore cannot be assumed that the present day environment adjacent to an archaeological site is the same as when the site was occupied. However, as noted above, there is so far little evidence of chronological change in fish catch within individual archaeological sites.

These tentative conclusions about the unusual aspects of New Caledonian fishing will be confirmed or refuted only with further work there and with better comparative data from other large archipelagoes in this part of the Pacific, particularly Vanuatu and Fiji, where very few fish assemblages have so far been analysed. Important avenues for future research include exploration of the nature and if possible the history of the marine environments in the vicinity of individual sites, and the development of measures of relative fish size, even without reconstruction of live fish size and weight.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Dick Shutler's many and varied contributions to archaeology and prehistory during his long career, including one of the few good undergraduate texts on Oceania (Shutler and Shutler 1975). Janet Davidson recalls with pleasure her first meeting with Dick in Honolulu in the mid-1960s, when the archaeology of Polynesian outliers was a shared interest, and many happy meetings since.

Janet Davidson and Foss Leach thank Aglaja Budec-Piric, Greta Burnside, Karen Grieg (formerly Fraser), and Michelle Horwood for their work on the analysis of the fish remains from New Caledonia. Christophe Sand thanks his colleagues André Ouetcho and Jacques Bolé, and also the traditional landowners of the excavated sites and the individuals who participated in the excavations. The research was financed by the Northern Province, the Loyalty Islands Province, the Southern Province, the New Caledonia Territory and the French Ministry of Culture. Philipe Béarez provided useful comments on an earlier draft.

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