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Fishbone from the Emily Bay Settlement Site, Norfolk Island

RICHARD WALTER[1] AND ATHOLL ANDERSON[2]

[1] Department of Anthropology, University of Otago, Dunedin, New Zealand
richard.walter@stonebow.otago.ac.nz

[2] Department of Archaeology & Natural History, Research School of Pacific and Asian Studies, Australian National University, Canberra ACT 0200, Australia
aja@coombs.anu.edu.au

ABSTRACT. Fishbone from the settlement site at Emily Bay and excavations in West Emily Bay was identified on the basis of five mouth parts, checked against eight paired bones and some multiple and unique bones. The number of specimens (NISP) was counted and the Minimum Number of Individuals (MNI) calculated to display relative abundance of families. Lethrinidae dominate all assemblages, with Carangidae, Labridae and Serranidae as significant secondaries. Many specimens are large examples of the species. The domination of benthic feeders implies baited hooks, used over submerged reefs close to shore, were probably the most common technology. There are no deep water species present. Norfolk Island fishing appears to be very like that of prehistoric New Zealand.

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Norfolk Island is one of a band of widely dispersed subtropical Pacific islands stretching from Australia to South America (Francis, 1993: 136). The three easternmost of these islands, Lord Howe, Norfolk Island and the Kermadecs, lie on the fringes of southwest Polynesia (SWP) near the southern limit of the tropical convergence zone. These SWP islands exhibit features of both temperate and tropical Pacific ecologies and share a number of common features of archaeology and biogeography.

In archaeological terms, the Kermadecs and Norfolk are both “mystery islands” (Kirch, 1988; Irwin, 1992; Weisler, 1996) and Lord Howe might well fall into the same category if archaeological remains exist there. The first two of these small, isolated islands were settled during the Polynesian expansion in East Polynesia, but were abandoned some time before European arrival. The reasons for abandonment appear to have been partly ecological and partly to do with the social and economic problems of isolation. The SWP islands all lie in proximity to larger, continental landmasses and this fact also may have affected the course of their prehistories.

In terms of marine biogeography, it is difficult to define a separate province for the SWP islands but they do share general features in common, and are unique from other Polynesian islands. The most characteristic of these is the mixing of tropical and temperate fish faunas and the maintenance of biogeographic links with their continental neighbours: Norfolk and Lord Howe Islands with Australia, and the Kermadecs with New Zealand (Francis, 1993: 148). They also maintain biogeographic links with one another and all three display low rates of marine vertebrate endemism. In several features of fish diversity, Norfolk Island falls into a position mid-way between Lord Howe and the Kermadecs (Table 1).

Table 1. Comparison of fish diversity, Kermadecs, Lord Howe and Norfolk Island (based on Francis, 1993).

	Kermadecs	Norfolk Island	Lord Howe
number of fish species	145	254	433
tropical species (%)	41	55	67

This combination of archaeological and biogeographic factors, plus the unique environmental status of the SWP islands as small, isolated and sub-tropical suggests that their prehistoric inhabitants may have developed a distinctive set of adaptive strategies. This paper intends to address this problem by examining the fishing adaptation of Norfolk Island, as understood though the excavations of the Norfolk Island Prehistory Project (NIPP).

The fishbone assemblages reported on below were collected from excavations at Cemetery Bay, Emily Bay, and Slaughter Bay during NIPP fieldwork in 1995, 1996 and 1997 (Anderson, 1996; Anderson, Smith and White, this vol.). The Cemetery Bay excavations were carried out in December 1995 following earlier reports that Polynesian cultural deposits might be present in the Bay area (Anderson, 1996). These horizons failed to eventuate, although some late prehistoric or early historic material was recovered. A more promising site was located at Emily Bay, where surface finds of adzes had been reported, and which was seen as a potentially attractive place to early Polynesian settlers. At Emily Bay cultural material, including ovens and basalt adze manufacturing flakes, were found in several localities and the site was targeted for more intensive excavation in April 1996 and November 1997. During these excavations, components of a Polynesian settlement were exposed and a number of artefacts and a large quantity of midden were collected. Specht (1984) had also identified Slaughter Bay as a potentially promising site for locating early cultural horizons and some testing was carried out there during the April 1996 field season. The Slaughter Bay excavations produced a small quantity of midden, but the site did not contain the rich cultural material that was anticipated.

Fishbone was recovered from the three Norfolk Island sites, primary sorting was carried out at Australian National University (ANU) and the material was sent on to the Otago Archaeology Laboratories (OAL) at the University of Otago, Dunedin, New Zealand where it was analysed using a methodology outlined below. The analysis had two aims. First, as one of the regional outposts of the Polynesian culture area the midden bone was seen as contributing to defining the full scope of Polynesian maritime subsistence adaptation. Second, the fishbone was analysed with a view to addressing the issue of local and SWP ecological adaptation.

Polynesian fishing. Polynesian fishing systems share many common elements across the full range of island ecologies, but within this broad universe of shared practices local fishing practices are finely targeted according to factors such as local habitat, technology and cultural preference. Thus common target families such as Scaridae will be caught using different technologies according to the type of marine ecosystems accessible to local fishing parties. On the raised reef islands of the southern Cooks for example, scarids are generally speared, or caught in small numbers in dip nets placed across the surge channels in the reef (Walter, 1992, 1998: 72). On Aitutaki, another island in the southern Cooks but one with a deep lagoon and extensive areas of sheltered coral reef, scarids are caught in larger numbers, using seine nets (Allen, 1995). Other factors which influence fishing strategies include cultural issues, such as prohibitions or special symbolic values, age structure and aggregating behaviours of target species and seasonal environmental conditions.

Polynesian fishing systems developed in the tropics but were successfully adapted to the temperate waters of New Zealand. Norfolk Island's intermediate position helps to extend the range of known Polynesian habitats and increases our understanding of Polynesian adaptive strategies. This theoretical interest is not confined to fishing, but is one of the central research themes of the Norfolk Island project. However because fishing leaves such well defined archaeological traces it is the subsistence practice which is most easily defined archaeologically.

The analysis of prehistoric Polynesian fishing systems involves the study of fishing technologies, as represented by fishing related artefacts, and the identification of targeted taxa from fishbones collected from prehistoric middens. Additional information might include a consideration of the size range of specimens. These data must be interpreted within the context of coastal geomorphology and ecology.

Methods

The general aims of the fishbone analysis were outlined above. The specific aims were to identify species targeted by Norfolk Island fishers and to determine their relative abundance within the different assemblages. The ability to compare fishbone assemblages and to build up a comparative model of Polynesian fishing practices requires archaeologists to use standard sets of analytical procedures in both the field and laboratory. This follows from the observation that the structure of an assemblage can be strongly influenced by such variables as screen size and other aspects of collection strategy, and by quantification methods and the selection of elements used for identification (Grayson, 1984; Nagaoka, 1993). In practice, total standardization is neither possible nor necessarily desirable, but a reasonable minimum requirement is that reports contain basic information on recovery technique, and on laboratory sorting, identification, quantification and storage procedures. This provides other researchers with enough information to enable comparative analysis to be carried out, whereas straight NISP (Number of Identified Specimens) or MNI (Minimum Number of Individuals) counts do not.

Field techniques for the recovery of midden during the Norfolk Island excavations varied slightly during the project. All archaeological material was recovered by normal excavation techniques and sieved. In 1995 the Cemetery Bay material was sieved to 2 mm, but at the EB95:06 excavation the density of extraneous material in 2 mm sieves, notably of rootlets, in relation to the scarcity of small cultural components, particularly of midden, led eventually to the use of 4 mm sieves. This practice continued, for the same reason, in the 1996 excavations, although in all cases the potential loss of material was carefully monitored by occasional fine sieving and judged to be insignificant. In the 1997 excavations, all material was sieved to at least 4 mm or 5 mm (the difference reflects use of sieves based on metric and imperial mesh sizes).

The output of residues was monitored regularly for materials of cultural origin. For most of these excavations, inspection failed to identify a significant quantity of cultural material passing through the larger screens. Nevertheless, where patches of midden were encountered—it was generally scarce in this part of the site—all material was wet-sieved to 2 mm and whole samples were taken. The fact that screening retained more than 150 teleost teeth, which are amongst the smallest specimens identified in fishbone middens, suggests that the collection strategies were adequate for identifying the major catch taxa and their relative abundance.

All material was bagged in the field and the contents of each bag were then dried and sorted into each of the main classes of bone and other materials before transport to the ANU laboratories, and consignment to specialists.

The methods used for processing the fishbone were based on standard protocols developed in the OAL (Walter *et al*., 1996). The basic principle involves the creation of analytical units through a two stage sorting process. In the first stage, the bones are all sorted to primary anatomical unit which is defined as the sided element. In the second stage, sets of these units are selected, and identified to the lowest possible taxonomic level. These are the analytical units which are later used for quantification purposes. The decision about which set of anatomical units should be used for identification purposes depends on the nature of the particular research question. The fish skeleton contains approximately 70 unique bones. Of these, it is common practice in Pacific archaeology to use the five paired mouth bones (maxilla, premaxilla, dentary, articular, quadrate) plus a range of multiple and unique bones commonly known as "specials", for identification purposes (Leach, 1986; Nagaoka, 1993). Recent experience in the OAL, however, suggests that a much wider range of paired elements than the jaw bones are identifiable to family level, and that some of these may be of greater potential use than some of the jaw elements (Walter, 1998: 65). Selecting which set of elements to use in a fishbone analysis involves a compromise. By electing to use a minimum number of bones certain levels of bias can be eliminated in relative abundance studies. This bias arises when some elements are very distinctive in a small number of fishes, but are either absent or equivocal in others. Appropriate bones to choose from in this case are those which are present in all (or most) fish, have good preservation qualities and occur either as single or paired elements, thus allowing reliable quantification. The five mouth parts fulfil these requirements well and have proven to be a particularly useful set (Anderson, 1973; Leach, 1986). The disadvantage of restricting the analysis to a small set of bones is that a number of fish taxa will be missed, or significantly under-represented. For example, Acanthuridae, Exocoetidae and Mullidae rank very highly in many present day Polynesian subsistence fisheries but are extremely rare in Pacific midden collections. Weisler *et al*. (1999) have also documented the effect that changing the range of identified elements can have on the composition of New Zealand fishbone assemblages. On the other hand, increasing the range of elements identified introduces the law of diminishing returns in relative abundance studies, and it has been shown that the use of just one or two of the most abundant paired bones (dentary for example) can be effective in these types of analysis (Anderson *et al*., 1996; Rolett, 1998; Walter, 1998: 65).

In this study, identification was made on the basis of the maximum number of paired bones and "specials". In addition to the five mouth parts the paired bones: ceratohyal, cleithrum, epihyal, hyomandibular, palatine, post-temporal, scapular, and supracleithrum were used along with a number of multiple and unique bones (Table 2). Use of these non-standard bones did not expand the range of identified specimens produced using paired mouth bones, nor did it provide a more effective measure of relative abundance which was the main interest of the analysis.

Table 2. Anatomical units and Minimum Number of elements used in the fishbone analysis. The top four ranked units, plus pterygiophore, cannot normally be identified to taxon using OAL collections and methods.

element	total
vertebra	3,479
unidentified	2,755
miscellaneous spines & rays	1,230
dorsal spines	648
premaxilla	239
dentary	213
pterygiophore	213
quadrate	168
tooth	160
maxilla	159
articular	121
palatine	84
hypural	76
hyomandibular	64
ceratohyal	51
opercule	48
inferior pharangyal plate	44
supracleithrum	41
post-temporal	41
scapular	41
pharangeal plate	30
epihyal	27
vomer	20
otolith	18
superior pharangyal plate	15
preopercule	15
scale	12
urohyal	8
cleithrum	5
branchiostegal rays	3
basiptergium	2
subopercule	1
grand total	10,031

Taxonomic identifications were made by Walter using the OAL Pacific and New Zealand fishbone reference collections which contain approximately 520 specimens of tropical and temperate water Indo-Pacific fish falling into 100 genera and 70 families. The nomenclature used here follows Randall *et al*. (1990). There are few Norfolk Island specimens in the OAL collections and thus few bones were identified below family level. However, identification below the level of family is not usually carried out in Pacific fishbone analysis as identification to family provides sufficient information to identify targeted ecologies and derive reasonable inferences about fishing strategies (Walter, 1998: 68).

Once the identifications were complete, the bones were bagged and labelled according to standard OAL procedures (Walter *et al*., 1996). The units created during the sorting and identification process were retained and each analytical unit was bagged and labelled with a unique three part laboratory number.

Prefix NIPP.

ID No. The original field bag number which encodes all the field information, such as provenance, that was assigned by the excavator.

Suffix A unique number for each analytical unit. This encodes all the laboratory information such as quantity, element, side, taxa.

In addition to the laboratory number, the full element and taxonomic identification was written on each bag, and sets from each provenance unit were placed in an outer bag on which all the provenance information was written. The results of the analysis were entered into the OAL computer database which can be searched according to the unique three part lab number. For example, NIPP-167-7 is the seventh sample processed from field bag 167 which was collected from Emily Bay, Trench 11, Area A1, Layer 2, Spit 2. It contains two left dentaries of the family Lethrinidae.

There is some debate in the archaeological literature as to which quantification method is appropriate in faunal analysis (Grayson, 1984). In New Zealand, MNI is commonly used (Leach and Boocock, 1993) but most tropical Pacific archaeologists use NISP, a method which eliminates the aggregation problems associated with MNI (Grayson, 1984), and which is, in any case, the necessary choice for tropical fish bones which can seldom be identified to species, unlike New Zealand taxa (Anderson, 1997). However in relative abundance analysis NISP can potentially introduce a bias in favour of species which have large numbers of particular identifiable elements (Grayson, 1984; Klein and Cruz-Uribe, 1984: 25; Nagaoka, 1993: 193). The best solution is to select a quantification method appropriate to the analysis in question but to provide as much raw data as possible so that the appropriateness of any derived unit can be independently assessed. In this study both NISP and MNI values are provided.

Results

The largest assemblage of fishbone was from Emily Bay and it provides the basis for a useful working model of prehistoric Norfolk Island fishing practices. The other assemblages are described below, but they are too small to provide any really useful information on subsistence or fishing practices.

Emily Bay. The Emily Bay excavations consisted of a number of test-pits and trenches spread out over about 100 m behind the main foredunes of Emily Bay (Anderson, Smith and White, this vol.). The stratigraphy was disturbed in many places, especially by bioturbation, and it varied in detail across the excavation units. However, it all seems to refer to a single occupational horizon. To document any stratigraphic variation that did exist, excavation of the cultural layer was carried out in spits of 10 cm depth. The following discussion assumes that the fishbone derives from a single occupation although the finer stratigraphic resolution is preserved in Table 3.

The fishbone analysis is based on eight provenance units for Emily Bay. These are the seven trenches plus the West Emily Bay (WEB) assemblage (collected during earlier government excavations for a toilet pit, see Anderson, Smith and White, this vol.). NISP counts for each spit in each unit are given, but MNI values are based on the assumption that the spits all fall within the same cultural layer. Table 3 shows NISP values for the Emily Bay fishbone generated using all elements. Lethrinidae dominate by a wide margin but there may be a bias towards this family based on size, and the presence of a wider range of identifiable elements (especially teeth). In Table 4 paired mouth bones are listed and these data are used to produce the MNI values shown in Table 5. By using only mouth parts much of the bias is eliminated although Lethrinidae still dominate the assemblage, with the Carangidae, Labridae and Serranidae families showing as significant secondary catch components (Fig. 1).

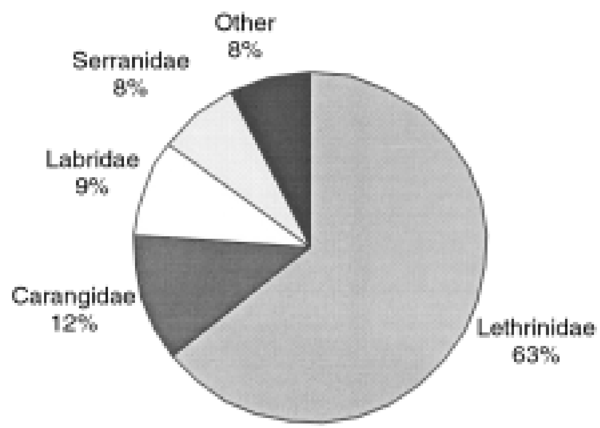

Figure 1. Emily Bay. Relative abundance, as measured by MNI, of identified fish families.

Cemetery Bay and Slaughter Bay. Although considerable reconnaissance work and subsurface testing was carried out in both these locations, very little cultural material was recovered. At Cemetery Bay a 3 m^2 trench was excavated close to the NW corner of the quarry approximately 5–8 m from where a shell adze was thought to have been found during sand mining activities many years earlier (Anderson, Smith and White, this vol.). The stratigraphy consisted of carbonate sands interspersed with silt enriched clays which are interpreted as slope-wash deposits. Layer 7 contained a small quantity of faunal material which the excavators considered may be of late prehistoric or historic origin. There are only rat bone gelatin radiocarbon ages for this horizon, and they are dubious (Anderson, Higham and Wallace, this vol.). A small quantity of fishbone was recovered from Layer 7 but only one specimen (Serranidae) could be identified to family level (Table 6). The Slaughter Bay excavations failed to identify any clearly defined prehistoric horizon. However, there was a remnant of an occupation layer, from which a basalt adze had been recovered (Nicolai, pers. comm.) exposed in the steep beach-front bank at the extreme eastern end of the bay. This contained some midden which is undated but probably of prehistoric age (Table 6).

Table 3. Emily Bay NISP values based on all identified elements (see also Table 2). Acan., Acanthuridae; Cara., Carangidae; Elas., Elasmobranchi; Holo., Holocentridae; Kyph., Kyphosidae; Labr., Labridae; Leth., Lethrinidae; Lutj., Lutjanidae; Mura., Muraenidae; Serr., Serranidae.

trench	spit	Acan.	Cara.	Elas.	Holo.	Kyph.	Labr.	Leth.	Lutj.	Mura.	Serr.	unident.	total
EB95:02	1	—	—	—	—	—	—	—	—	—	—	25	25
	2	1	—	—	—	—	—	4	1	—	1	151	158
	3	—	—	—	—	—	—	12	—	—	—	106	118
	total	1	—	—	—	—	—	16	1	—	1	282	301
EB96:10	1	—	2	—	—	—	13	109	1	—	11	1186	1322
	2	—	1	—	—	—	1	16	—	—	—	218	236
	3	—	—	—	—	—	1	36	—	—	—	195	232
	4	—	1	—	—	—	—	159	—	—	—	1596	1756
	total	—	4	—	—	—	15	320	1	—	11	3195	3546
EB96:11	1	—	—	—	—	—	—	—	—	—	—	30	30
	2	—	—	—	—	—	—	9	—	—	—	70	79
	3	—	—	—	—	—	—	1	—	—	—	67	68
	4	—	—	—	—	—	—	—	—	—	—	11	11
	total	—	—	—	—	—	—	10	—	—	—	178	188
EB97:21	1	—	—	—	—	—	—	—	—	—	—	4	4
	2	—	—	—	—	—	—	—	—	—	—	13	13
	total	—	—	—	—	—	—	—	—	—	—	17	17
EB97:22	1	—	—	—	—	—	—	—	—	—	—	2	2
	2	—	—	—	—	—	2	—	—	—	—	8	10
	3	—	—	—	—	—	—	2	—	—	—	26	28
	total	—	—	—	—	—	2	2	—	—	—	36	40
EB97:23	1	—	4	1	—	—	3	90	1	—	—	515	614
	2	—	12	9	—	1	19	123	1	—	2	861	1028
	3	—	11	—	1	5	12	212	—	1	5	1213	1460
	4	—	13	—	—	3	4	129	—	—	3	911	1063
	5	—	11	1	—	—	—	26	—	—	3	379	420
	6	—	5	—	—	1	11	70	—	—	3	298	388
	7	—	2	—	—	—	3	13	—	—	—	80	98
	8	—	—	—	—	—	—	4	—	—	—	23	27
	9	—	—	—	—	—	—	7	—	—	—	54	61
	total	—	58	11	1	10	52	674	2	1	16	4334	5159
EB97:24	1	—	—	—	—	—	3	14	1	—	1	129	148
	2	—	2	1	—	—	2	16	—	—	—	113	134
	3	—	1	—	—	—	1	5	1	—	—	77	85
	4	—	—	—	—	—	—	—	—	—	—	1	1
	6	—	—	—	—	—	—	—	—	—	—	6	6
	total	—	3	1	—	—	6	35	2	—	1	326	374
WEB	total	—	1	—	—	—	3	4	4	—	1	393	406
	total	1	66	12	1	10	78	1061	10	1	30	8761	10031

Discussion

Before offering an interpretation of the assemblage in terms of fishing practices, some cautions need to be raised. As discussed above, recovery strategy and the set of elements used for taxonomic identification purposes can have a major effect on the final composition of a fishbone assemblage. The Emily Bay material is dominated by very large specimens and arises from a field programme in which several sieving strategies were adopted. This might be reflected in the difference between the Trench EB96:10 data, obtained by screening through 4 mm mesh and the Trench EB97:23 and EB97:24 data obtained by screening most of the material through 2 mm mesh. However, those data could also reflect different sample sizes and, in any case, they do not suggest that finer screening would produce a very different fish bone assemblage. Screen residues were monitored during excavation and no evidence of retention problems was noted. Even if very small catch specimens are under-represented in the identifications, there would have to be an improbably large number of these to substantially alter the interpretation of fishing practices offered here. Further analysis of bulk samples is desirable nevertheless.

The MNI values for Emily Bay seem low with a total of only 153 fish, but the density of faunal remains from a site depends on the functions represented by the excavated components. Many New Zealand sites display much higher fishbone densities, but these are often substantial midden deposits. At the Anai'o site in the Southern Cook Islands a total MNI value of only 73 was reported from a 200 m^2 exposure of a fourteenth century A.D. layer (Walter, 1998). The material was taken from the living surface of a small village and no discrete midden dump was identified. If the Emily Bay site was a village or hamlet, it is likely that most of the faunal material was disposed outside the living zone

Table 4. Paired mouth parts and shark teeth from trenches EB95:02, EB96:10, EB96:11, EB97:22, EB97:23, EB97:24 at Emily Bay and West Emily Bay (these data used to generate MNI values shown in Table 5).

family	element	side	EB95:02	EB96:10	EB96:11	EB97:22	EB97:23	EB97:24	WEB	total
Acanthuridae	dentary	L	1	—	—	—	—	—	—	1
Carangidae	articular	L	—	—	—	—	1	—	—	1
		R	—	—	—	—	2	1	—	3
	dentary	L	—	—	—	—	7	—	—	7
		R	—	—	—	—	9	—	—	9
	maxilla	L	—	—	—	—	2	2	1	5
		R	—	—	—	—	5	—	—	5
	premaxilla	L	—	—	—	—	8	—	—	8
		R	—	—	—	—	4	—	—	4
	quadrate	L	—	3	—	—	8	—	—	11
		R	—	1	—	—	12	—	—	13
Elasmobranchi	tooth	—	—	—	—	—	11	1	—	12
Kyphosidae	dentary	L	—	—	—	—	1	—	—	1
		R	—	—	—	—	2	—	—	2
	maxilla	R	—	—	—	—	1	—	—	1
	premaxilla	L	—	—	—	—	3	—	—	3
		R	—	—	—	—	3	—	—	3
Labridae	articular	L	—	1	—	—	6	—	—	7
		R	—	1	—	—	3	—	—	4
	dentary	L	—	—	—	—	—	—	1	1
		R	—	—	—	—	—	—	1	1
	maxilla	L	—	—	—	—	1	—	—	1
		R	—	—	—	—	5	—	—	5
	premaxilla	L	—	3	—	—	8	2	1	14
		R	—	3	—	—	7	—	—	10
	quadrate	L	—	—	—	—	1	2	—	3
		R	—	—	—	—	3	—	—	3
Lethrinidae	articular	L	—	10	—	—	25	2	—	37
		R	1	15	—	—	36	2	—	54
	dentary	L	2	12	2	—	50	—	—	66
		R	1	22	—	—	50	—	—	73
	maxilla	L	2	7	1	—	24	4	—	38
		R	1	10	—	—	42	2	1	56
	premaxilla	L	2	19	—	—	59	5	2	87
		R	2	12	3	2	50	4	2	75
	quadrate	L	1	21	2	—	40	1	—	65
		R	—	17	—	—	27	6	—	50
Lutjanidae	articular	R	1	—	—	—	—	—	—	1
	maxilla	L	—	1	—	—	1	1	—	3
		R	—	—	—	—	1	1	1	3
	quadrate	L	—	—	—	—	—	—	2	2
		R	—	—	—	—	—	—	1	1
Muraenidae	dentary	R	—	—	—	—	1	—	—	1
Serranidae	dentary	R	—	1	—	—	—	—	—	1
	maxilla	L	—	—	—	—	4	—	—	4
		R	—	—	—	—	3	—	—	3
	premaxilla	L	—	4	—	—	2	—	1	7
		R	1	5	—	—	4	1	—	11
	total		15	168	8	2	532	37	14	776

and that portion of the site may fall beyond the excavation area.

The Emily Bay assemblage is dominated by benthic feeders with special emphasis on the "emperor" family, Lethrinidae. Although identification was not carried out below the level of family, the Lethrinidae specimens appear to be of a single species, probably *Lethrinus miniatus*. The Lethrinidae assemblage was dominated by large specimens. Although no estimate is presented here of live fish sizes, the mouth parts were significantly larger than any equivalent bones contained in the OAL collections. For example, the mean length of complete Lethrinidae maxilla in the assemblage is 50 mm (n = 28) (see Leach *et al*., 1996). The largest *Lethrinus* maxilla in the OAL collection measures 28 mm from a *Lethrinus olivaceus* specimen with a live tail length of 260 mm.

Lethrinus miniatus are amongst the largest species in the family and are the most commonly caught Lethrinid on Norfolk Island today. *Lethrinus miniatus* inhabit coral reefs during the day and forage more widely over sandy bottoms at night (Randall *et al*., 1990: 201). They can be caught on hooks over submerged reefs and are an important catch in

Table 5. Emily Bay. MNI values based on paired mouth parts and shark teeth as listed in Table 4.

family	EB95:02	EB96:10	EB96:11	trench EB97:22	EB97:23	EB97:24	WEB	total
Acanthuridae	1	—	—	—	—	—	—	1
Carangidae	—	3	—	—	12	2	1	18
Elasmobranchi	—	—	—	—	1	1	—	2
Kyphosidae	—	—	—	—	3	—	—	3
Labridae	—	3	—	—	8	2	1	14
Lethrinidae	2	22	3	2	59	6	2	96
Lutjanidae	1	1	—	—	1	1	2	6
Muraenidae	—	—	—	—	1	—	—	1
Serranidae	1	5	—	—	4	1	1	12
grand total	5	34	3	2	89	13	7	153

the contemporary inshore recreational fishery of Norfolk Island. The argument that the Emily Bay fishers were specifically targeting Lethrinidae is supported by the low representation of the families Carangidae, Labridae, Lutjanidae and Serranidae which rank next after Lethrinidae. If the Emily Bay fishers had a more generalized fishing system we might expect greater numbers of these families since they occupy similar habitats, and are usually caught using the same technology as Lethrinidae. Instead, it would appear that the Norfolk Island fishers were using a technology which selected the large Lethrinids from the available stock. The means by which that was achieved is unclear to us via the archaeological data, but is very likely to have involved a particular combination of hook form, bait and rigging.

In terms of MNI Lethrinidae represent 63% of the identified specimens with Carangidae ranking second at only 12% (Fig. 1). Since the assemblage is dominated by benthic feeders, it seems most likely that the Norfolk Island fishers relied on baited hooks which they used from canoes stationed over the submerged reefs. In fact, there is little evidence in the fishbone assemblage for the use of any technologies other than hook fishing. There is no pearlshell on Norfolk Island for hook manufacture but hooks could be made in bone or more perishable materials. A very typical East Polynesian form of a small one-piece hook was recovered in 1997 along with the point shank of another and evidence of hook manufacture in bone. There was also a broken harpoon (Schmidt, Anderson and Fullagar, this vol.). The one-piece hooks are precisely the types expected in relation to the catch.

Only one Acanthuridae specimen was present, probably *Prionurus maculatus* or another member of the Prionuninae sub-family. Fish of the family Acanthuridae are some of the most common caught on tropical reefs (although admittedly they are relatively uncommon in archaeological assemblages) and they are normally taken on spears and in nets. If netting was being practiced at Emily Bay a higher proportion of Acanthurids and other smaller specimens such as the schooling species (juvenile Carangidae, Mullidae, Mugilidae etc.) would be expected. Similarly, if the Norfolk Island fishers were practicing a more generalized foraging strategy we might expect to see Diodontidae represented in the assemblage. These fish produce very high NISP values in Pacific assemblages because they can be identified on the basis of their numerous dermal spines. Although rare, these fish are present in Norfolk Island waters but absent from the Emily Bay midden. Finally, only a small quantity of shark elements was identified and there were no examples of deep water pelagic species, such as those in the family Scombridae, which might indicate an offshore fishing regime. In summary, the Emily Bay fishing system was narrowly focussed in terms of target ecology and taxa. The community specialized in the exploitation of Lethrinidae which they probably caught using baited hooks over submerged coral heads within the lagoon and on the broken ground and reefs which lie in relatively shallow water between Emily Bay and Nepean Island.

Having speculated on the nature of the Emily Bay fishing system on the basis of fishbone analysis, it remains to comment on Norfolk Island within the wider structure of Polynesian fishing adaptations. The most important question stems from the environmental and biogeographic position of the island as falling mid way between tropical and temperate Polynesian settings. Although there are insufficient data to make any quantitative assessments at this point, the Norfolk Island data (as represented by Emily Bay) point strongly to a Polynesian fishing adaptation more

Table 6. Cemetery Bay and Slaughter Bay fishbone, NISP/MNI values.

site	location	element	Carangidae	Labridae	Lethrinidae	Lutjanidae	Serranidae	unidentified
Cemetery Bay (Layer 7)	Trench CB95:01	unidentified	—	—	—	—	—	21/1
		quadrate	—	—	—	—	1/1	—
Slaughter Bay	Lime Kiln	dentary	—	—	1/1	—	—	—
		quadrate	—	—	—	—	1/1	—
		unidentified	—	—	—	—	—	5/1

similar to that of New Zealand than to the tropics. Specifically, Norfolk Island fishing appears very close to that of northern New Zealand.

In common with Polynesia as a whole, the Norfolk Island assemblage is dominated by benthic feeders. Such fish are usually caught on bait hooks, which seems also to have been the case in Norfolk Island. In common with many northern New Zealand assemblages, there was a wide margin (as measured by both NISP and MNI) between the first ranked and next ranked taxon in the Emily Bay catch. Like many northern New Zealand middens, the Emily Bay midden was dominated by a single family, and it seems clear that these particular taxa were being specifically targeted (see Anderson, 1997 for an overview of northern New Zealand fishing). In tropical assemblages the numeric differences between the first few ranked taxa is usually lower and there is rarely any indication of mono-species targeting (at least in the benthic component). In northern New Zealand, the target species was usually Snapper (*Pagrus auratus*) (Anderson, 1997; Leach and Boocock, 1993) and the Emperor (Lethrinidae) seems to have filled this niche in the Norfolk Island fishing system. Interestingly, Emperors and Snapper have very similar habitats and feeding behaviour and are taken using similar capture technologies, as the Emily Bay hooks also suggest.

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