13

FAUNAL ASSEMBLAGES FROM THE TO'AGA SITE

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THE CALCAREOUS SAND depositional environment at To'aga favored the preservation of faunal material (table 13.1). Over 165 kilograms of invertebrate remains were recovered, representing more than forty families. The To'aga fish-bone sample—the largest in Western Polynesia—contains 2,196 identified bones across twenty-two taxa. Pig, chicken, rat, marine mammal, turtle, and bird comprise the 687 bones of the non-fish vertebrate sample. Each component of the faunal assemblage is described in detail below.

The problem of recovery bias is addressed here through the analysis of bulk sediment samples from the To'aga excavation. Generally, the use of smaller-sized screens increases the size of the faunal sample and the number of taxa recovered. The To'aga bulk samples were sieved through different screen sizes to determine the effects of screen size on the composition of the faunal assemblage.

Current knowledge of Western Polynesian subsistence practices is limited since few zooarcheological studies have been conducted in the region. In this context, the To'aga faunal assemblage is important for adding new information to our understanding of regional subsistence trends. The long temporal sequence at To'aga allows for an assessment of changing subsistence patterns. Despite the small sample of Western Polynesian sites, comparisons of the To'aga assemblage with other regional faunal assemblages may yield information about subsistence patterns.

METHODS

The faunal remains were recovered by dry-screening all excavated earth (except the clayey colluvial sediment) through 1/4" mesh. To determine the feasibility of screening the colluvium, Layer I of Unit 20 was screened through 1/4" screens. Only one poorly preserved *Turbo* shell was recovered from the 0.8 m^3 sieved. A decision was made not to screen the colluvial layer in other units because of the difficulty in dry-screening the matrix, and because of the low density and poor preservation of faunal and other material in this clayey deposit. (See chapter 7 for further discussion of the pH and other aspects of the To'aga site sediments.) During the 1987 field season, most of the shell recovered was identified, weighed, and discarded in the field. Voucher samples and the remaining unidentified shell and bone were shipped back to the laboratory. All faunal materials recovered from the 1989 field season were washed in the field and returned to the laboratory for identification and analysis.

Fish remains were identified to the family level using reference collections from the Bishop Museum, and the personal collections of Patrick Kirch (U.C. Berkeley), Melinda Allen (University of

Table 13.1
Summary of To'aga Site Faunal Remains

	Excavation Units		
Faunal Class	**1-14**	**15-30**	**Total**
Total Shell (kg)	50.291	118.367	168.658
Identified Shell (kg)	50.291	115.669	165.960
Total Non-fish (NISP)	322	365	687
Total Fish (NISP)	3462	6062	9524
Identified Fish (NISP)	723	1473	2196

Washington) and the author. Reference collections from the Bishop Museum were used to identify rat, dog, pig, marine mammal, and marine turtle. The bird component was identified by David Steadman of the New York State Museum (see chapter 14).

Although many Pacific faunal analysts use MNI (minimum number of individuals) to quantify vertebrate remains (e.g., Leach 1986; Anderson 1986; Green 1986), we use NISP (number of identified specimens) for the To'aga vertebrate assemblage. The problems with both measures have been discussed extensively elsewhere (see Chaplin 1971; Grayson 1979, 1984; Payne 1972). NISP was chosen here because the effects of aggregation make MNI an inconsistent measure. Although the problem of interdependence affects NISP, the measure is constant across aggregation units.

The invertebrate faunal component was identified using standard shell identification guides (Abbot and Dance 1986; Hinton 1972; Eisenberg 1981). Tentative identifications were confirmed using reference collections at the Burke Museum in Seattle and at the Bishop Museum in Honolulu. Invertebrate remains were quantified by weight. As with MNI and NISP, use of weight has its drawbacks because of variations in size and density of different shell taxa. For example, *Tridacna maxima*, the giant clam, has a very dense shell, and one large individual may weigh more than 1 kg. On the other hand, shells such as limpets (Patellidae) are very light, so that many individuals may account for a small amount of weight. As a result, heavy shells may be overrepresented and light shells underrepresented in any sample. Post-depositional alterations such as leaching and fossilization also may distort shell weight.

RESULTS

The To'aga faunal data are presented in three categories: the vertebrate component, which is subdivided into fish and nonfish, and the invertebrate component. Of the thirty excavation units, complete data by stratigraphic layer from three areal excavations (1987 Main Trench, Units 20/23, and Units 15/29/30) are presented in the text for comparison. These units were chosen to represent the site because they comprise a larger sample than the individual units. Data for the remaining excavation units are presented only in the summary tables for the separate faunal categories. The complete faunal data by stratigraphic layers from all excavation units are available from the author on request.

Fish Remains

The To'aga excavations yielded 2,196 identified fish bones representing twenty taxa (tables 13.2-6). Although this is the largest archaeological fish bone assemblage from Western Polynesia, an average of only 73 bones were identified for each excavation unit. Acanthuridae (surgeonfish), Diodontidae

Table 13.2
Fish Fauna Recovered from the 1987 Excavations
(NISP)

	Excavations Units								
Taxa	**1, 4-9**	**2**	**3**	**10**	**11**	**12**	**13**	**14**	**Total**
Diodontidae	289	1	--	4	15	--	--	19	328
Holocentridae	64	--	--	--	3	--	4	9	80
Acanthuridae	48	1	--	--	4	--	1	13	67
Serranidae	47	--	--	1	2	--	2	15	67
Scaridae	24	1	--	1	6	--	1	5	38
Carangidae	22	--	--	1	3	--	--	6	32
Balistidae	24	--	--	--	2	--	--	2	28
Muraenidae	15	--	--	--	--	--	1	1	17
Labridae	9	1	1	--	--	--	--	2	13
Ostraciidae	5	--	--	--	--	--	--	7	12
Lutjanidae	9	--	--	--	1	--	--	1	11
Aulostomidae	8	--	--	--	--	--	--	--	8
Congridae	5	--	--	--	2	--	--	--	7
Elasmobranchii	3	--	--	--	--	2	--	--	5
Lethrinidae	2	--	--	--	--	--	--	1	3
Belonidae	2	--	--	--	--	--	--	--	2
Kyphosidae	1	--	--	--	--	--	--	--	1
Sphyraenidae	--	--	--	--	--	1	--	--	1
Scombridae	--	--	--	--	--	--	--	1	1
Bothidae	--	--	--	--	--	--	1	--	1
TOTAL IDENTIFIED	577	4	1	7	38	3	10	82	722
UNIDENTIFIED	2003	16	--	45	190	2	19	464	2739
TOTAL	2580	20	1	52	228	5	29	546	3461

(spiny puffers), Holocentridae (squirrelfish), Serranidae (groupers/cods) and Scaridae (parrotfish) comprise approximately 78% of the identified fish remains (fig. 13.1). These taxa are usually the most abundant across time and space at the To'aga site.

The structure and composition of the To'aga fish-bone data probably reflect a combination of methodological, environmental, and cultural factors. Methodological factors include recovery bias and problems in identification and quantification. Bias

Table 13.3
Fish Fauna Recovered from the 1989 Excavations
(NISP)

Taxa	Excavation Units												Total
	16	18	19	21	22	24	25	26	27	28	20/23	15/29/30	
Diodontidae	14	1	--	481	6	1	--	--	8	5	44	35	595
Acanthuridae	36	--	1	28	9	--	1	--	3	5	53	32	168
Serranidae	31	--	2	34	7	--	--	2	4	6	53	23	162
Scaridae	42	--	4	5	1	--	--	--	7	8	25	15	107
Holocentridae	15	--	--	26	3	--	--	--	3	6	27	18	98
Muraenidae	--	--	2	10	3	--	--	1	3	1	38	3	61
Labridae	13	--	1	6	2	--	--	--	2	1	22	9	56
Ostraciidae	1	--	--	10	1	--	--	--	--	--	22	4	38
Carangidae	6	--	--	9	--	--	--	1	1	3	14	2	36
Lutjanidae	2	--	--	8	3	--	--	--	1	--	12	10	36
Balistidae	4	--	1	12	4	--	--	--	--	2	5	2	30
Congridae	--	--	--	9	--	--	--	--	--	1	10	1	21
Aulostomidae	2	--	--	8	--	--	--	--	2	--	7	--	19
Lethrinidae	--	--	1	1	--	--	--	--	--	2	6	2	12
Elasmobranchii	1	--	--	--	4	--	--	1	1	--	3	--	10
Mullidae	1	--	--	5	--	--	--	--	--	1	1	2	10
Scombridae	1	--	--	1	--	--	--	--	--	--	4	--	6
Bothidae	1	--	--	1	--	--	--	--	--	--	1	1	4
Kyphosidae	--	--	--	--	--	--	--	--	1	--	1	1	3
Batoidea	1	--	--	--	--	--	--	--	--	--	--	--	1
TOTAL IDENTIFIED	171	1	12	654	43	1	1	5	36	41	348	160	1473
UNIDENTIFIED	583	--	148	1310	230	--	--	16	100	144	1294	764	4589
TOTAL	754	1	160	1964	273	1	1	21	136	185	1642	924	6062

Table 13.4
Fish Fauna from the 1987 Main Trench (Units 1, 4-9)

	Layers				
Taxa	**IIA-1**	**IIA**	**IIB**	**IIC**	**Total**
Diodontidae	4	25	154	106	289
Holocentridae	3	17	25	19	64
Acanthuridae	3	13	20	12	48
Serranidae	5	11	17	14	47
Scaridae	2	1	21	1	25
Balistidae	4	8	10	2	24
Carangidae	2	4	10	6	22
Muraenidae	---	4	4	7	15
Labridae	2	3	2	2	9
Lutjanidae	2	1	5	1	9
Aulostomidae	---	1	4	3	8
Ostraciidae	---	1	3	1	5
Congridae	---	1	1	3	5
Elasmobranchii	---	2	---	1	3
Lethrinidae	---	---	2	---	2
Belonidae	1	1	---	---	2
Kyphosidae	---	---	1	---	1
TOTAL IDENTIFIED	28	93	279	178	578
UNIDENTIFIED	191	535	827	450	2003
TOTAL	219	628	1106	628	2581

in the recovery process is shown to affect the sample size and the taxa represented in the assemblage (see "Bulk Samples" section). Problems in the identification process include the quality of the reference collection, which can limit the accuracy of the identifications and the number of taxa represented. For the To'aga assemblage, several distinctive mouth parts could not be identified using the reference collection at hand. With a better reference collection, subfamily identifications may also be possible.

Another methodological problem is the inclusion of "special bones" in the NISP count. A few taxa are identified mainly by special bones that can number up to 300 per individual, thus greatly inflating the NISP count. This is especially true for Diodontidae, which can have more than 250 spines per individual, and to a lesser extent for Ostraciidae, Elasmobranchii, and Balistidae. Of the 923 Diodontidae bones identified at To'aga, 901 were spines and only 22 were mouth parts, most being concentrated in Unit 21 and in the 1987 main excavation trench. If the Diodontidae spines are removed from the NISP count, the ranking of diodonts drops from one to thirteen, and the shape of the graph changes (fig. 13.2). Although the presence of this poisonous fish may seem odd, its remains are common in middens across the Pacific (e.g., Allen 1990; Butler 1987; Masse 1989). Moreover, the fish is still eaten by some modern Pacific populations (Bagnis 1972, Masse 1986).

Table 13.5
Fish Fauna from Transect 5, Units 15/29/30
(NISP)

	Layers				
Taxa	**II**	**IIIA-1**	**IIIB**	**IIID**	**Total**
Diodontidae	9	1	9	16	35
Acanthuridae	9	---	8	15	32
Serranidae	11	1	4	7	23
Holocentridae	3	---	10	5	18
Scaridae	3	1	3	8	15
Lutjanidae	3	---	2	5	10
Labridae	6	---	2	1	9
Ostraciidae	---	---	1	3	4
Lethrinidae	2	---	---	---	4
Muraenidae	---	---	---	3	3
Carangidae	---	---	1	1	2
Mullidae	---	---	---	2	2
Balistidae	---	---	2	---	2
Kyphosidae	1	---	---	---	1
Bothidae	1	---	---	---	1
Congridae	---	---	---	1	1
TOTAL IDENTIFIED	48	3	42	67	160
UNIDENTIFIED	201	16	250	297	764
TOTAL	249	19	292	364	924

The structure of the To'aga fish-bone data also may reflect natural distributions and abundances of fish taxa. Most of the To'aga assemblage can be classified as inshore fishes, although a few families such as Serranidae, Lutjanidae, and Carangidae cover a wide range of habitats. Reef ecosystems are generally more diverse and have a higher productivity rate than open ocean environments; therefore, the abundance of inshore versus pelagic fish may reflect the natural diversity of the different environments.

Fishing strategies may also be reflected in the fish-bone data. The fishhooks recovered from the site (see Kirch, chapter 11) may have been used to catch serranids, holocentrids, and lutjanids, but probably not scarids or acanthurids which are more likely to be caught by netting or spearing. A comparison of modern Samoan reef exploitation (Hill 1986) and the To'aga fish data shows that the most abundant taxa in the archaeological assemblage can be caught by several fishing techniques (table 13.7). These taxa may have had more opportunity to be caught than taxa for which only one strategy was used.

Table 13.6
Fish Fauna from Transect 9 (Units 20/23)
(NISP)

	Layers					
Taxa	**IIB**	**IIIA**	**IIIB**	**IIIC**	**IV**	**Total**
Acanthuridae	3	2	30	18	---	53
Serranidae	2	5	37	9	---	53
Diodontidae	3	14	13	12	2	44
Muraenidae	3	3	23	9	---	38
Holocentridae	1	3	14	8	1	27
Scaridae	---	1	14	9	1	25
Labridae	---	1	15	6	---	22
Ostraciidae	---	---	3	6	13	22
Carangidae	1	2	9	2	---	14
Lutjanidae	1	2	9	---	---	12
Congridae	2	1	5	2	---	10
Aulostomidae	---	---	7	---	---	7
Lethrinidae	---	---	5	1	---	6
Balistidae	---	---	1	4	---	5
Scombridae	---	---	2	2	---	4
Elasmobranchii	---	---	3	---	---	3
Bothidae	---	---	---	1	---	1
Kyphosidae	---	---	---	1	---	1
Mullidae	---	---	1	---	---	1
TOTAL IDENTIFIED	16	34	191	90	17	348
UNIDENTIFIED	63	161	610	414	46	1294
TOTAL	79	195	801	504	63	1642

Non-Fish Vertebrate Remains

The non-fish vertebrate sample of 687 bones is small, averaging only 23 bones per excavation unit (tables 13.8, 13.9). About half the sample consists of *Rattus exulans*, the Pacific Rat, with nearly half the rat bones coming from Layer II of the 1987 Main Trench. Bird bones were the second most abundant, with 139 bones. Steadman presents an analysis of the 72 identified bird bones in chapter 14. Fifty-six marine turtle-bone fragments were scattered throughout the excavations with one-third of the sample concentrated in Layer IIIB of Unit 20, dating to about 2900-2400 B.P. From this same time period,

Table 13.7
Modern Samoan Fishing Methods (after Hill 1986)

Taxa	Gleaning	Line-fishing	Diving/ Spearing	Gill-netting	Throw-netting
Holocentridae	***	***	***	***	
Serranidae	***	***	***	***	
Acanthuridae	***		***	***	
Mullidae	***	***		***	
Lutjanidae	***	***			
Muraenidae	***		***		
Lethrinidae		***		***	
Carangidae		***			
Scaridae			***		
Mugilidae					***
Labridae				***	

three-fourths of the marine mammal bones were recovered from Layer IIIC of Unit 15. Another concentration of marine mammal bones was associated with the *'ili'ili* paving found in Layers I and II of Unit 22. No fruit bat bones (*Pteropus* sp.) were identified from the site, although the fruit bat is present on Ofu Island today.

Of the domesticated animals, only 1 pig (*Sus scrofa*) tooth and 15 chicken (*Gallus gallus*) bones were identified. The chicken bones are concentrated in Layer IIIB of Unit 20/23. Generally, the non-fish vertebrate bones were very fragmented and difficult to identify to species or even class. Thus, 44 bones were placed in the "general vertebrate" category and 40 in the "general mammal" category. Many of the bones placed in the mammal category may be either pig or dog, but a distinction between the two could not be made.

Invertebrate Remains

As is true for most Pacific island faunal assemblages, the invertebrate component dominated the To'aga faunal assemblage. The densest concentrations of shell midden were recovered from layers that dated to two periods of time and contained either *'ili'ili* paving or features interpreted as food preparation areas. For the period of 2500-1900 cal B.P., the instances of concentrated midden are dispersed across the site. Unit 28, Layer IIC of Transect 5 had a shell density of over 7.8 kg/m^3. Along Transect 9, about 27 kg of shell midden with a density of 11.9 kg/m^3 were recovered from Layer III of Unit 20/23 (table 13.10), along with one-third of the marine turtle remains for the site and half the chicken bones. The upper portion of this layer contained a large earth oven. The extension of Layer III into Unit 21 contained over 13 kg of shell midden (8.2 kg/m^3). The densest midden in the 1987 Main Trench, in Layers IIB and IIC, also dated to this time period (table 13.11).

In Transect 5, Layer II of Unit 15/29/30, interpreted as a cookhouse activity area dating to the period 1641-1477 cal B.P., contained nearly 12 kilograms of midden, a density of 7.4 kg/m^3 (table 13.12). This layer is contemporaneous with Layer I of Unit 16 of the same transect, which was associated with a dispersed distribution of *'ili'ili* gravel and

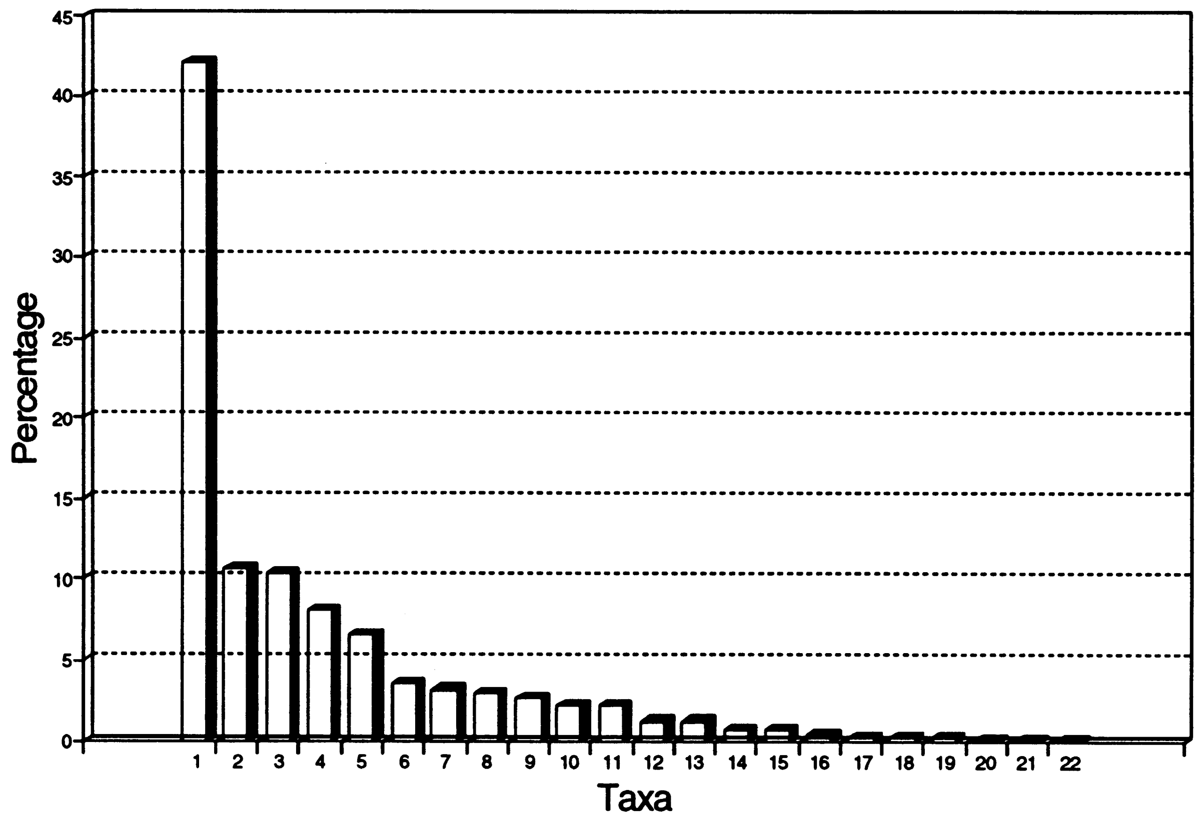

Figure 13.1 Relative frequency of fish taxa from the To'aga site, including Diodontidae.

contained the densest concentration of midden in the site (13.4 kg/m^3). A midden with 7.9 kg/m^3 density was also present in Layer IIC of Unit 28, Transect 5.

Only a few families make up the majority of the invertebrate assemblage. Over 76% of the 165 kilograms of identified shell consisted of three families, Turbinidae, Trochidae, and Tridacnidae, with *Turbo setosus* by far the most abundant species. Besides the shell, more than 14 kilograms of slate-pencil sea urchin (*Heterocentrotus mammilatus*), comprising over 8.5% of the invertebrates, were recovered from the site. Most of the sea urchins were concentrated in Units 20-24 along Transect 9; about half were associated with the earth oven in Layer III, Units 20/23.

The rank order of the invertebrate taxa varies little across time and space. Turbinidae is by far the major taxon in the assemblage with Echinoidea, Trochidae, Tridacnidae, Conidae, Cypraeidae, Muricidae, and Neritidae as secondary taxa. The remaining thirty-seven taxa are minor components, contributing less than 1% each to the assemblage. This high diversity may reflect both cultural and environmental factors. Food choice in foraging often reflects the natural abundance and distribution of resources. However, some of the most abundant taxa in the assemblage, such as Turbinidae, Tridacnidae, Echinoidea, and Conidae, were also used as raw material in the manufacture of artifacts. The abundance of these taxa therefore may reflect these dual uses and species may have been selected disproportionately to their natural distributions. A comparison of natural and archaeological invertebrate distributions through modern marine survey information would be useful in sorting out the influence of environment versus cultural effects on the invertebrate taxa represented archaeologically at To'aga.

ANALYSIS OF BULK SAMPLES

Archaeologists screen sediments in order to increase comparability within and between sites by systematically sampling the archaeological record.

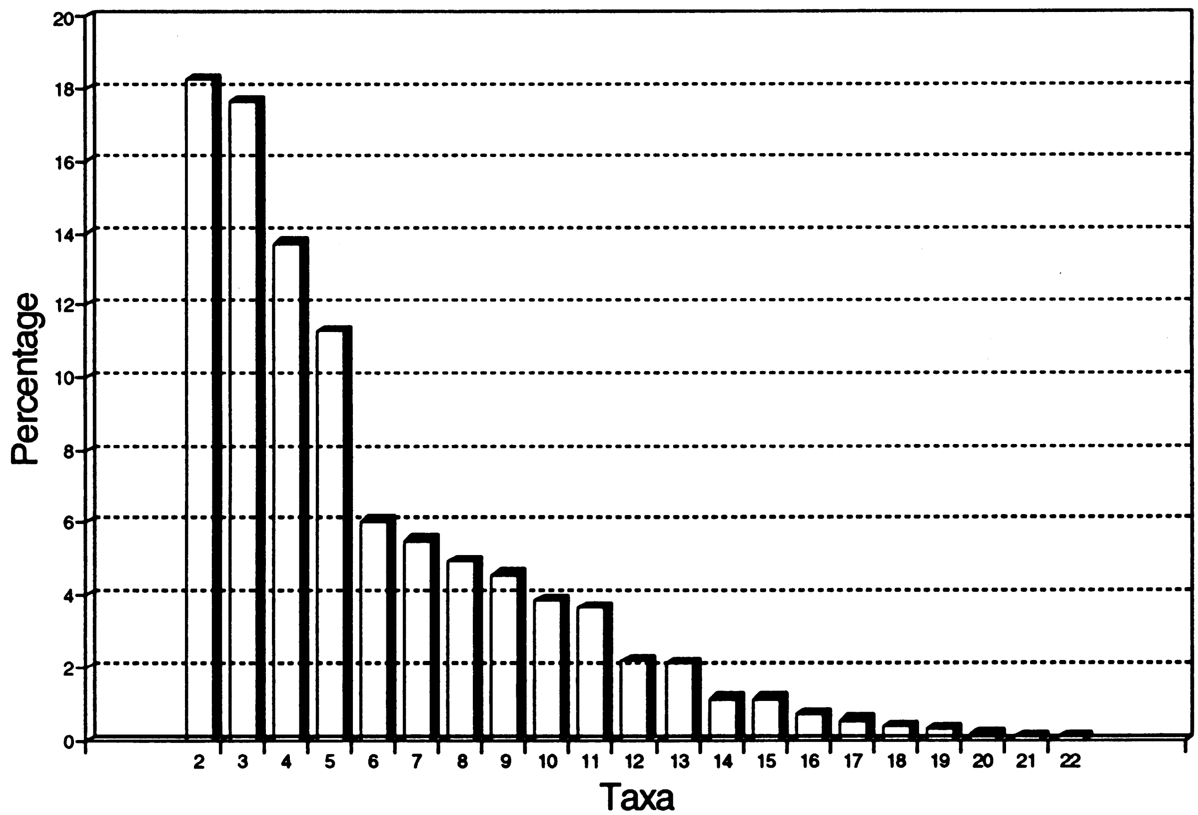

Figure 13.2 Relative frequency of fish taxa from the To'aga site, excluding Diodontidae.

Recovery methods can greatly influence the kinds and the amount of material retrieved from excavation (Grayson 1984). As with other sampling techniques, the size of the screen used is determined by the research problem. Pacific island archaeology has been oriented toward the recovery of artifacts, such as pottery, that can be readily recovered by 1/4" screens. Unfortunately, the consistent use of 1/4" screens does not always sufficiently sample other classes of archaeological material such as smaller faunal remains.

Experiments on the differential recovery of faunal material show that screen size affects the sample size and the number and kind of taxa represented (Thomas 1969; Casteel 1972; Butler 1987). Larger screen sizes bias the sample toward taxa with larger body sizes. The use of smaller screens increases the sample size and retrieves smaller taxa that would otherwise be lost through the larger screens.

To determine how our recovery methods influenced the composition of the To'aga faunal assemblage, bulk samples of ca. 5 kilograms (ca. 500 cm^3) was taken from Layer IIIA/B of Units 20/23 and from Layer II of Unit 30. These layers were chosen because they contained dense midden concentrations. Thus the two samples may not represent the site in general since the recovery rate may be less for areas with a lower midden density.

The bulk samples were wet-sieved through window screen in the field to reduce the bulk of the sediment for shipping. They were dry-screened in the laboratory through nested -3 phi (8mm), -2 phi (4mm), -1 phi (2mm), and 0 phi (1mm) geological sieves. The contents from each phi size were separated into gross categories (rocks, coral, shell, sea urchin, crab, and bone) and weighed (tables 13.13 and 13.14). The bone was then identified and quantified using NISP.

The recovery of bone was affected by screen size more than shell. Almost all the bone was recovered in phi sizes -2 and smaller. The shell recovered by screen sizes less than -3 phi was difficult to identify. Furthermore, the weight of the

Table 13.8 A
Vertebrate Fauna from the 1987 Excavations (NISP)

Taxa	Excavation Units													Total
	1	2	3	4	5	6	7	8	9	10	11	12	14	
Rattus exulans	1	1	---	41	27	55	41	2	21	3	7	---	20	219
Mammal	---	---	---	---	---	---	2	---	1	---	3	---	---	6
Gallus gallus	---	---	---	---	---	---	---	---	---	---	1	---	1	2
Bird	2	---	---	5	10	7	5	1	24	3	5	---	10	72
Marine Turtle	---	---	---	---	1	1	1	---	---	---	2	---	---	5
Other Vertebrate	---	---	5	---	---	---	1	---	2	---	---	7	5	20
TOTAL	3	1	5	46	38	63	50	3	48	6	18	7	36	324

Table 13.8 B
Vertebrate Fauna from the 1989 Excavations (NISP)

Taxa	Excavation Units																Total
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Rattus exulans	19	29	---	---	1	22	22	2	12	2	1	1	9	13	18	10	161
Sus scrofa	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Marine Mammal	18	---	---	---	---	---	---	7	---	---	---	---	---	---	---	2	27
Mammal	7	1	---	---	---	3	3	2	1	---	---	1	8	7	---	1	34
Gallus gallus	---	1	---	---	---	6	2	---	1	---	---	---	---	---	2	---	12
Bird	3	7	---	---	2	16	18	2	6	---	---	---	1	2	6	4	67
Marine Turtle	1	3	---	---	---	19	1	9	3	---	2	---	6	---	2	5	51
Other Vertebrate	11	6	---	2	1	---	---	---	2	---	---	2	---	---	---	---	24
TOTAL	59	47	1	2	4	66	46	22	25	2	3	4	24	22	28	22	377

Table 13.9
Non-Fish Vertebrate Fauna from the To'aga Site

A. 1987 Main Trench, Units 1, 4-9

Taxa	Layers					Total
	IIA-1	IIA	IIB	IIC	III	
Rattus exulans	9	63	88	28	--	188
Mammal	--	--	2	1	--	3
Bird	5	13	21	14	1	54
Marine turtle	--	1	2	--	--	3
Vertebrate	--	1	--	2	--	3
TOTAL	14	78	113	45	1	251

B. Transect 5, Units 15/29/30

Taxa	Layers					Total
	II	IIIA-1	IIIB	IIIC	IIID	
Rattus exulans	10	2	22	12	1	47
Mammal	8	--	--	--	--	8
Marine mammal	--	--	--	18	2	20
Gallus gallus	--	--	2	--	--	2
Bird	4	--	1	--	6	11
Marine turtle	3	--	--	1	4	8
Vertebrate	--	--	--	11	--	11
TOTAL	25	2	25	42	13	107

C. Transect 9, Units 20/23

Taxa	Layers					Total
	IIB	IIIA	IIIB	IIIC	IV	
Rattus exulans	5	2	5	20	2	34
Mammal	--	4	--	--	--	4
Gallus gallus	1	--	7	--	--	8
Bird	6	2	4	2	1	15
Marine turtle	--	1	18	3	--	22
Vertebrate	--	2	--	--	--	2
TOTAL	12	11	34	25	3	85

Table 13.10
Invertebrate Fauna from Transect 9 (Units 20/23)
(weight in grams)

Taxa	Layers I	IIB	IIIA	IIIB	IIIC	IV	Total
GASTROPODA							
Patellidae	---	0.3	---	0.2	0.4	---	0.9
Trochus maculatus	32.5	118.4	235.8	642.6	394.6	1.2	1425.1
Trochus niloticus	---	---	1.2	0.5	---	---	1.7
Trochus spp.	---	---	3.9	23.8	4.7	---	32.4
Tectus pyramis	---	---	21.1	46.5	---	---	67.6
Turbo crassus	48.2	276.4	932.9	1734.6	500.2	58.4	3550.7
Turbo setosus	263.9	792.8	1561.0	3980.6	2275.0	100.9	8974.2
Turbo spp.	8.3	114.6	140.8	135.1	125.3	0.7	524.8
Turbo operculae	89.9	138.1	228.7	1632.0	894.4	10.6	2993.7
Astrea stellare	---	2.0	7.5	34.1	8.9	---	52.5
Lunella cinereus	---	0.4	1.0	9.1	11.8	---	22.3
Nerita albicilla	---	---	---	---	1.1	---	1.1
Nerita picea	---	---	0.9	2.8	2.7	1.2	7.6
Nerita plicata	1.0	0.6	1.2	23.2	29.3	8.0	63.3
Nerita polita	5.2	3.3	1.5	47.4	44.9	5.6	107.9
Nerita spp.	1.0	2.2	4.3	38.0	11.4	---	56.9
Neritina spp.	---	---	---	---	---	0.1	0.1
Tectarius grandinatus	---	---	---	---	---	1.6	1.6
Cerithium nodulosum	---	---	---	54.8	13.7	---	68.5
Cerithium spp.	7.5	---	51.5	19.0	0.6	---	78.6
Clypeomorus spp.	---	---	---	1.7	2.4	---	4.1
Strombus mutablis	---	9.8	---	21.9	1.3	---	33.0
Strombus spp.	---	9.4	37.1	15.1	12.7	---	74.3
Hipponix spp.	---	---	11.3	4.7	6.0	---	22.0
Cypraea annulus	---	2.2	9.0	26.4	14.4	---	52.0
Cypraea arabica	---	---	---	---	19.2	---	19.2
Cypraea caputserpentis	---	7.7	9.2	16.0	68.7	---	101.6
Cypraea mappa	---	9.0	6.5	89.9	66.3	---	171.7
Cypraea moneta	---	3.1	29.9	62.0	80.4	---	175.4
Cypraea tigris	---	---	---	---	10.9	---	10.9
Cypraea spp.	41.3	23.8	57.6	206.6	141.9	2.0	473.2
Natica spp.	---	---	---	---	0.5	---	0.5
Tonna spp.	---	6.3	6.6	30.2	7.5	---	50.6
Cassidae	---	---	---	11.0	---	---	11.0
Cymatium nicobarium	---	---	2.5	---	---	---	2.5
Cymatium spp.	---	3.6	4.2	4.0	1.0	---	12.8
Bursa granularis	---	---	70.1	19.6	---	---	89.7
Bursa spp.	---	3.3	17.1	10.2	40.3	---	70.9
Drupa ricina	---	---	0.6	12.9	5.9	---	19.4
Drupa morum	---	---	---	6.9	---	---	6.9
Drupa spp.	5.9	2.4	15.9	25.4	1.4	0.8	51.8
Morula uva	---	---	---	---	1.2	---	1.2
Nassa spp.	---	---	---	16.9	---	---	16.9
Thais armigera	13.1	18.0	67.8	91.6	48.0	---	238.5
Thais tuberosa	---	8.1	---	29.6	---	---	37.7

(continued next page)

Table 13.10 (continued)

Taxa	Layers						
	I	IIB	IIIA	IIIB	IIIC	IV	Total
Thais spp.	---	6.3	46.9	43.4	17.1	---	113.7
Cantharus undosa	---	1.3	5.1	10.9	16.7	2.2	36.2
Nassarius spp.	---	0.3	2.9	1.6	6.7	---	11.5
Vasum ceramicum	27.0	12.6	22.4	40.9	14.5	---	117.4
Conus argus	---	---	---	---	38.2	---	38.2
Conus chaldeus	---	---	---	2.3	13.9	---	16.2
Conus eburneus	---	---	1.2	20.3	19.8	---	41.3
Conus cf. *maculifera*	---	---	---	0.5	---	---	0.5
Conus spp.	4.8	27.4	110.1	147.1	55.2	3.4	348.0
Bulla spp.	---	0.2	1.4	18.3	3.2	---	23.1
Dolabella spp.	---	---	0.8	5.5	5.7	---	12.0
Melampus spp.	0.4	1.6	11.9	21.3	28.0	3.6	66.8
Pythia spp.	---	---	---	3.3	6.8	11.1	21.2
PELEYCYPODA							
Mytilidae	---	20.0	6.7	23.9	1.9	---	52.5
Isognomon spp.	---	---	0.7	---	1.6	---	2.3
Chama spp.	---	---	---	1.1	7.2	---	8.3
Chlamys spp.	---	15.1	---	---	1.8	---	16.9
Cardiidae	---	14.9	---	---	---	---	14.9
Periglypta reticulata	---	4.7	---	---	0.8	---	5.5
Tridacna maxima	81.1	17.9	283.5	234.4	205.4	---	822.3
Quidnipagus palatam	---	10.6	18.1	70.3	31.8	1.8	132.6
Scutarcopagia scobinata	2.2	9.0	5.1	75.4	29.8	---	121.5
Trapezium oblongum	---	---	13.7	---	---	---	13.7
Asaphis violaceus	---	3.4	12.5	35.4	2.6	7.6	61.5
Pinna spp.	---	---	---	0.3	0.2	---	0.5
ECHINOIDEA	25.0	919.8	3052.9	3742.2	395.5	34.1	8169.5
CRUSTACEA	---	6.8	30.7	39.3	54.4	1.8	133.0
Unidentified	14.2	48.8	116.4	38.4	67.9	---	285.7
TOTAL (g)	672.5	2676.5	7281.7	13703.0	5875.7	256.7	30466.1
VOLUME (m^3)	1.90	0.85	0.40	0.95	0.90	0.30	5.30
DENSITY (kg/m^3)	0.35	3.15	18.20	14.24	6.53	0.86	5.75

Table 13.11
Invertebrate Fauna from the 1987 Main Trench, Units 1, 4-9
(weight in grams)

	Layers							
Taxa	**IC**	**IIA-1**	**IIA**	**IIB**	**IIC**	**III**	**IV**	**Total**
GASTROPODA								
Haliotis ovina	---	---	---	---	13.9	---	---	13.9
Patellidae	---	---	---	---	2.0	1.1	---	3.1
Trochus maculatus	---	36.7	66.8	145.4	136.9	20.5	---	406.3
Trochus spp.	5.0	---	20.0	65.0	71.3	1.0	---	162.3
Turbo crassus	20.0	498.0	383.1	1274.5	667.7	44.9	4.6	2892.8
Turbo setosus	60.0	2072.3	973.1	4646.3	2850.6	185.8	---	10788.1
Turbo spp.	---	215.2	235.0	313.1	189.5	32.0	8.1	992.9
Turbo operculae	---	347.3	872.3	1116.1	2045.2	18.1	4.5	4403.5
Astrea stellare	---	---	4.3	7.6	12.9	---	---	24.8
Astrea rhodostoma	---	---	---	---	5.0	---	---	5.0
Lunella cinereus	---	3.2	---	---	1.1	---	8.7	13.0
Nerita plicata	---	0.3	0.7	0.9	---	---	---	1.9
Nerita polita	---	6.7	4.3	7.9	16.8	1.0	14.9	51.6
Nerita spp.	---	20.0	9.0	65.4	43.4	1.3	---	139.1
Cerithium nodulosum	---	---	---	20.0	166.5	---	---	186.5
Cerithiidae	---	2.0	9.2	34.9	2.7	---	---	48.8
Strombus cf. *maculatus*	---	15.0	9.0	60.0	65.0	---	---	149.0
Strombus cf. *mutablis*	---	1.2	---	---	1.4	2.4	---	5.0
Strombus spp.	---	---	---	2.2	---	---	---	2.2
Hipponix conicus	---	11.0	3.0	15.3	15.9	---	---	45.2
Cypraea arabica	---	---	---	25.6	---	---	---	25.6
Cypraea annulus	---	11.6	0.5	---	8.4	---	---	20.5
Cypraea caputserpentis	---	2.6	4.1	---	3.3	---	---	10.0
Cypraea mappa	---	---	---	---	---	24.3	---	24.3
Cypraea moneta	---	1.0	---	---	31.6	9.7	---	42.3
Cypraea cf. *tigris*	---	0.4	---	---	---	---	---	0.4
Cypraea spp.	1.0	53.4	69.8	276.0	255.4	0.7	3.9	660.2
Policines spp.	---	---	---	5.0	---	---	---	5.0
Cymatium nicobarium	---	5.9	1.1	3.7	6.8	2.0	---	19.5
Cymatiidae	---	25.2	---	24.1	---	---	---	49.3
Tonnidae	---	---	1.5	4.2	17.2	---	---	22.9
Bursidae	---	---	15.2	19.5	16.1	13.2	---	64.0
Drupa grossolaria	---	---	---	---	1.7	---	---	1.7
Drupa ricina	---	2.3	---	6.5	---	---	---	8.8
Drupa spp.	---	1.6	2.7	5.9	---	---	---	10.2
Nassa spp.	---	---	---	1.4	---	---	---	1.4
Thais armigera	---	---	13.7	48.8	2.2	---	---	64.7
Thais spp.	---	0.9	---	---	1.8	---	---	2.7
Muricidae	---	79.2	70.0	183.0	285.0	---	---	617.2
Cantharus undosus	---	1.6	0.5	---	5.5	---	---	7.6
Nassarius spp.	---	---	---	---	6.4	---	---	6.4
Vasum ceramicum	---	---	9.3	64.4	68.1	---	---	141.8
Conidae	---	11.5	14.5	48.7	82.5	4.8	---	162.0
Bulla sp.	---	1.1	1.4	9.5	1.2		---	13.2
Melampus fasciatus	---	0.5	---	0.2	1.2	0.9	---	2.8
Melampidae	---	15.0	11.0	30.0	37.0	---	---	93.0
Pythia scarabeus	---	---	---	---	---	---	1.5	1.5

(continued next page)

Table 13.11 (continued)

Taxa	Layers							
	IC	IIA-1	IIA	IIB	IIC	III	IV	Total
PELECYPODA								
Anadara sp.	---	---	---	1.0	---	---	---	1.0
Arca spp.	---	---	---	---	6.0	---	---	6.0
Mytilidae	2.0	75.4	69.5	38.5	40.2	1.0	---	226.6
Isognomon spp.	---	---	---	---	0.7	---	---	0.7
Chama spp.	---	---	---	30.0	1.1	---	---	31.1
Codakia divergens	---	---	---	---	0.9	---	---	0.9
Gafrarium spp.	---	---	---	65.0	---	---	---	65.0
Lucinidae	---	---	3.0	7.0	---	---	---	10.0
Periglypta reticulata	---	---	---	59.2	0.6	---	---	59.8
Tridacna maxima	---	303.5	22.3	1320.4	1698.8	40.7	---	3385.7
Hippopus hippopus	---	---	---	121.4	215.0	---	---	336.4
Quidnipagus palatam	---	0.3	1.9	10.3	13.2	---	---	25.7
Scutarcopagia scobinata	---	3.3	---	7.5	10.9	4.8	---	26.5
Tellinidae	---	8.0	10.0	57.0	75.0	---	---	150.0
Asaphis violaceus	---	3.1	---	0.9	---	1.4	---	5.4
ECHINOIDEA	---	21.6	32.8	27.5	52.2	17.9	---	152.0
CRUSTACEA	---	4.8	5.1	28.4	1.9	0.3	5.3	45.8
TOTAL	88.0	3862.7	2949.7	10305.2	9255.7	429.8	51.5	26942.6
VOLUME (m^3)	0.10	0.65	0.95	1.85	1.85	1.75	1.05	8.20
DENSITY (kg/m^3)	0.88	5.94	3.10	5.57	5.00	0.25	0.05	3.29

shell recovered by the smaller screens added relatively little to the shell recovered from the larger screens.

The bulk samples show that the size of the vertebrate sample greatly increases as the screen size decreases. Only one unidentifiable bone was recovered from the -3 phi screen. The -2 phi screen recovered only a fraction of the material recovered from the -1 and 0 phi screens (tables 13.15 and 13.16). Comparisons of the density of identifiable fish bone obtained from the bulk samples to that from the excavation unit illustrate the amount of material being lost through the 1/4" screens (tables 13.17 and 13.18). While the standardization of the volume to a cubic meter exaggerates the recovery rate for the bulk samples, it shows that a significant amount of bone may be lost through 1/4" screens.

The smaller screen sizes also increase the sample's richness through the addition of new taxa. Balistidae and lizard were not recovered in either excavation unit. Along with Balistidae, four other fish families (Ostraciidae, Muraenidae, Carangidae, and Apogonidae) were added to the Unit 30 data through fine screening. Most of these are small-bodied taxa with small diagnostic skeletal elements that are less likely to be recovered by 1/4" screens.

Although the To'aga fish sample is the largest in Western Polynesia, the analysis of the bulk samples shows that sample size, taxonomic richness, and thus sample representativeness can greatly increase through the consistent use of smaller screens and bulk samples. This point is especially relevant for Pacific island archaeology where the vertebrate samples from most sites have been small. Because the representativeness of the 1/4" sample is suspect, the validity of interpretations based on measures of diversity, such as richness (the number of taxa present) and evenness (the distribution of abundance

Table 13.12
Invertebrate Fauna from Transect 5, Units 15/29/30
(weight in grams)

Taxa	Layers II	IIIA-1	IIIB	IIID	Total
GASTROPODA					
Haliotis spp.	---	---	---	2.7	2.7
Patellidae	0.8	---	2.2	0.4	3.4
Trochus maculatus	504.5	43.4	40.9	95.4	684.2
Trochus niloticus	42.5	---	---	1.3	43.8
Tectus pyramis	12.4	---	---	1.9	14.3
Turbo crassus	988.0	45.0	145.6	151.6	1330.2
Turbo setosus	4213.8	170.0	408.5	872.8	5665.1
Turbo spp.	172.8	13.6	47.4	138.9	372.7
Turbo operculae	2721.2	153.6	163.2	396.5	3434.5
Astrea stellare	21.3	3.2	1.2	57.4	83.1
Lunella cinereus	2.9	---	0.4	7.8	11.1
Nerita albicilla	4.0	---	---	---	4.0
Nerita picea	1.9	---	0.3	8.5	10.7
Nerita plicata	29.1	---	2.5	13.8	45.4
Nerita polita	36.0	1.1	3.9	82.6	123.6
Nerita spp.	23.7	---	16.1	51.7	91.5
Cerithium nodulosum	56.8	---	26.0	17.4	100.2
Cerithium columna	---	---	---	2.6	2.6
Cerithium spp.	5.0	---	0.2	9.2	14.4
Clypeomorus spp.	19.9	0.5	6.5	8.6	35.5
Strombus mutablis	---	---	5.2	5.2	10.4
Strombus spp.	29.8	2.7	8.4	11.2	52.1
Hipponix conicus	5.4	---	---	2.9	8.3
Hipponix sp.	7.8	---	1.0	1.8	10.6
Cypraea annulus	1.7	---	0.5	0.3	2.5
Cypraea caputserpentis	37.5	1.3	6.7	8.6	54.1
Cypraea eburneus	9.8	---	---	---	9.8
Cypraea mappa	24.8	0.8	3.8	63.5	92.9
Cypraea mauritania	0.8	---	---	---	0.8
Cypraea moneta	10.1	---	---	17.5	27.6
Cypraea tigris	---	---	0.9	---	0.9
Cypraea spp.	241.6	9.8	22.6	109.7	383.7
Policines spp.	---	---	2.3	0.8	3.1
Naticidae	0.3	---	1.8	4.6	6.7
Tonna spp.	11.6	---	0.1	5.4	17.1
Cymatium nicobarium	7.2	---	7.3	3.5	18.0
Cymatium spp.	6.2	---	---	4.5	10.7
Bursa granularis	42.5	---	---	---	42.5
Bursa spp.	5.8	---	---	---	5.8
Drupa ricina	34.9	9.7	---	9.7	54.3
Drupa morum	29.0	---	---	6.8	35.8
Drupa rubusidaceus	13.6	---	---	---	13.6
Drupa spp.	8.3	---	1.1	4.5	13.9
Morula sp.	2.8	---	---	1.2	4.0

(continued next page)

Table 13.12 (continued)

Taxa	Layers II	IIIA-1	IIIB	IIID	Total
Nassa sp.	2.3	---	1.0	2.2	5.5
Thais armigera	88.2	7.6	---	60.2	156.0
Thais tuberosa	111.7	---	12.9	17.4	142.0
Thais spp.	124.5	10.0	25.4	33.6	193.5
Cantharus undosa	11.0	---	1.9	21.4	34.3
Nassarius gaudiosis	---	---	---	0.6	0.6
Latirus filamentosa	66.8	---	---	---	66.8
Vasum ceramicum	42.2	---	3.6	7.6	53.4
Conus chaldeus	---	---	---	0.5	0.5
Conus eburneus	11.2	---	---	0.8	12.0
Conus spp.	349.5	0.4	15.0	36.6	401.5
Terebra sp.	5.7	---	---	---	5.7
Bulla spp.	15.7	0.8	7.2	5.3	29.0
Dolabella spp.	1.4	---	---	---	1.4
Pythia spp.	---	0.4	3.0	48.0	51.4
Melampus spp.	1.0	0.2	3.5	10.2	14.9
PELECYPODA					
Arca spp.	1.3	0.7	---	1.6	3.6
Mytilidae	8.9	1.2	9.7	14.8	34.6
Isognomon spp.	0.3	---	---	1.4	1.7
Chama spp.	2.7	---	1.0	26.4	30.1
Codakia spp.	---	---	0.3	---	0.3
Periglypta reticulata	26.9	---	11.0	3.6	41.5
Tridacna maxima	1170.1	7.7	215.2	310.8	1703.8
Hippopus hippopus	---	---	---	13.6	13.6
Quidnipagus palatam	28.9	1.6	4.2	3.6	38.3
Scutarcopagia scobinata	51.2	2.4	13.1	10.3	77.0
Trapezium oblongum	4.2	---	---	---	4.2
Asaphis violaceus	50.7	1.5	1.1	7.1	60.4
POLYPLACOPHORA	---	---	---	5.3	5.3
ECHINOIDEA	72.6	5.0	28.7	215.6	321.9
CRUSTACEA	17.7	1.0	11.1	8.8	38.6
Unidentified	198.4	19.4	30.5	162.4	410.7
TOTAL (g)	11853.2	514.6	1326.0	3212.5	16906.3
VOLUME (m^3)	1.60	0.10	1.50	1.85	5.05
DENSITY (kg/m^3)	7.41	5.15	0.88	1.74	3.35

Table 13.13
Units 20/23 Bulk Sample Analysis
(weight in grams)

<table>
<tr><th></th><th colspan="4">Screen Size</th></tr>
<tr><th>Class</th><th>>-3 ϕ</th><th>-2 ϕ</th><th>-1 ϕ</th><th>0 ϕ</th></tr>
<tr><td>Rock</td><td>522.5</td><td>30.7</td><td rowspan="4">133.6</td><td rowspan="4">103.3</td></tr>
<tr><td>Coral</td><td>234.4</td><td>34.1</td></tr>
<tr><td>Shell</td><td>56.6</td><td>19.6</td></tr>
<tr><td>Crab</td><td>8.6</td><td>---</td></tr>
<tr><td>Bone</td><td>0.4</td><td>1.0</td><td>2.9</td><td>2.5</td></tr>
<tr><td>TOTAL</td><td>950.2</td><td>104.5</td><td>136.5</td><td>105.8</td></tr>
</table>

Table 13.14
Unit 30 Bulk Sample Analysis
(weight in grams)

<table>
<tr><th></th><th colspan="4">Screen Size</th></tr>
<tr><th>Class</th><th>>-3 ϕ</th><th>-2 ϕ</th><th>-1 ϕ</th><th>0 ϕ</th></tr>
<tr><td>Rock</td><td>138.4</td><td>49.7</td><td rowspan="3">10.9</td><td rowspan="3">30.4</td></tr>
<tr><td>Coral</td><td>102.2</td><td>68.5</td></tr>
<tr><td>Shell</td><td>57.8</td><td>24.5</td></tr>
<tr><td>Bone</td><td>---</td><td>0.8</td><td>3.9</td><td>2.5</td></tr>
<tr><td>TOTAL</td><td>299.4</td><td>143.5</td><td>14.8</td><td>32.9</td></tr>
</table>

values) is also questionable (Gordon 1991). Ideally, a faunal assemblage should reflect the larger target population of the archaeological record, not simply the archaeological recovery techniques used.

TEMPORAL TRENDS IN THE TO'AGA ASSEMBLAGE

One goal of faunal analysis is the description and interpretation of temporal change in prehistoric subsistence patterns. A pattern of subsistence change which has been described for some Pacific island sites is a quantitative shift from the exploitation of wild or naturally occurring resources to a dominance on horticultural production (e.g., the Tikopia case documented by Kirch and Yen [1982] or the Mangaia case described by Steadman and Kirch [1990]). Temporal increases in the frequency of pig, dog, and chicken and decreases in wild vertebrate taxa such as birds, turtle, and marine mammal are taken to indicate this trend. In contrast, the character of the To'aga assemblage changes little over time and does not strongly reflect this kind of shift. Wild taxa are found throughout the site, and the sample of domesticated animals is too small to draw any firm conclusions. Although much of the wild taxa (especially the birds) are represented in early contexts, most of the chicken bone is also found in those early layers. Thus, there is no clear cut shift from one type of resource use to the other.

A corollary of the wild to domesticated fauna hypothesis is the reduction of marine resources with increasing reliance on horticulture (e.g., Janetski 1976, 1980; Kirch 1982, 1988). Resource exploitation and environmental degradation by humans are also suggested to contribute to the decline in marine resources, with decreases in the density of shellfish used to support this hypothesis. Invertebrate density varies at To'aga, increasing then decreasing over time (tables 13.10-13.12). However, the use of density measures may be misleading since changes in density may result from other factors, such as changing rates of sedimentation or shifts in settlement pattern.

In sum, the composition of the To'aga assemblage changes little over time. The invertebrate assemblage best illustrates this with a few taxa dominating the assemblage across time and space. A similar trend appears to be evident for the fish assemblage as well. At present, the cause of this pattern is not evident. Some possible causes include the exploitation of naturally abundant taxa from a temporally stable environment, a lack of change in subsistence practices, or a combination of both factors.

REGIONAL COMPARISONS

Comparisons of faunal assemblages from different areas or islands allow for the assessment of

Table 13.15
Vertebrate Taxa Represented in the Bulk Sample From Units 20/23 (NISP)

	Screen Size		
Taxa	**-2 ϕ**	**-1 ϕ**	**0 ϕ**
Balistidae*	---	7	5
Ostraciidae	---	3	4
Serranidae	---	3	2
Labridae	---	1	2
Holocentridae	---	1	2
Diodontidae	---	1	---
Muraenidae	---	1	---
Acanthuridae	---	---	1
Scaridae	1	---	---
Rattus sp.	---	---	2
Bird	---	1	---
Lizard*	---	---	1
TOTAL IDENTIFIED	1	18	19
UNIDENTIFIED	10	196	456
TOTAL	11	214	475

* Not found in regular 0.25 inch screened samples from this excavation unit.

regional trends. To'aga may be compared with other faunal assemblages from well-documented sites in Western Samoa (Green and Davidson 1969, 1974; Janetski 1976, 1980; Lohse 1980; Smith 1976), Tonga (Kirch 1988; Poulsen 1987), and Fiji (Best 1981, 1984; Hunt 1980; Kay 1984). First, the issue of data comparability is addressed to determine the quality of the regional data base. Differences in recovery, identification, and quantification techniques can seriously affect the comparability of data across assemblages (Butler 1988; Nagaoka 1988). If data sets are not comparable, differences between them may reflect methodological rather than regional differences. Once these issues have been addressed, the faunal data are then examined for the invertebrate, fish, and non-fish vertebrate categories.

For Western Polynesian faunal assemblages, recovery and quantification techniques vary considerably across sites (table 13.19). As was shown in the analysis of the bulk samples from To'aga, screen size influences the kind and the size of the faunal sample. Screen size differences can even change data at a nominal level since smaller screen sizes add taxa. Quarter-inch screens have been the most commonly used although for some sites screen size was not reported. In other cases, several screen sizes were used, but when and where the different sizes were used was not reported. This lack of information makes it difficult to evaluate the comparability of the data.

Table 13.16
Vertebrate Taxa Represented in the Bulk Sample from Layer II, Unit 30 (NISP)

	Screen Size		
Taxa	-2 ϕ	-1 ϕ	0 ϕ
Balistidae*	---	6	7
Diodontidae	---	8	---
Labridae	2	4	---
Ostraciidae*	---	5	---
Serranidae	---	3	---
Muraenidae*	---	2	---
Scaridae	---	1	---
Lutjanidae	---	1	---
Carangidae*	---	---	1
Apogonidae*	---	---	1
Rattus sp.	2	3	3
Lizard*	---	---	1
TOTAL IDENTIFIED	4	34	13
UNIDENTIFIED	18	246	532
TOTAL	22	280	546

* Not found in 0.25 inch screened samples from this excavation unit.

NISP was the common technique for quantification of the vertebrate component, except for the Fiji sites where MNI was used. For the invertebrates, weight was used except for Lakeba and Naigani. These differences in quantification may not be as severe as screen size differences since, in many cases, there is little difference between quantification techniques at an ordinal level (Grayson 1984; Janetski 1980). If the data are considered in terms of the rankings of taxa, it may still be possible to make valid comparisons.

In the identification process, differences in the reference collections and the diagnostic elements used can also affect the data. Kirch (1988) and Best (1984) noted that their fish reference collections were inadequate, limiting the number of possible taxa that could be identified. This problem also exists for the To'aga assemblage. Publication of reference collections and the elements used would help evaluate how these factors have biased the data.

Some differences among the faunal samples may be due to the range of diagnostic elements used to identify the assemblages, especially for the fish assemblages. Kirch, Poulsen, and Best used mainly the premaxilla, dentary, and special bones for their fish identifications. For the To'aga assemblage three additional elements, the articular, maxilla, and quadrate, were used. This increased the size of the To'aga sample about fifteen percent and added two taxa.

Table 13.17
Density of Identified Fish Bone from Layer III A/B, Units 20/23

	No. of Identified Fish	Sample Volume (m³)	Density (NISP/m³)
Excavation Unit	221	1.3	170
Bulk Sample	34	0.0005	68,000

Given the problems in data comparability of the Western Polynesian faunal assemblages, only general comparisons between the data sets can be made. The issue of comparability is important for future faunal work in the area. Ideally, a faunal data base would be created in which data from different sites could be easily assimilated into one body of knowledge with new data continually adding to our knowledge of subsistence patterns.

Fish

For many of the Western Polynesian sites either little faunal material was recovered or the data are poorly reported. The data on fish bones from Western Samoa consists of brief notes on their presence in the sites. Janetski (1976, 1980) mentions 10 fish bones identified from Potusa and an unknown quantity from Falemoa and Jane's Camp. Over 174 grams of fish bone were recovered from Lotofaga (Davidson 1969), but no other data are presented.

The best reported and largest samples of fish come from Tongatapu, Niuatoputapu, Lakeba, and To'aga. Kirch (1988) recovered a sample of 231 NISP across 11 taxa from Niuatoputapu. From Tongatapu, Poulsen (1987) identified 15 fish taxa containing 179 NISP. Lakeba produced 323 MNI or 1782 NISP, and 21 taxa from the four sites for which the fish component was analyzed (Best 1984). The To'aga assemblage is comparable in size to Lakeba with 2196 NISP and 22 taxa represented.

The most abundant fish taxa are inshore/reef fishes, and a few taxa make up the majority of the assemblage (fig. 13.3). The cause of this distribution of fish taxa may be cultural (fishing strategies, food preferences) or environmental (natural abundances and distributions). Unfortunately, the biases created by the recovery techniques, differential preservation, and identifiability may have influenced these distributions.

The most common fish families across sites are Scaridae, Lethrinidae, Serranidae, Acanthuridae, and Diodontidae. The dominance of taxa, such as Scaridae, Lethrinidae, and Diodontidae, may be due to preservation and identification bias as much as subsistence patterns. The diagnostic elements of these taxa are very robust and easily identified. It is

Table 13.18
Density of Identified Fish Bone from Layer II, Unit 30

	No. of Identified Fish	Sample Volume (m³)	Density (NISP/m³)
Excavation Unit	29	0.8	36
Bulk Sample	52	0.0005	104,000

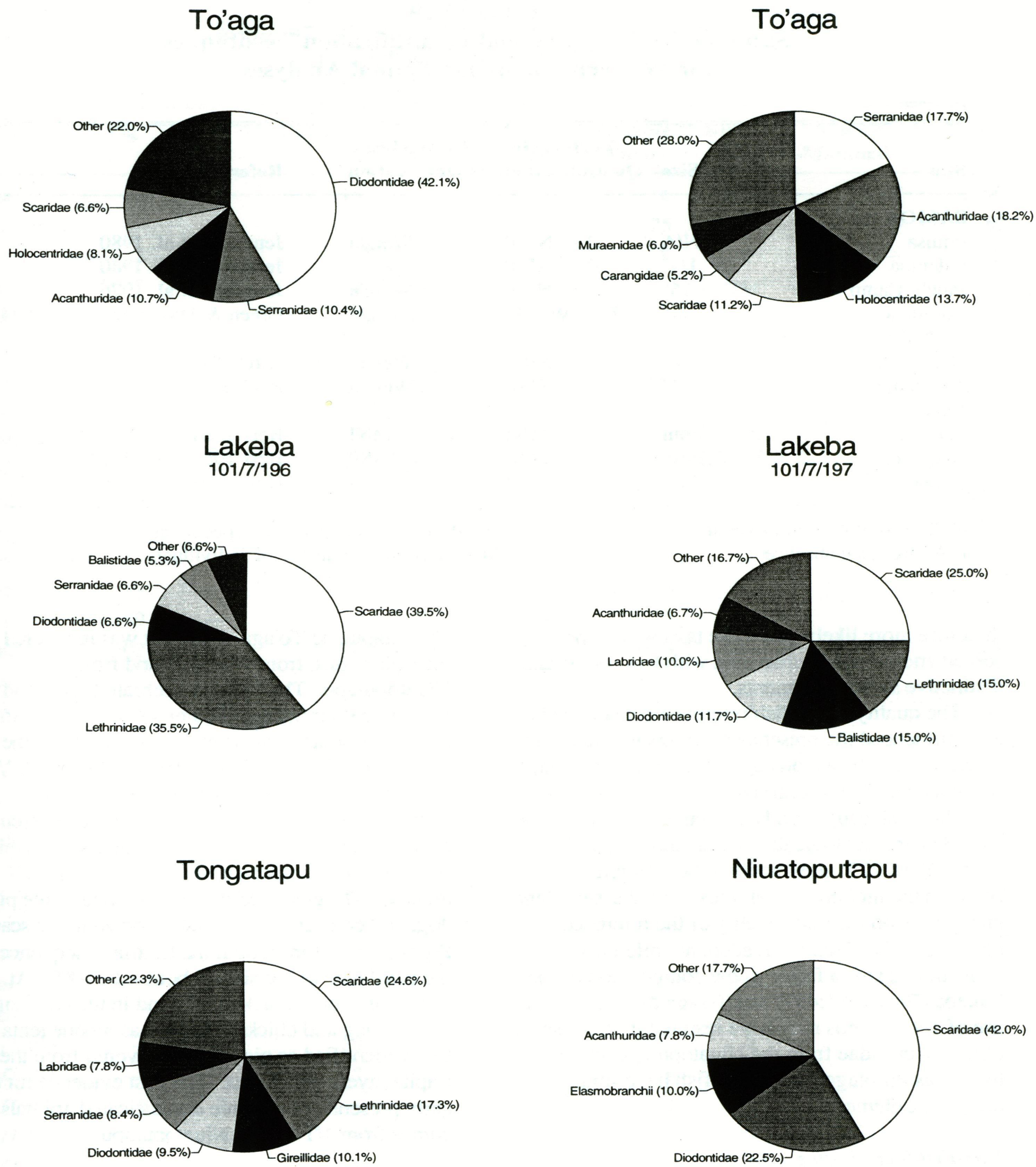

Figure 13.3 **Percentage composition of fish faunal assemblages from major Western Polynesian and Fijian sites; the two diagrams for the To'aga site are with and without Diondontidae.**

Table 13.19
Summary of Recovery and Quantification Techniques for Western Polynesian Faunal Analyses

Site	Screen Size	Vertebrate Quantification	Invertebrate Quantification	Reference
SAMOA				
Potusa	N/A	P/A, NISP	Weight	Jennings et al. 1980
Falemoa	1/4"	P/A, NISP	Weight	Jennings et al. 1980
Jane's Camp	1/2", 3/16"	P/A, NISP	Weight	Jennings et al. 1976
Lotofaga	1/4"	P/A, Weight	Weight	Green & Davidson 1969, 1974
TONGA				
Niuatoputapu	1/4"	NISP	Weight	Kirch 1989
Tongatapu	1/4"	NISP	Weight	Poulsen 1987
FIJI				
Lakeba	2.5, 5, 9mm	MNI	MNI	Best 1984
Naigani	2.5, 3.5, 7.1mm	MNI	NISP	Best 1981; Kay 1984
Yanuca	N/A	MNI	---	Hunt 1980

N/A, information not available
P/A, presence/absence
NISP, number of identified specimens
MNI, minimum number of individuals

therefore more likely that these taxa will be preserved and identified than taxa with less robust and distinctive skeletal elements.

The quality of the fish reference collections has also influenced the presence or absence of taxa in the assemblages. Based on ethnoarchaeological data, Mullidae and Pomacentridae are among the most abundant fish caught on Niuatoputapu, but none are recorded archaeologically (Kirch and Dye 1979). Kirch (1988:225) suggests that the differences between the modem and archaeological assemblages may be due to the poor quality of the reference collection. The lack of an adequate reference collection is also a factor in the composition of the Lakeba (Best 1981:497) and To'aga data. Finally the use of 1/4" screens may have resulted in the absence of Pomacentridae from the Niuatoputapu archaeological assemblage since these fish have small diagnostic elements.

Non-Fish Vertebrates

Compared to the fish, the non-fish vertebrate sample is smaller, but better reported (table 13.20). Rat, bird, and marine turtle are found at most sites. Marine mammal was identified at only two sites, Tongatapu and To'aga. Fruit bat was recovered from the Fijian sites, from Falemoa, and from Niuatoputapu. The 'wild' vertebrate fauna tend to be from earlier instead of later sites. Some of the largest amounts of turtle and bird were from the Lapita sites, TO-2, NT-90, 101/7/196 and 101/7/197.

Chicken is the most common of the three domesticated animals. Dog and pig are less abundant, possibly due to the problem of distinguishing between the two species when the bone is fragmented. The evidence for the presence of the pig, dog, and chicken from initial colonization is scant. Pig is present throughout the Lotofaga sequence, but the basal date of the site is about A.D. 1000. At Tongatapu, only chicken is found in the early site, TO-2. Dog and chicken, as well as a bone tentatively identified as pig, were recovered from the Lapita layers of Yanuca. The best evidence for the early presence of all three domesticated animals comes from NT-90, on Niuatoputapu.

Invertebrates

The invertebrate component comprises a large proportion of Western Polynesian faunal assemblages. The most abundant taxa vary across sites,

Table 13.20
Summary of Western Polynesian Vertebrate Faunal Assemblages (NISP)

Site	Pig	Dog	Chicken	Rat	Fruit Bat	Marine Turtle	Bird	Marine Mammal	Fish
To'aga	1	---	15	380	---	56	139	27	2196
Jane's Camp	---	---	P	---	---	25	P	---	87
Falemoa	2	---	---	---	P	P	P	---	P
Potusa	37	---	P	---	---	---	---	---	10
Lotofaga									
Locus A	P	P	---	P	---	---	P	---	>39g
Locus B	P	P	---	P	---	---	P	---	>74g
Locus C	P	P	---	P	---	---	P	---	>61g
Tongatapu									
TO-1	10	---	47	294	---	17	125	---	72
TO-2	---	---	7	9	---	404	109	2	43
TO-3	3	---	1	2	---	19	42	---	1
TO-4	---	---	---	---	---	1	2	---	---
TO-5	---	---	3	2	---	18	73	1	27
TO-6	189	---	16	198	---	15	167	1	36
Total	202	---	74	505	---	474	504	4	179
Niuatoputapu									
NT-90	2	4	12	1	1	71	31	---	10
NT-91	---	---	---	---	---	---	---	---	1
NT-93	3	---	6	---	---	6	1	---	15
NT-100	5	---	7	16	---	10	3	---	46
NT-110	---	7	1	---	---	---	1	---	11
NT-112	3	---	37	---	---	2	7	---	4
NT-113	---	---	---	---	---	---	---	---	1
NT-135	19	3	3	---	---	3	4	---	12
NT-163	1	---	26	---	---	1	5	---	34
Total	33	14	92	17	---	93	52	---	231
Lakeba									
101/7/196	---	---	19	---	---	28	2	---	76
101/7/197	---	---	2	20	11	8	69	---	60
101/7/47	1	2	---	---	---	22	1	--	180
101/7/132	3	1	---	---	---	3	---	---	7
101/7/135	---	---	---	---	---	---	1	---	---
101/7/2b	---	1	---	---	---	---	---	---	---
101/7/166	---	1	---	---	---	---	---	---	---
Total	4	5	21	20	11	61	72.	---	323
Naigani	---	1	---	3	5	12	4	---	18
Yanuca	4	2	2	4	2	9	11	---	23

P = present in unknown quantities

but the dominant taxa tend to reflect the marine environment near the site. For example, the exploitation of a sheltered lagoon is reflected in the abundance of bivalves in the Tongatapu assemblage. Other sites contain mainly *Turbo* or other taxa reflecting the exploitation of a fringing reef environment. Changes in the dominant taxa at Niuatoputatpu, Tongatapu, and Lakeba are also used to indicate changing marine environments.

While it appears that the most abundant taxa are good indicators of environment, the influence of environmental versus cultural factors still needs to be determined. As at To'aga, the bulk of the invertebrate assemblages is concentrated in a few taxa. Whether this uneven distribution reflects the exploitation of naturally abundant taxa or cultural preferences will need to addressed in future studies.

CONCLUSIONS

The analysis of the To'aga faunal assemblage has generated a number of new questions. Despite the time depth represented at the To'aga site, there is a striking lack of change in the resources exploited. A few taxa comprise a large percentage of the fish and invertebrate components of the assemblage. The overall pattern of high diversity may reflect the exploitation of naturally abundant taxa or culturally preferred taxa. Population studies of marine environments off To'aga would be useful for creating a baseline of natural distributions which could then be compared to the archaeological data.

Addressing these and other faunal questions requires data robust enough to compile into a cumulative data base and to use at a level higher than nominal. The To'aga analysis has shown that methodological biases introduced during excavation and analysis can severely affect the data, reducing its robustness. Thus, interpretations must be made cautiously. The problems created by these biases are compounded when data are compiled from different sites into a regional data base. Variability in and among data sets may be attributed to differences in recovery or analytical techniques rather than prehistoric cultural patterning. Faunal analysis can be a useful tool for understanding subsistence practices, an important aspect of prehistoric culture. Its utility in future studies, however, depends upon the commitment of faunal analysts and archaeologists to create quality faunal data.

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