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The taphonomy of fish bone from archaeological sites in East Otago, New Zealand

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ABSTRACT: Fish bone assemblages from Pleasant River Mouth are analysed in order to determine the degree of subsurface weathering that each has undergone. It is apparent that different assemblages and different fish species will exhibit different weathering patterns. The analysis is then extended to the nearby site of Shag River Mouth. It seems that the weathering of fish bone can be used to determine the degree of weathering for an entire context, and that a simple visual assessment of element survivorship profiles for each assemblage is sufficient to indicate the comparative degree of weathering, though much more work must be done before the method can be widely applied with confidence.

KEYWORDS: PLEASANT RIVER MOUTH, NEW ZEALAND, FISH BONE, TAPHONOMY

RESUMEN: Se analizan restos óseos de peces procedentes del yacimiento de Pleasant River Mouth a fín de determinar el grado de meteorización superficial que han sufrido. Resulta aparente que distintas muestras y distintas especies de peces exhibirán distintos patrones de meteorización. El análisis es asimismo ampliado al yacimiento próximo de Shag River Mouth. Parece ser que la meteorización de los huesos de peces puede ser utilizada para determinar el grado de meteorización de todo un conjunto y que una simple evaluación visual de los perfiles de supervivencia de elementos óseos en cada muestra es suficiente para indicar su grado de meteorización diferencial. A pesar de ello debe aún llevarse a cabo mucho trabajo a fín de que el método pueda ser aplicado de modo general con un mínimo grado de confianza.

PALABRAS CLAVE: PLEASANT RIVER MOUTH, NUEVA ZELANDA, HUESOS DE PECES, TAFONOMÍA

INTRODUCTION

Processes associated with the treatment of prey, deposition of food remains, and post-deposition conditions seriously affect the long-term survival of archaeological bone. Though some of these processes are cultural or technological in origin, insofar as they impact on bone survival, all are taphonomic. Fish bone would seem to be particularly affected in this way since it is more fragile than the bone of birds and mammals and so would be expected to be destroyed more easily (but see Nicholson, 1996). This paper examines post-depositional taphonomic processes for a fish bone assemblage from Pleasant River Mouth in Southern New Zealand, and extends the analysis to other recorded assemblages in the same area. The archaeofaunal record is patterned by taphonomic processes, and this paper is concerned as much with identifying these patterns as with the taphonomic processes themselves.

METHODS

Typically in fish bone analyses in New Zealand and the Pacific five paired facial bones are identified to the lowest possible taxonomic level; the dentary, articular, quadrate, maxilla and premaxilla (Leach, 1986, 1997). These bones are generally distinctive and are usually more robust than other skeletal elements so that they survive better in archaeological contexts. In some species other 'special' bones, also notable for both their distinctiveness and robustness, may also be used for identification. When calculating MNIs identifying these five bones is generally sufficient, but when examining a number of wider issues, such as the differential treatment of body parts, it becomes necessary to identify a much wider range of elements. In doing so a wider range of patterns becomes apparent.

This paper uses two counts of fish bone, the familiar MNI, and also the MAU, or minimum animal unit, which combines the MNIs for each element and divides the total by the number of occurrences of the element in a live animal (Binford, 1978). Normalising the counts for each species in the assemblage for the most frequent element gives the %MAU, with the most frequent element having a score of 100%.

Pleasant River Mouth is an estuarine site located on the east coast of the South Island of New Zealand. It is one of a number of similar large sites in the East Otago area representing the early phases of Maori occupation. The site was excavated between 1991 and 1993 by the University of Otago Department of Anthropology field school. All deposits were excavated stratigraphically and dry-sieved on site through 3.2 mm mesh, and all artefactual and faunal remains were retained. Faunal remains include mammal (mostly dog and seal), moa (an extinct family of large flightless birds [Dinornithiformes]), small birds, fish and shell fish. Two of the excavated areas show stratigraphic evidence of multiple occupation, and radiocarbon dating indicates three phases of activity across the site: 14th to early 15th centuries A.D.; mid 15th century; and late 15th to early 16th centuries (Smith, 1997).

Fish bone assemblages from other East Otago coastal sites of similar antiquity often result in MNIs in the thousands (Table 1). By contrast at Pleasant River much less fish bone was recovered (Table 2). Only five assemblages have sufficient bone to indicate systematic exploitation at even a low level, and three species between them—barracouta (*Thyrsites atun*), blue cod (*Parapercis colias*) and red cod (*Pseudophycis bachus*)—account for 75% of the total identified catch.

	Long Beach		Purakanui		Shag Mouth		Shag Mouth	
	Layer 4				Layer 2		Layer 4	
	MNI	%	MNI	%	MNI	%	MNI	%
Barracouta (*Thyrsites atun*)	2419	81.5	1318	47.86	133	73.89	604	67.94
Blue cod (*Parapercis colias*)	1	0.03			6	3.33	12	1.35
Blue moki (*Latridopsis ciliaris*)			2	0.07				
Brill (*Colistium guntheri*)			1	0.04				
Elephant fish (*Callorhinchus milii*)			1	0.04				
Flounder (*Rhombosolea* sp.)	1	0.03	1	0.04				
Gemfish (*Rexea solandri*)	1	0.03					2	0.22
Hapuku (*Polyprion oxygeneios*)	8	0.26	9	0.33	1	0.56	4	0.45
Jock Stewart (*Helicolenus percoides*)							1	0.11
Ling (*Genypterus blacodes*)	138	4.6	111	4.03	3	1.67	12	1.35
Maori chief (*Paranotothenia angustata*)	2	0.06			1	0.56	14	1.57
Red cod (*Pseudophycis bachus*)	387	13	1273	46.22	20	11.11	200	22.25
Red scorpionfish (*Scorpaena papillosus*)					3	1.67	3	0.34
Rock cod (*Lotella rhacinus*)					1	0.56		
Tarakihi (*Nemadactylus macropterus*)							1	0.11
Trumpeter (*Latris lineata*)			2	0.07	2	1.11	3	0.34
Warehou (*Seriolella brama*)	1	0.03			1	0.56		
Wrasse (Labridae)	8	0.26	27	0.98	10	5.56	33	3.71

TABLE 1

Published fish MNIs early East Otago coastal sites other than Pleasant River Mouth. Long Beach data from Fyfe (1982: 55). Purakanui data from Anderson (1981: 206). Shag River Mouth data from Anderson & Smith (1996: 239).

	A1/L2	A2/L2	A5/L2	A7/L1-2a	A7/L2b	TOTAL
Barracouta	1	28	15	16	14	74
Blue cod	18	0	0	1	1	18
Carangid sp.	0	0	0	1	0	1
Mackerel	1	0	0	0	0	1
Maori cheif	4	0	0	0	0	4
Red cod	5	1	4	15	2	28
Tarakihi	2	0	0	0	0	2
Wrasse	1	0	0	2	0	3
	32	29	19	35	17	131

TABLE 2

MNI of fish from larger assemblages at Pleasant River Mouth, obtained by the standard method.

RESULTS AND DISCUSSION

The majority of blue cod are from Area 1, Layer 2 (A1/L2). More intensive butchery of moa and mammals, indicated by increased occurrence of cut marks and bone fragmentation (Smith, 1997), coupled with seasonality studies that indicate extended occupation (Samson, 1995), indicates that A1/L2 represents a short term settlement and subsistence exploitation, rather than a seasonal occupation accompanied by specialised processing as elsewhere in the site. Blue cod are easily caught from rock platforms, again indicating low level subsistence exploitation. The remaining assemblages are dominated by red cod and barracouta, a pattern similar to other East Otago assemblages. Assuming an equation between economic importance and representation in the archaeofaunal assemblage, then the seasonal exploitation of large game was the primary subsistence focus at Pleasant River Mouth, and fish were generally of lesser importance.

Apart from A1/L2 there is only one other instance in which the interpretation of faunal patterns observed for large species are reflected in the fish bone. In A7/L1-2a a dense lens of gill arch bones (branchials and hyals) of barracouta was interpreted as evidence of deliberate targeting of a single species, which was processed and preserved for off-site consumption. Two calculations of %MAU for barracouta are shown in Table 3: %MAU for all identified elements; and %MAU* calculated discounting the gill arch bones. For %MAU* proportions of elements are much as commonly expected, with the five major mouthparts being the most common. Vertebrae by %MAU* are nearly as common as mouthparts, indicating that in general barracouta in this context were being treated as whole fish. For %MAU, calculated for all elements, it is clear that they were not being treated as whole fish, that different body parts were receiving different treatment. The gill arch lens was interpreted as discard from fish preservation by drying (Campbell, n.d.), an activity commonly attested ethnographically (Best, 1977 [1929]; Boultbee, 1986; Beattie, 1994).

Radiocarbon dates for A7/L1–2a show it to be the youngest excavated assemblage from the site, with two shell dates pooling at cal A.D. 1509–1583 at one sigma. Bone from the gill arch lens has also been dated to cal A.D. 1473–1536 at one sigma, statistically indistinguishable from the shell date (Petchey, 1998: 153). There is no indication in the stratigraphy of the site that the gill arch lens is intrusive, and the dates confirm this. It represents a discrete deposition episode in the shell midden formation process of L1–2a as a whole. The dates indicate short term use of the site, specifically for barracouta preservation, at a time when large game were becoming scarce and new resources had to be exploited.

The other numerous species in the assemblage is red cod but no such discrepancies are shown here. The five standard bones account for most of the elements identified, apart from vertebrae, and the %MAUs for red cod show that vertebrae are about as equally common as mouthparts, indicating that the red cod represented in this assemblage were prepared, eaten and discarded as whole fish on site.

Even robust facial bones may be expected to be subject to destruction by taphonomic processes. The lens of fragile gill arch bones would normally not be expected to survive at all. That it has is probably due to rapid and deliberate burial, resulting in protection by overlying deposits. Probably the density of the deposit created self-buffering local conditions favourable to preservation. These kinds of deposits would normally be destroyed through a combination of abrasion, trampling and chemical or micro-biological dissolution. These processes can conveniently be grouped under the heading of weathering. While the three processes are quite different it seems a reasonable, though as yet untested, hypothesis that the effects will be very similar—the progressive destruction of bone with the most robust elements or taxa surviving longest.

Nicholson (1996) has shown that the diagenetic degradation of bone is due to a number of complex interacting factors, including pre-burial treatment of bone (especially cooking method, or lack thereof); burial depth; soil type (acidity, porosity, etc); and associated microbiological

	Barracouta						Red Cod				
Element	L	R	UP	MAU	%MAU	%MAU*	L	R	UP	MAU	%MAU
Dentary (2)	16	7	0	11.5	3	100	15	12	0	13.5	100
Articular (2)	14	6	0	10	2.6	87	5	11	0	8	59.3
Quadrate (2)	16	6	0	11	2.8	95.7	6	6	0	6	44.4
Maxilla (2)	7	12	0	9.5	2.5	82.6	11	10	0	10.5	77.8
Premaxilla (2)	8	9	0	8.5	2.2	73.9	11	11	0	11	81.5
Prevomer (1)	0	0	2	2	0.5	17.4	0	0	9	9	66.7
Palatine (2)	6	1	0	3.5	0.9	30.4	3	2	0	2.5	18.5
Ectopterygoid (2)	1	1	0	1	0.3	8.7	0	0	0		
Basihyal (1)	0	0	374	374	96.6		0	0	0		
Urohyal (1)	0	0	16	16	4.1		0	0	0		
Dorsal Hypohyal (2)	302	297	0	299.5	77.4		0	1	0	0.5	3.7
Ventral Hypohyal (2)	297	307	0	302	78		0	0	0		
Ceratohyal (2)	197	220	0	208.5	53.9		1	1	0	1	7.4
Epihyal (2)	234	273	0	253.5	65.5		0	0	0		
1st Pharyngobranchial (2)	203	200	0	201.5	52.1		0	0	0		
2nd Pharyngobranchial (2)	399	375	0	387	100		0	0	0		
3rd Pharyngobranchial (2)	246	234	0	240	62		0	0	0		
Infrapharyngeal (2)	273	235	0	254	65.6		0	0	0		
Hyomandibular (2)	1	4	0	2.5	0.6	21.7	0	0	0		
Preopercular (2)	1	1	0	1	0.3	8.7	1	0	0	0.5	3.7
Interopercular (2)	0	0	0	0	0	0	0	0	2	1	7.4
Opercular (2)	5	6	0	5.5	1.4	47.8	0	0	0		
Subopercular (2)	0	2	0	1	0.3	8.7	0	1	1	1	7.4
Cleithrum (2)	3	4	0	3.5	0.9	30.4	0	2	0	1	7.4
Coracoid (2)	0	1	0	0.5	0.1	4.3	0	0	0		
Scapula (2)	2	2	0	2	0.5	17.4	0	2	0	1	7.4
Postcleithrum-upper (2)	0	0	0	0	0	0	1	0	0	0.5	3.7
Supracleithrum (2)	1	3	0	2	0.5	17.4	5	5	0	5	37
Post-temporal (2)	3	6	0	4.5	1.2	39.1	0	0	0		
Otolith (2)	0	0	0				0	1	0	0.5	3.7
Basioccipital (1)	0	0	1	1	0.3	8.7	0	0	10	10	74.1
1st Vertebra (1)							0	0	12	12	88.9
Vertebra (37)	0	0	307	8.3	2.1	72.2	0	0	304	8.2	60.9

TABLE 3

Counts of identified barracouta and red cod bone from A7/L1-2a. Bracketed number = number of elements in the body of a live fish; L = left; R = right; UP = unpaired; MAU = minimum animal units (Binford, 1978: 69); %MAU = MAU normalised for the most common element; %MAU* = %MAU discounting barracouta branchial and hyal bones.

agents (bacteria and fungi). Local conditions are of primary importance, and the weathering process may be self-buffering, with the conditions that facilitate weathering being cancelled by the effects of the process itself. This paper makes no attempt to try and disentangle the process. That said, two points should be made about the sand matrix in which the midden deposits were buried: sand drains well and so any self-buffering conditions may be repeatedly flushed away by rainfall; and sand dries rapidly, so that alternate wetting and drying of bone may increase the rate of weathering. In order to come to some understanding of this process the effects of weathering on the Pleasant River Mouth fish bone assemblages were examined. It is assumed that what is being observed is an average process that is amenable to simple statistical analysis.

Behrensmeyer (1978) examined the weathering patterns of large African mammal bone left on the ground surface, and observed that although weathering is a continuous process, it can be broken down into a set of recognisable stages. While the subsurface weathering patterns of fish bone will clearly differ from those observed by Behrensmeyer, it is clear from examination that the weathering process is more visible in some bones than others, and that this too can be broken down into seemingly natural and recognisable stages:

Stage 1. No discernible weathering; fine surface features and (where appropriate) surface gloss retained. Gloss refers to the shininess and smoothness of the surface of the bone, which differs between species.

Stage 2. Some weathering; loss of fine surface features or gloss.

Stage 3. Significant weathering; partial to complete loss of surface features, some longitudinal splitting possible.

Stage 4. Excessive weathering; bone extensively abraded in appearance, pitted, element may be difficult to identify.

The classification of any particular bone depended on the highest stage of weathering it exhibited over a significant portion of its surface.

It should be clear that this series of weathering stages is offered only as a working hypothesis. Behrensmeyer similarly described her work as "hypotheses which need testing through additional research on both recent and fossil bones … they should be considered provisional," but as Lyman & Fox (1989) pointed out "virtually no testing has taken place. Instead, some analysts have taken Behrensmeyer's hypotheses as interpretive principles and applied them uncritically to bone assemblages." The intention of this paper is to set up hypotheses that are testable through further research, but the method so far yields meaningful and expectable results. Since this work is exploratory, recording was limited to the five major facial elements; dentary, articular, quadrate, maxilla and premaxilla.

Burnt bones were not examined for weathering since they are likely to respond differently to weathering agents. For this reason A2/L2, which contained the highest MNI for barracouta of any excavated assemblage, is not included in the analysis, since 85% of this bone was burnt.

Figure 1 shows the weathering profiles for all five elements combined for the red cod and barracouta from A7/L1-2a and the barracouta from A7/L2b. In comparing the barracouta and red cod from A7/L1-2a it is apparent that a higher percentage of barracouta bones have weathered to stages 3 and 4. Both assemblages come from the same deposit and so will have been subject to the same processes of burial and diagenesis. Little red cod is weathered past stage 2, indicating either that it is less weathered overall, or what seems more probable, that it deteriorates rapidly and disappears after stage 2.

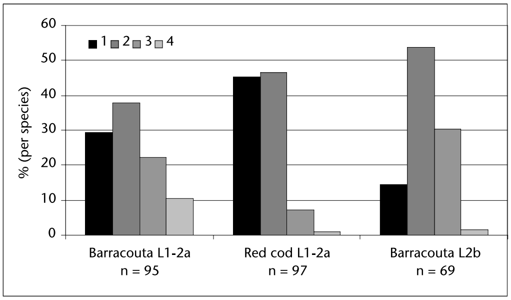

FIGURE 1

Weathering profiles by species assemblage in Area 7, for all elements combined.

The reasons for the different weathering profiles probably relate to the differing mechanical strength and structural density of the two species' bone. If barracouta and red cod bones degrade at different rates then it may also be the case that they are differentially resistant to the onset of subsurface weathering. Certainly barracouta is an oilier fish than red cod and weathering in barracouta bone may begin soon after deposition with the autolysis of fats in the bone. Also the surface of red cod bone appears shinier and harder than that of barracouta bone. Although it is only a subjective impression, the observed pattern could be explained if red cod bone is less porous at the surface, though more porous in the interior than barracouta bone. All these possibilities, however, remain untested.

The weathering profiles of barracouta from the two different assemblages can also be compared. The L2b assemblage is considerably more weathered than the L1-2a assemblage. A greater proportion of bone has begun to weather and more is also weathered to stage 3. This suggests that more bone has also weathered to destruction in L2b than in L1-2a. The differences between the two are not differences of kind, as between the barracouta and red cod from L1-2a, but differences of degree. This also indicates that the L2b assemblage as a whole is generally more weathered than the L1-2a assemblage, though there is insufficient red cod bone from L2b to provide a cross check. The greater age of L2b may account for this different degree of weathering. Also L2b is closer to the water table and so may have been in a more acidic matrix whereas the L1-2a assemblage is part of a dense shell midden that may have had a more neutral pH. The clean windblown sand overlying L1-2a may have built up rapidly and so protected the assemblage.

Figure 2 shows the weathering profiles for the same three species assemblages, broken down by element. For the barracouta from L2b and the red cod from L1-2a the most frequent element, the dentary, is weathered to stage 4, and the least frequent element, the quadrate, is only weathered to stage 2. The most frequent elements are the most robust and less easily destroyed by weathering, whereas in the case of quadrates once weathering has begun destruction occurs relatively rapidly and the bones seem not to survive, at least in a recognisable state, to stages 3 or 4.

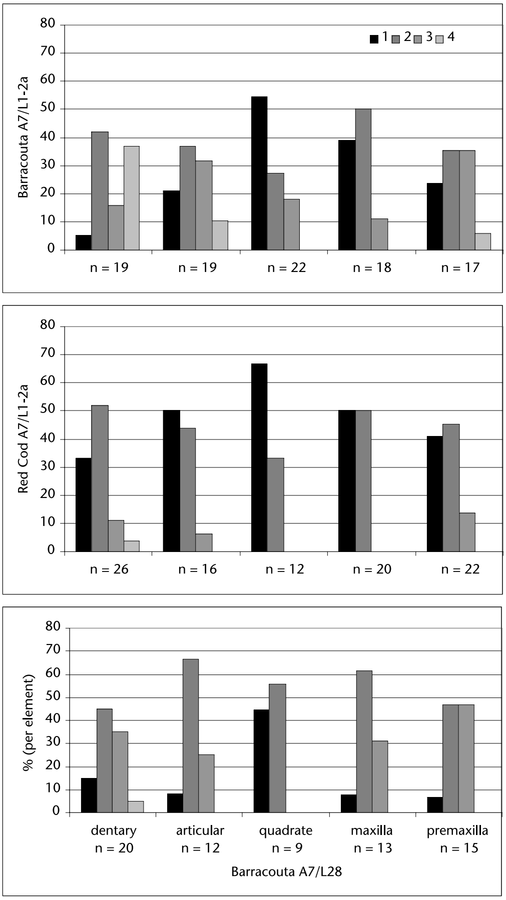

FIGURE 2

Weathering profiles by element for each species assemblage in Area 7.

However the barracouta assemblage from L1-2a is unusual in that quadrates are the most common element and the other elements are all roughly equally represented. It was noted above that this was the least weathered assemblage, and although weathering has begun in this assemblage it does not seem sufficiently advanced to fall into the expected pattern. Once the assemblages are broken down by element numbers become unreliably small, and a larger sample size might better resolve the effects of weathering at this stage of the process.

How can we quantify this process? The simplest statistic that can serve as a ‘weathering index’ is some sort of measure of centralising tendency, and the median has been selected for this purpose. This median score is calculated as though the weathering scores were spread out on a continuum (which in reality they are, though represented here for analytical convenience as a series of discrete steps). The median, then, is the weathering score that the element ranked n/2 would be assigned.

In Figure 3 median weathering score by element for the three species assemblages is plotted against %MAU, which represents survivorship. For the L2b barracouta and the L1-2a red cod the two statistics vary together fairly closely, with weathering of the L2b barracouta more advanced, as has already been noted. However the L1-2a barracouta assemblage, which was interpreted as being the least weathered, does not follow this pattern. If weathering is the taphonomic process responsible for the differential survival of elements then we would expect a weathering index to correlate with survivorship, which it generally does. The pattern breaks down where weathering is not

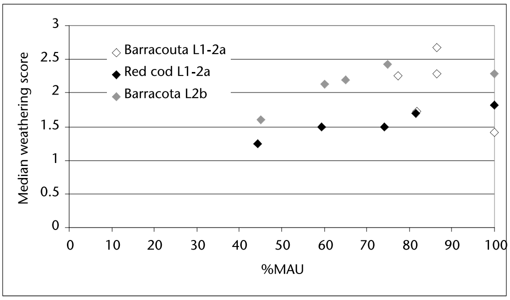

FIGURE 3

Weathering median score plotted against %MAU for each species assemblage in Area 7.

very advanced, and might also break down at the other extreme of a very weathered assemblage. If weathering and survivorship vary together, as Figure 3 indicates they do, then the survivorship profiles shown in Figure 4 will stand as proxy measures of weathering.

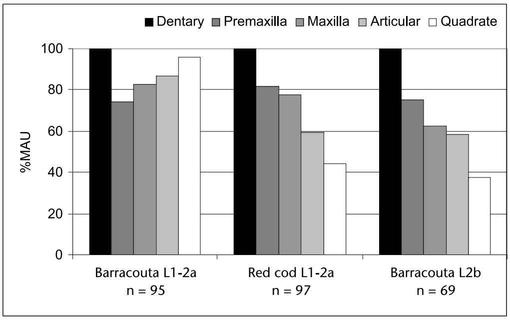

FIGURE 4

Survivorship profiles for each species assemblage in Area 7.

Survivorship of skeletal elements would appear to be dependant on the same variables already proposed to explain the different weathering profiles between species, that is structural density and mechanical strength. With a sample of only two species from one assemblage and one from another, however, it would be premature to generalise this pattern too far, but the conceptual link between weathering and survivorship is clear—elements that survive best are those that weather least.

Lernau & Ben-Horin (1994) have come to a similar conclusion in their development of the concept of taphonomic curve and index. The analysis presented for Pleasant River has the advantage of simplicity in both counting and statistical analysis—in fact a visual assessment of the survivorship profile is all that is required. Even so, like Lernau and Ben-Horin I emphasise that this work is only preliminary, and the method needs to be much more widely tested before it can be confidently applied.

The data for Pleasant River have been examined and graphed in four ways, but each leads to the same interpretations: barracouta bone and red cod bone weather and survive differently; the barracouta from A7/L1-2a is considerably less weathered than the other two assemblages; and survivorship relates directly to weathering. In order to see if this pattern can be extended to other fish bone assemblages from East Otago, without re-analysing the assemblages, the data for Shag River Mouth (Anderson *et al.*, 1996a) was collated, and survivorship profiles analysed. This site is richer than Pleasant River, with denser and deeper deposits and much higher fish counts. It dates to a tight range of 20–50 years in the 14th century (Anderson *et al.*, 1996b: 67). Shag Mouth was a semi-permanently occupied village (Anderson & Smith, 1996) roughly 12 km north of Pleasant River, and it may even be the case that early in its use Pleasant River was seasonally occupied from Shag Mouth (Smith, 1997: 71).

The survivorship profiles for barracouta assemblages from Shag Mouth demonstrate a similar pattern to the Pleasant River assemblages (Figure 5). Some assemblages would seem to be more weathered than others, with the Area C Layer 5 the least weathered and the Area C Swamp Layer 2 assemblage the most weathered. The Area D:2 layer 1 assemblage is also highly weathered. An examination of weathering on moa bone from Shag Mouth (Anderson *et al.*, 1996c: 207) shows that for this taxon the most highly

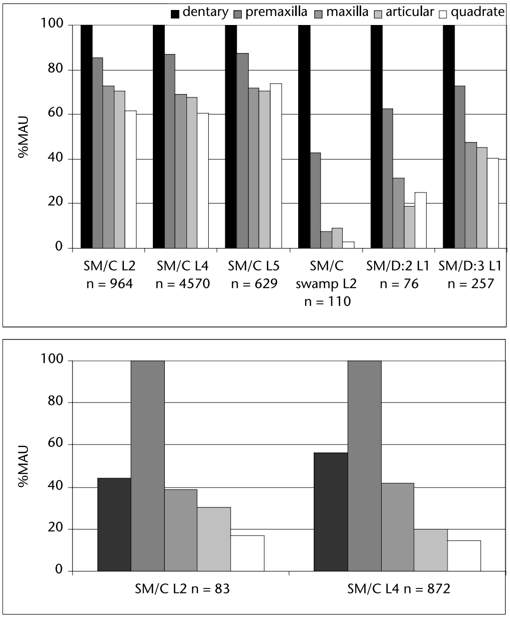

FIGURE 5

Top: survivorship profiles for barracouta assemblages at Shag River Mouth. Bottom: survivorship profiles for red cod assemblages at Shag River Mouth with the elements arranged in the same order.

weathered assemblage was the Area C Swamp assemblage, and that the Area D:2 assemblage was also highly weathered—in other words even without re-analysing the Shag mouth assemblages for weathering, the survivorship profiles for barracouta bone (and by implication, weathering patterns) conform to known taphonomic patterns. In fact, were we to visually assess the survivorship profiles to rank the barracouta assemblages from least to most weathered (SM/C L5; SM/C L2; SM/C L4; SM/D3 L1; SM/D:2 L1; SM/C Swamp L2) we would obtain virtually the same result from visually assessing the moa bone weathering profiles provided by Anderson *et al.* (1996c: 207, figure 14.3), expect that SM/C L2 is here slightly more weathered than L4.

Turning to the two red cod assemblages from Shag Mouth for which sufficient bone survived to provide a large enough sample (Figure 5), it is apparent that the survivorship profiles differ markedly from the red cod in the Pleasant River A7/L1-2a assemblage. At Shag Mouth the most common element is the premaxilla, at Pleasant River it is the dentary. The reasons for this discrepancy are unclear—it may be due to the differential weathering of elements at different stages of the process. Even so, the Shag Mouth red cod profiles follow the same pattern as the barracouta profiles, with SM/C L2 being slightly more weathered than SM/C L4.

Figure 6 shows the survivorship profiles for four species from SM/C L4—the barracouta and red cod already profiled in Figure 5, and two other species for which there were sufficient numbers to plot the profiles—blue cod and ling (*Genypterus blacodes*). This further demonstrates that different species will have different survivorship profiles. As all these species assemblages are from the same context it may be assumed that all have been subject to the same subsurface weathering conditions, but the patterns that result from this are quite different.

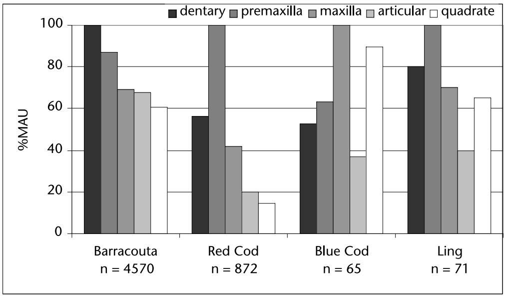

FIGURE 6

Survivorship profiles for four species assemblages from SM/C L4.

CONCLUSIONS

In summary, taphonomy patterns archaeofaunal assemblages. In this case I have examined the subsurface weathering of fish bone, which can be graphically represented in several ways. The simplest way of doing this is to plot survivorship profiles of the major identified elements. The shape of the profile will give a good indication of how weathered the assemblage is. In the case of Shag Mouth, weathering in fish bone correlated with weathering in other taxa, particularly moa, indicating that a simple measure of fish bone weathering can be used to indicate the extent of weathering throughout the whole assemblage. A problem arises when different species weather at quite different rates, so that in order to determine how advanced weathering is, the basic shape of the survivorship profile of each species must be determined. For barracouta this is becoming clear, but for other species this is not yet the case.

It is clear that fish bone (in fact, all bone) is affected to a considerable degree by taphonomic processes, and this in turn affects archaeological analysis. Other taphonomic factors may also have to be taken into account, as appropriate to each context—burning (particularly apparent in the Pleasant River A2/L2 assemblage), gnawing by rats and dogs, trampling, and direct exposure to sun and rain, to say nothing of cultural factors such as technology, cultural preferences and food preparation techniques. This analysis has asked far more questions than it has answered. For instance, how and why do different species weather differently? What does this mean in terms of survivorship, or failure to survive? How does the destruction of evidence of an unknown number of individuals who may have originally been deposited, and the differential destruction of species, affect our analyses? Can this process be quantified? One question that may be asked of complex and time-consuming taphonomic analyses is, is it worth the time and effort? At least this question can be answered—with the simple analysis of existing data time and effort are minimal, while the potential gain in information is high, but a more comprehensive database is required before the method can be more widely applied with confidence.

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