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ECOLOGICAL METHOD AND THEORY: TIWAI PENINSULA

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INTRODUCTION

This paper describes an assessment of the most useful biological methods and viewpoints for an initial description of the relationships between prehistoric man and the organic sector of his environment. Material used was collected from Tiwai Peninsula, Southland, between 4 and 8 April 1969, in conjunction with an Otago Anthropological Society excavation.

Rescue excavations and some site surveying prior to the erection of an aluminium smelter on the western tip of Tiwai Peninsula, have revealed the presence of several areas of middens and ovens, and also an adze making site. The flaking floor, where these 'argillite' adzes were being made, was associated with a midden composed predominantly of cockle shells (*Chione stutchburgi*), along with numerous bird bones (including moa), some dog and seal bones, and a few fish bones (see Park, 1969), Site S/

Since this report is based on only a single visit to the site, the methods used consist of simple descriptive analyses made while walking and driving over the area. When I began the survey, I knew which species of birds and molluscs had been found in the midden during previous digs and a little about their abundance. I centred my efforts around two problems - the availability and nearest possible source of the most important mollusc and bird species represented in the midden. Most of the molluscan material will be published at a later date and I shall present here only those conclusions pertinent to the problem of "community studies" versus "species studies".

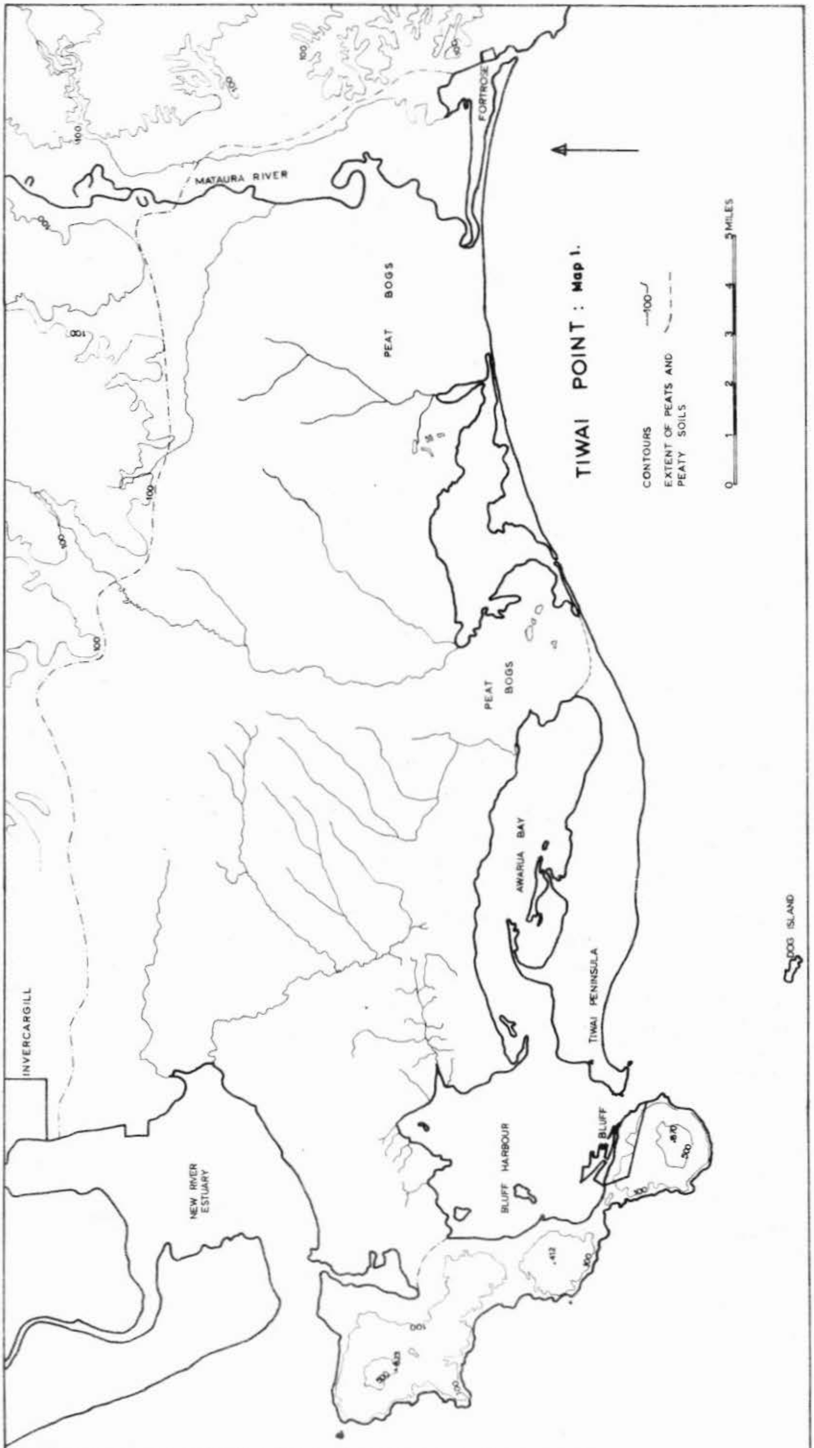
TOPOGRAPHY AND CLIMATE

The site is on an undulating plain. The only relief consists of:

1. Beach ridges less than six feet high running roughly parallel to each other down the length of the peninsula.

2. A narrow lagoon about a mile long lying in a hiatus between two series of beach ridges.

3. A series of low rocky or sandy knolls less than 45' high. (See Map 2).


TIWAI POINT : Map 1.
CONTOURS
EXTENT OF PEATS AND PEATY SOILS
0 1 2 3 4 5 MILES
MATAURA RIVER
FORTROSE
PEAT BOGS
PEAT BOGS
AWARUA BAY
TIWAI PENINSULA
DOG ISLAND
INVERCARGILL
NEW RIVER ESTUARY
BLUFF HARBOUR
BLUFF

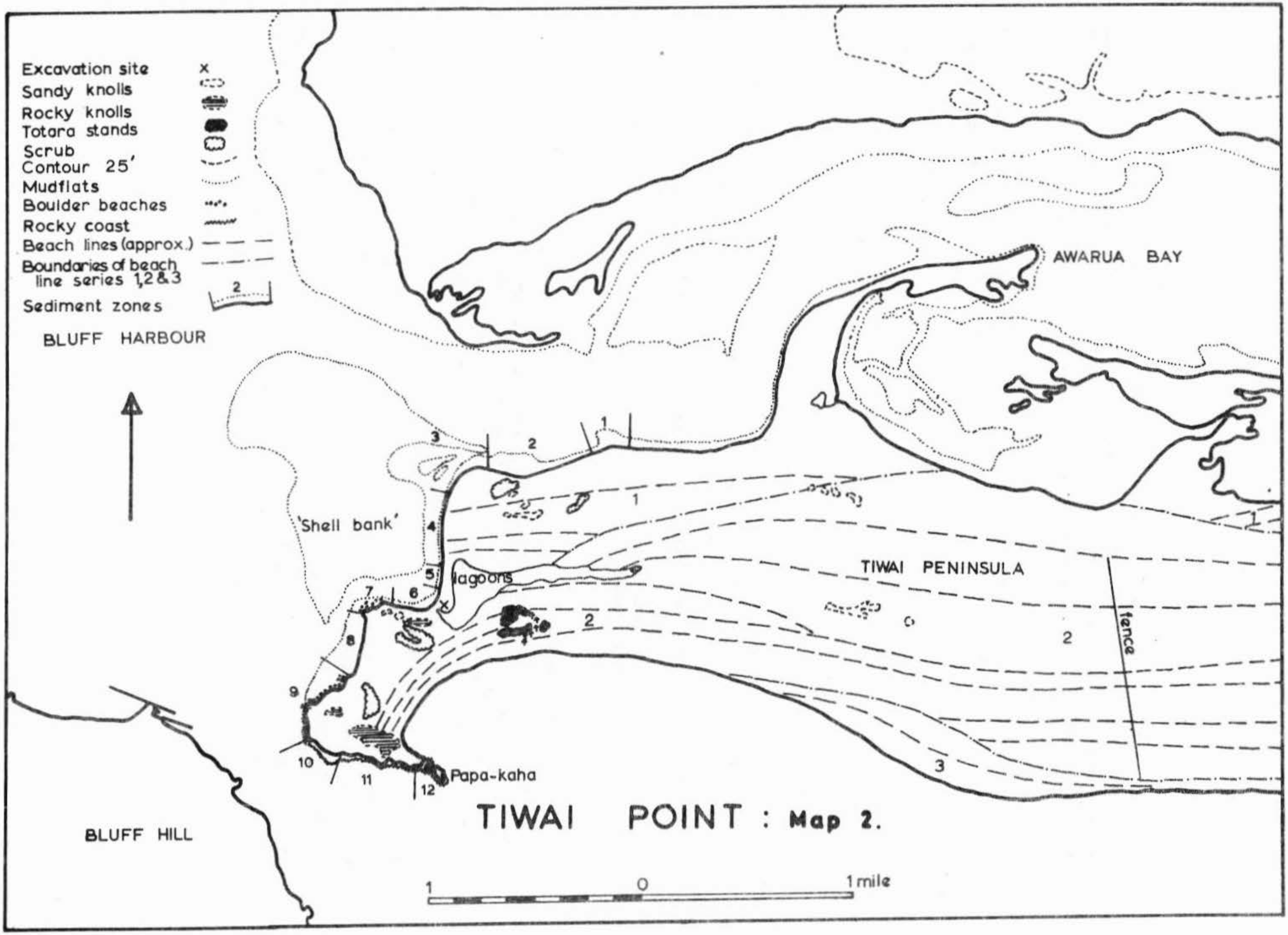
The western half of the peninsula is nominally sheltered from the prevailing westerlies by Bluff Hill (870'), but strong dessicating westerlies and south-westerlies laden with salt spray are a dominating feature of the local weather. The recorded rainfall at Invercargill is 43" per annum, and most of this falls during strong wind storms. The outer beach of the peninsula is subject to heavy lime massed gravels, plentifully strewn with driftwood. The inner beach is somewhat more protected and is backed by a seven-foot high bank of eroding, cemented quartz pea-gravels.

The soil varies from a very dark brown loam to a black peaty loam, containing a high proportion of fine quartz gravel, and of a very loose and open texture. Raeside et al. (1968) classify Tiwai Peninsula as carrying 'Southern yellow-brown sands' though sands are notably lacking in the soils. Natural access to the peninsula is by sea or along the beaches. Land access is limited by extensive peat bogs to the north and east of the peninsula. (See map 1)

MOLLUSCS AND SEDIMENTS

I subdivided the beaches close to the site into sediment-mollusc associations (see Tables 1 and 2) and roughly sampled the cockle populations. All the species of midden shells except for Scutus breviculus were found along the shorelines. Eight species of largish molluscs which were found locally were not in the midden, suggesting that it is worth testing the hypothesis that there have been recent changes in the mollusc populations. The largest cockles were found on those edges of the shell bank which were closest to the site (see Map 2), but observations and local information indicate that the shellbank and its channels have changed considerably in the recent past. It became very evident that to make statements about prehistoric cockle populations we must first understand the factors controlling the cockle as a species. The other molluscs taken from the tidal flats are each controlled by a different constellation of factors, which must be assessed for each species if we wish to make predictive statements about prehistoric mollusc populations.

There is no certain evidence in the midden for the collection of shellfish from the two reef outcrops. There are a few scraps of paua shell (Haliotis iris), some very small mussels (Mytilus edulis) smaller than those found attached to coarse gravels inside Awarua Bay, and the possibility that the catseyes (Lunella smaragda) were collected from the kelp fringe of the reefs rather than from the Zostera beds where they also


Excavation site
Sandy knolls
Rocky knolls
Totara stands
Scrub
Contour 25'
Mudflats
Boulder beaches
Rocky coast
Beach lines (approx.)
Boundaries of beach line series 1,2 & 3
Sediment zones
BLUFF HARBOUR
AWARUA BAY
'Shell bank'
lagoons
TIWAI PENINSULA
fence
Papa-kaha
BLUFF HILL
TIWAI POINT : Map 2.
1 0 1 mile

occur. On this exposed coastline it seems more probable that the catseyes were collected from the shallow and sheltered Zostera beds inside Awarua Bay. The reefs carry an impoverished biota at the present time and the midden evidence suggests this is longstanding.

Alcithoe shells were about the third most abundant shell in the midden, all the shells having been broken presumably to extract their contents. The natural habitat of these Alcithoes (probably A. swainsoni) is a sandy flat below neap low tide levels. (Morton and Miller, 1968: 490) No live Alcithoes were found; none of their shells were found inside Awarua Bay but they were found rolled up on the outer sea beach where the beach profile is relatively shallow. They were the only mollusc which probably was taken from outside Awarua Bay proper.

THE BIRD FAUNA AND VEGETATION

Only one collection of bones from the midden has been analysed (by C. Higham and R. Scarlett) but from this analysis it is evident that at least four groups of birds are important - petrels, shags, moas and bush birds (parakeets and pigeons) (See Table 4). Most of these birds except the parakeets seemed to have been present on the site as whole carcasses. The notable lack of parakeet extremities may simply be because they are the smallest and most lightly boned of the birds present.

The shags and petrels present are all colonial nesters. The Stewart Island shags (Phalacrocorax carunculatus chalconotus) nest at present on Papa-kaha, the colony having 90 nests when visited on 20.11.55 (Sansom, 1956: 17). This site was not used until 1953 but Stewart Island shags are notorious for deserting their colony sites if disturbed and so the site may have been used intermittently previously. The nearest known nesting site of Spotted Shags (Stictocarbo punctatus) is at Centre Island, 30 miles to westward and closer to the site of Wakapatu (Higham, 1968). However, both species of shags could have found suitable nesting sites on Bluff Peninsula. The Little Shag (Phalacrocorax melanoleucos brevirostris) is absent from the midden though common in the bay at present. Its roosting and nesting habits and its smaller size may have made it a less economic food source. At present in Otago and Southland it nests in small colonies hidden in trees and Carex swamps. The petrels could have been collected from nesting colonies on the end of Tiwai Peninsula and the sooty shearwaters from Bluff Hill where nests have been recorded (Beattie, 1944).

To determine the availability of bush birds, a general summary must be made of all the factors which may indicate the presence of a forest community contemporary with the midden material. This particular analysis can be made in terms of the broad subdivisions of podocarp-hardwood and beech forest communities, since New Zealand bush birds show wide ecological tolerances and particular species are not limited to particular types of podocarp forest. It is worth distinguishing between beech forest and other forest types, because bird populations are appreciably lower in beech forests.

THE VEGETATION

Existing lowland podocarp forests require a minimum of 40 inches of rainfall per annum (Burrows, 1961). Because it is unlikely that there is a significant difference between the rainfall of Invercargill and Tiwai Peninsula, the water regime of the peninsula may be marginal for forest at the present time. However, historical records indicate that the surrounding districts, including Bluff Hill, were well covered with matai/totara/kahikatea forests (Holloway, 1954), but a brief description by R. Williams who sailed into Bluff Harbour in 1831 (map in Hocken Library) suggests that by then at least the western tip of the peninsula carried no forest. A survey map of about 1870 shows some bush limited to the region of the present day totara stands, but as it was probably low and wind-sheared it may not have been visible from Bluff Harbour.

The following description of the vegetation is taken from my field notes. About three-quarters of a mile east of the flaking loor site there are roughly three small stands of Hall's totara (Podocarpus hallii) 15 ft high with a few exotic pines (Pinus radiata) and macrocarpas (Cupressus macrocarpa) 80 ft high standing among them. Scattered totara tress (usually only 6-10 ft high) occur up to half a mile down wind of these stands (i.e., to the east), especially along the banks of the lagoons. The healthier stands of totara, where they are not strongly invaded by sheep and cattle, are regenerating quite vigorously. In April 1969 many of the trees were fruiting heavily (on the down wind side) and there was a good range of seedlings and poles in the healthiest stand. Rabbits were introduced at Bluff in 1864 (Wodzicki, 1950: 108) and Tiwai Peninsula was very heavily infested until the local Rabbit Board was formed about 1955 (L. Lockerbie: pers. comm.). There are historical records of purposeful firing of the vegetation. The survival of the totara stands under these conditions does not suggest a marginal existence. However, Halls' totara is known as an ecologically aggressive species by comparison with other podocarps such as matai (Podocarpus spicatus) and its existence as a 15 ft high wind-sheared scrub is not conclusive evidence for former forest. Occasional trees and fallen logs show that in the recent past the stands were 30 ft high, but no evidence was found that the stands ever covered more than the general area which they enclose at the present time.

Occasional moribund specimens of hardwood species and of ferns typical of the understory of Southland lowland podocarp forest suggest that the stands were once floristically much richer than they are now. Only single specimens of many of the species listed in Table 3 were found, all the trees were under 15 ft high, and usually much less. The two specimens of Parsonsia heterophylla found were particularly healthy. Holloway considers this sort of evidence to be indicative of the former presence of lowland podocarp forest.

The beach ridges which run the length of the peninsula seem to have been laid down in three successive periods, the northernmost ones first (B. L. Wood: pers. comm.). These ridge series are associated with variations in the size and density of mounds which have all the appearance of being forest dimples left by the overthrow of a forest by an easterly wind. (The prevailing westerlies shape the shrubby vegetation into 'aerofoil' forms which, when attacked from the east, would tend to behave like a parachute, and so may have been peculiarly vulnerable to overthrow by only moderately strong east winds.) Among the oldest beach ridges the dimples are up to 3 ft high and 8 ft wide and of irregular shape. In the middle series the mounds are neatly round, oval, or crescentic and much smaller. There are very few mounds among the youngest beach ridges. The two mounds that have been dug into consisted of a mixture of very dark loam and gravel to at least 2 ft below the natural surface. No wood or charcoal was found. The dimpled zone begins about a mile to the east of the totara stands and there are no dimples at all among the totaras. Any forest that may have existed at the western end at the time or times of wind throw was unaffected.

The vegetation of the dimpled area is dominated by tussock and flax (Phormium tenax) associations. A wide strip down the centre is dominated by lush Southland red tussock (Danthonia rubra) with zonal strips on the seaward side of pure bracken, mixed bracken-Cassinia and finally a band of Festuca novaezelandiae with or without wind-sheared Coprosma scrub right against the beach gravel. Flax is plentiful everywhere, sometimes forming dense patches of strong growing plants. The mosaic of manuka scrub, Coprosma scrub and Coprosma-tussock associations (both tall and short tussock) on the western tip of the peninsula suggests a long history of fire induced associations.

DISCUSSION

Methods

The particular methods used in any ecological survey must be closely adapted to each specific problem. In general, the methods of autecology (see below) will be of most use to the archaeologist. The quantitative methods of synecology are designed to answer particular questions about biological communities as such and their orientation may make them totally unsuited to archaeological enquiry about the environment. Their usefulness is therefore limited and they should always be carefully tied to a given problem.

Two general points became apparent during this work. Since the archaeologist is looking at an area as a habitat for a given group of people, his viewpoint will be different from that of the biologists. In consequence, he would be well advised to collect as much primary data for himself as he can, using his own two feet to explore his area. Also, since there are so many ways of looking at the inter-relationships between plants, animals and their physical environment, it is generally more economical for the archaeological ecologist to start work after the digging has begun. He can then define his problems in archaeological terms first and thus work outwards into zoological and botanical fields of enquiry, then back to the site to look for factors suggested by the environment, and so on, to and fro.

"Microenvironment"

The approach in this paper has been supplementary to that of Flannery in his South-west Iran and Guatemalan work (e.g., Coe and Flannery, 1964). Flannery maintains that prehistoric man exploited microenvironmental rather than macroenvironmental units. It may be useful to go one step further in New Zealand where ethnographic evidence suggests that prehistoric man selected quite intensively particular species often at particular stages of their life cycle. In this case a more useful viewpoint would be that prehistoric man selected species from <u>his habitat</u> which may or may not include a variety of communities, and these are important only insomuch as they affect the availability of the utilized species.

This is an autecological viewpoint. Autecology can be defined as the study of <u>individual</u> organisms or species in relation to an area or habitat. It is contrasted with the <u>synecological</u> approach which considers <u>associations</u> of organisms in relation to an area (Cloudsley-Thompson, 1967: 1). An autecological approach involves the definition of the term 'habitat'. Dansereau and others define 'habitat' as the immediate conditions which the organism experiences. It is the ultimate subdivision of the environment to which the organism is confined and where exchanges actually take place (Dansereau, 1957). Other authors use 'habitat' as a synecological term to mean some level of community organization and so speak of an organism as occupying several habitats (see Appendix).

The species utilized by the occupants of Ocos, Guatemala, are discussed by Flannery as being almost entirely members of specific communities. There is very little discussion of the requirements and tolerances of even important food species. As far as the reader is able to discern, the distribution of the microenvironment labelled 'red mangrove forest' must be taken as completely coincident with the distribution of 'Racoon, porcupine, anteater and crabs' (Coe and Flannery, 1964: 652). This can be an economic way of presenting evidence if a large number of common species of a well-defined biotic community have been utilized, but it can be a misleading method in that biotic communities are not closed entities. Their internal structure can change over time as species leave by extinction and enter by migration. Also, the environing community is only one of the important factors controlling a utilized species and it is not even a single and indivisible factor.

Communities at Tiwai

Division of the Tiwai mollusca into communities such as 'the mudflat' or 'the rocky shore' was relatively unrewarding. An area of small boulders embedded in sand can yield Cellana strigilis and Zediloma corrosa from the boulders and cockles from the sand. The typically rocky shore mussel (Mytilus edulis) was seen live only on a gravel beach. Rather than a series of discrete communities along the inner shoreline of Tiwai Peninsula there is a rough gradient from silty gravels carrying a high proportion of bivalves out to the rocky points which carry a high proportion of pulmonate species and almost no bivalves. Working in terms of communities was misleading. To provide predictive data about the supply of mollusca at Tiwai, it would be necessary to delineate the habitats of relevant species by close study of their tolerances and requirements and the distribution of particular crucial factors in the prehistoric environment.

Avian communities pose different problems. Petrels and shags are peculiarly different to treat as members of a community since their habitats encompass such large sectors of the physical environment. The synthesis that David Lack has recently published on the relationships between the breeding and feeding habits and habitat selection within seabird species is the first of its kind and, though his hypotheses still require more testing, they contain useful suggestions for the archaeologist (Lack, 1967).

Bush bird species show many curious gaps in their present day distributions and the factors controlling these populations, both as species and as communities, are often obscure. Consequently, having assessed floristic evidence for past forest communities on the Peninsula, only a general statement can be made about past pigeon and parakeet populations by extrapolating from inadequate general information about present day distributions. It is just feasible that both species could have been taken in totara stands 30 ft high, particularly when the trees were fruiting, or in the forest which produced the largest forest dimples. Since both the midden and possible former forests are undated, the source of the bush birds in the midden remains nebulous. It was worth searching for evidence of a former forest community but we need more specific information about parakeet habitats and about pigeon habitats, as well as better chronological control before we can make more determinate statements about the availability of these bush birds. If the midden soil were successfully analysed for traces of plant foods such as fern root or berries, and general community analysis carried out for bush bird habitat, autecological studies for the particular plant species involved would still be necessary.

Evidence for long term variability in the vegetation types of the Peninsula may eventually be significant when more is known about moa habitats. This variability also makes it practicable to set up the hypothesis that all the food species so far recovered from the midden could have been gathered within a mile of the site (with the possible exception of the Spotted Shags).

Prehistoric man has gone from New Zealand. We cannot study his requirements, his energy transfers, i.e., his autecology, directly. But we can study the autecology of the species which he utilized as these species exist now in present day environments, and by extrapolating carefully we should be able to make some good probability statements about their availability to Polynesian man.

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APPENDIX 1

Terminology

Flannery uses biotope and microenvironment as synonyms whose meaning is ill-defined. Microenvironment is an uncommon term in modern ecology and its occasional usage is generally with the concepts of microclimate and microhabitat which, in general, are applied to the study of such places as the crevices in rocks and logs or the interior of animal carcasses. Flannery may have derived his usage from the classic work of Hesse, Allee, and Schmidt, where biotope is defined as "the primary topographical unit" - that is an area showing uniformity in the principal habitat and conditions. Hesse gives as examples of biotopes mud beaches, sandy beaches and gravel beaches, and these are parts of his "biochore" of the sea coast (Hesse, Allee, Schmidt, 1951). To Dansereau, biotope is synonymous with "niche" and can be most variable in physical size.

Since ecological terminology is still fluid, it may be as well for the archaeologists to use the most generally understood terms for the sake of efficient communication. Atkinson et al. have published a list of definitions after consultation with a number of New Zealand biologists and soil scientists. They make it clear that the list is not authoritative but a basis for consideration and discussion. However, its wide disemmination in the publication 'Tuatara' should help create a consensus of usage. They purposely exclude "specialist words", and this may be a reason why they do not define 'biotope' and 'microenvironment'. In defining 'community' they distinguish it from 'ecosystem' thus: "The term 'community' focusses attention on the species within the biosphere volume, whereas the term 'ecosystem' focusses attention on nutrient cycling and energy flow within the biosphere volume." (Atkinson et al., 1968) Archaeologists cannot afford to ignore discussions such as this.

Model building

A raison d'etre for environmental analyses in the study of New Zealand prehistory may be expressed in terms of a Black Box problem as described by David Clarke. We are faced with "a complex system completely concealed but for an output terminal and an input terminal. The only information available about the system within the box must come from observing the changing relationships between varying values at the input and output terminals." (Clarke, 1968). If we regard the midden contents as one output terminal, then the human activities which resulted in that output become the Black Box of the problem since these activities can never be directly observed. The prehistoric environment is then seen to be a power source for one of the input terminals and its relevance as a piece of evidence about what went on inside the Black Box becomes apparent. Unfortunately, the prehistoric environment is also, strictly speaking, a Black Box but the relationships between its various input and output states are relatively rigid and determinate, and we have many very similar contemporary environmental systems available for direct study.

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APPENDIX 2

TABLE 1

Zone	Topography	Sediments	Ripple marks	Depth at which anaerobic layer lies
1	Gravel shelf muddy hollows	Coarse gravels some stones over 3" diam.	Steep edge landwards	3" - 6"
2	Lower beach graded. Upper beach gravel ridges	Lower beach silt. Upper beach fine quartz gravel	Steep edge landwards	2" - 3"
3	Shell bank, tidal channels & gravel shelf	Heavy gravel, shell heaps	None	Variable
4	Graded beach on edge of tidal channel	Fine gravel and silt	Steep edge seawards	3" - 6"
5	Graded beach on edge of tidal channel	Fine silt	Complex. Main set steep edge seawards	1" - 2"
6	Graded beach on edge of tidal channel	Moderately coarse gravel with silty areas	Not noted	In silt 1" - 2"
7	Graded beach with bedded boulders in upper beach	Bedded boulders with small sandy beaches between	Irregular, but symmetrical profile	2" - 4"
8	Graded sandy beach in curve of small bay	Sand & fine pea gravel	None	Not present?
9	Graded beach near wharf	"Cobble" gravels increasing to 2' loose boulders	None	Not present?
10	Low reef of ridge & furrow type. Kelp fringe	Bed rock (Tiwai Pt.)	None	None
11	Steep boulder beach	Large loose boulders	None	None
12	Low reef-rock islands with dispersed pools & channels	Bed rock	None	None

SEDIMENTS ALONG THE AWARUA SHORELINE.

TABLE 2

Zone	Live molluscs	Other species found as dead shells only
1	*Chione stutchburyi* *Macomona liliana* *Zediloma corrosa* *Zeacumantus subcarinatus* *Cominella glandiformis* *Mytilus edulis*	*Amphidesma australe* *Sigapatella novaezealandiae* *Ostrea angasi*
2	As previous zone, plus:- *Lunella smaragda* *Buccinulum sp.* *Cellana sp.*	*Paphirus largillierti* *Maoricolpus roseus* *Ostrea*
3	*Chione stutchburyi* (few)	*Amphidesma australe* *Macomona liliana* *Paphirus largillierti* *Protothaca crassicosta* *Mactra discors* *Melarapha cincta*
4	*Chione stutchburyi* *Zediloma corrosa* *Zeacumantus subcarinatus*	*Amphidesma australe* *Lunella smaragda* *Ostrea angasi*
5	As previous zone	No sample taken
6	As previous zone	No sample taken
7	*Chione stutchburyi* (few) *Macomona liliana* *Zediloma corrosa* *Z.digna* *Melarapha cincta* *M. oliveri* (few) *Cominella glandiformis* *Cellana strigilis redimiculum* *C.ornata* *Cellana sp.*	*Ostrea angasi*
8	*Chione stutchburyi* (few)	*Amphidesma australe* *Paphirus largillierti* *Protothaca crassicosta* *Mactra discors* *Perna canaliculus* *Modiolus areolatus* *Zenatia acinaces* *Ostrea angasi*

TABLE 2 (cont.)

Zone	Live molluscs	Other species found as dead shells only
8 (cont)		*Haliotis iris* *Cookia sulcata* *Lunella smaragda* *Maoricolpus roseus* *Cominella glandiformis*
9	*Chione stutchburyi* (few) *Zediloma corrosa* *Z.digna* *Cellana strigilis redimiculum* *C. radians* *Cellana sps.*	*Amphidesma australe* *Macomona liliana* *Paphirus largillierti* *Ostrea angasi* *Haliotis iris* *H.australis* *Lunella smaragda* *Maoricolpus rosens* *Zeacumantus subcarinatus* *Buccinulum sp.* *Lepsiella scobina* *Modiola granulosa*
10	*Zediloma corrosa* *Z. digna* *Melarapha cincta* *M. oliveri* (few) *Lepsiella scobina* *Cellana strigilis redimiculum* *C.ornata* *Elminius modestus* (few)	*Haliotis iris* *Aulacomya maoriana*
11	No sample - very little life	No sample
12	At half tide:- *Zediloma digna* *Zediloma - small sp.* *Melarapha cincta*	*Protothaca crassicosta* *Mytilus edulis (1)* *Perna canaliculus* *Haliotis iris* *Cellana strigilis redimiculum* *Cellana ornata* *Lunella smaragda* *Cookia sulcata* *Buccinulum sp.*

Species list of molluscs and barnacles from zones of Awarua Bay shoreline. See Table 1 for description of substrates.

TABLE 3

Species found in relict stands of Hall's Totara

Podocarpus hallii	*Dicksonia squarrosa*
P. ferrugineus	*Pteridium aquilinium*
Pittosporum colensoi	*Polystichum vestitum*
Griselinia littoralis	*Paesia scaberula*
Pseudopanax edgerleyi	*Histiopteris incisa*
Pseudowintera colorata	*Blechnum capense*
Myrsine australis	*B. lanceolatum*
Coprosma propinqua	*B. fluviatile*
C. parviflora	*Asplenium bulbiferum*
C. areolata	*Phymatodes diversifolium*
Fuchsia excorticata	
Cyathodes junipera	*Tmesipteris tannensis*
Gaultheria antipoda	
	Muehlenbeckia australis
Phormium tenax	*Rubus cissoides*
Juncus gregiflorus	*Parsonsia heterophylla*

TABLE 4

Species	Minimum number of Individuals	Extremities
Sooty shearwater (Puffinus griseus)	18	11-13
Broad-billed Prion (Pachyptila vittata)	12	8
Spotted Shag (Stictocarbo punctatus)	6	6
Stewart Island Shag (Phalacrocorax carunculatus)	5	5
Parakeet (Cyanorhamphus novaezelandiae)	27	5
N.Z. Pigeon (Hemiphaga novaeseelandiae)	4	4
Emeus crassus	2	2
Euryapteryx gravis	1	1
E. crassus or E. gravis	2	2
Anomalapteryx or Megalapteryx	4	4

Analysis of a collection of bird bones from Tiwai midden. Only those species for which there is more than one individual are listed. The minimum number of individuals as determined from bones distal to the ulna or tibia and from cranial bones is given in the right-hand column. (By courtesy of Professor C. Higham)