

THE BOULDER BEACH FAUNA OF OTATA ISLAND

by D. H. Wood

INTRODUCTION

Boulder beaches appear to offer a rather inhospitable environment to intertidal animals, but nevertheless a considerable number of species has invaded this rather limiting habitat. Some of these species are rarely if ever found elsewhere, and can be considered as forming the boulder beach species assemblage proper, while others are either "interlopers" usually from open rock areas nearby, or "casuals" from the sub-littoral zone.

From work done on boulder beaches at Waitangi (Bay of Islands), Fletcher's Bay (Coromandel Peninsula) and Whangaparapara (Great Barrier Island), Trevarthen (1950 and 1951) drew some tentative general conclusions about the species inhabiting boulder beaches :-

1. The following species are physiognomic in the "local" boulder beach assemblage of species :

<u>Suterilla neozelanica</u>	<u>Heterozius rotundifrons</u>
<u>Marinula filholi</u>	<u>Petrolisthes elongatus</u>
<u>Cyclograpsus lavouxii</u>	Red shrimp
<u>Zediloma digna</u>	<u>Actinia tenebrosa</u>
<u>Z. morio</u>	<u>Leptoplana brunnea</u>
<u>Nerita melanotragus</u>	<u>Acanthoclinus quadridactylis</u>
<u>Notoacmea daedala</u>	Encrusting algae
<u>Anisodiloma lugubris</u>	

2. Other species are apparently of importance in comparisons (usually invaders from adjacent open rock areas):

<u>Melarhappe oliveri</u>	<u>Cellana radians</u>
<u>Elminius modestus</u>	<u>Anemonia divacea</u>
<u>Chamaesipho columna</u>	<u>Cominella virgata</u>
<u>Lepsiella scobina</u>	<u>Anthopleura aureoradiata</u>
<u>Hemigrapsus sexdentatus</u>	

3. Four zones can be recognised from the distribution pattern of these species :

- I Suterilla Zone above E. H. W. S.
II Marinula-Cyclograpsus Zone from about M. H. W. S. to just below M. H. W. N.

III General Pebble Community Zone from the lower limit of zone II to about M. L. W. N.

IV Mixed Lower Littoral Zone about M. L. W. N. and below.

4. These zones appear to be related to the physical structure of the beach - the arrangement of the stones, the level of the sand, and the distribution of the decaying debris.

These conclusions were tested in a study of the boulder beaches on Otata Island, the results of which are recorded and discussed below.

LOCATION

Otata, the largest island of the Noises group, lies in the Hauraki Gulf 15 miles in a northeasterly direction from Auckland city (see Fig. 1). The coastline of the eastern half of the island is cliffed and rugged, with many offshore stacks, rocks and reefs as evidence of the battering it receives from N. E. storms blowing down the Hauraki Gulf. On this side of the island two boulder beaches occur :-

1. At the western end of a small bay (the site of traverse 1, see Fig. 2) protected from the open sea by a cliffed peninsula and many offshore rocks and reefs;
2. At the head of a narrow unprotected inlet (the site of traverse 2, see Fig. 2) with cliffs on either side.

The coastline of the western half of the island is not pounded by such heavy seas as the eastern half, and two sandy beaches occur as well as the only other boulder beach on the island. This boulder beach forms a tombola between the island and a small stack at its southern end, and is backed by a low clay bank at its northern end (the site of traverse 3, see Fig. 2). No rocks lie offshore.

METHODS

On each of the three beaches a traverse at right angles to the shore was run from the cliff or bank at the head of the beach down to low water. Quadrats one yard square were marked off at intervals along the traverse and investigated by removing the rocks and stones from within the quadrat until bedrock or sand was reached. The species found were noted, and their abundance within each quadrat and their ecological position recorded.

The site of the traverse, the number of quadrats, and their distance apart were decided upon after having surveyed the beach with the following ideas in mind :

1. To obtain a comprehensive species list of the fauna on the beach;
2. To find out the distribution of the species on the beach in relation to tidal levels;
3. To investigate particularly the distribution of Suterilla neozelanica.

RESULTS

The species recorded from each traverse are listed in Appendices I, II and III, and the quantitative distributions of the more important species on the three beaches are illustrated in Figures 3, 4 and 5, together with a diagrammatic profile of the traverse of the respective beach.

DISCUSSION OF RESULTS

Traverse 1 (Appendix I and Fig. 3)

The beach across which traverse 1 was layed out was a more or less typical sheltered boulder beach. The upper part of the beach was formed of pebbles and stones 1 inch to 4 inches in maximum diameter. These had been piled up by waves to a depth of about 3 feet and formed a storm bank against the cliff at the top of the beach. At about M. H. W. N. the slope of the beach became very much gentler (see Fig. 3) and occasional boulders up to 2 feet in maximum diameter occurred embedded amongst the smaller stones. A little below M. H. W. N. to below M. L. W. S. the beach was formed of a single layer of these larger boulders between which smaller rocks and stones occurred and a thin layer of coarse sand had been deposited.

At station 5 small patches of Apophloea sinclarii grew in the cracks of the larger boulders, while just above M. L. W. N. at station 6 it formed much larger patches on the surface of all the bigger boulders. Below M. L. W. N. at station 7 some corallina turf also occurred and corallina paint was common on the boulders.

In the distribution of the species the four zones referred to by Trevarthen could be clearly seen. There was a narrow Suterilla Zone above E. H. W. S. in which there was present an amphipod (species 'A') living amongst decaying algal debris beneath the surface, a collembola species which occurred deeper down than the amphipod, and Suterilla neozelanica which was found crawling on the damp surface of stones 1 foot to 2 feet 6 inches below the surface of the beach.

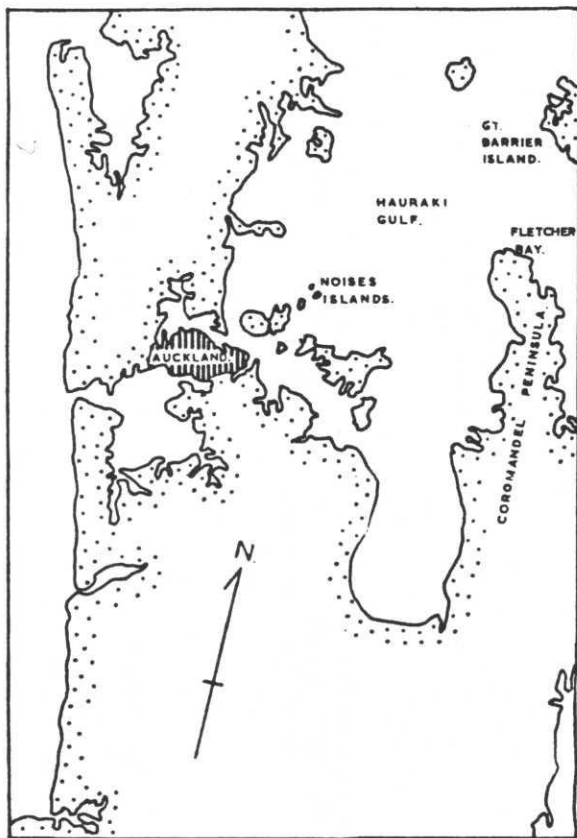


FIG. 1 THE HAURAKI GULF.

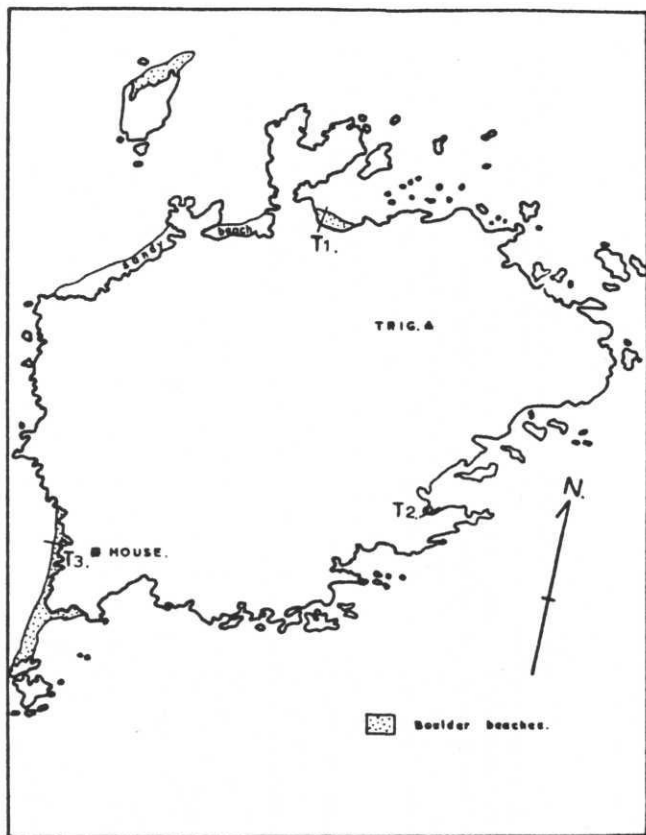


FIG. 2 OTATA ISLAND SHOWING BOULDER BEACHES AND TRAVERSE LOCATIONS.

Between about M. H. W. S. and M. H. W. N. (i. e. about station 2) there was a Marinula-Cyclograpsus Zone in which occurred amphipod 'A', again among algal debris, a few Melarhaphé oliveri on the larger surface stones as well as Marinula filholi and Cyclograpsus lavouxii beneath the surface layer of stones. M. filholi did not extend as far down the beach (i. e. below M. L. W. N.) as might have been expected, probably because the depth of the layer of small stones below M. H. W. N. (i. e. at station 3) was only 6 inches which allowed them to dry out almost to the sand level, and perhaps also because there was no algal debris in this part of the beach. Both an amphipod (species 'B') and a nereid polychaete lived under the lowest stones against the sand at this station as well as a few Nerita melanotragus and many M. oliveri on the scattered large surface rocks.

Below station 3 on the beach the General Pebble Community Zone began in which all the species listed for this zone by Trevarthen were present except Zediloma digna, Acanthoclinus quadridactylis and a red shrimp. The absence of Z. digna was probably owing to the lack of algal debris which was not common anywhere on the island. There were no small pools amongst the boulders in which A. quadridactylis could remain as the tide receded so that it was not surprising that it was not found, but no explanation can be given for the absence of the red shrimp unless it was overlooked. The zone extended down to between M. L. W. N. and M. L. W. S. (about station 7.) Only two of the species in it, M. oliveri and Chamaesipho columna, were "interlopers!" They occurred only on the larger more stable boulders which offered a very similar habitat to the open rock of the nearby cliffs where both species were much more common.

Below this level on the beach (i. e. from station 7 down) a Mixed Lower Littoral Zone could be distinguished in which a large array of species occurred. In this lower part of the beach the majority of the boulders were stable and consequently many of the species which were present occurred equally as commonly on the solid rock of the cliff base or the reefs. Such species were the several chitons - Sipharochiton pelliserpentis, Ischnochiton maorianus, Amaurochiton glauca, Ornithochiton neglectus; the limpets Siphonaria zelandica and Cellana radians; the barnacles C. columna and Tetraclita porosa; the tube worm Pomatoceras coeruleus; and the carnivorous gastropods Lepsia haustrum, Cominella virgata and Lepsiella scobina.

Thus this Otata boulder beach which was similar to the beach described by Trevarthen at Waitangi both in having about the same degree of shelter and a lower region of stable boulders between which sand had been deposited, also harboured a similar assemblage of species. However the fauna except for M. oliveri and C. columna did not include any "interlopers" from the open rock or the reefs above M. L. W. N. compared with the presence of such species as high as M. S. L. at Waitangi. The occurrence of "interloper" species higher up the beach at Waitangi could have been the result of the extra shelter afforded to the beach by the reef which truncated it at about M. L. W. N., since no such reef was present on the Otata beach.

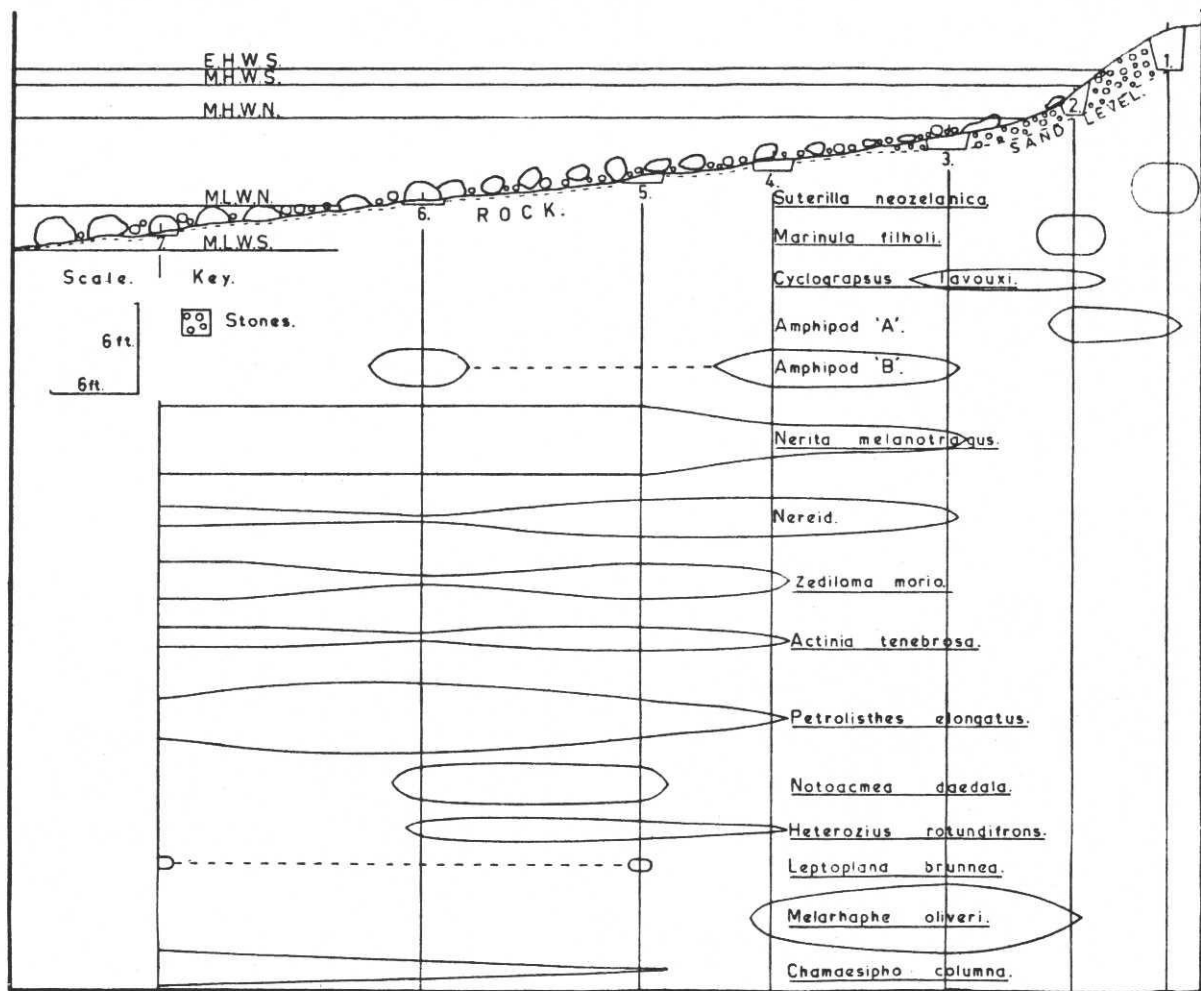


FIG. 3. DIAGRAM SHOWING PROFILE OF TRAVERSE I, STATIONS, AND DISTRIBUTION KITES OF SPECIES.

Traverse 2 (Appendix II and Fig. 4)

The beach down which traverse 2 was run differed considerably from the beach described above in such features as the degree of exposure, the size of the boulders, the amount of sand deposition, and the slope of the upper beach (above M. H. W. N.). Associated with these physical differences there were also some interesting changes in the fauna.

The upper part of the beach from just above M. H. W. N. to the base of the cliff was quite extensive (see Fig. 4). It was made up of pebbles 1 - 2 inches in maximum diameter in a layer about 2 feet deep through which occasional pieces of bed rock projected. Also a few large rocks lay half buried amongst the pebbles. In several places below the pebbles deposits of sand or loam occurred. About M. L. W. N. the pebbles formed a comparatively steep bank. Below this bank the beach was a jumble of scattered large (from 4 to 8 feet maximum diameter) angular rocks between which many smaller rocks (6 inches to 1 foot maximum diameter) and pebbles (1 - 3 inches in maximum diameter) occurred. No sand had been deposited in this area of the beach and in several places smooth slabs of bedrock were exposed. No algae grew on any of these rocks.

The Suterilla Zone was present as before above E. H. W. S. and accompanying S. neozelanica in this zone was again a species of collembola. No amphipods were present though, probably because there was extremely little algal debris for them to feed on.

Since the Suterilla Zone was so extensive a study was made of the depth distribution of the species (see Fig. 4). This showed that it occurred in a maximum density at a depth of about 12 inches and was rarely found closer than 6 inches to the surface. The obvious difference between the pebbles at 6 inches and those at 12 inches below the surface was the amount of moisture on their surfaces. Above 6 inches the pebbles were dry, at 6 inches depth the surfaces of the pebbles were just damp, while at 12 inches and below the pebbles were quite wet. At station 1, where S. neozelanicus occurred at a depth of 6 inches, loam was present below this depth and the pebbles lying just above it had comparatively moist surfaces. Similarly at station 4, where S. neozelanicus occurred in maximum density at a depth of 6 inches, sand was present 12 inches below the surface and the pebbles at 6 inches below the surface were quite wet, owing no doubt to a more humid atmosphere in the interstices between the pebbles above the sand, sand having a high water retention capacity.

Thus S. neozelanica, though clearly intolerant of submersion, occurring as it does only at and above E. H. W. S., was found only on the damp surfaces of pebbles. If the damp surface was a result of moisture absorption by a thin coating of organic matter, and this organic material was the food supply of S. neozelanica, its association with damp pebbles is readily explained.

A striking feature of this beach was the absence of Marinula filholi and Cyclograpsus lavouxi. The Marinula-Cyclograpsus Zone (M. H. W. S. to just below M. H. W. N.) was occupied by an amphipod species, an isopod species, a few specimens of Leuconopsis obsoleta well below the surface, and Melarhappe oliveri on the large surface rocks. The absence of M. filholi was probably owing to the lack of decaying algal debris on which it seems to be dependent as a food. It was hard to discover a reason for the absence of C. lavouxi unless it was that the pebbles were of such small size that the interstices between them were too small to be a suitable habitat for the crab.

The area of beach below M. H. W. N. had a fauna very much modified from that at the same level on the previously studied beach. In the General Pebble Community Zone the usual physiognomic species occurred with the exception of Heterozius rotundifrons and Leptoplana brunnea, but also in this zone there were present as many "interloper" species from the open rock of the cliff face (i. e. Chamaesipho columna, Saxostrea glomerata, Elminius modestus, Pomatoceros coeruleus and Modiolus neozelandicus as well as M. oliveri whose range extended up the beach into the Suterilla Zone). This change was obviously the result of the presence of large angular rocks on which these "interloper" species were attached.

It was hardly possible to distinguish a Mixed Lower Littoral Zone since the number of species usually restricted to it were much reduced in numbers. Of these species only Cellana radians, Lepsiella scobina and Risselopsis varia were present. This probably resulted from the absence of any shelter to the beach so that no sand had been deposited between the boulders, and the smaller rocks (less than 1 foot maximum diameter) were rolled about by the waves on the surface of the bed rock.

So, in comparing this beach with the first Otata beach, the effects of exposure and the presence of very large boulders and absence of a boulder beach proper below M. H. W. N. can be clearly seen. Large rocks cause an increase in the number of sedentary "interloper" species while exposure reduces the variety of species particularly in the Mixed Lower Littoral Zone.

Traverse 3 (Appendix III and Fig. 5)

The beach down which this traverse was run was composed entirely of pebbles from a $\frac{1}{2}$ to 4 inches in maximum diameter. It extended from a clay bank well above E. H. W. S. down to a little below M. H. W. N. where the pebbles gave way to a coarse shingle. Thus it was equivalent to only the top part of either of the previous two Otata beaches described. The pebbles formed a layer 1 - 2 feet deep above the sand and had been built up by wave action into a series of steep banks and terraces (see Fig. 5). There was a storm bank above E. H. W. S., a spring tide bank above M. H. W. N. and a neap tide bank below M. H. W. N. The storm bank and terrace above it were comparatively stable, but the other two banks varied in position with the

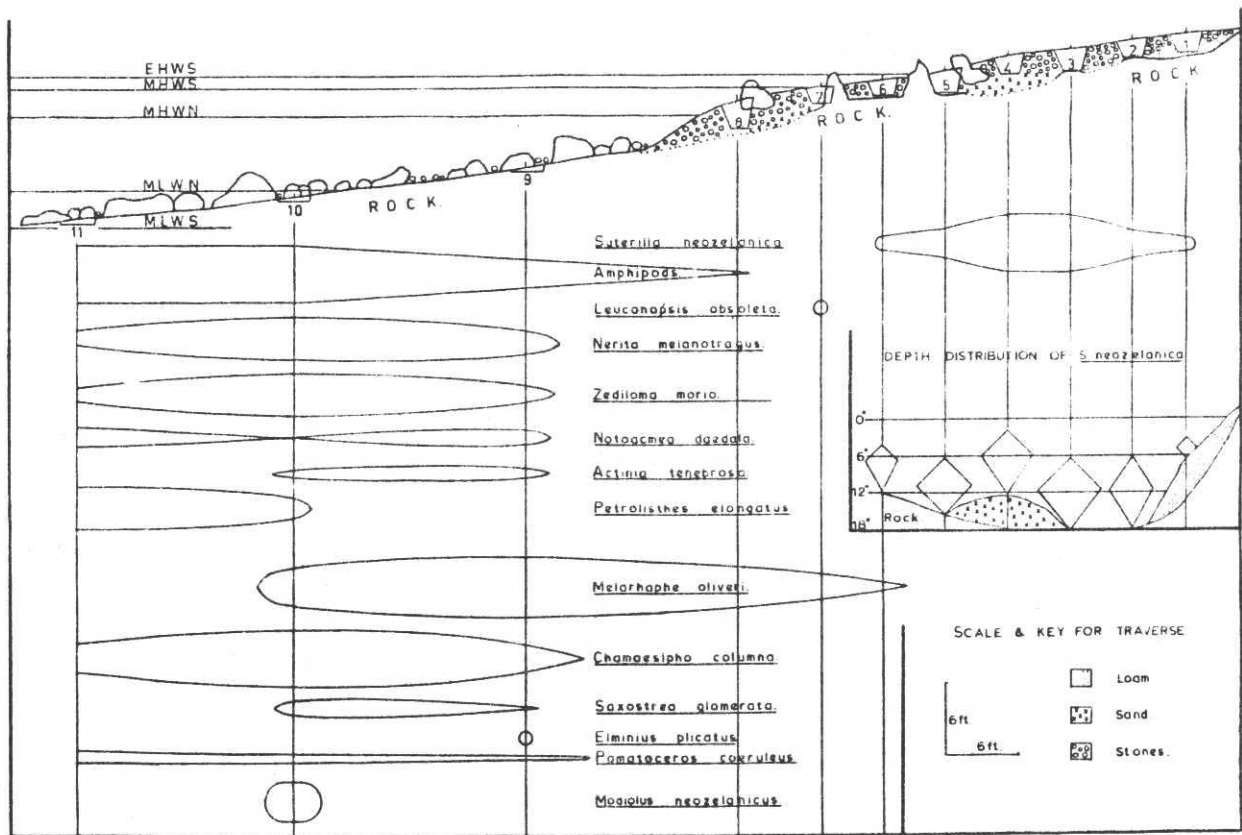


FIG. 4. DIAGRAM SHOWING PROFILE OF TRAVERSE 2, STATIONS, AND DISTRIBUTION KITES OF SPECIES.

height of the tides and roughness of the sea.

On this beach only 3 species were found. Suterilla neozelanica was present in the stable storm bank of the beach above E. H. W. S. and occurred, as previously, well below the surface where the pebbles were covered with a film of moisture. Marinula filholi occurred from about M. H. W. S. to M. H. W. N. in the continually changing spring tide bank. Like S. neozelanica, M. filholi was present only beneath the surface where the stones were moist. At about M. H. W. N. an amphipod species was present particularly where there were decaying algal holdfasts. As on the second Otata beach Cyclograpsus lavouxii was absent, and the reason for its absence was probably the same as before. At station 6 no animals were present.

This traverse further confirmed the distribution pattern of S. neozelanica and M. filholi on pebble beaches. It also supported the suggestion that Melarhapse oliveri was present, at least in the upper part of the beaches, only because of the presence of large stable rocks since it was absent from this beach where no such rocks occurred.

SUMMARY OF DISCUSSION

Traverse 1 showed that on a fairly sheltered boulder beach 4 zones, each with a typical assemblage of species, can be distinguished in relation to tidal heights. The species which occurred in the zones were the same as those listed by Trevarthen for boulder beaches studied by him.

The fauna of the exposed beach down which traverse 2 was laid out was found to be much modified from that of a more sheltered beach. The lack of shelter considerably reduced the number of species below M. L. W. N., and the numerous large stable rocks present formed a suitable habitat for sedentary species typical of the fauna of the adjacent cliffs. These species were common on the beach almost up to M. H. W. N. level, forming a typical group among the boulder beach fauna. A more intensive study of Suterilla neozelanica on this beach showed that it only occurred well below the surface layer of stones reaching a maximum density about 12 inches below the surface. It occurred only on pebbles and rocks with damp surfaces.

The absence of large rocks from the third beach studied, accompanied by a parallel absence of Melarhapse oliveri, suggested the necessity of a stable substratum (i. e. large boulders) for the presence of this species on boulder beaches.

Thus these results from the three beaches of Otata Island confirmed the tentative general conclusions of Trevarthen which are set out in the introduction.

The writer wishes to acknowledge the help given in the field by Miss S. Pirrit.

APPENDIX I

List of species found at the stations on traverse 1 with an indication of their abundance and ecological position.

Species	Stations						
	1	2	3	4	5	6	7
	**						
* Suterilla neozelanica	(I)	A***					
Collembola	(I)	A					
Amphipod 'A'	(I)	C	A				
Melarhaphe oliveri	(E)	P	A	A			
* Marinula filholi	(I)	C					
Cyclograpsus lavouxii	(I)	C	C				
Isopod (? Ligia sp.)	(I)		C				
Nerita melanotragus	(S, E)		C	A	A	A	A
Nereid	(U)		O	O	C	P	O
Amphipod 'B'	(U)		C	A		A	
Zediloma morio	(S, E)			C	A	O	C
Actinia tenebrosa	(S)			P	O	P	O
Petrolisthes elongatus	(U)			O	A	A	A
Heterozius rotundifrons	(U, I)			P	O	O	
Notoacmea daedala	(S)				A	A	
Chamaesipho columna	(E)				P	O	A
Leptoplana brunnea	(U)				P		P
Anisodiloma lugubris	(S)					O	
Rissoina chathamensis	(U)					P	O
*Siphonaria zelandica	(S)					P	O
*Sipharochiton pelliserpentis	(S)					P	
Asterina regularis	(S)					P	P
Turbo smaragda	(S)						C
Maoricrypta monoxyla	(T)						C
*M. costata	(S)						O
Sigapatella novaezelandiae	(C)						O
Haliotis isis	(S)						P
Cellana radians	(E)						A
Rochefortula reniformis	(C)						O
*Saxicava arctica	(B)						P

Appendix I (cont'd)

Species	Stations						
	1	2	3	4	5	6	7
<i>Ischnochiton maorianus</i>							P
<i>Tetraclita porosa</i>							P
<i>Pomatoceras coeruleus</i>							A
<i>Hemigrapsus sexdentatus</i>							P
<i>Cancer novaezelandiae</i>							P
<i>Ophiuronereis fasciata</i>							P
<i>Evichinus chloriticus</i>							P
<i>Anemonia sp.</i>							O

Other species occurring just below station 7 :-

Amaurochiton glauca
Ornithochiton neglectus
Lepsia haustrum
Cominella virgata
Lepsiella scobina
Marginella sp.
Herpetopoma bella
**Stephopoma roseum*
**Lassaea maoria*
Lepidonotus sp.

* Additions to the species list of molluscs from the Noises Islands (Sumich, J. 1950).

** (I) Living between or on sub surface stones
(E) Living on exposed surface of stones
(S) Living on undersides or in cracks of surface stones
(U) Living under stones
(T) Living attached to T. smaragda shells
(C) Living in Corallina
(B) Rock borer, living in rock
(A) Living amongst the barnacles

*** Approximate numerical values of abundance symbols

Symbol	Numbers of individuals except for <u>C. columna</u> & <u>M. neozelanicus</u>	Approx. area covered by <u>C. columna</u> & <u>M. neozelanicus</u>
P	1 - 5	2 ins. sq.
O	5 - 15	4 " "
C	15 - 30	8 " "
A	30 - 50	12 " "
>A	>50	>12 " "

APPENDIX II

List of species found at the stations on traverse 2 with an indication of their abundance and ecological position.

Species		Stations												
		1	2	3	4	5	6	7	8	9	10	11		
<i>Suterilla neozelanicus</i>	(I)*	C*	A	>A	>A	A	C							
<i>Collembola</i>	(I)	P	C	C	A	C								
<i>Melarthaphe oliveri</i>	(E)						P	C	A	>A		A		
** <i>Leuconopsis obsoleta</i>	(I)							O						
Amphipod	(I)								P	A	>A	>A		
Isopod (? <i>Ligia</i> sp.)	(I)								A					
<i>Nerita melanotragus</i>	(S, E)										C	A	C	
<i>Zediloma morio</i>	(S, E)										C	A	C	
<i>Notoacmea daedala</i>	(S)										O		C	
<i>Actinia tenebrosa</i>	(S)										O	O		
<i>Chamaesiphe columna</i>	(E)										A	>A	A	
<i>Pomatoceras coeruleus</i>	(S)										P	P	O	
<i>Saxostrea glomerata</i>	(E)										P	O		
<i>Elminius plicatus</i>	(E)										O			
<u><i>Spiroorbis</i> sp.</u>	(S)										P			

Appendix II(cont'd)

Species	Stations											
	1	2	3	4	5	6	7	8	9	10	11	
<i>Petrolisthes elongatus</i>											C	A
<i>Cellana radians</i>											C	O
<i>Modiolus neozelanicus</i>											>A	
<i>Risselopsis varia</i>											>A	
<i>Lepsiella scobina</i>											C	

* See Appendix I for explanation of abundance symbols and ecological position symbols.

** An addition to the species list of molluscs from the Noises Islands (Sumich, J. 1950).

APPENDIX III

List of species found at the stations on traverse 3 with an indication of their abundance and ecological position.

		Stations					
		1	2	3	4	5	6
<i>Suterilla neozelanica</i>	(I)*		C*	C	O		
<i>Marinula filholi</i>	(I)					C	A
Amphipod	(I)						A

* See Appendix I for explanation of abundance symbols and ecological position symbols.

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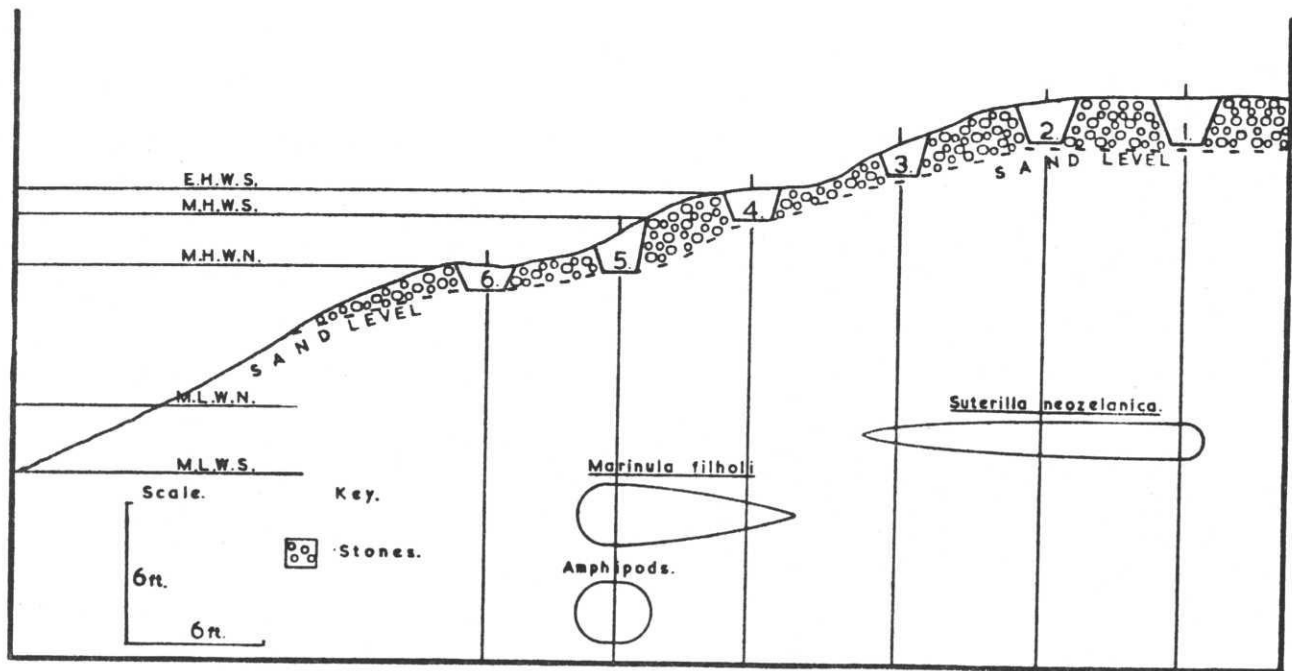


FIG. 5. DIAGRAM SHOWING PROFILE OF TRAVERSE 3, STATIONS, AND DISTRIBUTION KITES OF SPECIES.