The Macrofauna of an Unstable Beach Discussed in Relation to Beach Profile, Texture and a Progression in Shelter from Wave Action

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By

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Abstract

The beach at Ingles Bay, Kaikoura, is shown to have two gradients in texture, becoming progressively finer: (i) moving southwards into increasing shelter from wave action, and (ii) moving down from E.H.W.S. to E.L.W.S. level. Infauna is only present at Gooch's Beach, where sand occurs, but this beach is variably sheltered according to weather conditions and is unstable in that it may be disturbed by heavy seas. The distribution of macrofauna is determined in relation to three surveyed transects and to substratum texture. It is found that there are two distinct and unrelated infaunas, that of the supralittoral fringe and that of the lower intertidal zone (in addition to epifauna within flotsam, which is disregarded). The two infaunas are separated by barren beach. The lower intertidal infauna is limited in species (mostly polychaetes) and apparently all are derived from the infratidal zone rising to higher levels as shelter increases. Towards increased shelter colonisation is more abundant and varied and penetration of the intertidal occurs to much higher levels. Also, there is a change in the characteristic fauna of the lowest levels as shelter is increased but it is not resolved whether this is a progression in the establishment of climax communities at places of different beach stability or whether the change reflects close association with beach textures. The supralittoral fringe infauna is characterised by the amphipod *Talorchestia quoyana* and various flies and beetles: its lower limit descends where the beach has greater shelter.

Introduction

The shore of Ingles Bay, off the town of Kaikoura, is chiefly a steep shingle beach that is terraced by wave and tidal action. It is almost devoid of flotsam and appears to be barren of intertidal fauna. The shingle is mostly composed of greywacke that is apparently derived from the Hapuku River and transported southwards by the surf of strong northerly winds. An aerial photograph displayed in the Edward Percival Marine Laboratory shows the Hapuku outflow running southwards into Ingles Bay but whether there is a regular inshore counter-current to the prevailing offshore northerly Canterbury Current needs investigation. There certainly is no southerly inshore current that is strong enough to transport the cobbles of the beach without the additional effects of surf.

The rocks of Kaikoura peninsula terminate Ingles Bay in the south and provide enough shelter for the southern extremity of the beach to become sandy and modified in profile. A local map names this part Gooch's Beach. A small river, Lyell Creek, opens to the sea too far north of Gooch's Beach to affect it and the beach is virtually unaffected by a streamlet (sometimes dry) that drains to the adjacent rocky beach by a culvert near the marine laboratory.

The prevalent swell of this coast is south-easterly: although this breaks heavily against the shingle beach of Kaikoura it becomes progressively diminished southwards towards Gooch's Beach. The protection afforded to Gooch's Beach influences the beach profile and substratum texture in subtler ways than are immediately apparent. Although northerly swell appears to occur seldom, the quite frequent strong, northerly surface winds quickly build up steep northerly seas that cut Gooch's Beach considerably. Heavy sea conditions are normally separated by more or less calm periods during which fine particles settle and quantities of algae, torn from the reefs, are deposited on Gooch's Beach where it forms dense mats extending down from above high tide level to a variable extent, sometimes even to low tide level. This decaying flotsam has a rich characteristic fauna and its breakdown presumably influences the substratum texture and provides food for the beach infauna. Owing to its situation, then, Gooch's Beach may have its profile changed and the substratum texture and constitution modified according to the prevalent degree of scouring/sedimentation and the history of the offshore water (i.e., clear, or bearing sediment and algal debris). It is a changeable and unstable beach.

Three transects were selected (Figure 1) in November, 1964, to demonstrate the relationship between the intertidal macrofauna and the beach profiles and textures. Later papers will describe a nearby beach of uniform texture and features of the flotsam fauna.

Methods

Beach profiles were obtained by the ranging rod and sea horizon survey method (Morgans, 1965b) and related to tide datum through observations of low tide level on the afternoons of 23 and 24 November 1964 (adding the low spring tide correction of 1.3ft to the predicted Lyttelton levels).

Samples of surface sand, to a depth of several inches, were taken for analysis of texture at stations as seemed rewarding. Each sample comprised about 1.5–2Kgm (volume approximately one quart) and it was treated with formalin for trapped animals since little silt was present to be affected by this procedure. Later, animals and fluid were removed and the substratum sample oven-dried (usually at 60–70°C. for a day or two). Texture was determined by weight after automatic shaking for 30 minutes in a stack of eight-inch "Endecott" standard sieves.

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So far as possible the recommendations of Morgans (1956) were followed but it was impossible to obtain a set of sieves exactly matching the Wentworth series. Available sieves had apertures (square mesh) as follows: 4760, 2057, 1003, 500, 250, 124, 64, 45 microns. Thus, the only significant discrepancy is that the apparent "granules" grade contained the smallest pebbles *sensu stricto* which, of course, were thus missing from the apparent "pebbles" grade.

The infauna of the beach was assayed in two ways: (i) quantitatively at each station, by digging a 19in circle to approximately 11in depth and sieving the sand over 19in diameter sieves of which the finest was 16-mesh (square apertures, 1003 microns); (ii) qualitatively, by random digging and sieving. Sieving for fauna was done by agitation of the sieve-stack in the sea and attempting to prevent water from entering the top sieve from above (which can lead to swimming animals and flotsam contaminating the sample).

Beach Profile and Texture

The shingle beach is steep and terraced off Kaikoura town and the profile becomes less steep and the terracing less pronounced as the increasing shelter of Gooch's Beach is approached. The trend continues across Gooch's Beach, the profiles of Transects C, B and A becoming progressively flatter (Figs. 3A, 4A, 5A).

Concurrent with the change in beach profile is, as might be expected, a change in texture. Although this paper is not concerned with the apparently barren beach north of Gooch's Beach, a brief examination of the texture of the barren beach was considered desirable. This was done by taking substratum samples from approximately high and low water levels at the four localities named in Figure 2, which shows the textures present. The most northerly sample is from opposite the railway bridge over Lyell Creek. The beach here is pebbly with a considerable proportion of cobbles (some of large size) and the high and low water levels have similar texture. Off Brighton Street (see Figure 1) the texture is generally finer, without cobbles, moreover, the texture at low water level is markedly finer than that at high water level. The substratum off Margate Street is almost the same as that off Brighton Street but at the southernmost locality of this series (Gooch's Beach off Number 240 The Esplanade) the substratum is of even finer texture. These samples demonstrate a progressive reduction in beach particle size from north to south along Ingles Bay and examination of Figures 3B, 4B and 5B shows that this trend, as with the trend of beach profile, continues across Gooch's Beach (in Transects C, B and A at levels 5.6ft and 1.1ft above datum).

The Margate Street and Brighton Street samples show that deposits are coarser at high water level than at low water level and this feature of beach texture is confirmed by the Gooch's Beach transects. This, then, is the second textural trend that is demonstrated. (The only anomaly to this trend is the situation off 240 The Esplanade, and this was probably an incidental effect of the great mat of flotsam on the beach at and above high water level there on that occasion.)

Frequent field notes comment on the lack of substratum homogeneity at any spot: e.g., the substrata off both 240 The Esplanade, and Margate Street were noted to be "many layered, the layers being either of granules or of very coarse sand, or of a mixture"; on 23.11.64 it was noted that at Transects A and B: "in general the top 2–4 inches is more sandy than lower depths, which are gravelly—the surface layers are yellow-brown, the lower layers dark-grey" (i.e., wet greywacke granules); and on 24.11.64 it was noted that "at Station C3 granules on the surface lie over sandy granules beneath". Such layering was clearly caused by different sea conditions and Gooch's Beach is more prone to variation in sea conditions than the more uniformly exposed, shingle beach north of it. Consideration of textural analyses must, therefore, be confined to the most outstanding features and there is no point in tabulating the Phi quartile deviation or skewness of each sample.

Transect C is complete from E.L.W.S. to the terrestrial plant line without curtailment by rock or soil. The substratum was sampled at nine stations and a most interesting pattern of texture is revealed (Figure 3B) showing a remarkably quasi symmetry about Station 5 which is the upper level of the more extreme spring tides (the lower level of which is about Station 10). The intertidal region is here dominated by very coarse sand except at E.H.W.S., which is dominated by granules, and at E.L.W.S., which is dominated by fine sand. Expect for the lowest and highest stations the median grade is very coarse sand but there is nevertheless an increasing coarseness of texture up the beach to E.H.W.S. level. Above this level the beach is only affected by heavy surf (which presumably accounts for the upper distribution of granules and very coarse sand) and by wind (which presumably affects chiefly the finer particles). The analyses reveal a conspicuous lack of coarse and medium sands intertidally and show their progressive increase above E.H.W.S. level. It will be realised that a horizontal line bisecting Figure 3B passes through the median grades of the stations sampled.

Transect B has a lesser vertical range than C in that its lower end terminates at the exposed rocks of a reef and its upper end at a stony soil salting cliff above which bushes grow. Six stations were assayed for texture and the results are shown in Figure 4B. The two general trends of texture that have been remarked upon are here evident, viz., (i) it is finer than at Transect C, and (ii) it is finer at low water level than at high. Pebbles are mostly at H.W.S. level at which, as in Transect C, there is a conspicuous reduction in the amount of very coarse sand present. Coarse and medium sands show the same trends as at Transect C but are rather more noticeable here. Perhaps the chief feature of note is the abundant presence of very fine sand at and below M.S.L. which may be due to the influence of protecting rocks at the lowest extremity of this transect. The only rather well sorted substratum was that of Station 10. (The substratum of Station 8 might have been influenced by a nearby rocky outcrop.)

Transect A is considerably truncated by rocks at its lower end and rocky outcrops closely flank the transect and even obtrude into it (Figure 1, insert). Station 6a, next to a scoured gulley around an outcrop of rock, was considered untypical of this piece of beach so Station 6b, seven feet from 6a, and at the same level, was examined. Station 7a was a survey station enabling return to the transect line at 7b. The upper end of the transect rises above E.H.W.S. level but abuts a concrete

breakwater against which some cobbles and pebbles have been piled by strong surf at high tide. E.H.W.S. level is at about Station 4 although observed high water on 24.11.64 appeared to be 6 inches higher, possibly due to piling up in this angle of the shore. Six substratum samples were analysed (see Figure 5B) and, despite anomalous results for Stations 6b and 7b, they corroborate the two major textural trends mentioned. The median grade at high springs level is medium sand, and a grade finer than the median grade at the same level on Transect B, but despite this the sand at the two localities is of almost identical texture. It seems that similar changes occur descending Transect A as descending Transect B except that finer grades predominate in A and achieve complete dominance at all levels below about M.S.L. Despite the lower part of the transect running between flanking rocks the sediments suggest it to be normally more a region of deposition than of scouring: the substratum at Stations 8 and 9 was extremely well sorted in strong contrast to that at higher stations of this transect and at any station of Transects B and C.

Faunal Distribution

The purpose of this work was to determine macrofaunal distribution in the soft substrata of Gooch's Beach and therefore the stony areas (e.g., Station A2) and flotsam were avoided. A quantitative digging was made at each sandy station (results summarised in Table I) and further quantitative results of a limited nature accrued through removing animals from substratum samples (Table II). Random digging at the level of each station proved a useful means of amplifying knowledge (Table III). The major features of distribution are summarised by quantitative representations in Figures 3A, 4A and 5A, kite widths being proportional to numbers of specimens taken.

Transect C is barren of fauna save for a rather sparse fauna at and below M.L.W.S. and a supralittoral fringe fauna situated apparently at the upper limit of wave upwash (Tables I–III and Figure 3A). Tendrils of the terrestrial weed *Convolvulus* extend as low as Station 2. The long polychaete *Lumbrineris* is the only animal present in fair numbers.

The author did similar work at a position 2–3 yards west of Transect C on 6 May 1962, and found the following fauna: A supralittoral fauna that reached down to the lowest flotsam (about 40–46 inches above H.W.S.T. level) and that was dominated by the amphipod *Talorchestia quoyana* in large numbers but that included a spider (K.003 E), flies (K.003 D), other insects (K.002 D, E, F) and a few oligochaete worms (K.002 A). The intertidal was barren save for one *Metacirolana japonica* at a level 14 inches lower than H.W.S.T. and one polychaete worm, *Nerine antipoda,* at a level 9½ inches above L.W.S.T. The variety of the supralittoral fauna may be taken as reflecting the presence of flotsam (absent from Transect C) and the virtual barrenness of the entire intertidal is significant (the station made at L.W.S.T. level yielded no animal).

Transect B, of the major survey here considered, has a considerably richer and more varied fauna than Transect C but again is barren over a considerable stretch between the lower beach fauna and the supralittoral fringe fauna. In this transect the lower beach fauna extends higher than it does in Transect C, i.e., to above M.S.L. The fauna of this region is dominated by polychaetes in variety and, although large worms such as *Lumbrineris* and *Nerine* are well established, the most characteristic, locally dominant species is the little *Scolecolepides benhami* whose

abundant tubes form a sort of " turf " below M.L.W.S. As indicated in Table II there were many more than 200 of these tubes in the quart of substratum sample. *Callianassa filholi* was fairly common at E.L.W.S. but scarcely extended higher: a lone *Mactra discors* here was the only bivalve in Gooch's Beach. The isopod *Isocladus armatus* and amphipod *Allorchestes novizealandiae* seem to be frequently found at the water's edge, and in the flotsam so often found there.

The supralittoral fringe fauna of Transect B is an amplified version of that found at Transect C. The amphipod *Talorchestia quoyana* is, of course, characteristic of decaying algal flotsam and its common presence in the sand no doubt reflects the abundant flotsam that was present (see Figure 4A). The centipede, *Maoriella,* was juvenile.

The bottom of Transect A ends in a sandbank which, though small (about 6ft x 12ft) appears to be compact and permanent, with a seaward edge maintained a few inches higher than the adjacent seaward rocks. It is dominated by polychaetes which extend up the transect to various levels and, generally speaking, attain higher levels than are inhabited in Transect B (cf. Figures 4A and 5A). *Abarenicola* is abundant and the presumably predatory *Perinereis nuntia* is important but of lesser abundance and range. Table I shows that the varieties *brevicirrus* and *vallata* are found in equal proportion and that intermediate specimens are quite common so that although the specimens examined by Knox (1951) showed constant varietal differences these Kaikoura specimens may point to further examination of the species being desirable. *Haploscoloplos cylindrifer* and *Scoloplos* sp. are important, the latter apparently replacing *Scolecolepides* at low spring tide levels. Although Station 9 is dominated by polychaetes it is unique for Gooch's Beach in that no less than eight spp. of amphipods are recorded from the quantitative digging together with some white hemibranchiate sphaeromids and three tanaids (*Apseudes* sp.).

The beach of Transect A is almost barren at and rather below high tide level. Above E.H.W.S. level the beach is narrow but wide enough to support a supralittoral fringe fauna yet this fauna is absent from both the sand of Station 3 and the stones of Station 2.

Discussion

This work has shown that where a marine beach infauna is present it is distinctly divided into two faunas that have no inter-relationship and no overlap in range. These faunas are those of the supralittoral fringe and of the lower intertidal zone. Where there is fairly considerable exposure to wave action the lower limit of the former fauna is separated from the upper limit of the latter by a considerable vertical distance but this "vertical" gap between the faunas closes as conditions become sheltered. Whether or not the faunas meet, or overlap, under extremely sheltered conditions in this region merits investigation.

Mention must be made of a third fauna, that inhabiting the flotsam resting upon the beach. Casual observation suggests that the beach infauna is enriched by overlying flotsam: certainly, it is likely that the supralittoral fringe fauna is more or less inter-related with the flotsam fauna and it was hoped to throw more light on this relationship by dealing separately with the two faunas concerned. This work has specifically avoided the flotsam fauna (to be reported upon in another paper) which is regarded for the present as a separate fauna from the supralittoral fringe infauna. There is some reason to regard them separately for the supralittoral fringe fauna was well in evidence at Transect C, where flotsam was virtually absent (what fragments there were, were dry and shrivelled) while it was absent from Transect A, despite the presence of plentiful algal flotsam. Also, of course, flotsam may have a rich fauna where it lies on solid rock.

While the closeness of inter-relationship between the flotsam fauna and the supralittoral fringe infauna has yet to be determined here, there is nevertheless some relationship and both faunas have much wider lateral ranges in Ingles Bay than the infauna of the lower intertidal zone and are much less influenced by substratum texture than the last fauna. Most of the beach of Ingles Bay is free of flotsam and is entirely barren in contrast to Gooch's Beach which is particularly prone to accumulating flotsam.

The tables and figures of this paper indicate the composition of the supralittoral fringe fauna. By far the commonest species is the flotsam hopper *Talorchestia quoyana* but a variety of terrestrial arthropods (e.g., various diptera and beetles) and certain oligochaetes (K.002 A) are typically present. It should be noted that these include predators as well as detritus feeders and that larval insects are characteristic. The lower level reached by this fauna is apparently raised by increased wave action (lower limit at Transect C is 3ft higher than at Transect B).

Rocks and reef limit the beach area and complicate environmental conditions but it is obvious that the infauna of the beach is dependent on sheltered conditions. The important direct effects of wave action on the fauna are beach disturbance and scouring: apparently all the transects are subjected to this except, possibly, the lower part of Transect A. One might reasonably infer that there would be little time for a climax community of the lower intertidal fauna to become established except at Stations A8 and A9, and that younger communities exist higher up Transect A and at Transects B and C. The facts are not inconsistent with this interpretation but are inadequate to support a community-succession hypothesis.

We may now consider this low-level fauna in regard to the indirect effects of exposure to wave action, i.e., effects exerted upon it through the sediments of the beach. Apart from the changes in beach profile two trends in texture have been demonstrated, viz., from coarser to finer (i) moving southwards along Ingles Bay beach, and (ii) moving down the beach from H.W.S.T. to L.W.S.T. level. These trends match the situation as demonstrated by the hypothetical case presented in Figure 6.

If one regards the lower intertidal fauna here as more closely influenced by the beach texture (and concomitant conditions of water table, etc.), than by the duration of the existence of a certain beach texture (i.e., its stability) then its distribution at Gooch's Beach could be expected according to this hypothesis to reflect the first trend of substratum texture mentioned and, to a far more limited degree, the second. By analogy with Figure 6 we might reasonably expect (a) different species to characterise the low tide levels of each transect, and (b) species characteristic of the lowest level of Transect C would be found at a higher level at Transect B, and at a higher level (if at all) at Transect A. Unfortunately, expectation (a) involves a progression that coincides with the possible progression (mentioned above) in development of a climax community and so cannot prove one rather than the other hypothesis. (Comparison of Figures 3A, 4A and 5A shows that some progression of species at lowest transect levels does exist, e.g., *Lumbrineris, Nerine, Abarenicola, Callianassa,* amphipods). So far as expectation (b) is concerned, it may be supported by the upward movement of *Scolecolepides benhami* in Transect A relative to Transect B (and it does seem that this little worm favours the presence of considerable quantities of very coarse sand) but this distribution cannot, even considered with the distribution of *Allorchestes,* be regarded as fully matching expectation (b). It is therefore unresolved whether the observed faunal distribution is indicative of maturing community-succession or that it is correlated with substratum texture. The progressive upward extension of certain species with increasing shelter is a phenomenon that lends no weight to expectation (b) since these species are most abundant at lowest levels, i.e., favour low tide level rather than a particular texture.

However, the rise of the species of the lower intertidal fauna up the beach with increasing shelter is a most notable contrast to the well-known phenomenon of biota rising up the rocky littoral under the influence of increased exposure to wave action.

The lower intertidal fauna is obviously an extension of species that habituate the shallow infratidal. It is rather sparse in variety in Gooch's Beach but certain species may be numerous in the most sheltered places. The dominance of polychaetes has been mentioned and in conclusion this beach lacks *Zostera,* bivalves and crabs, presumably because it is too exposed and too unstable.

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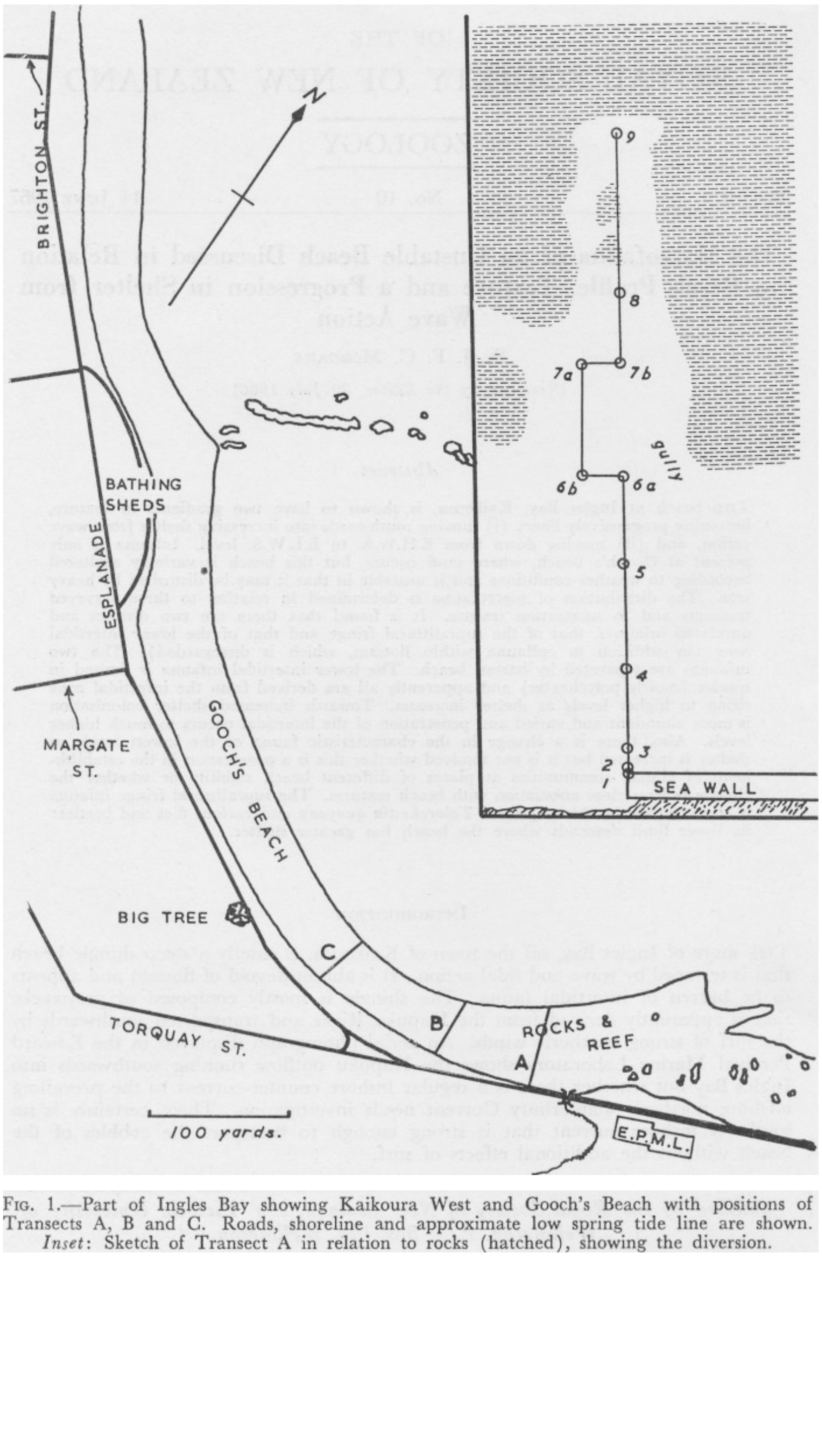

FIG. 1.—Part of Ingles Bay showing Kaikoura West and Gooch's Beach with positions of Transects A, B and C. Roads, shoreline and approximate low spring tide line are shown. *Inset*: Sketch of Transect A in relation to rocks (hatched), showing the diversion.

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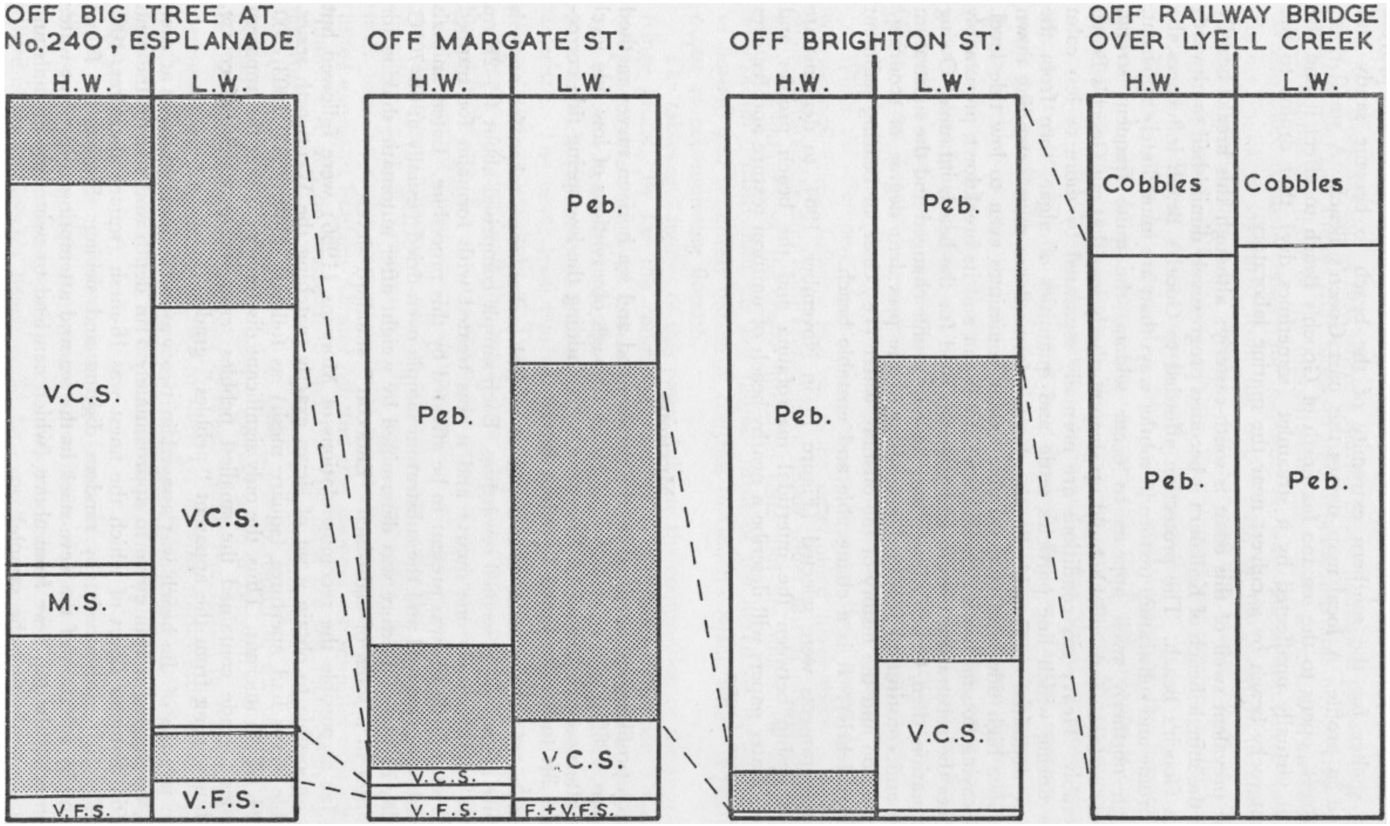

2.—Proportional composition (by weight) of beach surface samples at "High Water" and "Lo
1 November 1965. H.W. at approximately 5.6ft and L.W. at approximately 1.1ft levels in rela
date being assumed the same as predicted. Nomenclature according to Wentworth scale (slightly
—see text); Granule and Fine Sand fractions are shaded.

Fig. 2: on 2 this

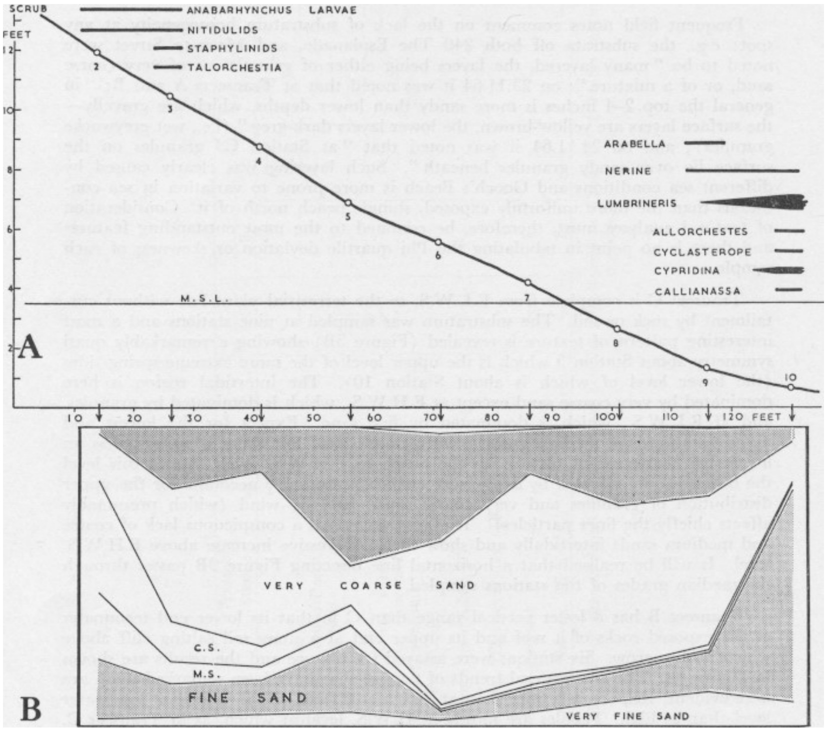

FIG. 3.—(A) Profile of Transect C related to tide datum with the distribution of the macro-fauna of the sand. (B) Proportional composition (by weight) of surface substratum samples at positions indicated by arrows from the upper figure. Nomenclature according to the Wentworth scale (slightly affected by available sieve meshes—see text); Granule and Fine Sand fractions are shaded.

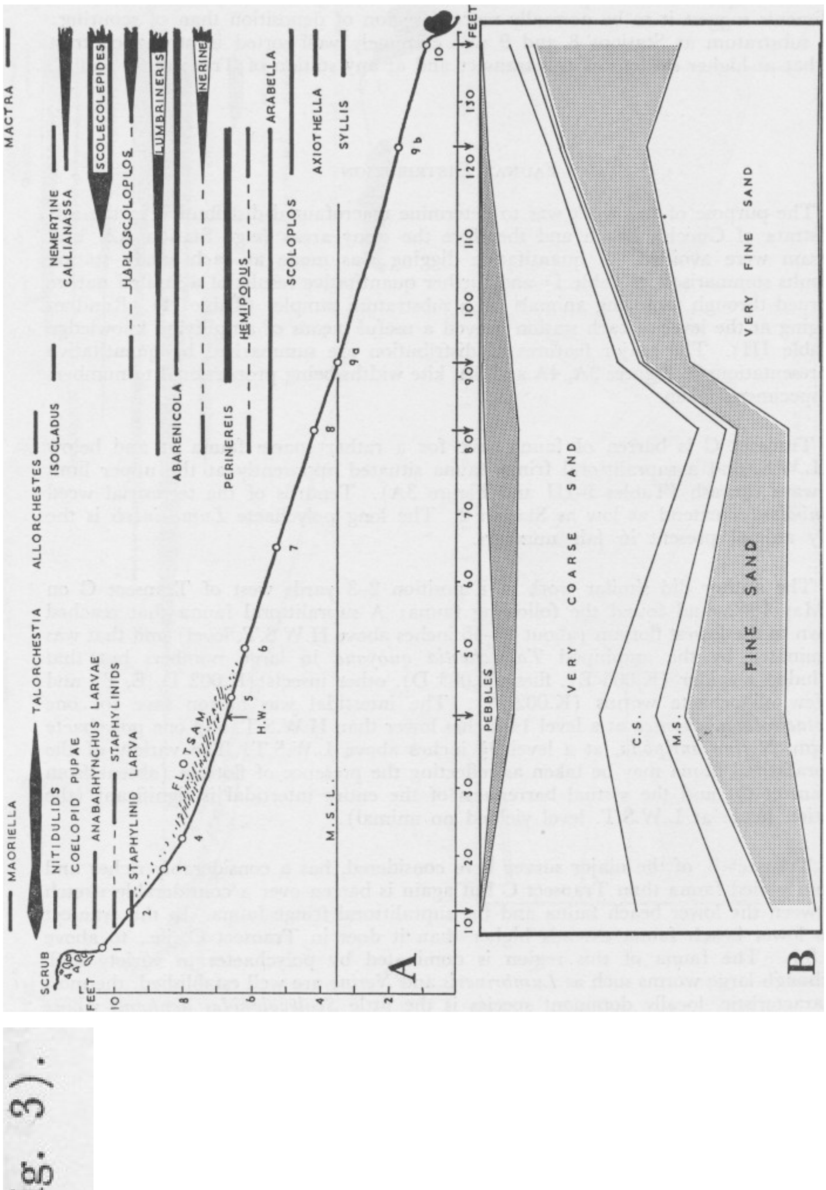

Fig. 3).

) and (B).—Profile, faunal distribution and substratum texture of Transect B (see legend of
"H.W." marks observed H.W.S.T. level at 0845 hours on 24.11.64.

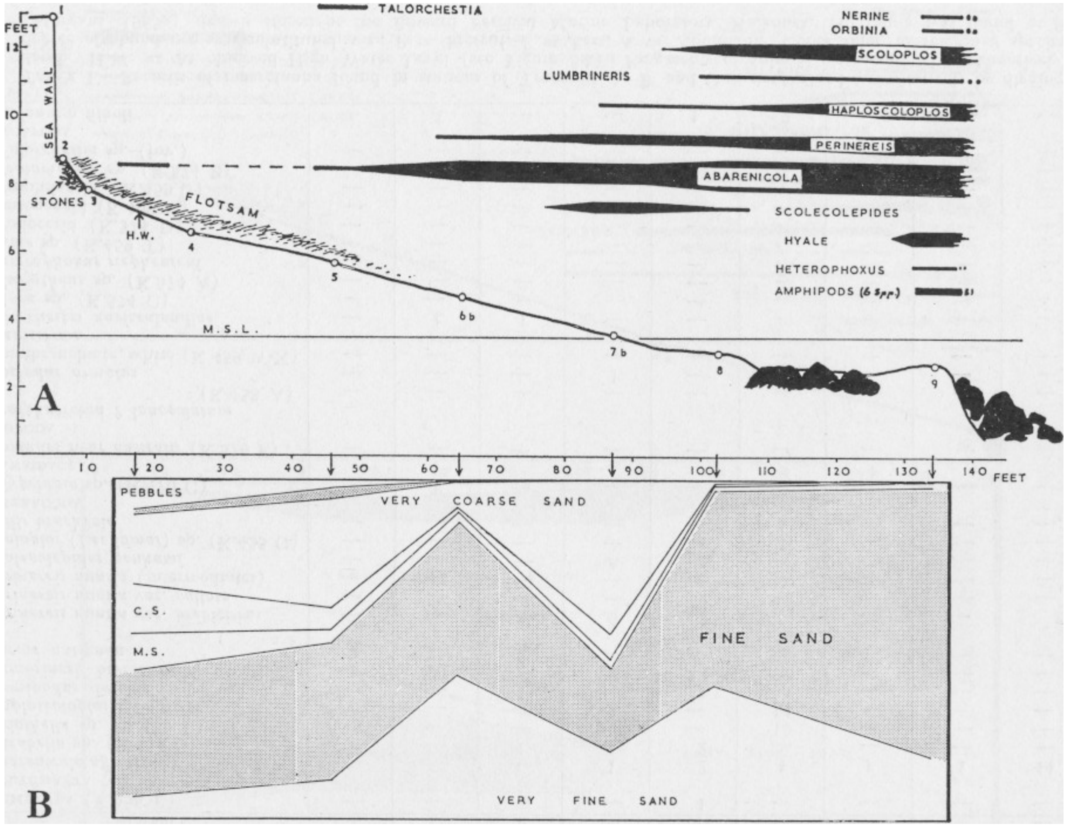

FIG. 4 (A)

sect A (see legend of Fig. 3). "H.W.
24.11.64.

FIG. 5 (A) and (B).—Profile, faunal distribution and substratum texture of Trans
marks observed H.W.S.T. level at 0845 hours on

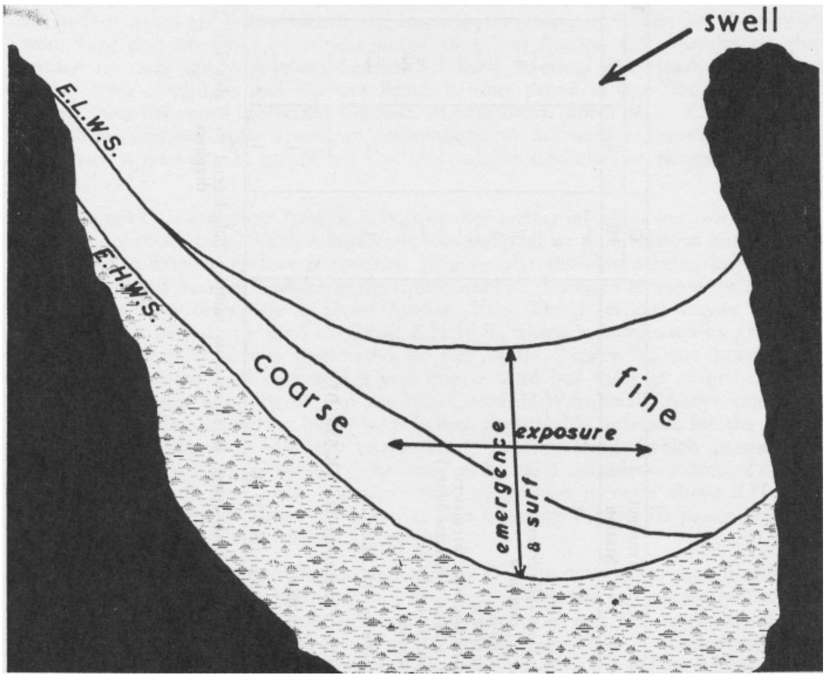

FIG. 6.—A hypothetical bay, of a type quite frequently found, where one end of the bay is sheltered by a rocky point from a predominant, oblique swell. There is consequently a gradient across the bay in degree of exposure to wave action and a gradient up and down the beach in both emergence and degree of subjection to heavy surf. The two gradients sort beach deposits into the texture pattern shown (but, of course, without a sharp division line between the coarser and finer particles).

…ing 19 inch circles to 11 inches …ely and sometimes a subjective …cimens of the "K" collection … Stations C2–8, B2–7, A3, 4.

Transect	C		B				A					
Station	9	10	8	9a	9b	10	HW	5	6b	7	8	9
NEMERTEA (K.456 E)	—	—	—	—	1	—	—	—	—	—	—	—
POLYCHAETA												
Abarenicola affinis	—	—	—	1	2	4	1	1	44	P	126	115
?*Arabella* sp. (K.454 C)	1	—	1	1	2	—	—	—	—	—	—	—
Axiothella sp. (K.460 L)	—	—	—	—	—	10	—	—	—	—	—	—
Haploscoloplos cylindrifer	—	—	—	1	—	14	—	—	—	1	4	37
Hemipodus simplex	—	—	1	—	1	—	—	—	—	—	—	—
Lumbrineris brevicirra	1	20	—	2	7+	20+	—	—	—	—	3	1
Nerine antipoda	2	?1	2	—	5	30–40	—	—	—	—	—	—
Perinereis nuntia var. *brevicirrus*	—	—	—	6	2	—	—	—	3	13	5	15
Perinereis nuntia var. *vallata*	—	—	—	—	2	—	—	—	—	5	5	10
Perinereis nuntia (intermediates)	—	—	—	—	—	—	—	—	—	4	1	7
Scolecolepides benhami	—	—	—	A	A	—	—	—	—	8	1	—
Scoloplos (*Leodamas*) sp. (K.455 G)	—	—	—	—	1	1	—	—	—	—	6	38
Syllis brachyola	—	—	—	—	—	1	—	—	—	—	—	—
OSTRACODA												
?*Cypridina* sp. (K.470 C)	—	F	—	—	—	—	—	—	—	—	—	—
TANAIDACEA												
Apseudes near *australis* (K.574 E)	—	—	—	—	—	—	—	—	—	—	—	3
ISOPODA												
Exosphaeroma ? lanceolatum (K.458 A)	—	—	—	—	—	—	—	—	—	1	—	—
Isocladus armatus	—	—	—	1	—	—	—	—	—	—	—	—
Hemibranchiate, white (K.459 W-X)	—	—	—	—	—	—	—	—	—	1	—	F
AMPHIPODA												
Allorchestes novizealandiae	—	1	1	—	—	—	—	—	—	—	—	—
?*Aora* sp. (K.574 C)	—	—	—	—	—	—	—	—	—	—	—	1
?*Eurystheus* sp. (K.574 A)	—	—	—	—	—	—	—	—	—	—	—	2
Heterophoxus stephenseni	—	—	—	—	—	—	—	—	—	—	—	1
Hyale sp. (K.459 T)	—	—	—	—	—	—	—	—	—	—	—	24
?Podocerid (K.574 D)	—	—	—	—	—	—	—	—	—	—	—	1
Pontogeneid (K.459 V)	—	—	—	—	—	—	—	—	—	—	—	1
?Prophliantid (K.459 U)	—	—	—	—	—	—	—	—	—	—	—	1
?*Protomedeia* sp. (K.574 B)	—	—	—	—	—	—	—	—	—	—	—	3
?*Talorchestia* sp. (juv.)	—	—	—	—	—	—	—	1	—	—	—	—
DECAPODA												
Callianassa filholi	—	3	—	—	1	2	—	—	—	—	—	—

of macrofauna found in stations of Transects A, B and C as determined quantitatively by diggi
t observed High Water Level (see Figure 5A). Fragments of animals were counted conservative
e was substituted, viz., P = Present, F = Few, A = Abundant. Codes refer to reference spec
that is stored at the Edward Percival Marine Laboratory, Kaikoura. No fauna was found at

TABLE I.—Records
depth. H.W. = A
degree of abundanc
(Morgans, 1965a)

	C	B				A			
	10	2	8	9b	10	6b	7	8	9
	—	—	—	6	—	—	—	—	1
	—	—	—	—	—	3	5	5	—
	—	—	—	—	—	—	—	1	1
	F	—	1	—	—	—	—	—	—
	1	—	—	—	3	—	—	—	1
	—	—	—	—	—	—	—	—	1
	—	—	—	—	—	2	1	1	3
	—	—	—	—	—	—	—	1	—
	—	—	—	200+	21	—	—	—	—
	—	—	—	1	1	—	—	—	—
	1	—	—	—	—	—	—	—	—
	—	—	—	1	—	—	—	—	—
	—	1	—	—	—	—	—	—	—
	—	1	—	—	—	—	—	—	—

Marks species that were not taken in the quantitative

Transect Station
NEMATODA
POLYCHAETA
Abarenicola affinis
Haploscoloplos cylindrifer
Lumbrineris brevicirra
Nerine antipoda
‡*Orbinia papillosa*
Perinereis nuntia var. *brevicirrus*
Perinereis nuntia (intermediates)
Scolecolepides benhami
Syllis brachyola
OSTRACODA
‡*?Cyclasterope* sp. (K.566 C)
ISOPODA
‡Sphaeromid, ?Platybranchiate (K.558 B)
AMPHIPODA
‡*Talorchestia quoyana*
INSECTA
‡?Staphylinid (larva) (K.504 C)

10
A
—
—
FC
—
—
—
—
—
1

Table II.—Records of animals found in substratum samples (cf. legend to Table I). ‡ diggings.

Transect	C		B		
Station	2	3	2	3	*
POLYCHAETA					
Lumbrineris brevicirra	—	—	—	—	—
AMPHIPODA					
Talorchestia sp.	—	4	—	—	—
Talorchestia quoyana	—	—	C	6	13
DECAPODA					
Callianassa filholi	—	—	—	—	—
CHILOPODA					
‡*Maoriella* sp. (juv.) (K.464 F)	—	—	1	—	—
INSECTA					
‡?*Anabarhynchus bilineata* (larva) (K.464 A)	1	3	2	1	—
‡?Coelopid pupae (K.464 E)	—	—	5	—	—
‡?Nitidulid beetles (K.464 C)	F	P	4	—	—
‡Staphylinid beetles (K.464 B, etc.)	—	P	3	—	F
BIVALVIA					
‡*Mactra discors*	—	—	—	—	—

interesting records revealed by random digging next to the stations concerned (cf. legend
position at a level $4\frac{7}{8}$ inches lower than Station B4. ‡ Marks species unrecorded in Tables
two species of Staphylinid beetle were present, one of which was probably *Cafius maritimus*.
No interesting records were yielded by random digging at Transect A.

TABLE III.—Certain
to Table I). * = A
I and II. Probably