The Conchological Society of Great Britain and Ireland

(Founded 1876)

Papers for Students No. 14

BRITISH LITTORAL MOLLUSCA

(1) Shells of Rocky and Sandy Coasts

by

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Molluscs might easily be considered one of the most evolutionarily successful groups of animals living to-day. They have adapted to the terrestrial environment of which Cepaea hortensis (Müller) is an example and spends its whole life exposed to the air; while others spend their life completely immersed in an aquatic or marine environment such as the pelagic purple raft shell Ianthina ianthina (L.) which spends its life floating around the oceans and the demersal Lima hians (Gmelin) which makes a nest in shell gravel well below L.W.M.

However there is one other very large and important group of molluscs which spend most of their life on the seashore and these are the littoral molluscs. This zone is basically a marine zone which periodically becomes terrestrial in nature when the tide retreats. It is a very narrow zone as shown in figure 1. The molluscs we will be looking at therefore will only occur as can be seen from figure 2. upwards from the lowest part of the beach uncovered by the tide the E.L.W.S. to the highest point on the beach washed by the waves by the highest spring tides E.H.W.S. This region which corresponds only in part with the legal term foreshore would in the context of this paper be better termed INTERTIDAL ZONE (between the tides). The limits of this zone are slightly artificial in the case of a number of the resident molluscs which can exist either above or below the limits we are using; for example the winkle Littorina neritoides L. can exist well into the splash zone while the common cockle Cerastoderma edule (L.) can spend its life living at considerable depths never uncovered by the tides.

The physical conditions on the majority of molluscs living in the intertidal zone are very exacting due to the effects of the tides. The molluscs which live here and which are sometimes found in a much greater variety than in the other two environments have had to adapt to a wide range of conditions or factors which tend to determine the distribution of both the fauna and flora on the seashore.

Below I have listed briefly a number of the conditions, to which shore molluscs are modified both in their structure and their behaviour, and which also cause definite distribution patterns on the shore.

<u>Some of the physical and biotic factors which determine the general and World Wide distribution of seashore life</u>.

<u>PHYSICAL</u>

a) NATURE of SUBSTRATE (Rock, Shingle, Sand or Mud Shores)

b) WAVE ACTION (Physical pounding and influence of spray)

c) TEMPERATURE (Range in water and air)

d) DRYING EFFECTS of WIND and SUN

e) CHANGES in SALINITY (Rock pools, streams and estuaries)

f) LIGHT (Rocky shore seaweeds)

<u>BIOTIC</u>

a) FOOD (While tide is in and out)

b) PREDATORS (Fish, crustaceans and molluscs when tide is in, birds and mammals when tide is out. Man at all times for commercial and other purposes)

c) REPRODUCTION

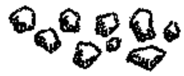
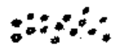
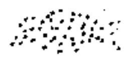
d) ADAPTABILITY (Ability to survive in both terrestrial and aquatic environments)

e) POLLUTION (This is a factor, recently introduced by man.)

It must be remembered though that even on the same shore conditions vary from one part to another. Molluscs that live high up on the shore will be under water for much shorter periods than those lower down on the shore. Each species has its own optimum periods of submersion and emersion, and will thus tend to be found only in that region or niche where these conditions prevail.

Any interested observer to the seashore will immediately notice that a sheltered rocky shore, which are common on the Devonshire coast, is richly covered with seaweeds and will give an immediate impression of a great diversity of life, while there is usually little or no indication of life of any kind on an exposed sandy beach, such as that found at Sandwich in Kent. But in all cases what is immediately visible is but a minute proportion of the actual population, so much of which lives under rocks or seaweed, burrows in sand or bores into solid rock. The conditions we find on these two types of shores are so different that I wish to consider sandy and rocky shore molluscs separately although both these types of shore intergade into one another, rock often being surrounded by sand and vice versa. Therefore bearing in mind the other physical factors mentioned I will begin with sandy shores.

Sandy shores are made up of fine fragments of very hard rock, usually of quartz grains because everything less hard soon becomes reduced to a still smaller grain size. This particle size is one of the most important factors influencing the animals living on and in a sandy beach. The predominant particle size of a beach can be judged quite easily by rubbing some of it between the fingers, when it can be classified as COARSE or FINE. The table below shows a simple system of grading.

Type of Beach (Grade)			Diam. of particles in mm's.
Gravel			> 2.0
Coarse	Sand		2.0 - 0.2
Fine	Sand		0.2 - 0.02
Mud			< 0.02

Coarse sandy beaches are generally found on open ocean coasts such as those of North Devon, Braunton Burrows and along the Welsh coasts near Dale. On such beaches the water tends to drain away quite quickly at low tide, which can be observed when one walks over the sand by the white dry prints formed. This is known as Dilatancy and causes increased resistance to mollusc movement through the sand. The drainage of sandy beaches is also influenced by its slope, the greater the slope the greater the drainage and vice versa. An average sandy beach has about a 2 degree slope but this can be influenced by the effect of heavy seas found on open coasts. Often therefore there is very little animal life present on coarse sandy beaches.

Beaches of fine sand occur inside bays on the open coast or along coasts where the prevailing winds do not blow onshore, and generally have a better fauna. Owing to the small size of the particles water is retained by capillary action within the minute spaces between the individual grains of sand. This thixotropic property of fine sand can be observed when pressure is applied to it as it then becomes soft, wet and sloppy. This is of the greatest importance to burrowing molluscs because by agitating the sand they reduce its resistance to their passage. This has its drawbacks though because it means that the surface layers can be churned up by heavy seas and so forms an unstable habitat. It also means that the molluscs cannot construct permanent burrows, as can molluscs such as Mya truncata L. which lives in mud. One therefore finds that all animals living in the sand are capable of moving rapidly down into it for protection. In addition to wave action this may be from Sanderlings, Turnstones and other seabird predators. The most numerous molluscs to be found are the bivalves, which have tended to become flattened, such as the Tellinidae (Tellina tenuis da Costa and T.fabula Gmelin) or have a very powerful foot such as the elongated, almost straight razor shells such as Ensis silliqua (L.) which burrows vertically with great speed and is correspondingly difficult to secure.

Plants in the form of large, macroscopic seaweeds are absent on sandy shores because they have not any form of stable holdfast to cling to. This absence of plant food on sandy shores is therefore another major factor influencing the molluscs that live there. It means that they have to find other methods of collecting or finding food. If therefore one studies the molluscs population of this type of shore one is able to divide the population, as in figure 3, into three categories:- Suspension feeders, Deposit feeders and Predators.

Firtsly, the plankton or suspension feeders, of which the Common cockle Cerastoderma edule (L.) is a good example. This usually lies only partly buried in the sand and tends to become the prey of the Oystercatcher which has a specialised bill or beak for opening it and leaves piles of dead shells scattered on the beach. Most suspension feeders have two short frilly siphons which project slightly above the level of the sand. Water is taken in through one and expelled through the other, after the minute particles of food have been retained by filtering. Other examples of this group are Venerupis rhomboides (Pennant), Venus fasciata (da Costa) and Spisula subtruncata (da Costa).

Secondly, the deposit feeders which also lie buried in the sand but much deeper and have very long siphons. The inhalant siphon sweeps over a considerable area of the sands surface and sucks in detritus, bottom diatoms and other small forms. The exhalant siphon projects well above the surface and expels the filtered water. Of these the tellins and Donax vittatus (da Costa) are good examples.

Thirdly, the last group the predators. These are the carnivorous snails, such as Nassarius reticulatus (L), which live in the sand. Other examples Natica poliana della Chiaje and N. catena (da Costa) also prey on the sandy shore populations by drilling a hole using the radula and an acid secretion in the hosts shell and then sucking out the contents. One of the species often attacked is Gari fervensis (Gmelin).

Although one usually associates zonation with rocky shores one also finds that sandy shore molluscs show this phenomenon. The kite diagrams, figure 4, illustrate the positions of four species of sandy shore molluscs. Macoma balthica (L.) being included as it can be found both on sandy and muddy shores. The reasons for this zonation are not fully understood but all the factors mentioned so far, such as particle size and feeding methods, influence them. Such factors as salinity, temperature and light which play such an important role on rocky shores have little effect on the buried mollusc population of a sandy shore.

We now come onto rocky shores which can be very variable in character depending on the type of rock, hard or soft, igneous or sedimentary. The slope of the rock strata on a shore is most important: if horizontal, a flat rocky platform may be formed and constitute a shore; if inclined, high pools or sheltered crevices may be found, both harbouring highly characteristic assemblages of animals and plants.

We can study the mollusc population by looking more closely at some of the niches in which they are found. These will fall under the following headings:-

1. Bare rocky surfaces
2. Seaweed covered rocks
3. Crevices
4. Pools
5. Overhangs and Boulders

and lastly a brief look at Rock Borers and some other types of rocky shores.

We will therefore begin with Bare Rock Surfaces. These are usually found exposed to the Atlantic surf, like those on the West side of Skokolm in Wales; but even in regions of great wave impact where there are no seaweeds there may be few animals, these will consist of species all highly adapted for life under such exposed conditions. They tend to be either permanently attached such as the barnacles or capable of gripping firmly like the limpets such as *Patella vulgata* (L.); or sometimes have a very strong shell as has the short spired white form of *Nucella lapillus* (L.) the common dog whelk which can withstand being rolled about without damage.

Most of us though are more familiar with the weed-covered rocks which are often very slippery and found in sheltered bays such as around the S. Devon coast, for example at Start Point. These represent major algal regions and often have associated many molluscs which feed on them. It is on this type of rocky shore that "Zonation" in the distribution of the fauna and flora is seen most clearly. When one is searching for molluscs therefore a knowledge of these zones is of great help It is here where the larger marine algae, figure 5, can act as valuable zone indicators as they are conspicuous and are similarly zoned. For example *Pelvetia canaliculata* is found at the top of the beach near the splash zone, *Fucus serratus* and *vesiculosus* are mid-shore species and *Laminaria digitata* is only uncovered completely at Low Spring Tides.

A great population of animals occur on and under the seaweed, which provides shelter from wave-action and from the drying effect of sun and air. At the top of the shore we find *Pelvetia canaliculata*, as already mentioned and in this same area live the very small littorinids *Littorina neritoides* L. and *L.saxatilis* (Olivi) usually invisible against the rocks' surface and which have evolved a method of breathing air using the mantle cavity while exposed for long periods. Also associated with Pelvetia is the black tufted lichen *Lichina pygmaea*. At the base of this lichen protected from desiccation is to be found the minute rose-coloured bivalve *Lasaea rubra* (Montagu) colloquially known as the Coin shell. Further down the shore the many coloured forms or varieties of *Littorea littoralis* (L.) are to be found associated with *Fucus serratus* or *vesiculosis* on which they depend for their food. Another species *Phasianella pullus* (da Costa) or pheasant shell which one can find dead in large numbers on sandy shores, in fact lives on rocky shores feeding on the small south westerly distributed red alga *Chondrus crispus*. And lastly at the extreme low tide mark on the huge fronds of *Laminaria digitata* are to be found feeding both the beautiful blue-rayed limpet *Patina pellucida* (L.) and the small almost invisible green *Lacuna pallidula* (da Costa) or pale chink shell.

Now we come to Crevices. The type of the rock here influences the shape and depth of crevices which can be large or small. When they are large they are usually damp and shady sometimes even forming pools or overhangs. However the space within them is usually restricted so conditions vary considerably according to whether they are high or low on the shore and whether they face seaward or landward. Often large numbers of Gastropods and a few species of bivalve such as *Mytilus edulis* L., the shore mussel, frequent the seaward facing crevices which, although exposed to light, do afford shelter and a suitable foothold against the action of waves. The Gibbulas are one of the commonest groups found in crevices on rocky shores, *Gibbula umbilicalis* (da Costa) being the most frequent while *G.cineraria* (L.) less so.

Rock pools represent local areas which never dry out. The seaweeds and the animals which occur include many of those already encountered on bare rocks such as

Patella vulgata L. and P.aspera Röding which feed on the encrusting seaweeds such as the coralline Lithothamnion leaving bare patches. Another species is the large top-shell, Calliostoma zizyphinum (L.) which tends to be a pinky purple colour and blends in with its surroundings remarkably well. But one also finds species which cannot withstand even very temporary drying up, being normally inhabitants of shallow off-shore waters. The normal factors determining the distribution of these animals tend not to take effect in rock pools. They often therefore become refuges for sea-stars, prawns, crabs and small fish such as Gobies and in the lower pools one can sometimes find the internally shelled sea-slugs or nudibranch molluscs such as Dendronotus frondosus (Ascaneus) hiding amongst the seaweeds beautifully camouflaged against attack from some marine or shore predator.

Overhangs and Boulders. The sides and roof of caves or north-facing well protected overhanging surfaces of massive rocks have a particularly rich fauna, because the surface remains damp as well as sheltered from the sun and wind when the tide is out. The surface is often completely covered with encrusting usually plant-like animals, though seaweeds themselves are few because there isn't enough light for photosynthesis to take place. A number of carnivorous molluscs are found in this habitat such as the small cowry or money shells Trivia arctica (Montagu) and T.monacha (Montagu) which feed on the compound seasquirts attached to the rock surface. Overhangs and for that matter the undersides of boulders often piled high-up on rocky shores afford a special protection for animals against wave-action, drying out or excessive light. They also afford safety against such animal predators as the sharp-billed Herring Gulls which are constantly on the look out for such soft-bodied nudibranch molluscs as Archaedoris pseudoargus (Rapp) beautifully camouflaged against its colourful background and Aeolidia papillosa (L.) which attaches its long strings of eggs to the rocks. Sometimes in larger overhangs in the S.W. one can be lucky enough to find one of our most interesting and certainly scientifically most studied molluscs the Octopus, Octopus vulgaris Lamarck, a member of the class Cephalopoda. Usually a pool covers at least one of the two entrances to an octopus lair giving it protection against most of the physical factors which affect rocky shore animals and also an easily accessible escape route.

Some animals, notably bivalve molluscs actively bore into the rocks, such as the small piddock, Barnea parva (Pennant), and its relatives. All need to be sought by breaking into the rock with a hammer and chisel, and this then is some feat even for a small fleshy mollusc with a pair of highly adapted thin calcareous valves.

Other stable "shores". When shingle settles in fine sand, it never becomes stable or fixed because of the thixotropic properties of the sand mentioned earlier. On the other hand when shingle settles on mud it sticks and so the stones tend to become stabilised and form an artificial "rocky" shore for lack of a better term. In time a number of usually Rhodophytic seaweeds become attached, mussels settle enmeshing the stones with their byssus threads which again helps to stabilise the area further. And so one begins to find a number of other rocky shore inhabitants such as Littorina littorea (L.), the edible winkle and Nucella lapillus (L.) which can now find a stable foothold and also an adequate food supply on the Mytilus beds. The interesting point here is that Nucella when feeding almost exclusively on Mytilus tends to show a large number of coloured varieties, where as they tend to be predominantly white when feeding on barnacles. Concrete pier piles, harbours, seawalls, wooden posts and groynes also form stable substrates and so often tend to accumulate an interesting rocky shore assemblage of fauna and flora.

Summarizing therefore one can say that although we have said one can never really separate any one type of shore from another one does find a quite different set of molluscs on a sandy beach to those living on a rocky shore. There is also an obvious preference by bivalves for sandy shores where they can burrow in large numbers while the gastropods with their large foot prefer rocks. However, as there are more numerous niches on a rocky shore, there tends to be a greater number of different species to be found on this type of shore.

To conclude. The molluscs on sandy and rocky shores are far too numerous to list in an account of this nature. All I have tried to do is to give some idea of the conditions and some of the mollusc species which can be found alive, at present, on our shores. So let us now return to a strand line on the seashore. The shells that are washed up by a storm on most of our coastal beaches come from a large number of habitats and different niches. Many may belong to sandy shore species such as Tellins, Razor shells, and Natica's, others may be rock and clay borers like the piddocks while others like Nucella and Mytilus are rocky or stable shore forms which have died and have been cast up on the beach as empty shells some way from where they originally lived. And so wherever you are, on whatever type of beach or shore, may I say "Happy Hunting", but please restrict the numbers of specimens that you remove from the beach and return the habitats, i.e. rocks, sand, etc. to their original position or condition before you leave the beach.

Acknowledgments

I would like to thank Dr. J. McOmie for reading the paper and making helpful suggestions, to Rev. H.E.J. Biggs for editing the manuscript, to Dr. Emson for correcting figures, and to my wife for bearing with me while I typed it out.

GLOSSARY

Algae	Seaweeds.
Biotic	Living.
Capillary action	When water is held in a small space by the action of surface tension
Colloquial	Conversational use of a word.
Demersal	Bottom living and feeding organisms.
Desiccation	Drying up.
Dilatancy	The result of rapid drying out of sand.
Environment	Collective term for the conditions in which an organism lives.
E.H.W.S.	Extreme High Water Spring Tides.
E.L.W.S.	Extreme Low Water Spring Tides.
Igneous rocks	Consolidated from molten rock material.
Emersion	Exposure to air or opposite of submersion.
L.W.M.	Low Water Mark.
Mantle cavity	Space between the mantle, which forms the shell, and body; houses the gills.
Pelagic	Animals that live and feed in the open sea.
Photosynthesis	Synthesis by plants, which includes algae, of organic compounds from water and carbon dioxide using energy absorbed from sunlight.
Physical	Properties of matter and energy.
Rhodophyceae	Algae which are red in colour because of a predominance of the red pigment phycoerythrin.
Seasquirts	Tunicates; usually sessile and sedentary in nature on rocks; primitive chordates.
Synthesis	Putting together, combination.
Thixotropic	The ability to hold water by capillary action.
Zonation	Belts which divide up the shore, above or below which certain animals will not be found under a given set of conditions.

Suggestions for further reading and reference

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Papers for Students No. 7 and No. 11.

Date of Publication 17th April, 1972.

"Papers for Students" edited and distributed by

H.E.J. Biggs, 48, Park Road, Bromley, Kent.
(On behalf of the Society.)

Figure 1.

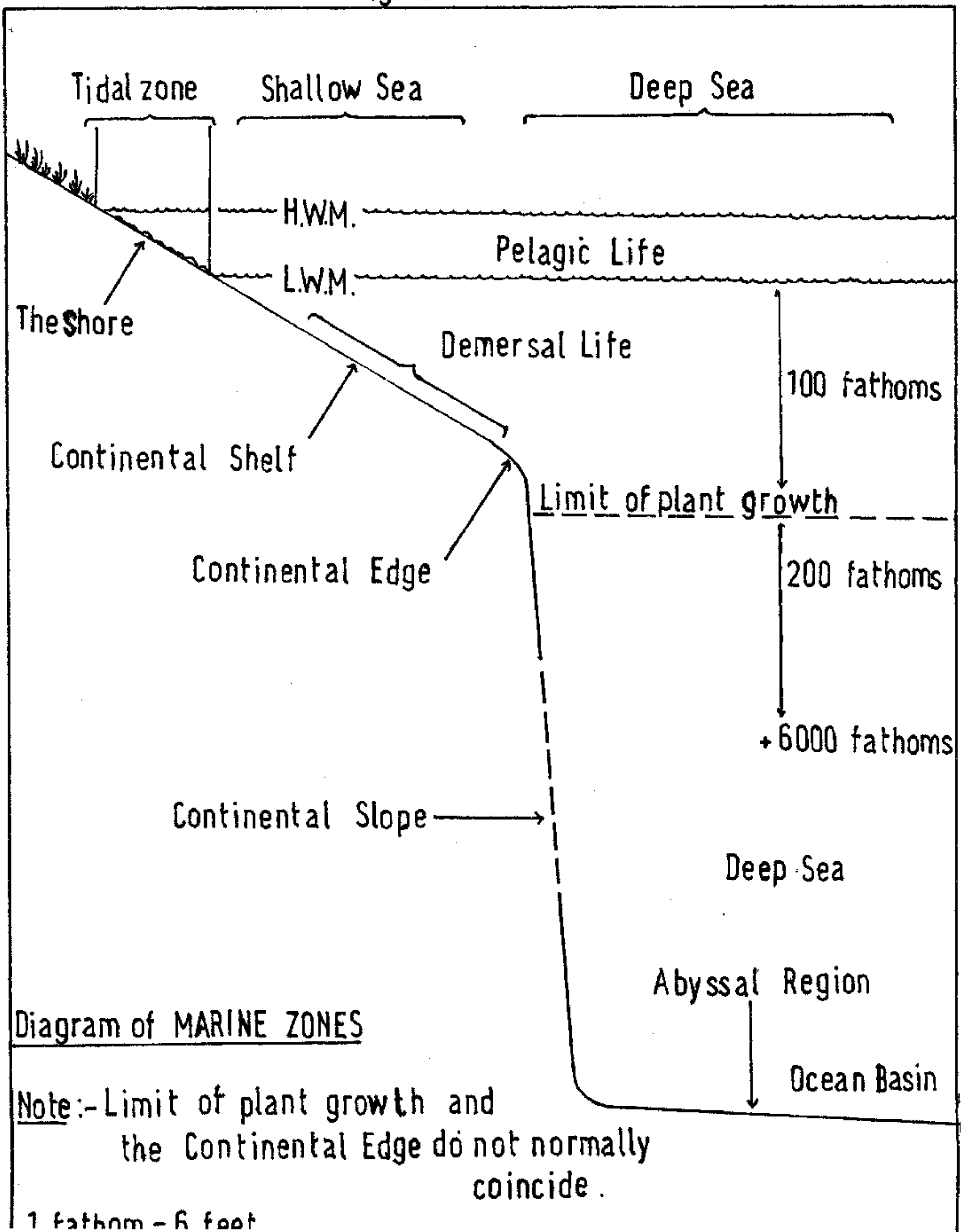

Tidal zone
Shallow Sea
Deep Sea
H.W.M.
Pelagic Life
L.W.M.
The Shore
Demersal Life
100 fathoms
Continental Shelf
Limit of plant growth
Continental Edge
200 fathoms
+6000 fathoms
Continental Slope
Deep Sea
Abyssal Region
Diagram of MARINE ZONES
Ocean Basin
Note:- Limit of plant growth and the Continental Edge do not normally coincide.
1 fathom = 6 feet

Figure 2.

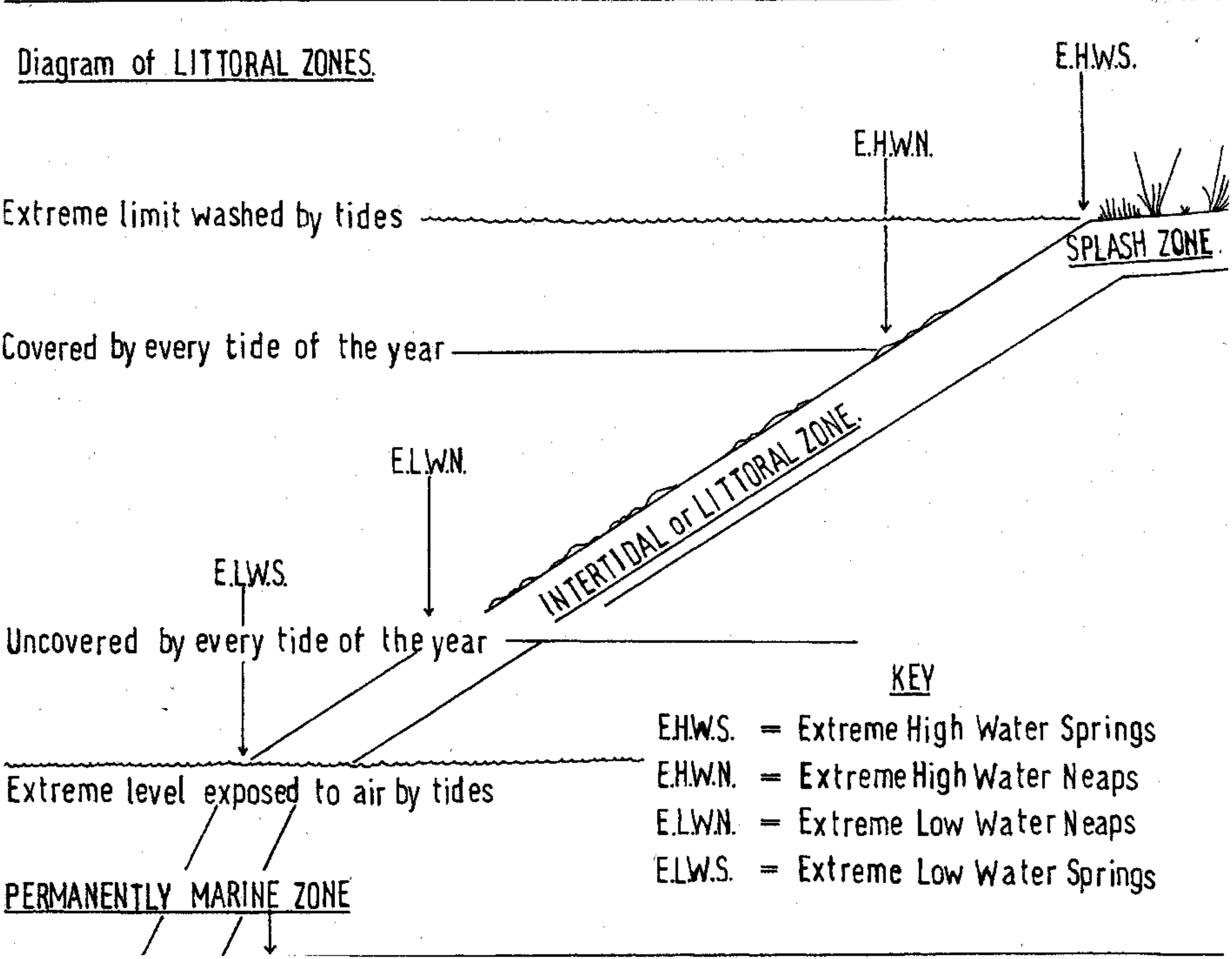
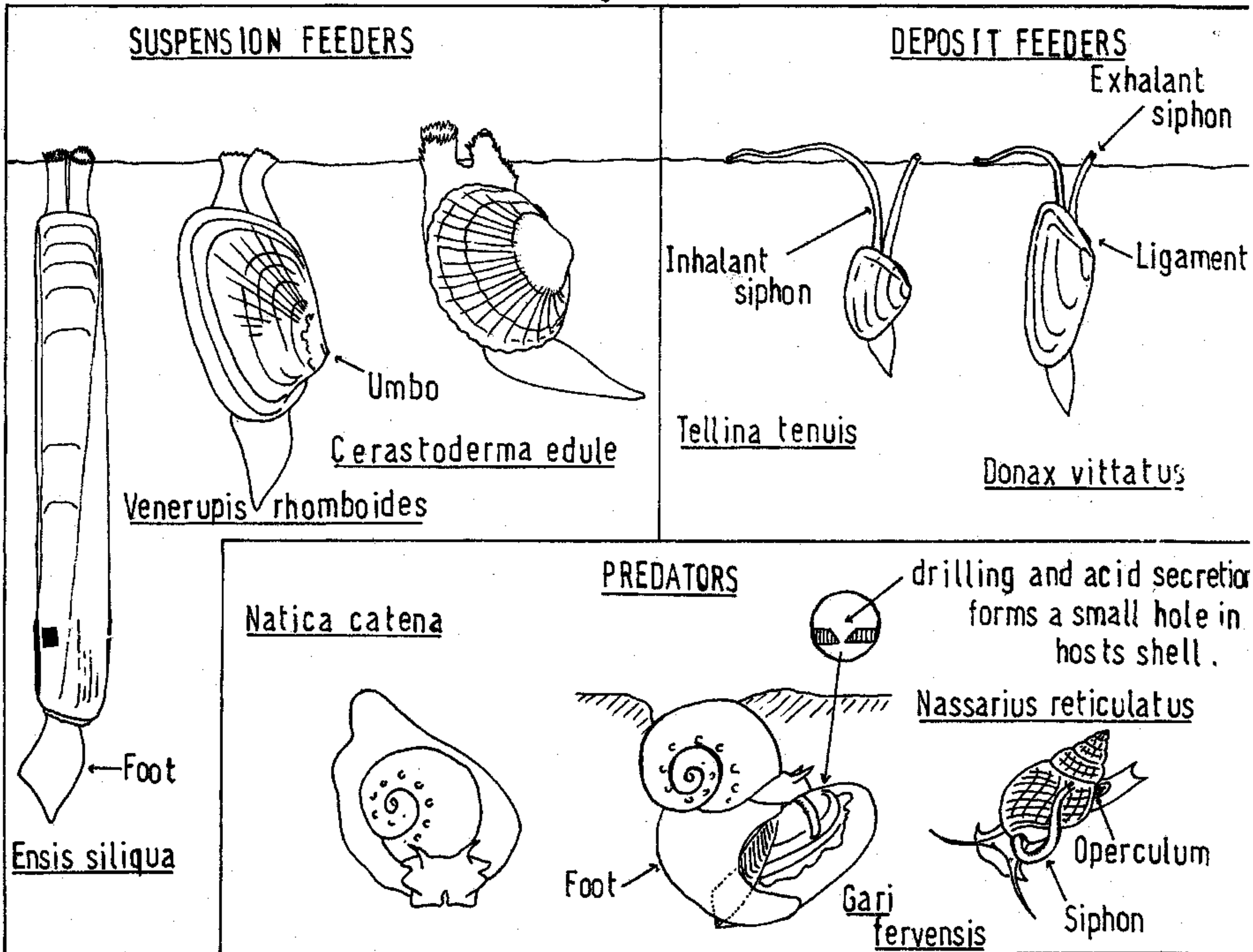


Diagram of LITTORAL ZONES.
E.H.W.S.
E.H.W.N.
Extreme limit washed by tides
SPLASH ZONE.
Covered by every tide of the year
INTERTIDAL or LITTORAL ZONE.
E.L.W.N.
E.L.W.S.
Uncovered by every tide of the year
Extreme level exposed to air by tides
PERMANENTLY MARINE ZONE
KEY
E.H.W.S. = Extreme High Water Springs
E.H.W.N. = Extreme High Water Neaps
E.L.W.N. = Extreme Low Water Neaps
E.L.W.S. = Extreme Low Water Springs

Figure 3.



SUSPENSION FEEDERS
DEPOSIT FEEDERS
Exhalant siphon
Inhalant siphon
Ligament
Umbo
Tellina tenuis
Cerastoderma edule
Donax vittatus
Venerupis rhomboides
PREDATORS
drilling and acid secretion forms a small hole in hosts shell.
Natica catena
Nassarius reticulatus
Foot
Foot
Operculum
Ensis siliqua
Gari fervensis
Siphon

Figure 4.

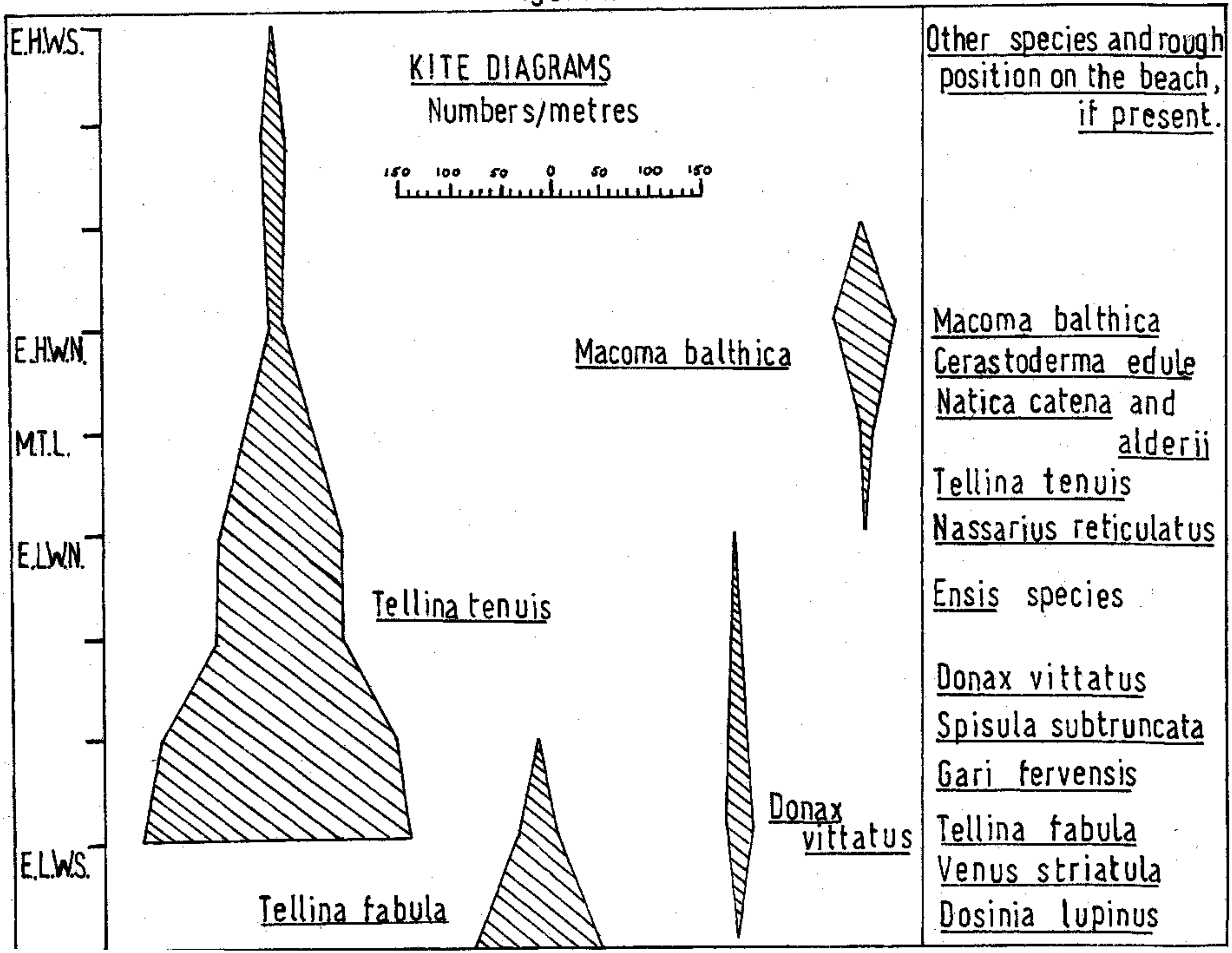
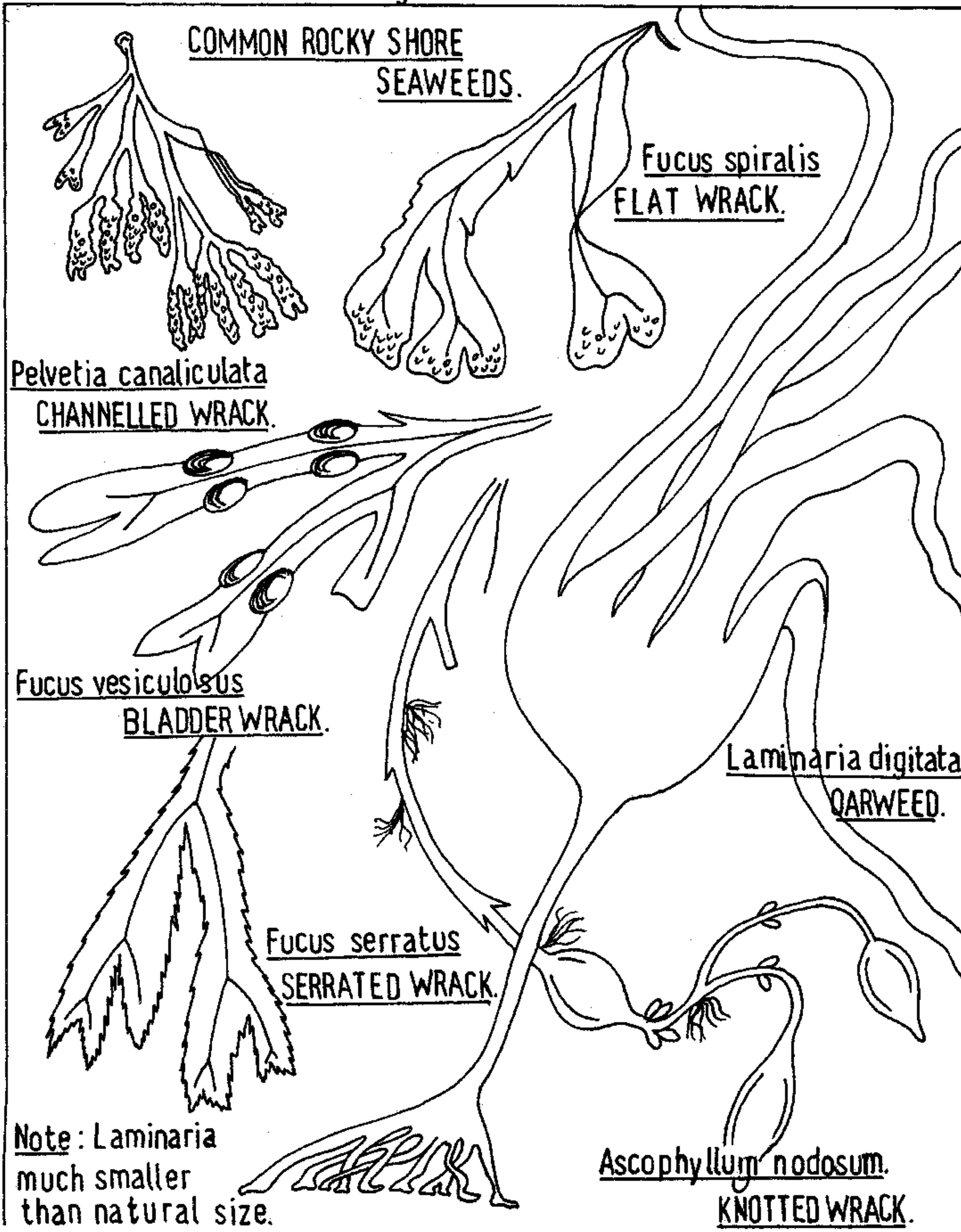

E.H.W.S.
E.H.W.N.
M.T.L.
E.L.W.N.
E.L.W.S.
KITE DIAGRAMS
Numbers/metres
150 100 50 0 50 100 150
Tellina tenuis
Tellina fabula
Macoma balthica
Donax vittatus
Other species and rough position on the beach, if present.
Macoma balthica
Cerastoderma edule
Natica catena and alderii
Tellina tenuis
Nassarius reticulatus
Ensis species
Donax vittatus
Spisula subtruncata
Gari fervensis
Tellina fabula
Venus striatula
Dosinia lupinus

Figure 5.



COMMON ROCKY SHORE SEAWEEDS.
Fucus spiralis
FLAT WRACK.
Pelvetia canaliculata
CHANNELLED WRACK.
Fucus vesiculosus
BLADDER WRACK.
Laminaria digitata
OARWEED.
Fucus serratus
SERRATED WRACK.
Note: Laminaria much smaller than natural size.
Ascophyllum nodosum.
KNOTTED WRACK.