

THE JOURNAL OF CONCHOLOGY.

VOL. 20.

21st DECEMBER, 1934.

No. 3.

THE LITTORAL ZONE.

By A. P. GARDINER, B.Sc.

(Presidential Address delivered at the Annual Meeting, 13th October, 1934.)

THE Littoral Zone, which is the area between high- and low-water marks of the spring tides, is a region second to none in interest to the zoologist. There is little doubt but that it was the site of the origin of life, and it presents to the naturalist countless examples of the wonderful adaptations which enable animals and plants not only to exist, but to thrive under conditions of continual change and stress of circumstances. The region is one of the most thickly populated, and the inhabitants are of many different forms and habits. A study of the molluscs alone of this zone presents to us a great number of examples of the probable steps by which animals in past ages have migrated from the sea to fresh water and to the land, and there are numerous cases of species which are still effecting this change at the present time. The keen struggle for existence, which is of necessity found in such a thickly populated area, has resulted in many cases of epizoic and epiphytic conditions and also of such devices for securing food and foothold as symbiosis, commensalism and parasitism.

It is my hope to deal with a few of such points of interest as these in certain coastal areas which seem to me to be favourable to the purpose. Nearly every type of the littoral zone, except the coral reef and the mangrove swamp, occurs in the British area, and the modifications of these types are innumerable. The chief factor which has caused this variation is the position of our islands in relation to the tidal wave. As this sweeps in its course with a velocity of as much as 500 to 600 miles an hour it impinges on the west coast and is split up and diverted in many directions. Some results of this are seen in the characters of the west coast of Scotland, the coast of Lancashire and Cardigan Bay, the Bristol Channel and the coast of Hampshire and Dorset. In the Scottish area the

direction of the tidal wave is more or less at right angles to the coast-line, with the result that deep inlets exist free from extensive deposits of silt and sand. The hardness of the rock in this region probably helps to maintain this condition. In West Wales and Lancashire, on the other hand, the course of the tidal progress is largely parallel with the coast-line, with the result that any inlet is likely to be filled up with sand and the inshore waters thus become shallow, resulting in vast areas being exposed at low tide. The funnel-shaped Bristol Channel is placed at such an angle as to receive the full force of the tidal wave, which becomes piled up as it passes into this great inlet. The result of this is that at Chepstow the difference of water-level is as much as 60 feet. The mean range for this Channel is 42 feet for spring and 21 feet for neap tides. St. Malo and the Channel Islands have, roughly speaking, 40 feet and 20 feet. On the Hampshire coast there are four tides in the twenty-four hours, owing to the tide entering each end of the Solent; the rise and fall is small.

The direction of the wind has a great influence on the height of the tide; many a day's collecting has been made or marred in the Salcombe Estuary or in the Helford River by this factor. In illustration of wind influence, it is recorded that in 1905 the height of the tide in Suffolk was increased by 6 ft. 3 in. by a N.N.W. wind.

For purposes of study it is usual to divide the tidal area into zones. Davenport's system of division is as follows:—

- (1) The Submerged Area. Exposed only at low water of spring tides.
- (2) The Lower Beach. Exposed twice daily.
- (3) The Upper Beach. Only reached by extreme high tides.

The brown algæ afford what is probably the best method of marking out the zones. At the highest point of the upper beach is found *Lichina*. At a slightly lower level *Pelvetia canaliculata* occurs, and near this we find *Fucus platycarpus* and, where fresh-water is present, *Fucus ceranioides*. We then reach the very extensive and conspicuous area of *Fucus vesiculosus*. This is followed by *Ascophyllum nodosum*, never without the parasitic *Polysiphonia fastigata*. With this is *Fucus serratus* followed by *Himanthalia lorea*, with its disc-shaped organs of attachment, and, finally, in the submerged zone *Laminaria saccharina* and *L. digitata*.

This algal mode of division only holds where rocks and stones are present, and it is impossible to draw hard and fast lines. For example, on sand and mud the characteristic vegetation in sheltered positions of the submerged zone consists of the Angiosperm *Zostera*.

In general, the factor which above all determines the flora and fauna of a given region is the perpendicular height, depending on the angle of the coast with the horizontal. Horizontal distance makes no difference. For example, at Oban, in places the tide only recedes a few yards, while at the Seymour and Icho Towers, in Jersey, it is necessary to go out as much as 2 or 3 miles to reach the extremity of the low water fauna.

Other important factors of determination are the changes of density and temperature and, especially in rock pools, the concentration of the hydrogen ion. Moore, in 1915, attributed the observed increase of alkalinity of sea water to the increase of the phytoplankton; a similar change has been observed in rock pools at different places when *Ulva* and *Enteromorpha* have made rapid growth.

After these few general remarks on the subject of my address I will try to illustrate some of the points which seem to me to be of the greatest interest by reference to collecting and observation conducted for many years at the following places :—

- (1) Salcombe Estuary with some points of comparison with the Helford River.
- (2) Oban.
- (3) Places on the west, south, and south-east of Jersey.
- (4) Pendine, Pembrokeshire.
- (5) The bay between the Castle and Penance Points, Falmouth.

SALCOMBE ESTUARY.

This is probably as nearly an ideal collecting ground as it is possible to find; it affords good examples of Davenport's three zones.

The *Submerged Zone* is extensive, and in the sand and mud areas is covered with *Zostera*. Near the mouth, however, the ground becomes hard in places with rock and stone and, finally, when the bar, immortalized by Tennyson, is reached, we find clean sand with little life except a curious form of *Spisula solida*, which has generally to be obtained by the use of the dredge.

Davenport's *Lower Beach* is also represented in several different forms. Near the Marine Hotel it consists of sand and mud and, alas! empty bottles and tins. Further down the estuary it is composed of rocks and pools rich in life.

The *Upper Beach*, too, is typical, and presents most of the forms usually found in this position. The particular zone is dealt with elsewhere.

We will consider first the *Zostera* as exposed at a good tide, and

it must be a good one. Vigorous work with a strong garden fork, even at a moderate state of the tide, will expose two fine worms of the Polychæta—*Amphitrite edwardsi* Quatrefages, and lower down in the zone *Amphitrite johnstoni* Malmgren. The latter occurs also on a bank, the Salstone far up the Kingsbridge branch of the estuary where, however, the former is scarce or absent. Both are found near the Marine Hotel. Associated with them is a very large handsome member of the Aphroditidæ, *Lepidasthenia argus* Hodgson, and frequently a smaller member of the same family of worms, *Lepidonotus clava* (Montagu). The flat form of both of these worms prevents them from getting in the way of their fat and rotund companions. With these two associations of worms we shall find the small bivalve, *Mysella bidentata* (Montagu). These filter feeding bivalves must derive benefit from the débris and minute organisms occurring in the burrows of the worms and they also enjoy a sheltered habitat, especially valuable to them in their early stages. *Mysella bidentata* does not always depend on this kind of shelter, as witness its occurrence in crevices of rocks; I have noticed this particularly in the summer months, far more than in the springtime, at Marazion and at Falmouth.

Other small bivalves such as *Cardium exigum* Gmelin, *Thyasira flexuosa* (Montagu), and, more rarely, the minute *Lepton* (*Epilepton*) *clarkiæ* Clark, occur near these Polychæte worms and also near the common lug-worm, *Arenicola marina* L., and the rather rarer *Arenicola ecaudata*, Johnston. I do not think that these species have any particular commensal relation to the worms.

If we examine some of the harder parts of the shore we shall see definite holes; on thrusting down the fork and lifting the ground quickly, burrows with a yellowish lining of as much as an inch in diameter will be seen. If we are fortunate and quick, and if the water does not fill the holes too quickly, we shall capture the two Crustaceans, *Upogebia deltaura* Leach and *Upogebia stellata* (Montagu). Of these two the former is the larger. With still greater good fortune we shall see on the yellow lining of the burrows the beautiful flat white bivalve, *Lepton squamosum* (Montagu). Specimens of these which were found by Winckworth and Salisbury spatting while in captivity. In this case also, a flat organism, the *Lepton*, allows its commensal to pass it with ease in the burrow. The *Lepton* leads a sheltered life and feeds upon débris and minute organisms in the burrow.

The most exciting find is yet to be made. Far down the zone the fork will expose the worm-like Echinoderm, *Leptosynapta inhærens* (Müller). Firmly attached to this we may find one, perhaps more, examples of the bivalve *Entovalva* (*Devonia*) *perrieri* (Malard). These

are generally attached near the posterior end of the Echinoderm. Until this species was rediscovered by Orton, and further found in quantity by Winckworth, it was one of our rarest shells. This case, and that of *Lepton squamosum*, are good examples of the comparative ease with which some animals are found when looked for in the right places, but never elsewhere. Our classic textbooks on conchology are frequently deficient in matters of this kind, and there is much work to be done by us all.

If we cross the ferry we find two other very interesting associations. In some of the most glutinous areas the fork will turn up a squirming mass of arms. This consists of the Echinoderm *Ophiocnida* (*Acrocnida*) *brachialis* (Montagu), and with it will be found two commensals, *Mysella bidentata* (Montagu) and the flat Chætopod worm *Harmothoe lunulata* (Delle Chiaje).

In a bay of clean sand a little way down the estuary slit-like holes will betray the Echinoderm, *Echinocardium cordatum* (Pennant). With this occurs another bivalve, *Montacuta* (*Tellimya*) *ferruginosa* (Montagu), but this association is not a very close one, the bivalve being generally found free from the Echinoderm. The colour of the former matches the sand so well that it is easily overlooked. Many specimens of this shell in the older collections were taken from the stomachs of fish at Cruden. I have dredged it without *Echinocardium* in 5 fathoms off Teignmouth.

A worm, *Polydora ciliata* (Johnston), bores into both living and dead shells. The sponge, *Cliona celata* Grant, has the same habit. The sponge may be obtained by dissolving the shell with dilute hydrochloric acid.

Associations of probably a purely epizoic character are seen in the angled white tubes of the worm *Pomatoceros triqueter* (L.). *Serpula vermicularis* L. makes a rounded tube in the same position. Another tube-building worm, *Filograna implexa* (Berkeley), makes a mass of much smaller tubes. Shells and algæ are frequently covered by the tubes of the worm *Spirorbis borealis* Daudin; these resemble small Gastropod shells.

The worm *Sabellaria alveolata* (L.) constructs dense masses of tangled tubes, often many yards in extent; these reef-like structures afford shelter to countless species of mollusca, worms, crustacea, etc., and are a rich hunting ground.

Competition for space and desire for protection result in even the dead shells of Gastropods being turned to account by Crustaceans and Cœlenterates in wonderful commensal and symbiotic associations. *Eupagurus prideauxi* (Leach) often has the anemone *Adamsia palliata* (Bohadsch) on its shell. *Eupagurus bernhardus* (L.) generally has *Calliactis parasitica* (Couch) as its companion. The

Hydroid, *Hydractinia echinata* (Fleming) also frequently covers the shells inhabited by crabs. These family parties are often completed by a worm, *Nereilepas* (*Nereis*) *furcata* Savigny. These are cases of true symbiosis, the benefit of the association being mutual. The active crab moves the anemone from place to place, the latter feeds on the débris of the crab's captures and, in return, protects the crab from prowling fish by means of its stinging organs. Another hermit crab, *Eupagurus cuanensis* (Thompson), uses a sponge, *Suberites domuncula*, and not a shell for its home.

Another interesting case of the use of dead shells is that of the worm *Phascolion strombi* (Montagu); this blocks up the mouth of the shell with a cement substance in much the same way as a bird, the nut-hatch, diminishes the size of a hole in a tree with mud to adapt it to nesting purposes. I have found the shells of *Turritella*, *Aporrhais*, and *Dentalium* to be those most frequently used. In the Cambridge University Museum there is a series of such shells with the worms in situ. On the coast of Brittany this worm is found associated with a Gastropod, *Odostomia perezii* Dautzenberg and Fischer, and a bivalve, *Montacuta* (*Tellimya*) *perezii* D. & F. I am indebted to Mr. R. Winckworth for information on this matter; he thinks that the occurrence of the bivalve in British waters is so probable that he has included it in his 1932 list under the name of *Montacuta phascolionis* D. & F., marked "Q". Every blocked shell should be examined with great care. I have dredged these on the Cornish coast and at Oban.

Musculus marmoratus (Forbes) occurs just below the tide limit, living in Ascidians. Near the Salstone *Lamellaria perspicua* (L.) is found under the test of the Ascidian, *Leptoclinum maculosum* Edw. This seems to be a case of the bivalve seeking shelter for breeding purposes. Miss K. White found this association on several occasions in the Isle of Man.

In the *Zostera* beds of Helford, but not in those of Salcombe, I have observed the association of *Bittium reticulatum* (da Costa) with a sponge. Of course, the occurrence of *Cerithiopsis barleei* Jeffreys with *Ficulina ficum* has been known for a long time.

Before leaving Salcombe the largest British bivalve, *Pinna fragilis* Pennant, should be sought for by looking along the surface of pools, where the broad end of the shell may be seen just projecting above the surface of the sand or mud. This animal has been found by treading on it with the bare foot, but this is not a pleasant way of detecting it.

Salcombe has not produced *Pelseneeria* (*Stilifer*) *stylifera* (Turton) with its Echinoderm host, but the Pea Crab, *Pinnotheres pisum* (Pennant) occurs with *Modiolus*. This seems to show definite

selection in the behaviour of the crab, for Orton found that fat and well-nourished mussels were selected. The female appears to sit upon the ctenidia and scrapes up the mucus laden with food particles. She is visited there, while inside the mussel shell, by the male, who sometimes comes to an untimely end by being trapped between the valves of the shell.

A reasonable explanation of how such associations as those of worms, Echinoderms, and Crustacea with bivalves may have arisen, seems to be that any spat of these prolific molluscs which happens to remain in, or enters, burrows, has a better chance of reaching maturity than has spat not thus protected. This seems to be one way of accounting for the fact that *Lepton* and *Devonia* are found in the company of the animals with which they live. Further, it is easy to imagine that the actual parasitic habit of animals like *Devonia* may have arisen through propinquity brought about at first by chance. The ingesting of mollusca by sponges and Ascidians may have arisen in a similar way.

The leaves of the *Zostera*, as well as the soil in which it grows, have a characteristic fauna. At Salcombe and at Helford the dominant species are *Cantharidus striatus parvus* (da Costa), *Rissoa membranacea* (J. Adams), and *Haliclystus*. *Buccinum* and *Littorina* are frequent on the substratum, while at Helford, but not in similar situations at Salcombe, *Haminoea navicula* (da Costa) may be found by thrusting the hands down into the mud around the roots of the *Zostera*.

Instead of mentioning any other species found at Salcombe, I will record a fact that has come to my notice in connection with the occurrence of different species in different years. In April, 1930, *Tethys punctata* (Cuvier) swarmed in hundreds between the Marine Hotel and the Castle, but there was not one on the opposite side of the estuary. *Archidoris britannica* (Johnston) and *Aeolidia papillosa* (Linné) were also very plentiful. There were very few *Pleurobranchus membranaceus* (Montagu). In the following year *Archidoris* and *Aeolidia* were as numerous as ever, *Pleurobranchus* was scarce and *Tethys* absent. In April, 1933, *Pleurobranchus* simply swarmed everywhere, in the dredges, on the Salstone, and near the Hotels. On the other hand, only one *Aeolidia* and two or three *Archidoris* were seen. These were the results of the hunting of my pupils, not only of my own efforts. There was little in the differences of climatic conditions to account for these facts, and the observations were made during spring tides of about the same date. A very extensive inshore migration of these species, lasting for a very short time, seems to be indicated. Full records, taken over a long period of time, would be of great interest.

JERSEY.

The chief collecting grounds are at the south and south-east, near the Seymour and the Icho Towers, and at the west end of the island at la Pulente and l'Etac.

The most notable characteristics of our area here are the swift tides and the flat shores. The result is that the tides recede for a vast distance and ebb and flow with great rapidity. Marshall states that the ebb takes seven, and the flow five, hours. Particularly is this the case at the two Towers. The Icho Tower is, if anything, the more dangerous of the two because the wild jumble of rocks between it and the mainland is intersected by deep and wide channels running parallel with the latter. Through these the rising tide rushes with great velocity, and woe to the person who too long delays his return to the shore.

Much of the best collecting is 3 miles or more from the land. Marshall, in his *Additions to British Conchology*, refers to the occurrence of *Mactra glauca* Born. It is found in grit to the north-east of the Seymour Tower, and is accompanied by *Donax variegatus* (Gmelin) of several varietal forms. Here also occur *Gari fervensis* (Gmelin), *Gari depressa* (Pennant), *Pharus legumen major* Bucquoy, Dautzenberg & Dollfus, *Solen marginatus* Montagu, *Ensis ensis* and *siliqua* (Linné), *Lutraria magna* (da Costa), and many other bivalves; an extensive and typical association for this kind of substratum. There are pools near the Tower with big stones under which large *Octopus vulgaris* Lamarck lurk. Marshall refers to the danger of collecting in this place in saying, "the stranger is at first appalled at the apparent disappearance of the island and at the utter chaos of the rocks which surround him." On one occasion I could only find my way back from the Seymour Tower by compass, owing to a sea fog that prevented my seeing more than a few yards around me.

One interesting association which occurs near the Towers, at Green Island, St. Brelade's Bay, la Pulente, and l'Etac is that of *Lepidopleurus cancellatus* (Sowerby), *L. scabridus* (Jeffreys), *Tornus subcarinatus* (Montagu), *Alvania lactea* (Michaud), and *Alvania carinata* (da Costa); these occur under stones rather deeply embedded in the mud and sand. With them occurs a Crustacean, *Axius stirhynchus* Leach, whose burrows are gutters of which the embedded stone forms the roof. This seems to be an association similar to that of *Upogebia* and *Lepton squamosum*. If this is the case, the difficulty of accounting for the supply of food of these species of mollusca is removed. A third association typical of this place is that of *Haliotis tuberculata* Linné, *Acanthochitona communis* (Risso), and *Ocenebra aciculata* (Lamarck). These are found under large

stones resting on others at an angle in pools. It is in the occurrence of the first and last of these, and of *Alvania lactea* (Michaud), and of the great numbers of *Acanthochitona communis* (Risso) that the molluscan fauna of this place differs from that of similar situations in Great Britain. The three above-named species of the Loricata seem to take the place, to a great extent, of *Lepidochitona cinereus* (Linné), *Acanthochitona crinitus* (Pennant), and the more local *A. discrepans* (Brown), *Tonicella marmorea* (Fabricius), and *T. rubra* (Linné) and *Callochiton achatinus* (Brown), of the British coasts. It is difficult to explain why a species occurring in both regions should be very common in one and rare in the other, when there is no satisfactory explanation to be got from the environment. This is a point that arises in other parts of this paper and I have ventured to call such species "equivalent".

One other point is the rarity of *Galeomma turtoni* Sowerby in Jersey, although it is fairly common in other islands of the group. I found two under the same stone at l'Etac, at the end of a long day. The next day the turning over and turning back of hundreds of stones at the same place did not yield one.

Mr. Pike, of the Jersey Museum, showed me specimens of *Onchidella celtica* (Forbes & Hanley) from l'Etac. These occurred, like mine at Trevone, at a much lower zone than has been attributed to them. I have never found specimens at or near the high-water mark, much less above it, as has been stated by many writers.

OBAN.

Mr. Winckworth, who directed me to the best hunting ground in Kerrera Sound, told me that I should go home "tired, bleeding, but successful", and I did! Never have I come across such sharp stones perched at such precarious angles. The shore is so steep that the tide only recedes a few yards and care is necessary to avoid being thrown into deep water when turning a stone.

The "equivalent" species of chitons are *Tonicella marmorea* (Fabricius), *T. rubra* (Linné), *Callochiton achatinus* (Brown), and *Lepidopleurus asellus* (Gmelin). These are dominant and seem to replace those found in the south.

The Laminaria is remarkable for the grand Pecten *Chlamys nivea* (Macgillivray) and for the beautiful *Margarites helacinus* (Fabricius). The latter seems to be equivalent to *Lacuna parva* (da Costa) in the south. *Chlamys distorta* (da Costa) was very fine. The largest *Lacuna crassior* (Montagu) that I have ever seen occurred here. I swallowed the largest one when turning over a rock; however, regurgitation took place, so that, unlike the fisherman's largest fish, it was not lost.

Other invertebrates found here were *Terebratulina caput-serpentis* (Linné), *Crania anomala* (Müller), *Munida rondeletii*, *Galathea strigosa* (Fabricius), and *Pycnogonium littorale*. The *Fucus* was thickly covered with *Clava squamata* (Müller); only at the Salstone have I seen so much of it.

It was noticed that the *Lepidopleurus asellus* (Gmelin) in the Laminarian zone were much larger than those dredged. The largest of the former measured 1.9×1.3 cm., while the latter were only 0.8×0.5 cm.

Trophon truncatus (Ström) is very common and seems to be the equivalent species to *Philbertia purpurea* (Montagu) on a beach such as that of Marazion or of Falmouth.

Patelloida tessulata (Müller) largely replaces *Patella vulgata* Linné.

Cantharidus clelandi (Wood) and *Trichotropis borealis* Broderip and Sowerby occurred in numbers just below the tide-mark, and *Lima sulcata* Brown in deeper water off the Maiden Rock. Perhaps the comparative scarcity of *Nucella lapillus* (Linné), *Patella*, and *Mytilus edulis* Linné accounts for the extraordinary richness of the fauna in other respects.

The greatest find of all was *Emarginula crassa anassa* Dean. On our first day almost the first upturned stone yielded two large ones, but the total number of adults found in two weeks in two separate years was small. Of these, one found by Miss White probably holds the record for size in British waters. There were very many small ones occurring with *Emarginula conica* Lamarck. This species seemed "equivalent" to *Emarginula reticulata mulleri* Forbes & Hanley of the south.

Trivia monacha arctica (Montagu) is very large and entirely takes the place of *Trivia monacha monacha* (da Costa).

FALMOUTH.

Time prevents me from saying much about this locality, so famous as the chief hunting ground of Cocks.

Excellent examples of the Upper Beach are presented. Here one finds *Littorina neritoides petraea* (Montagu) well on its way to become a land form. With it live dwarf *Littorina saxatilis* (Olivi), *Mytilus edulis* Linné, and the bivalve *Lasæa rubra* (Montagu). These hide in the *Lychina*. *Otina ovata* (Brown) may be on its way to the land from its damp caves, but I have always found it much farther down the zone than would be expected for a Pulmonate. Near the Lizard it occurs at about half-tide. In connection with the question of migration to the land Tattersal states that *Littorina neritoides* (Linné) has lost its metamorphosis, having no free veliger stage. The same is true of *Littorina saxatilis* (Olivi), so that

these two species, accustomed to long exposure to the air, are far advanced in the landward migration.

Littorina littoralis (Linné), of a lower zone, has a somewhat abridged metamorphosis, while the still more maritime *Littorina littorea* (Linné) has retained its full typical series of larval changes. At first sight it seems that the most natural and easy method by which transition from sea to land could take place would be through the intermediate brackish and freshwater existences. This, no doubt, is sometimes the case. An obvious example is seen in the estuarine and brackish species, *Hydrobia jenkinsi* Smith. This now swarms in thousands in the River Pang at Bradfield, and I have frequently found it alive in a damp coppice. Here, probably, it has been deposited by flood water and survived for a time. In this method of migration the osmotic difficulty has to be overcome. In this physical process water tends to pass through a membrane from a more dilute into a more concentrated solution until equilibrium is established. This flow is most deadly in its results, for example, brittle starfish are killed so suddenly by immersion in freshwater that even they have not got time to perform autotomy. Exquisite specimens may be obtained in this way without the risk of loss of arms.

In favour of the theory of direct migration from sea to land direct, rather than through an intermediate freshwater phase, it is known that the Upper Beach *Lasæa rubra* can live exposed to air for nine days, but not for one in freshwater. The numbers for some other species are :—

<i>Littorina neritoides</i> .	Air 42 days.	Freshwater 11.
<i>L. saxatilis</i> .	„ 31 „	„ 7.
<i>L. littorea</i>	„ 23 „	„ 7.
<i>L. littoralis</i> .	„ 6 „	„ 2.

These results are those of Colgan (1910).

As a rule the lower its zone on the shore the less power an animal has of resisting freshwater. These considerations seem to point to the possibility of *Pomatias elegans*, for instance, having undergone direct transition. Cooke, in 1895, observed landward migration of three species of *Littorina* at Panama. These were actually on trees.

The Falmouth section of coast, including as it does rocky coves, sandy beaches, and reefs of rocks with splendid pools, is an excellent place for observing examples of protective resemblance. Space only permits me to mention *Rostanga rufescens* Iredale and O'Donoghue. Here I have frequently found this red nudibranch under stones, but never on red sponge ; thus this would seem to be a case of warning rather than of protective colouration.

In the rock pools *Patelloida virginea* (Müller), *Patella depressa* Pennant, *Patella athletica* Bean, are very inconspicuous on the calcareous algæ *Melobesia*, *Lithothamnion*, and *Corallina*. *Littorina littoralis* frequently, but by no means always, matches the *Fucus* on which it lives. Cases of protective resemblance in the Nudibranchs are very numerous.

I have often wondered if the blue lines of *Patina pellucida* (Linné) may not help to break up the outline of the animal in the same way that the bright stripes of the larvæ of Hawk-moths help to render the creature inconspicuous.

Arca tetragona britannica Reeve, *Arca lactea* Linné, *Ocenebra erinacea* (Linné) on this coast and *O. aciculata* (Lamarck) and *Haliotis* in Jersey are good imitations of lumps of stone.

These Cornish beaches are not what they were thirty years ago, when I worked them year in and year out for six years. During the War an oil tank ship went on the rocks and was burnt there. For some years the flora and fauna were wiped out. In 1931 life was nearly but not quite normal near the site of the disaster. Gillan Creek, towards the mouth of the Helford River, might at one time have served as the happy hunting ground of good biologists—its fauna was ruined in one night by a drift of oil from a wreck on the Eddystone. We were at Gillan the day before and the day after. This occurred some years ago and perfect recovery has never been made. How many millions of crabs and lobsters in the adult and larval state must have been killed, to say nothing of other animals of importance as fish food!

Finally, one word about the last type of shore: Our example is Pendine and Amroth in Pembrokeshire. On this sandy wave-swept expanse the molluscs must either burrow in the sand and have long tubes, or be prepared to roll like *Actæon tornatilis* (Linné), the most characteristic animal of this region; it can often be found in the wet sand by following its tracks. *Tellina squalida* Montagu, *Diplodonta rotundata* (Montagu), and *Mysia undata* (Pennant) amongst the scarcer species, with *Cyprina islandica* (Linné), large white *Venus striatula* (da Costa), *Donax*, *Lutraria*, *Spisula*, *Mya*, *Pharus*, *Cultellus*, *Ensis*, *Solen*, and *Mactra* form banks of dead shells.

In the submarine forest at Amroth *Pholas* and *Barnea* of great size occur in the subfossil wood. Pendine is also famous for *Clathrus turtonis* (Turton). A pupil of mine whom I sent there found three in one day. Here there are no stones to leave unturned and none to leave the wrong way up.



Gardiner, Alan P. 1934. "The Littoral Zone (Presidential Address)." *Journal of Conchology* 20(3), 65–76. <https://doi.org/10.5962/p.406768>.

View This Item Online: <https://www.biodiversitylibrary.org/item/329039>

DOI: <https://doi.org/10.5962/p.406768>

Permalink: <https://www.biodiversitylibrary.org/partpdf/406768>

Holding Institution

Smithsonian Libraries and Archives

Sponsored by

Biodiversity Heritage Library

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: Conchological Society of Great Britain and Ireland

License: <https://creativecommons.org/licenses/by/4.0/>

Rights: <http://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.