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ON THE DISTRIBUTION OF SOME COMMON ANIMALS AND PLANTS ALONG THE ROCKY SHORES OF WEST SOMERSET

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THE Bristol Channel has long been noted for its impressive tidal range, extensive shores and muddy water. More recently the overall paucity of the marine fauna and the contamination of certain species with considerable quantities of heavy metals have attracted attention in the Press. Boyden & Little (1973) described the fauna of sandy and muddy shores but there is no previous account of zonation patterns on the rocky sea shores of Somerset.

This paper describes twelve detailed transects taken during the autumn of 1974 on the north-facing shore of West Somerset between Porlock Weir and the mouth of the River Parrett. It is intended as a baseline against which any subsequent changes can be recorded and thus I decided to use the technique of Moyse & Nelson-Smith (1963) which has been used for this purpose not only in Milford Haven but also in Bantry Bay (Eire) and Fensfjorden (Norway).

METHODS

The transect sites are indicated in Fig. 1. In each case a line was selected up the seaward-facing side of the rocks, keeping to the bedrock or stable boulders, and extending from low water mark to above high water mark. Ideally they should have extended to the level of the lowest flowering plant but this was not always practicable. Areas of mud, sand and shingle were avoided and such special habitats as rock pools and gullies ignored.

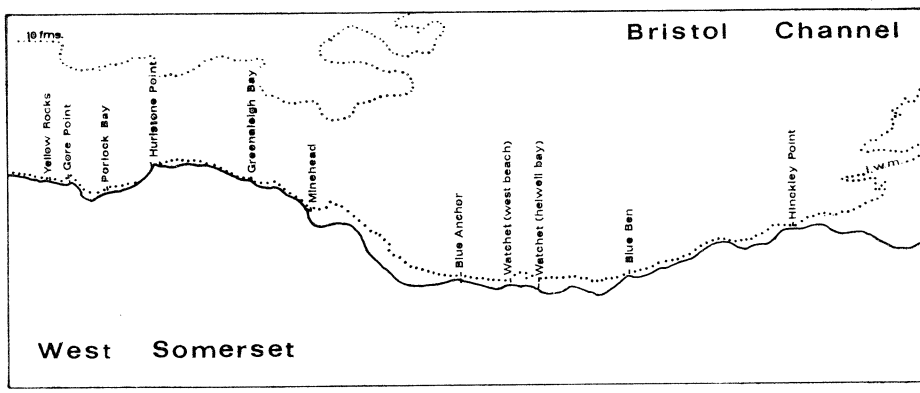
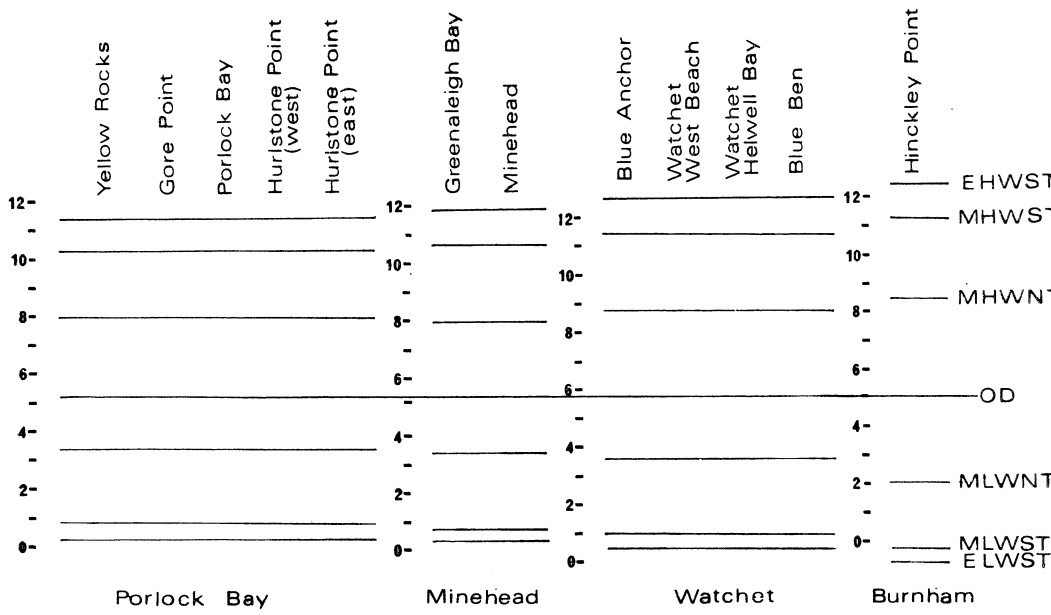


FIG. 1.

(a) The position of the twelve transect sites along the coast of West Somerset.



(b) The mean tidal levels (in metres above Chart Datum) for the twelve sites all referred to Ordnance Datum. Data from Admiralty Hydrographic Department (1973).

All the transects, except that of Minehead Harbour, started at low water mark with stations taken at 1 metre intervals upwards. The heights were subsequently referred to Chart Datum by reference to the Admiralty Tide Tables (Admiralty Hydrographic Dept. 1973) from which the mean levels of high and low tides were also obtained. The horizontal distances between the stations were recorded and used to plot the shore profiles in Fig. 2.

The artificial rocky shore at Minehead does not extend down to low water mark. The baseline for this transect was calculated from Table 2 in the tide tables although I question the accuracy of this method in the Bristol Channel.

The fieldwork was carried out in fine, settled weather, and there was no difficulty in establishing "sea level" at low water. On some shores the accuracy of the survey was checked from the line of debris deposited by the previous high tide.

At each station the area of rock examined was large enough to include all the survey species if they were present. This often required about 2 sq metres of rock surface, extending sideways from the marked point but only about 25 cms above and below it. Attention was concentrated on 23 common species, or groups of species, and no attempt was made to note all the species encountered.

The abundance of each of the survey species was assessed by reference to the appropriate abundance scale. These scales, set out below, are very similar to those of Crapp (1973) and were derived from modifications by Ballantine (1961) and Moyse & Nelson-Smith (1973) to the original version of Crisp & Southward (1958). This sytem is unquestionably quicker and more readily repeatable than direct counts and is certainly no less accurate on irregular rock surfaces.

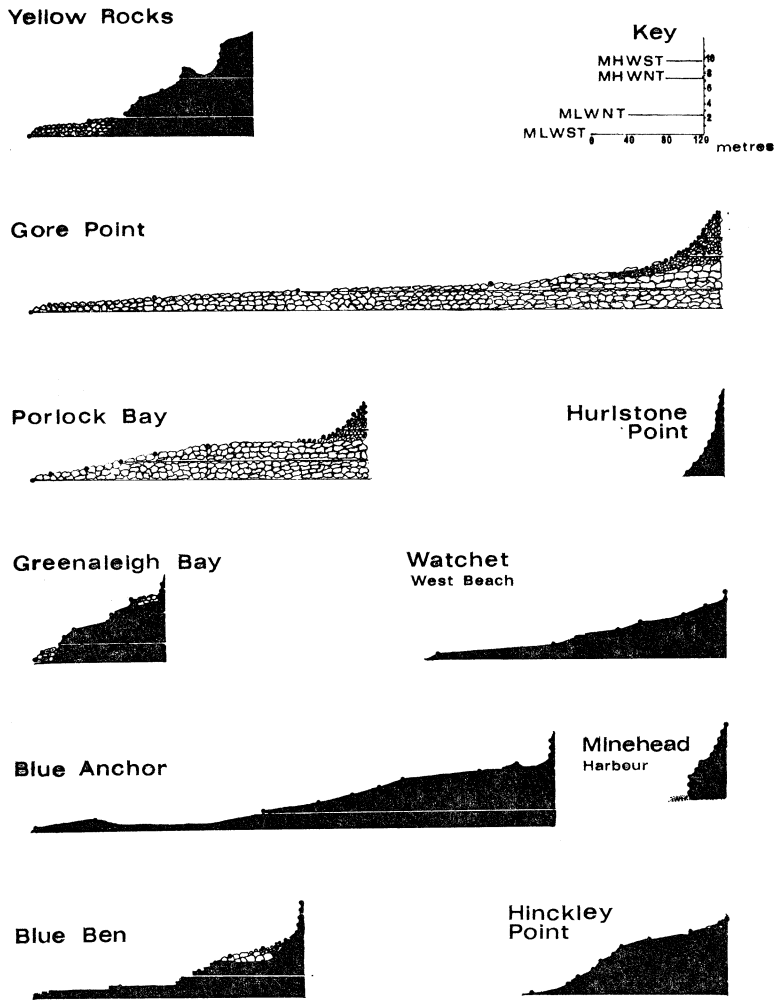


FIG. 2.

Shore profiles for the transect sites. The two sides of Hurlstone Point and the two sites at Watchet are similar.

THE ABUNDANCE SCALES

1. *Lichens*

7. More than 80% cover
6. 50–80% cover
5. 20–50% cover
4. 1–20% cover
3. Large scattered patches
2. Widely scattered patches, all small
1. Only one or two patches

2. *Algae*

7. More than 90% cover
6. 60–90% cover
5. 30–60% cover
4. 5–30% cover
3. Less than 5% cover but zone still apparent
2. Scattered plants: zone indistinct
1. Only one or two plants

3. *Acorn Barnacles and Small Winkles*
   7. More than 5 per sq cm
   6. 3–5 per sq cm
   5. 1–3 per sq cm
   4. 10–100 per sq decimetre
   3. 1–10 per sq dm: never more than 10 cms apart
   2. 1–100 per sq m: few within 10 cms of each other
   1. Less than 1 per sq m

4. *Limpets and Large Winkles*
   7. More than 200 per sq m
   6. 100–200 per sq m
   5. 50–100 per sq m
   4. 10–50 sq m
   3. 1–10 per sq m
   2. 1–10 per sq Decametre
   1. Less than 1 per sq Dm

5. *Mussels and Piddocks**
   7. More than 80% cover
   6. 50–80% cover
   5. 20–50% cover
   4. Large patches but less than 20% cover
   3. Many scattered individuals and small patches
   2. Scattered individuals, no patches
   1. Less than 1 per sq m

6. *Topshells and Dog-Whelk*
   7. More than 100 per sq m
   6. 50–100 per sq m
   5. 10–50 per sq m
   4. 1–10 per sq m: locally more
   3. Less than 1 per sq m: locally more
   2. Always less than 1 per sq m
   1. Less than 1 per sq Decametre

Abundance 7 corresponds to the Extremely Abundant category of Crapp (1973) and included in the 'Abundant' category of earlier authors.

Abundance 6 corresponds to the Superabundant category of Crapp (1973) and included in the 'Abundant' category of earlier authors.

Abundance 5 corresponds to the Abundant category of Crapp (1973) and earlier authors.

Abundance 4 corresponds to the Common category of the earlier authors.

Abundance 3 corresponds to the Frequent category of the earlier authors.

Abundance 2 corresponds to the Occasional category of the earlier authors.

Abundance 1 corresponds to the Rare category of the earlier authors.

A Brief Description of the Shores

The rocky shores of West Somerset lying to the west of Minehead are formed from the Hangman Grits, one of the hardest facies in the Old Red Sandstone series. The land falls steeply from over 300 m to the sea but only at Hurlstone Point is the bedrock exposed over the whole shore. On all the other shores at least part of the intertidal zone is covered by boulders or a storm beach of mobile shingle. Within Porlock Bay the shores are composed of boulders with a storm beach along the top. At Minehead too the solid rock is covered by pebbles and the site surveyed there was the east-facing side of a concrete groyne that extends northwards from the outside of the harbour wall and is not of very recent construction.

East of Minehead, the coastline is composed of much softer Jurassic or Triassic rocks which have been eroded to leave extensive wave-cut platforms backed by nearly vertical low cliffs. In some places these cliffs are eroding rapidly, perhaps by as much as 1 m a year. The shore within the wave-cut platform is often geologically complicated, with alternating bands of harder and softer rocks, heavily folded and

* Note: for Piddocks the abundance of holes is recorded, not the number of animals.

crisscrossed by large and small faults; providing excellent opportunities for studying the influence of rock type on the settlement of marine organisms.

The tidal range increases eastward along the Somerset coast and four sets of corrections are required to plot the results of the transects. The mean levels are set out diagrammatically in Fig. 1b, with all the heights referred to Ordnance Datum (OD). The figures represent the vertical extent in metres. High tide levels vary appreciably more than low tide levels and this prevents our making a simple proportional adjustment to plot the data against one set of coordinates.

The whole scale of tidal influence on Somerset shores is greater than elsewhere in the British Isles. Not only is the overall range unusually large but the differences in tidal level from day to day and between spring and neap fluctuate accordingly. Figures 3 and 4 represent tidal predictions for the maximum and minimum tides of a year, whilst Fig. 5 sets out the predicted heights of high and low water for a month (September 1974) and Fig. 6 the comparable data for a year. The large tidal range does not affect the length of time for which a site on the shore is covered by the sea, but it greatly affects the horizontal speed at which water flows and the influence of waves—for the size of the waves does not increase in proportion.

On a typical British shore, with a tidal range of perhaps 4 metres, the effect of waves breaking on the middle shore will be felt at low water mark and the resulting spray may well be carried onto the upper shore and above. On Somerset shores, however, a wave of the same size breaking on the middle shore would have no influence on the lower shore, six or more metres under water, and the whole upper shore will receive much less spray.

The predictions for February 28th. 1975 (Fig. 3) indicate that the flood tide would have risen 6 metres in 2 hours at Watchet! The Bristol Channel is 20 km wide at this point, so the volume of water moving is indeed very large. One consequence of this water movement is that the mud, brought down into the estuaries by the rivers, cannot settle out, save temporarily at slack water, and is kept in suspension. As a result the water is always turbid and the scour (abrasion) on the rock surface is considerable as tons of fine sand particles are eternally swept across it and delicate encrusting animals and plants do not survive.

The Exposure of the Shores to Wave Action

Ballantine's (1961) exposure scale has proved to be the most useful method for the comparative description of rocky shores in southwestern Britain. But, being a biologically-defined scale, it depends on the abundance of selected "indicator species" varying in accordance with the degree of exposure of the shore to wave action. When these indicator species vary in abundance for other reasons it becomes difficult to to apply the scale. Aberrant behaviour by one species does not matter very much as the scale depends on the responses of several species, but unfortunately seven of them do not penetrate very far up the Bristol Channel, and decrease in abundance as they approach their eastern limit.

In Porlock Bay all the indicator species are present except *Alaria esculenta*, but east of Hurlstone Point *Laminaria* and *Lichina* species disappear, whilst *Chthamalus stellatus*, *Littorina neritoides* and *Monodonta lineata* all progressively decrease in abundance to die out at Watchet; followed by *Gibbula umbilicalis* at Kilve. *Patella* species appear to hybridize in this area and are not useful as indicators. The exposure of

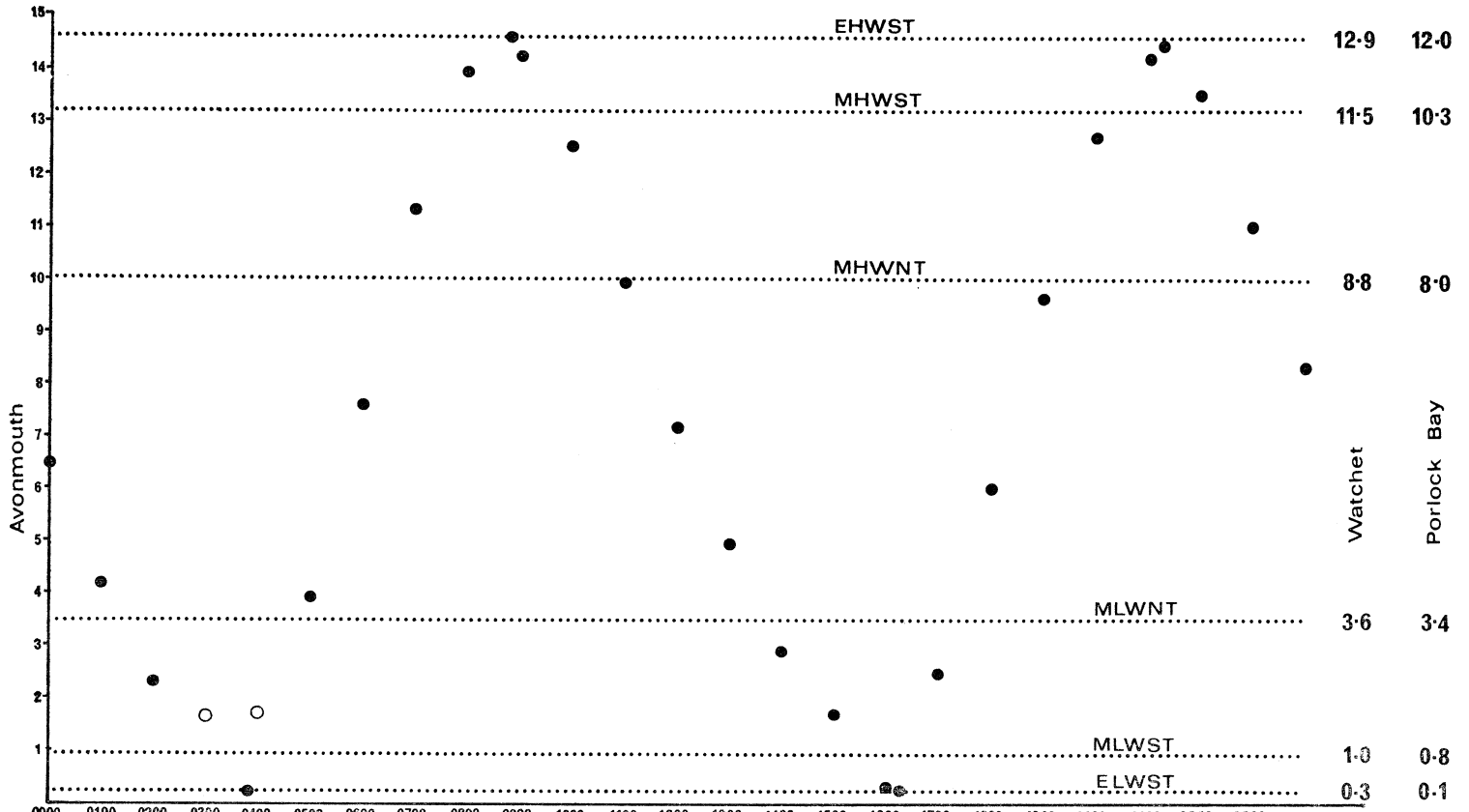


FIG. 3.

Hourly predictions of tidal level in metres for the highest tide of 1975. Data for Avonmouth with corrections for Watchet and Porlock Bay shown at the right. (Admiralty Hydrographic Dept. 1974).

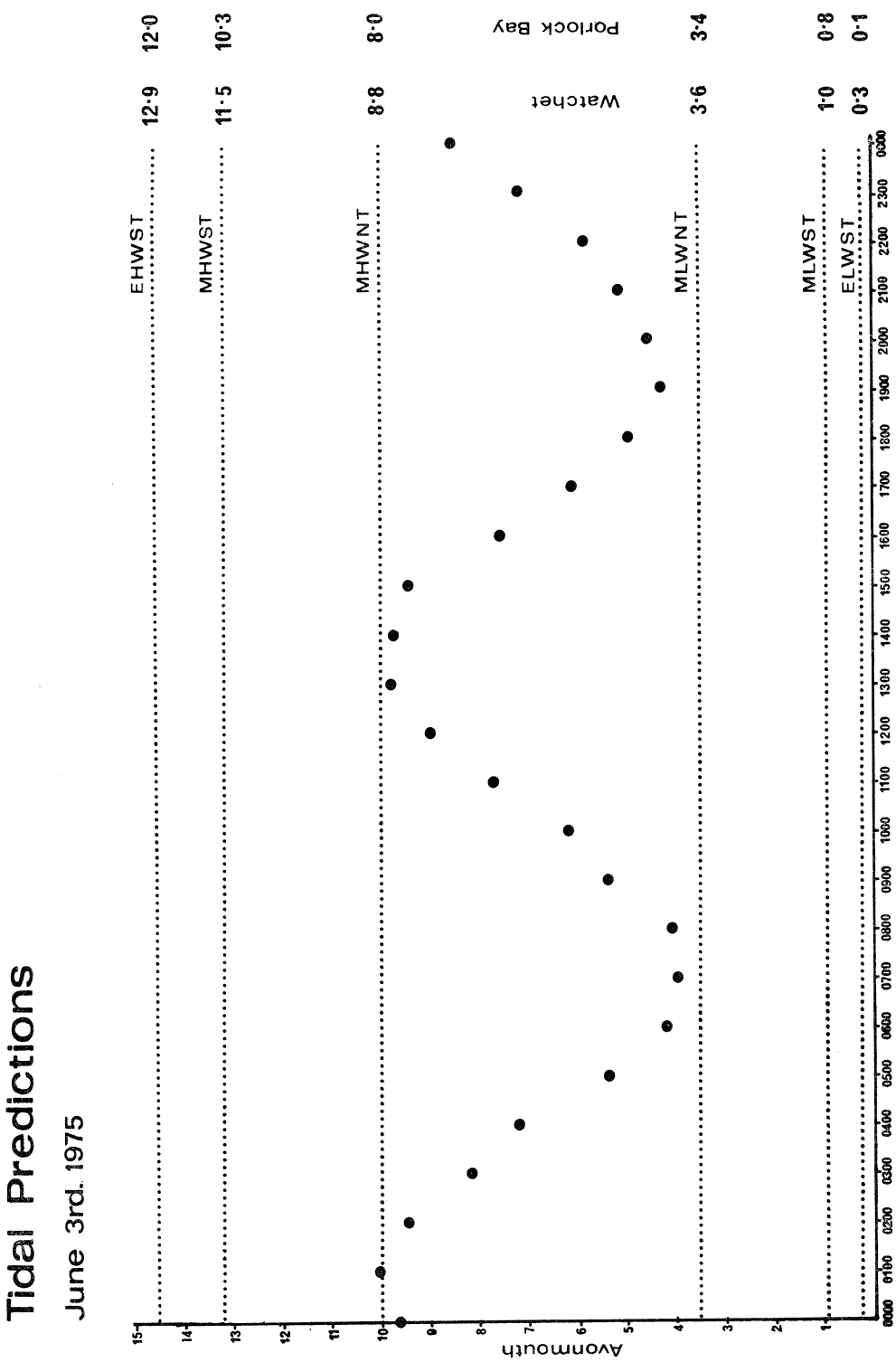


FIG. 4.

Hourly predictions of tidal level in metres for the smallest tide of 1975.

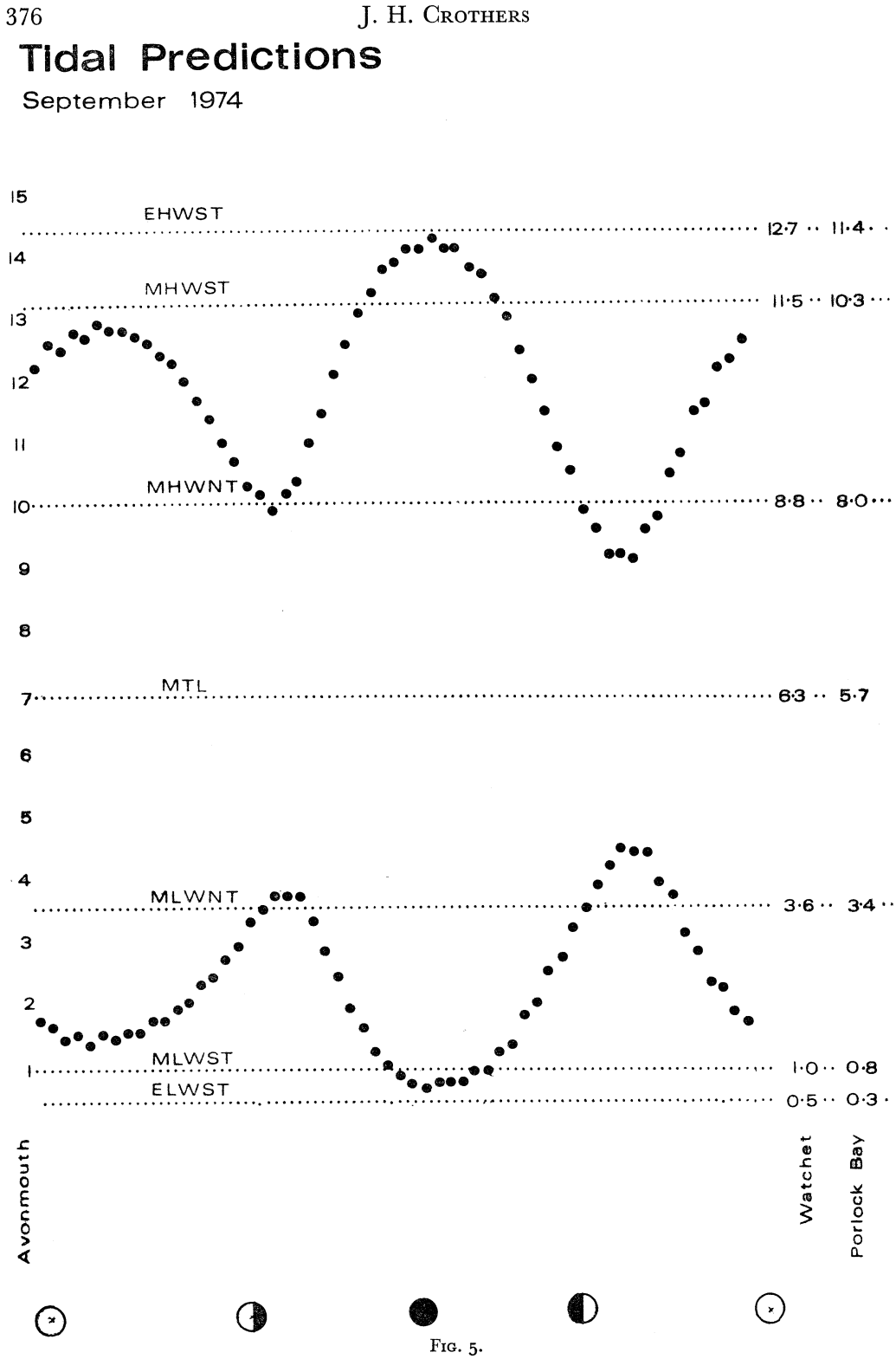


FIG. 5.

Daily predictions of high and low water in metres for the month of September 1974. Data for Avonmouth with corrections for Watchet and Porlock Bay at the right. Admiralty Hydrographic Department (1973).

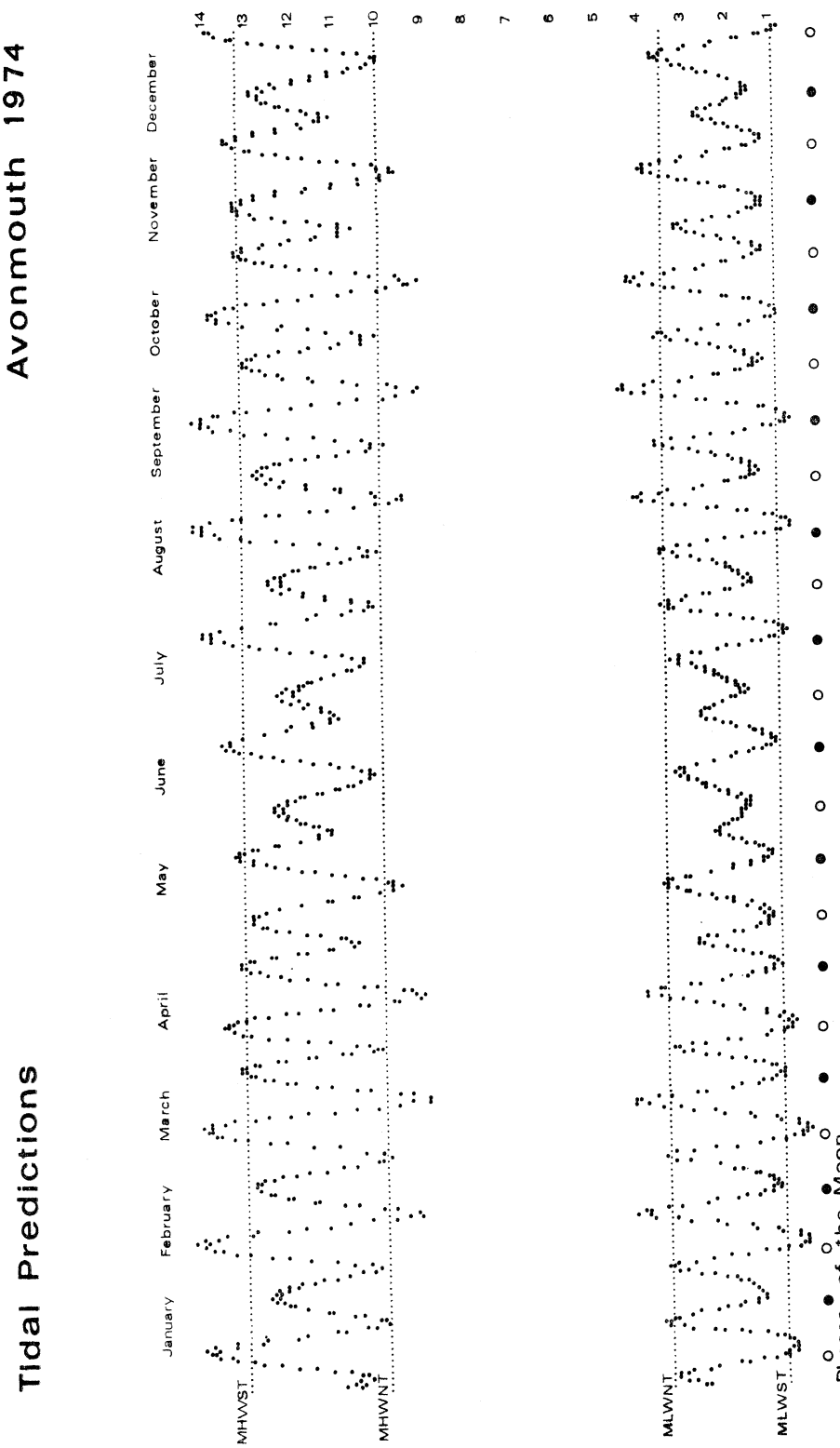


FIG. 6.

Daily predictions of high and low water in metres for the year 1974 at Avonmouth. (Admiralty Hydrographic Department 1973).

some Norwegian shores has been assessed from the shape of dog-whelk shells (Cowell et al. in prep.) following Crothers (1973) but Somerset shores appear to be colonized by a genetically distinct population of this species (Crothers 1974) which does not show this variation with exposure.

Bearing in mind all these problems the shores have been assigned to exposure grades as follows:

Exposure 2 (Very Exposed)	Hurlstone Point west
Exposure 3 (Exposed)	Hurlstone Point east
intermediate between 3 and 4	Yellow Rock
Exposure 4 (Semi-exposed)	Gore Point, Greenaleigh Bay, Minehead
Exposure 5 (Fairly Sheltered)	Blue Ben, Hinckley Point
Exposure 6 (Sheltered)	Blue Anchor, Watchet west beach, Watchet Helwell Bay.

This gradation is due to the slope of the shore as much as to changes in the fetch. Hurlstone Point and Minehead are steep but some of the other shores in equally exposed positions are so extensive that all large waves break well offshore.

DISTRIBUTION PATTERNS IN THE SPECIES STUDIED

(1) *The Fucoid Seaweeds* Fig. 7

Pelvetia canaliculata, the Channel Wrack, is not a common plant along this stretch of coast. Too often the rock surface is covered by a storm beach of shingle or is subjected to severe erosion/abrasion at the level where this plant would otherwise settle. Hurlstone Point (the only natural shore without any high level shingle) is too exposed for this species except in local shelter. Where it does occur it is zoned around MHWST, as in Pembrokeshire and elsewhere. The record from Watchet west beach was of two individuals near the top of an isolated stack.

Fucus spiralis, the Flat Wrack, is more abundant, growing between the spring and neap high tide marks, and extending above MHWST on north facing cliffs, especially in the absence of *Pelvetia*. It is commoner towards the eastern end of the survey area but does occur between Yellow Rock and Gore Point, though not on either transect.

Fucus vesiculosus, the Bladder Wrack, occurs as the normal vesiculated form on all the more sheltered shores. The bladderless form, *f. evesiculosus* (=*f. linearis*) was recorded at Greenaleigh Bay and occurs sporadically on Hurlstone Point. The species occupies the middle shore, between high and low water mark of neap tides.

Ascophyllum nodosum, the Egg or Knotted Wrack, occurs on the middle shore at all sites of exposure 5 or 6 and may grow to a great size. The epiphytic red seaweed *Polysiphonia lanosa* is particularly common on the upper *Ascophyllum* at Watchet.

Fucus serratus, the Saw Wrack, shows its usual distribution pattern on the lower shore in Porlock Bay but east of Minehead extends very much further up the shore often reaching MHWNT though never extending above the highest *F. vesiculosus* or *Ascophyllum*. It is the upward sweep of this species which makes the seaweed zonation appear so odd to strangers. It may be related to the very gentle slope of the shores

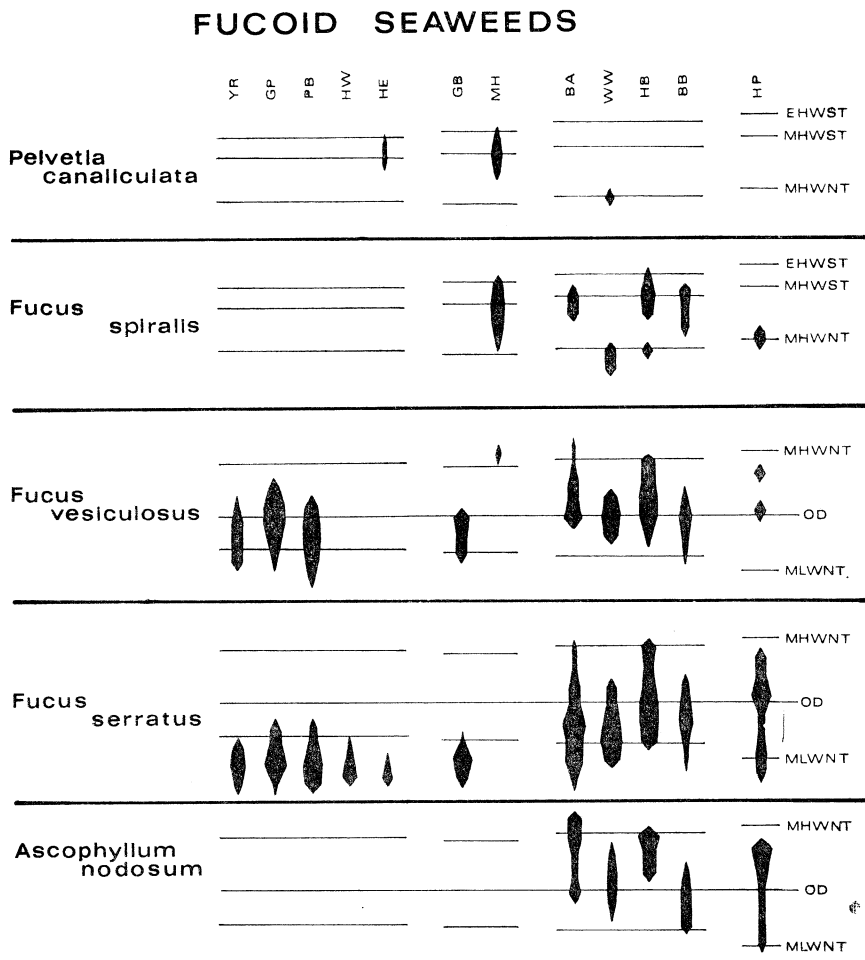


FIG. 7.
Zonation of Fucoid Seaweeds: Tidal levels as in Fig. 1b.

which allows the rock surface to remain damp for most of the time and so permit the germination of "sporelings" which otherwise would dry out and die.
Laminaria digitata, the Kelp, is restricted to the extreme lower shore in Porlock Bay. A few tattered individuals can sometimes be found on the east side of Hurlstone Point but not at Greenaleigh Bay. The increasing tidal scour coupled with the turbidity and darkness on the lower shore may prevent development of the gametophyte generation further east.

(2) *Limpets* Fig. 8

Patella aspera, *P. intermedia* and *P. vulgata* are all present in North Devon and certainly recognizable in Porlock Bay, but on West Somerset shores they appear to hybridize and many individuals cannot with certainty be assigned to species in the field. The situation appears similar to that described by Fretter & Graham (1962) around the

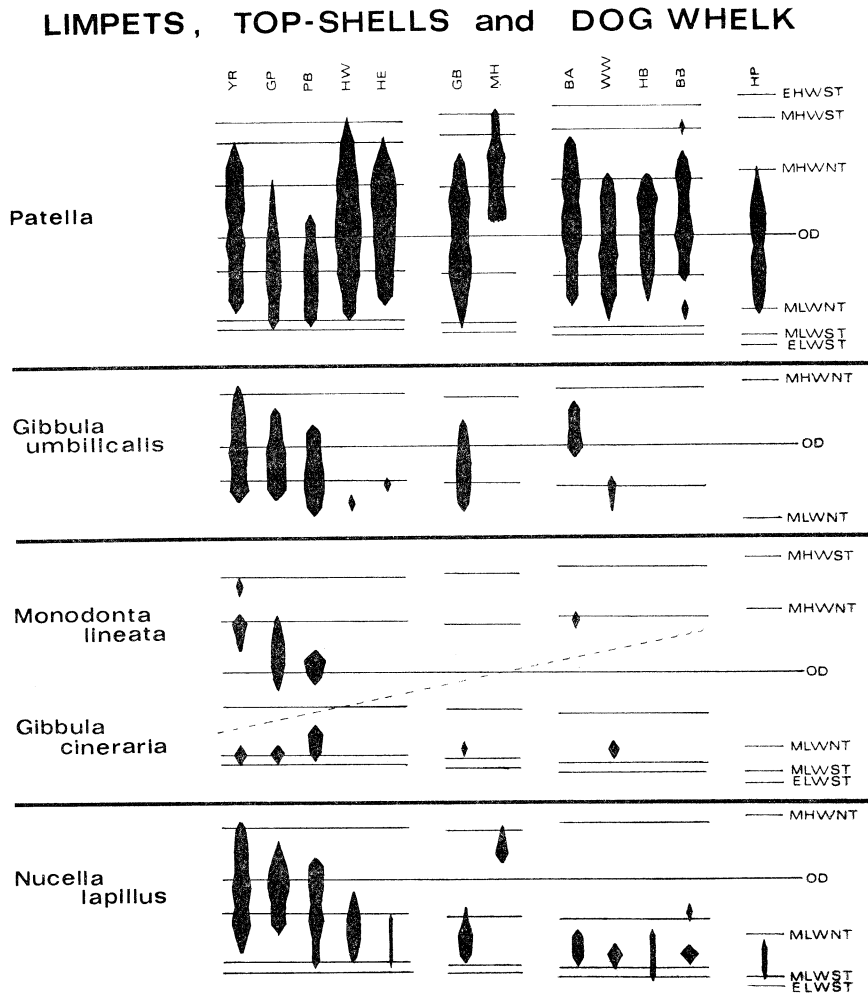


FIG. 8.
Zonation of some shore Gastropods: Tidal levels as in Fig. 1b.

Isle of Wight. The distribution of *Patella* species is closely bound up with the distribution of the fucoid algae: limpets feed on the newly germinated "sporelings" of the algae and abrasion of the rock surface by the fronds of full-grown fucoids will kill any newly-settled limpet spat within reach. There is a complex balance on rocky sea shores between limpets and fucoids, tilted in favour of limpets by increasing exposure to wave action. Removal of limpets from exposed shores permits the development of algae, as was seen in Cornwall after the *Torrey Canyon* incident in 1967 (Nelson-Smith 1968). In Fig. 8 note that *Patella* species are most abundant on Hurlstone Point, and (in Fig. 7) that middle shore fucoids are absent from there: the expected pattern. Limpets extend down to MLWST in Porlock Bay but note that their lower limit gradually rises to MLWNT at Hinckley Point, reflecting the decrease in lower shore algae. (The Minehead transect must be ignored as the concrete shore does not reach MLWNT.)

(3) *Barnacles* Fig. 9

The settlement of barnacle spat is inhibited by the large brown algae as, like the limpet spat, they can be swept off. Sometimes one can see cleared circles around isolated plants amongst a dense settlement of young barnacles. Thus barnacles are generally commoner on those shores, or those parts of shores, where limpets are most abundant. A careful comparison of Fig. 9 with the *Patella* data in Fig. 8 will show this to be true.

Barnacles are sedentary when adult and depend for food on the microscopic

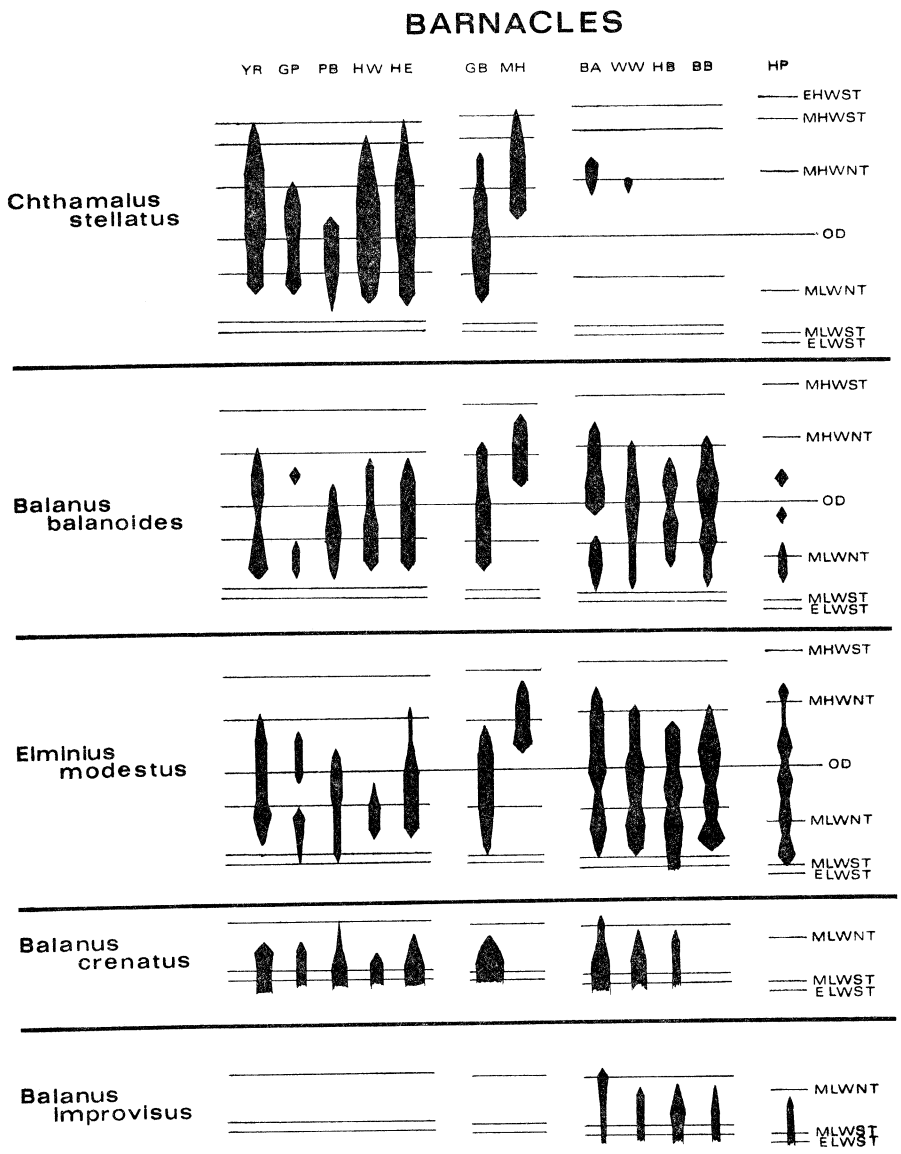


FIG. 9.
Zonation of Barnacles: Tidal levels as in Fig. 1b.

planktonic organisms, that abound in the surface water of the sea, being brought to them; so they are most abundant at those levels of the shore most frequently in contact with surface seawater, either as splash or by being covered by the tide. In practice this means the middle shore with an upward extension on those steep shores which receive appreciable quantities of spray.

Five species were considered sufficiently common to be included in this survey. Three others are confined to crevices and the undersides of boulders in Porlock Bay.

Chthamalus stellatus is the dominant exposed shore barnacle in southwestern Britain, tending to be zoned above, but extensively overlapping, *Balanus balanoides*. It is one of those southern species which reach their northern and eastern limits in the British Isles (see Lewis 1964 Fig. 65) and did not in 1974 extend east of Watchet on the southern shore of the Bristol Channel. On the shores west of Minehead, where it is abundant, note that it does not extend far, if at all, above EHWST, whereas at Dale (Moyse & Nelson-Smith 1963) it reaches as much as 4 metres above the equivalent level.

Balanus balanoides was present on all the shores examined but never the dominant barnacle. It is a northern species, reaching its southern limit in northern Spain and it never seems to reach such a large size at this end of its range as it does in northern Scotland or in Norway. Fig. 9 shows it to be a middle shore species, only extending above MHWNT on, or in the shade of, north-facing verticals.

Elminius modestus, the immigrant Australasian species, is now firmly established on all shores in the Bristol Channel that offer a possible substrate for growth. Least abundant on the most exposed shores it becomes the dominant species east of Minehead.

Balanus crenatus is the dominant lower shore species in Porlock Bay but gradually decreases in abundance east of Minehead and is progressively replaced by *Balanus improvisus*; a species known to be tolerant of estuarine conditions but not often found on the shore.

(4) *Bivalves* Fig. 10

Mytilus edulis, the Common Mussel, usually occupies much the same zone on the shore as *Balanus balanoides*. It too is a sedentary plankton feeder which can survive on the outer rock faces, but it does not do very well on the Somerset shores and is dominant over barnacles only where a stream runs over the shore west of Gore Point. On most of the shores surveyed mussels are present as diminutive individuals clustered in small crevices. The increasingly muddy water may render Somerset shores less suitable for this filter feeder than the coast of North Devon.

The Piddocks live in burrows which they bore into the rock. The two dominant species are *Pholas dactylus*, which can burrow more than 10 cms down, and *Barnea parva* which lives near the surface. *Barnea candida* has also been recorded. It is impossible to identify the species without excavating the rock so they have been lumped together for Fig. 10. The distribution of these animals is largely controlled by the softness of the substrate and are thus absent from shores near Minehead or further west. The record in Porlock Bay is from the stiff clay of a submerged forest.

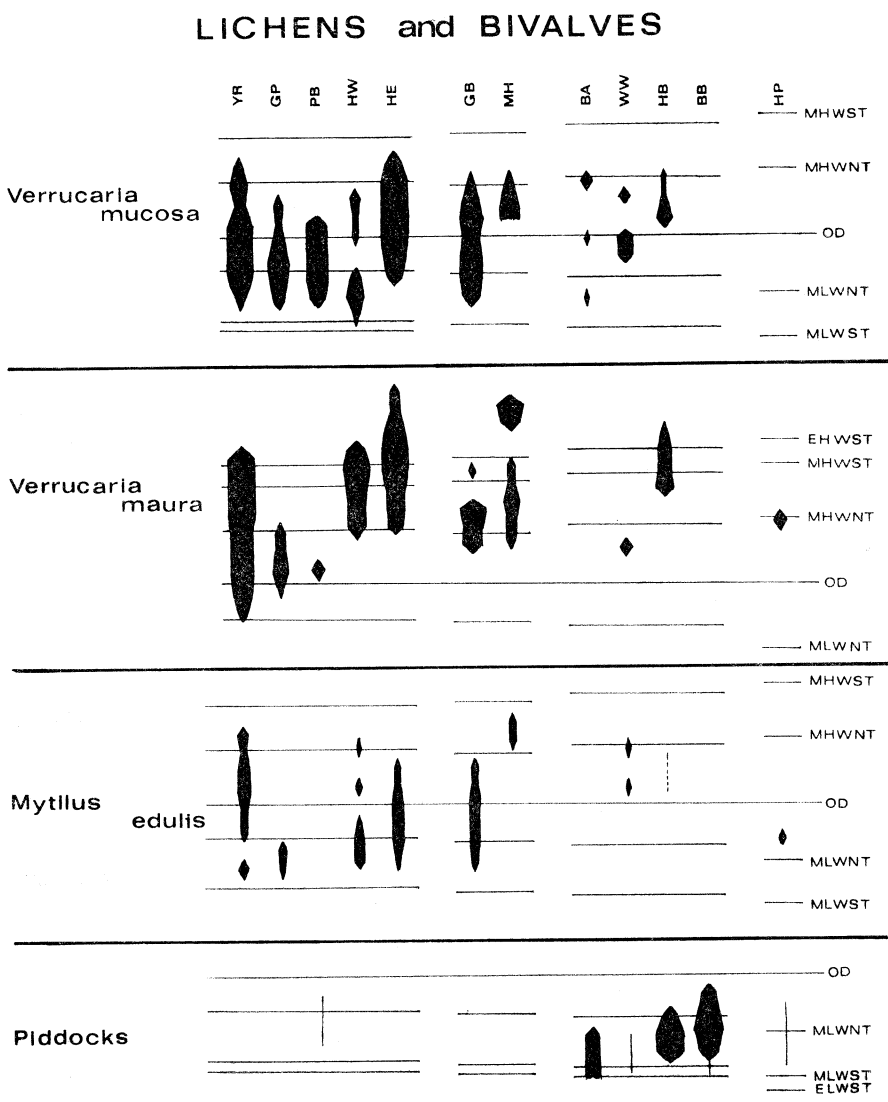


FIG. 10.
Zonation of Lichens and Bivalves: Tidal Levels as in Fig. 1b.

(5) *Lichens* Fig. 10

Only the two commonest shore lichens have been included in this survey. The crumbling cliffs of West Somerset do not offer many suitable sites for the supratidal species (and any plants that did grow would be extremely difficult to observe). "*Verrucaria mucosa*" agg., the dark green lichen typical of the middle shore, sometimes extends onto the upper shore on steep north-facing slopes. The overall abundance is inversely related to the abundance of the fucoid algae as they are unable to obtain sufficient light beneath a dense fucoid canopy.

"*Verrucaria maura*" is the name used for the black granular lichen community, zoned above the *V. mucosa*, and responsible for the prominent black line around MHWST

on so many shores. It is scarce only where the substrate is unsuitable, as on a storm beach or the soft cliffs at Watchet. Like the barnacle *Chthamalus*, it does not extend as far above EHWST as it does at Dale.

(6) *Winkles* Fig. 11

Littorina littorea, the Edible Winkle, feeds on decaying fucoids and other detritus which tends to collect in gullies and on sheltered shores. So it is not found on exposed shore transects, but even on the more sheltered shores it is less common than would be expected, especially towards the eastern end of the survey area. It does not penetrate the Bristol Channel beyond Weston-super-Mare and is already declining in numbers at Blue Anchor and Watchet. It is interesting that large individuals

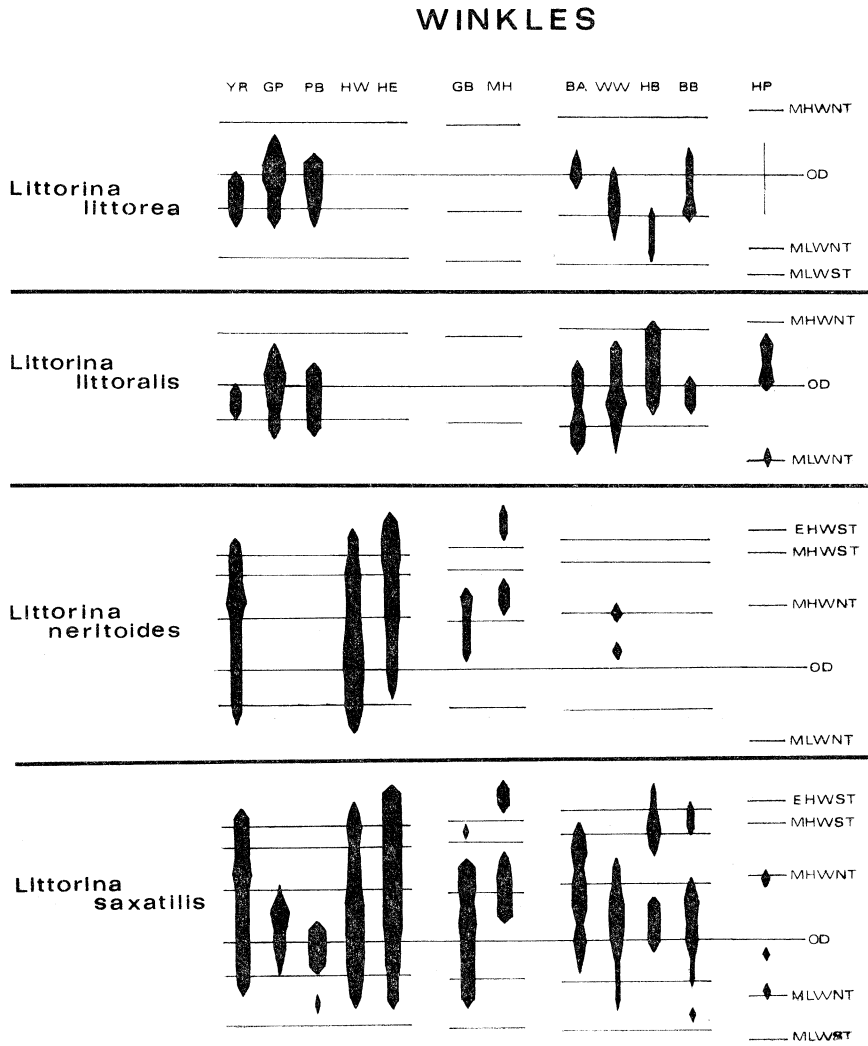


FIG. 11.
Zonation of Winkles: Tidal Levels as in Fig. 1b.

predominate on our shores so the selection process which is reducing numbers seems to affect the young stages rather than the old.

Littorina littoralis, the Flat Winkle, feeds on the large fucoid algae and thus shows a strong positive correlation in distribution with them, particularly with *Fucus vesiculosus* and *Ascophyllum nodosum*. Sacchi & Rastelli (1967) have shown there to be two species of Flat Winkle, one large (*L. obtusata*) and one small (*L. mariae*) which are zoned differently on the shore. At the time of these surveys (Autumn 1974) there were young Flat Winkles all over the shores and the problems of identification were such as to make me include both species under the old name.

Littorina neritoides, the Small Winkle, is another species which reaches its eastern limit in the Bristol Channel on the western mole of Watchet Harbour. It is primarily an exposed shore species, living in empty barnacle shells and other small crannies, and supposedly feeding on diatoms and other microscopic algae splashed onto the rocks by the waves. It too does not extend as high up the cliffs at Hurlstone Point as it does on some shores near Dale.

Littorina saxatilis, the Rough Winkle, one of the most abundant snails on European shores, was found on all shores. It is a very variable animal, but most recent authors have considered the variation to be of sub-specific rank. James (1964) described named varieties and subspecies but his classification is difficult to apply in Somerset as so many intermediates occur; no attempt was made to subdivide rough winkles for this survey. The more recent assessment by Heller (1975) was not available at the time but a preliminary examination suggests that all four of the species into which he has divided *saxatilis* are present.

(7) *Topshells* Fig. 8

The three species surveyed all progressively decrease in abundance from west to east and a fourth, *Calliostoma zizyphinum*, does not extend east of Greenaleigh Bay. The decrease of *Gibbula cineraria*, a northern species, is possibly due to the decreasing plant growth on the lower shore—the zone in which it normally lives—associated with the increasing turbidity and tidal range. The explanation for the others must be different for both *Monodonta lineata* and *Gibbula umbilicalis* are southern species reaching their northern and eastern limits in the British Isles (Lewis 1965 Fig. 65). They appear to die out at Watchet and Kilve respectively and are greatly reduced in abundance east of Minehead.

(8) *The Common Dog-Whelk* Fig. 8

Nucella lapillus, the Common Dog-Whelk, is a predator of barnacles and thus tends to live on shores where barnacles are abundant. It appears unable to survive above MTL in southern Britain, probably through an inability to avoid dessication whilst feeding higher up, so tends to be commonest on the lower middle shore. It is however unusual to find it so confined to the lower shore as it is at Watchet and elsewhere east of Minehead. Animals introduced onto the middle shore did not stay/survive more than a few months. The dog-whelks from Somerset, Avon and Glamorgan have shells of a much more elongated shape than those from other parts of south-western Britain (Crothers 1974) and may vary in other, physiological, ways as well.

DISCUSSION

The zonation patterns of the animals and plants surveyed are generally similar to those seen on the Pembrokeshire coast (Moyse & Nelson-Smith 1963); but there are some differences which can be ascribed to particular environmental factors:

1. *The extensive wave-cut platforms east of Minehead*

The very gentle slope of these shores ensures that no large waves ever break onto the rocks, thus producing quite sheltered shores even though the fetch may be 100 km or more. The speed with which water is sucked off these shores during the ebb of a spring tide is truly remarkable and any poorly-attached organism is very likely to be swept away. On the other hand the residual water drains off the platform very slowly, allowing the rock surface to remain moist and permitting the invasion of the middle shore by *Fucus serratus*.

2. *The tidal range*

The increasing tidal range decreases the amount of light that reaches the lower shore. Sunlight is selectively absorbed by seawater and red light, the waveband most useful for photosynthesis, does not penetrate much deeper than 5 m (Levring 1966). Figs. 3–6 show that the lower shore is covered by at least 5 m of water for most of the time and there is insufficient light on the lower shore towards the eastern end of the area to support plant growth. This in turn affects the distribution of herbivorous animals and of any carnivores that might feed on them.

Then there is the effect of reducing the importance of wave splash. As mentioned on p. 373 the waves do not increase in size in proportion to the tidal range so that the upper shore is a good deal dryer than in areas of more normal tidal range: contrast the situation at Machrihanish on the western side of the Mull of Kintyre (Scotland) where the tidal range is but 0.5 m, and the whole shore can be splashed by waves all the time. The effect in Somerset is to reduce the upward spread of upper shore species into the supra-tidal zone.

(3) *The reduction in the marine fauna from west to east*

Several species reach their eastern limit in the Bristol Channel on the stretch of coast covered by this survey. This may be due in part to the increasingly estuarine environment (the species disappear in the same order in Milford Haven (Nelson-Smith 1967)) and in part to a temperature effect. The temperature regime within the relatively landlocked waters of the Bristol Channel is more extreme than in the more oceanic water further west. The appreciably lower winter temperature may be significant for southern species approaching their northern limit.

The progressive reduction in the marine fauna may be influenced by pollution from the heavily industrialized areas near Cardiff, Newport and Avonmouth; and no account of the Bristol Channel would be complete without some mention of the contamination of certain shore invertebrates with cadmium and other metals. The quantity of cadmium in the tissues of limpets and dog-whelks markedly increases northeastwards up the Channel. Fig. 12 shows the pattern in limpets, rising steeply to concentrations in excess of 500 parts per million (dry wt) at Portishead. Peden, Crothers, Waterfall & Beasley (1974) obtained similar results with concentrations over 100 ppm (wet wt). Is it significant that *Patella* does not extend further up the Channel?

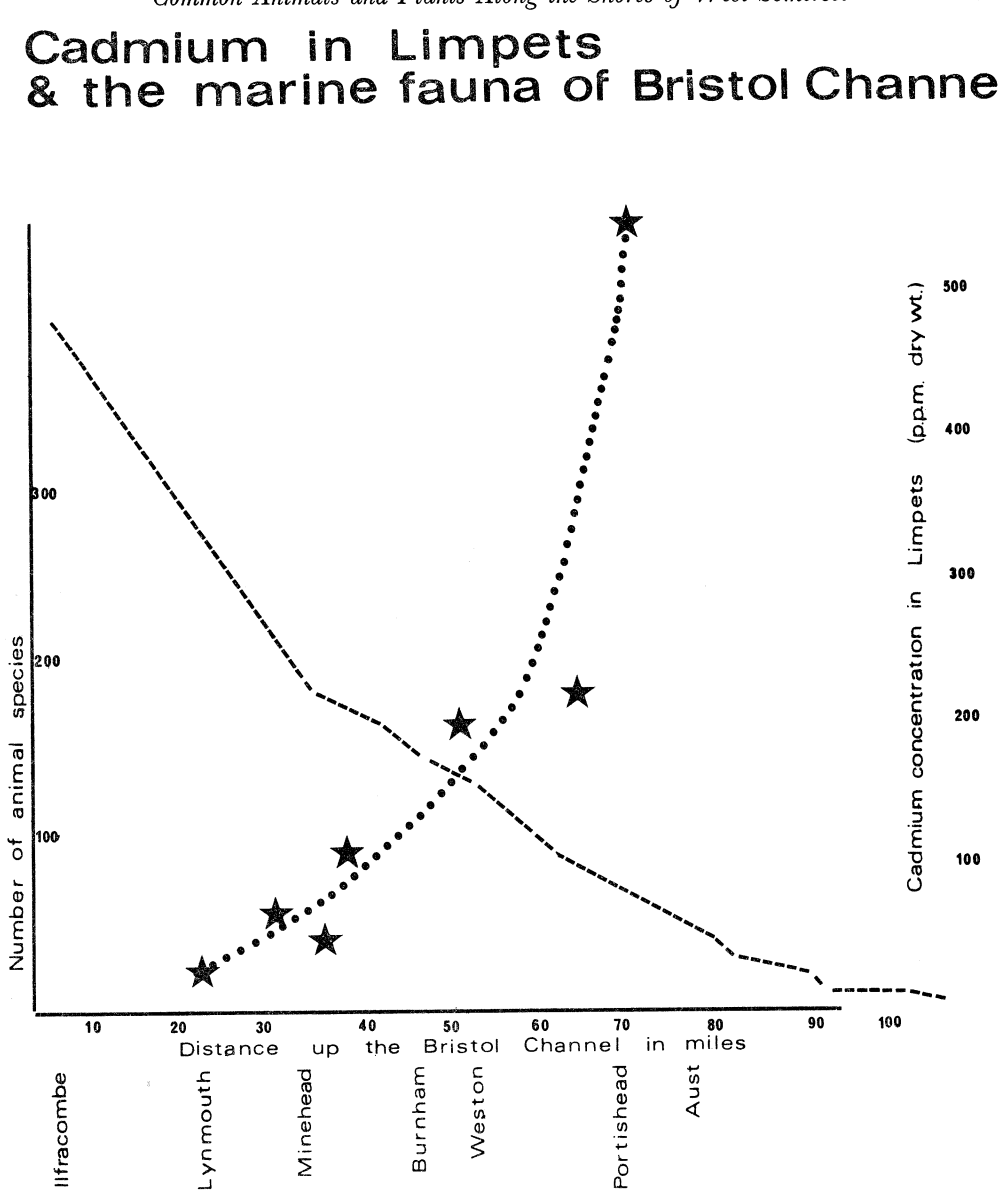


FIG. 12.

The relationship between the decrease in total marine fauna and the level of cadmium contamination in limpets (*Patella*) in the Bristol Channel.

It might appear from the figure that there is a strong correlation between this contamination and the total marine fauna. In fact there is little evidence to support

this at present: both patterns being due to the hydrology of the Severn Estuary/ Bristol Channel. The cadmium is thought to have been discharged into the sea at Avonmouth and has dispersed away from its point of entry, the decrease westwards reflecting the distance the metal has been transported so far. The decrease in the total marine fauna would occur in the absence of any pollution, in response to the decreasing salinity, increasing turbidity, tidal scour and the more extreme temperature regime.

It is not known how limpets are affected by having such high levels of cadmium in their tissues. But any effect on the limpet population will inevitably influence all the other shore species through disruption of the limpet: fucoid balance referred to on p. 380. Peden et al. (1974) concluded that no immediate threat to public health existed from this pollution. None of the patterns revealed in this paper, or by Boyden & Little (1973) or indeed by the forthcoming revised marine fauna (Boyden, Crothers, Little & Mettam in prep.), can be directly attributed to pollution. But cadmium is in one respect comparable to radiation: the less there is of it in the environment the better.

The rocky shores of Somerset will be surveyed at regular intervals to record any changes in distribution patterns that may occur. This paper contributes to this monitoring programme by describing the situation as it was in the autumn of 1974.

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