

Note on the Distribution of *Lichina confinis* and *L. pygmaea* in the Plymouth District.

By

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With one Chart.

INTRODUCTION.

VERY little work has as yet been done on the occurrence and distribution of marine lichens in the Plymouth district. The present investigation of the genus *Lichina* was undertaken at the suggestion of Dr. J. H. Orton, who, having noticed the two *Lichina* species at New Train Bay near Padstow, North Cornwall, thought it might be of interest to determine their distribution in the Plymouth area.

The characteristic appearance of the *Lichina* vegetation is too well known to require more than a brief mention (10). Both are small fruticose lichens with densely branched, dark-coloured thallus. *L. confinis*, the smaller of the two, has rounded branchlets barely 3 mm. long, and forms small patches 2-4 cm. across, while *L. pygmaea* has slightly longer branches, up to 10 mm. in length, with flattened lobes, and may form circular patches varying from a few inches to a foot or more in diameter. In colour *L. confinis* is black or very dark brown, but *L. pygmaea*, though usually very dark, may occasionally be light brown or greenish in colour.

The definite zones occupied by these two lichens on the shore are also well known, and have been recorded by Nylander (7), Joubin (4, p. 13), Cotton (2, p. 26), and Knowles (6, p. 105). On most rocky coasts the zone immediately above mean high water is colonised by the black crustaceous lichen *Verrucaria maura*, the lower limit of which is bounded by the brown alga *Pelvetia canaliculata*. *L. confinis* occurs at the upper limit of the *V. maura* zone where this overlaps the belt of orange lichens (for detailed account see Knowles [6, p. 101]), and is not strictly marine, though exposed to spray and probably to occasional immersion by very high tides. The vertical width of the *L. confinis* zone varies with the exposure, being greatest where there is a wide spray zone. *L. pygmaea*, on the other hand, never occurs above the *Pelvetia* zone, but is usually most abundant a little below it, though it may be present down to low neap-tide level (2), (6). This lichen is truly marine, and is incapable of surviving the desiccation to which *L. confinis* is often exposed.

The rocks round Plymouth Sound are chiefly Devonian (13), consisting for the most part of slates, grits and shales, the strata running at various angles but often nearly vertical; volcanic rocks occur at Rum Bay and Drake's Island, felsite at Kingsand; the shore below the Hoe, Tinside to Devil's Point, is limestone, this rock also occurring at Mount Batten and the north-west end of Drake's Island, while there are two further exposures, one at Cremyll and a small one below Mount Edgumbe.

LOCALITIES INVESTIGATED.

The localities investigated include all the shores skirting the Sound itself, from Reny Rocks to Batten Breakwater, Tinside to Devil's Point, Cremyll to Penlee Point, as well as Drake's Island and the Breakwater, and outside the Sound as far as the mouth of the River Yealm to the east and from Penlee Point to Rame Head and Whitsand Bay (Polhawn Cove) to the west (see Chart). These localities will be considered briefly below, working from east to west, with the exception of the calcareous rocks which will be taken together at the end.

River Yealm to Ram's Cliff. Both species of *Lichina* occur all along this part of the coast, the width of the zones varying chiefly with the slope of the foreshore. Where the rocks are steep, as to the east of Wembury Church, and at Staddon Point, the lichen zones are well developed, but where the foreshore is flatter the zoning is not so marked, and with the restriction of the spray zone *L. confinis* is less abundant, as for example between Wembury Church and Reny Rocks. Both species are necessarily absent from the sandy bays at Wembury and Bovisand, and *L. pygmaea* is also absent from the protected part of the south bank of the River Yealm. Throughout the area both species are usually found on the south and west faces of the rocks, these being the sides exposed to greatest wave action and insolation.

Ram's Cliff to Mount Batten (Jennycliff Bay). This area is interesting because of the entire absence of *L. pygmaea* between Ram's Cliff and a point just south of Batten Breakwater. The disappearance of *L. confinis* is not complete, but this species becomes steadily less common to the north of the Bay. The coast here is much less exposed than the part previously considered, lying as it does well within the Breakwater and facing west. The central part of the Bay is rather flat, with some sandy beaches, but numerous steep rocks also occur, especially towards Ram's Cliff. Owing to the decreased exposure and more level foreshore, the less steeply inclined rocks are covered with a dense growth of seaweeds, the different zones of which overlap; this would effectually prevent the establishment of *L. pygmaea* which seems to require a good supply of light and air.

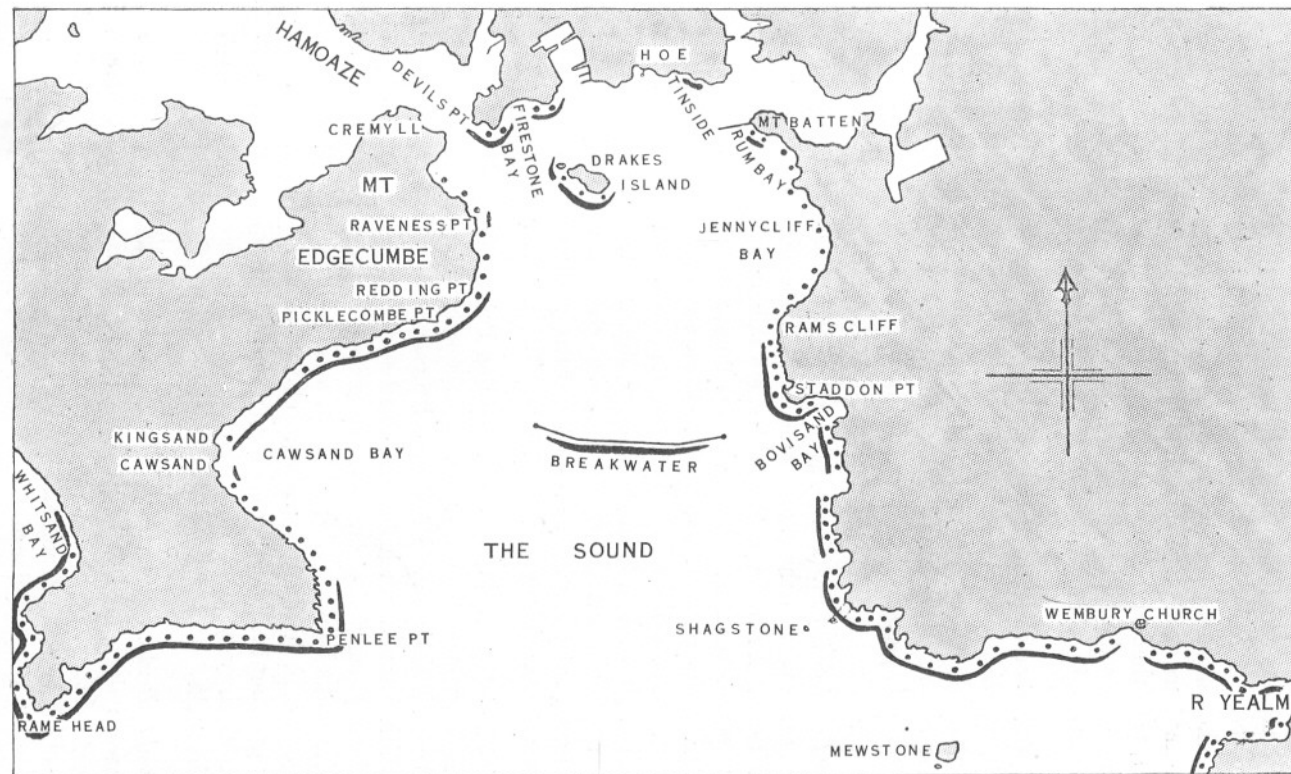


Chart of the Plymouth District showing the distribution of *Lichina confinis* and *L. pygmaea*.

Continuous line — *L. pygmaea*
 Dots . . . *L. confinis*.

There are many rocks, however, especially towards Ram's Cliff, which appear to be eminently suitable for the growth of this lichen, having steep faces, barnacle-covered, but bare of fucoids, the competition factor being thus removed. The small red seaweed, *Catenella opuntia*, which normally occupies the same zone as *L. pygmaea* but on the shady sides of the rocks, is abundant here even on the less shady surfaces, and this would indicate, however, that the insolation of this part of the shore is less intense than might be supposed, and possibly this, combined with decreased exposure to wave action, is enough to account for the absence of the lichen.

The Cattewater and the Hamoaze. Neither of these areas was investigated in detail, but *L. pygmaea* is certainly absent from the Cattewater; both this area and the Hamoaze are sheltered from direct wave action, and as the latter also offers few if any rocky situations such as are necessary for the growth of *L. pygmaea*, it is probable that this lichen is absent from here also.

Cremyll to Redding Pt. (Mt. Edgcumbe). Both species of *Lichina* are rare along this part of the shore, which, like Jennycliff Bay opposite, is very sheltered. From Cremyll to Raveness Point the foreshore consists chiefly of pebble beaches, but at Raveness Point the cliffs jut out into the water, and at this point only does *L. pygmaea* occur as two or three small patches on a limestone rock. Between Raveness and Redding Points the Staddon grits which form the bulk of Mount Edgcumbe, and which reappear at Picklecombe Point, give place to river gravel, which forms a boulder beach from which *L. pygmaea* is entirely absent, though *L. confinis* appears occasionally.

Redding Point to Cawsand. From Redding Point the coast bears away west and is exposed to much more direct wave action. About half-way between Picklecombe Point and Kingsand the grits give place to felsite which forms a much flatter, less dissected foreshore. *L. confinis*, though locally very abundant on the grits, hardly occurs along the felsite, the rocks being too low to form a suitable spray zone, and the lichen does not, in this district, make use of occasional immersion by spring tides by growing at a lower level than usual (2, p. 28). *L. pygmaea* is abundant all the way along and shows a decided preference for the sunny side of the rocks.

Cawsand to Penlee Point. This stretch is again marked by the absence of *L. pygmaea* although *L. confinis* occurs quite abundantly. The coast faces north-east, and the wooded cliffs dip very steeply to the water. Exposure both to wave action and insolation is therefore low, and this is emphasized by the abundance of *Catenella opuntia* even on the exposed surfaces of the rocks.

Penlee Point to Whitsand Bay. All along this part of the coast the Lichina vegetation is very well developed. The rocks, which consist of Dartmouth slates, form steeply inclined surfaces, barnacle-covered, and the exposure is too great to allow the growth of seaweed to any great extent. *L. pygmæa* forms a well-marked zone, 4-5 ft. wide vertically, the individual patches sometimes occupying an area of two or three square feet—as at Polhawn Cove, Whitsand Bay. *L. confinis* shows a vertical range of 2-3 ft. between Penlee and Rame Head, but is less abundant in Whitsand Bay. Although the exposure of this part of the coast is great, the actual cliff face is low, and therefore the spray zone is comparatively narrow, and this possibly accounts for the restricted vertical range of *L. confinis* in this district as compared with its range at Clare Island (2) and Howth (6).

Drake's Island. The rock here is mostly volcanic, but at the north-west end is a small mass of limestone. On the sheltered north shore there are two or three small sand and pebble beaches, but with these exceptions the foreshore is short and the rocks rugged. *L. pygmæa* is entirely absent from the north and north-east sides, but appears on the east and is abundant all along the southern shore. On the limestone mass, the more or less level top of which about corresponds to the Pelvetia zone, *L. pygmæa* occurs occasionally on the edges of small sunny pools. *L. confinis* is comparatively rare on the island, though it appears at intervals along the southern side. It seldom grows on flat surfaces, but prefers cracks and hollows on the seaward side of the rocks.

The Breakwater. The upper level of the Breakwater is below the *L. confinis* zone, and this lichen is therefore absent, but *L. pygmæa* is well represented on the sloping seaward face, the exposure of which is too great to permit a dense growth of seaweed. *L. pygmæa* shows a vertical range of about 4-5 ft., the region of greatest abundance being in the upper middle part of the zone: it is especially frequent along the upper and lower edges of the limestone blocks of which the Breakwater is built, but where the surface of these is very rough it may cover them more or less entirely. It is usually associated with a good deal of *Enteromorpha* and *Porphyra*. It is entirely absent from the two ends of the Breakwater which are built up with a horizontal surface in the *Fucus platycarpus* zone—that is, just below the Pelvetia level; neither does it occur at all along the inner north-facing side of the Breakwater, which, though more steeply inclined than the outer face, is protected, and along which the brown seaweeds form a more or less continuous covering.

Calcareous rocks. The calcareous rock of the district takes the form

of hard limestone, on which the lichen flora is thin and poorly developed in most places, with fewer orange forms, while the *Verrucaria maura* belt is ill-defined or lacking (6, p. 116). The calcareous areas investigated include Mount Batten, Tinside, Firestone Bay, and Devil's Point.

Mount Batten. Neither species of *Lichina* occurs on Batten Breakwater itself, and indeed they are but poorly represented in this locality. *L. confinis* grows thinly in the crevices of rocks exposed to spray, but is never common; *L. pygmaea* is present for a few yards on the south-west face at the limit of the main limestone mass, and a few patches of this species also occur among the *Pelvetia* plants on the seaward side of some high rocks further down the beach. *V. maura* is similarly scanty, and favours shady places, also growing rather lower on the rocks than usual.

Tinside. The lichen vegetation of this area is very scarce altogether: *L. confinis* does not occur at all, *V. maura* is scanty, being present in the more shady and sheltered places only, and *L. pygmaea* is only found here and there. The limestone of this part is worn into innumerable small pockets, and it is chiefly in these, at a level corresponding to the upper *Pelvetia* zone, that *L. pygmaea* occurs. The pockets probably remain moist for a considerable time, but it is noticeable that the situations are usually exposed to the sun.

Firestone Bay and Devil's Point. *L. confinis* is comparatively rare throughout this area, only appearing on the rocks most exposed to spray, and even on these it is confined to a very narrow zone. *L. pygmaea*, however, is quite common, its zone of occurrence ranging from the upper *Pelvetia* to the upper *Ascophyllum nodosum* zones, i.e. about 3 ft. vertically. It is most abundant where the algal vegetation is not well developed, that is, on the more exposed rocks, but it may also be present in rather more shady situations, as around the bases of the *Pelvetia* or *Fucus platycarpus* plants. The centre of Firestone Bay consists of an artificial frontage of large limestone blocks, from which both species of *Lichina* are absent, although *V. maura*, and the brown seaweeds grow well on the sides of the stones.

DISCUSSION.

Both species of *Lichina* are to be found abundantly in many parts of the Plymouth district, and their absence from others can probably be accounted for by a consideration of environmental conditions more especially with regard to exposure both to wave action and insolation.

Lichina confinis is the more generally distributed of the two species, occurring more or less all round the shore wherever there are rocks exposed

to spray. An exception might be noted in the limestone area of Tinside where *L. confinis* does not appear to be present. No part of the area investigated, with the possible exception of Rame Head, is subjected to very great exposure, and in all parts the actual cliff face is low, the spray zone being therefore restricted. It is probably due to this that, though so widely distributed through the whole locality, the vertical range of this lichen here is so narrow, rarely exceeding 2-3 ft., and often less than this, as compared with 12-15 ft. at Clare Island (2), and 50 ft. or more at Howth (6). Another point which might be noted is that as Plymouth is further south than these Irish localities, the desiccation to which the lichen is subjected during the summer months is probably greater in the former district. The absence of the species from the limestone of Tinside, which receives little spray in the summer, and its but scanty growth in the other limestone areas, also its comparative abundance along the tree-shaded rocks between Cawsand and Penlee, seem to emphasize that moisture is a limiting factor in the distribution of this lichen in the Plymouth district.

Lichina pygmæa. The occurrence and distribution of this lichen at Plymouth are similar in many particulars to those at Clare Island and Howth, but differ slightly in detail, more especially with regard to extent of vertical range. The chief points which correspond in all three areas are summarised below:—

1. *L. pygmæa* is most abundant on rocks which have steeply inclined faces, though it may occur on horizontal surfaces in certain situations.
2. It prefers rough surfaces and is abundant on barnacles.
3. It grows best in exposed and semi-exposed positions, the action of breaking waves seeming to be of special importance since the lichen is absent from protected situations.

The vertical range of *L. pygmæa* as seen on the Plymouth shores would appear to be more restricted than in the Irish localities, although there is no great difference in the vertical range of the tides at the three places, the smallest being at Howth with a 12 ft. spring-tide range as compared with 16 ft. at Plymouth and Clare Island. *L. pygmæa*, in the Plymouth district, extends from the upper *Pelvetia* zone to half-tide level only, but never as low as low neap tide, with its area of greatest abundance corresponding approximately to Mean High Water Neaps—that is, just below the *Fucus platycarpus* zone. It never occurs as undergrowth to *F. vesiculosus* or *A. nodosum*, though in some parts, as at Devil's Point, it grows around the base of *P. canaliculata* and *F. platycarpus* where these do not form a dense covering. In the places where *L. pygmæa* is most abundant there is little or no growth of the larger seaweeds, the steep rock surfaces being presumably too exposed for these plants to survive the action of the waves. Even *Pelvetia* and *F. platycarpus*, the least affected by exposure (2, p. 24), are sometimes absent, *L. pygmæa* forming the only macroscopic

vegetation, as at certain parts of Drake's Island and between Penlee and Rame Head.

Of the factors affecting the growth and distribution of the lichen considered, exposure to wave action is probably of greatest importance, though insolation, foulness of water, and salinity may also play a part. It is not easy in this district to get any clear idea of the effect of insolation, since it is only the southern shores which are directly exposed to breaking waves, and hence the absence of *L. pygmaea* from less highly insolated parts facing northwards may be due rather to the protection from wind and wave action than to decreased light intensity. This is supported by the observations of Joubin (4, p. 13) at the Ile de Bas, off the north coast of Finistère, where *L. pygmaea* grows freely on the exposed north and west shores, but is absent from the sheltered south side. He does not, however, give any details as to the aspect favoured by the lichen in the more exposed situations. On the west coast of Inverness-shire *L. pygmaea* is absent from the shores of sheltered sea lochs, but occurs abundantly along the coast outside, and in these exposed situations it is certainly not confined to the most highly insolated aspects so long as the surface is exposed to breaking water. Whether it is the actual mechanical stimulus of the moving water, or the high aeration—the water being not only fully saturated with dissolved oxygen as are all the surface waters of the sea, but having also a high content of air bubbles—it is certain that exposure to wave action plays a very important part in the distribution of *L. pygmaea*. The significance of light in the economy of the lichen, apart from its direct effect in photosynthesis, may lie rather in the need for a certain degree of drying-out of the thallus between tides, which could only be obtained on the better-lighted, bare rock surfaces. Such periodic drying-out is certainly essential in the case of many of the seaweeds of the foreshore. The effects of foulness of water, and salinity, have not been investigated; the degree of exposure demanded by this lichen makes its absence from such sheltered areas as the Cattewater and the Hamoaze easily accountable without supposing any inhibition due to foulness of water or low salinity, although these may have some secondary effects.

Fruiting of *L. pygmaea* occurs freely throughout most of the district, but is less common among the Tinside and Mount Batten specimens.

SUMMARY.

The occurrence and distribution of the lichens *Lichina confinis* and *L. pygmaea* have been investigated for the Plymouth district. Both species occur frequently throughout the area. *L. confinis* is the more generally distributed, being present, though sometimes scantily, on most of the coast with the exception of Tinside; on the exposed shores

outside the Sound itself it forms a zone 2-3 ft. wide, being especially common between Penlee Point and Rame Head. *L. pygmæa*, though very abundant on the open coast, is scanty or entirely absent along the sheltered parts of the Sound, as from Cawsand to Penlee, Cremyll to Redding Point, Jennycliff Bay, etc.

The distribution of the two species of *Lichina* in this district emphasizes the importance to both of the degree of exposure to wave action to which the situation is subjected. The importance to *L. confinis* lies in the height to which the spray is flung up the rocks, since occasional wetting by salt water is essential to this species. In the case of *L. pygmæa*, mechanical stimulus, aeration of water, and probably the removal of the competition factor—the larger fucoids being unable to maintain a footing on steep exposed rock surfaces—all play a part. The effect of light would appear to be secondary, and is probably of importance as connected with the desiccation of the lichen thallus between periods of immersion.

I should like to take this opportunity of expressing my gratitude to the Council of the Marine Biological Association for allowing me to work at the Plymouth Laboratory, and also to thank Dr. E. J. Allen and the members of the Staff for their kindness. I am especially indebted to Dr. J. H. Orton and Dr. W. R. G. Atkins for advice and criticism.

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