

AN INTRODUCTORY SURVEY OF THE PERIWINKLE SPECIES FOUND AROUND THE SHORES OF LUNDY

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ABSTRACT

A preliminary survey of the species of periwinkle present on Lundy was made and six species were found to be present, these being *Melaraphe neritoides*, *Littorina arcana*, *L. nigrolineata*, *L. saxatilis*, *L. neglecta* and *L. littoralis*. Sheltered and exposed sites were examined, and it was found that *L. arcana* and *L. saxatilis* tend to occur together except in the most exposed sites. It was also found that *Melaraphe neritoides* is abundant at both types of site showing a large vertical range.

Littorina arcana and *L. saxatilis* both show several colour morphs and this is attributed to natural selection.

INTRODUCTION

Lundy's coastline is much indented and steep cliffs make it difficult or impossible to reach sea level from above in many places. The tidal range is 7m and the prevailing wind is west; therefore the east side is relatively sheltered, tending to show more gentle shorelines than the rugged west coast which is exposed to long-distance swell from the Atlantic and very strong wave action during frequent storms. However, strong winds are suffered from all directions.

Nine different sites were studied during a two week period in August 1990, being chosen for ease of access as well as position; these comprised four on the east side, three on the west, and one at each of the southern and northern points of the Island. The sites were chosen in an attempt to examine how varying environmental conditions, common to different areas of the coastline, affected the distribution of the species.

Surveys on the littoral ecology of Lundy have previously been carried out (Harvey 1948; 1950; Hiscock and Hiscock 1979) but these have been on all littoral species and have not concentrated purely on *Littorina*. However, reference will be made to their work during this report.

Although only four species of rough periwinkle are recognised on north-western shores, these being *Littorina nigrolineata*, *L. arcana*, *L. saxatilis* and *L. neglecta*, three other species of periwinkle were also included in the survey, these being *Melaraphe neritoides*, *L. littorea* and *L. littoralis*. The latter of these can be further subdivided into the species *L. obtusata* and *L. mariaae*, although this was not done for the purposes of this study.

The basic aims of this project were to make a general survey of the shores of Lundy to determine the species of rough periwinkle and other winkle species present (in the light of a similar survey carried out around the coast of Great Britain by Drs Mill and Grahame (1990a and 1990b) of the University of Leeds) and to study their distribution in terms of relative number, zonation and whether they preferred sheltered or exposed sites.

METHODS AND MATERIALS

a SPECIES IDENTIFICATION

The four species of rough periwinkle can be distinguished initially from other species of periwinkle by the angle at which the aperture runs into the shell. In the case of rough periwinkles, the aperture runs into the shell at an angle to the spire, whereas the other species show the aperture being more or less parallel to the spire where the two meet.

1. rough periwinkles

Littorina arcana and *L. nigrolineata* are oviparous, i.e. they lay eggs, whereas *L. saxatilis* and *L. neglecta* are ovoviviparous and therefore give birth to live 'crawlaways' (Mill and Grahame 1990a).

L. nigrolineata can be easily recognised in the field by its shell which bears strap-like ridges, these being wider than the grooves separating them. These grooves usually contain a black pigment, hence their name, although this is not always present. Secondary grooves may also be present on some wider ridges.

L. arcana and *L. saxatilis* are easily confused in the field, both having several different morphs and possessing shells which may be rough or smooth. The only reliable method of identification between the two species is to examine the soft parts. This is done by boiling fresh specimens for a few minutes and removing the body from the shell. Mature females can be easily distinguished as *L. saxatilis* possesses a brood pouch which is very obvious when full and occupies about two thirds of the length of the pallial oviduct, whereas *L. arcana* has a jelly gland occupying about half (Hannaford Ellis 1979). The collections for this project were made in August when mature females of *L. arcana* were in evidence (Mill and Grahame 1990a); so in general, the distinction could be made very easily. Males can only be identified if found within a large group of females, all of the same species.

L. neglecta can be distinguished from *L. saxatilis* as it matures at a few millimetres and it tends to be more globular and have a flatter spire than *L. saxatilis* (Mill and Grahame 1990a). It is generally found living in empty barnacle shells lower down the shore than *L. saxatilis*, and usually has a wide dark band running into the aperture.

2. other periwinkles

Littorina littorea grows to about 2.5cm in height and is sharply conical with surface sculpturing visible on close inspection. It is found on the middle to lower shore and often has bands on the inside of the aperture edge.

Melaraphe neritoides is also more pointed, having a fragile appearance and being dark in colour, although the shell goes chalky white when it dries out.

Littorina littoralis is very easily recognised, being larger and the spire being very compressed.

b METHOD

The following nine sites were surveyed; Hell's Gates (south-facing, relatively exposed), Pilot's Quay (faces due west, therefore very exposed), the Pyramid (two transects were studied here, one facing south-west and the other due west), Kittiwake Gully (faces north-east, relatively exposed), Brazen Ward (east facing, therefore sheltered), Quarry Beach (also east facing), and two at the north end of the Landing Beach (both very sheltered). At each site a transect was chosen, considering ease of access as well as suitability. The beginning point (0m) was usually taken as being a few metres above the *Pelvetia* zone, i.e. in the splash zone, and as far as possible, from where winkles began to appear although this was not possible at every site.

A line was then run along the site and collections were made at varying intervals along the transect, depending on the site. All the animals were taken from a line 1m to either side of the central transect wherever possible. However, in some cases, particularly on the more exposed sites, this was not always possible, the terrain being highly irregular. Also animals under about 5mm in length were very difficult to identify and therefore only some small animals were sampled. In some cases, if the transect passed through a small rock pool, all the animals would be taken from this; however most of the animals were found in sheltered cracks or crevices.

The animals were then identified, either by the shell morphology (*Littorina nigrolineata*, *L. littorea*, *L. neglecta*, *L. littoralis* and *Melaraphe neritoides*), or by boiling them and examining the soft parts (*L. arcana* and *L. saxatilis*). Any interesting features were also noted, e.g. size, colour, shape, etc. Size was measured by taking the greatest length of the shell.

RESULTS

The animals taken from Hell's Gates, Quarry Beach and the two sites on the Landing Beach were not very brightly coloured, whereas those of the same species on the other sites seemed to show more diversity in terms of the colour of the shell. (See discussion).

No *Littorina littorea* were found at any of the sites, unless some were found and misidentified. However, this is thought to be unlikely.

SITE	SPECIES						MALES	TOTAL
	M. N.	L. A.	L. NI.	L. S.	L. NE.	L. L.		
H.G.	1	5	41	4	1	1	5	58
P.Q.	22	29	3	5	11	0	10	80
P.1.	25	10	13	10	10	0	6	74
P.2.	176	15	1	4	0	0	5	198
K.G.	25	20	0	0	22	0	9	76
B.W.	17	15	1	8	5	0	30	76
Q.B.	1	16	3	8	0	1	6	35
L.B.1.	0	0	0	0	0	10	0	10
L.B.2.	0	12	5	7	1	7	22	54
TOTAL	267	122	67	46	50	19	93	664

Table to show the number of each species of periwinkle found at each site.

H.G. = Hell's Gates

M.N. = *Malaraphe neritoides*

P.Q. = Pilot's Quay

L.A. = *Littorina arcana*.

P.1. = Pyramid, site 1.

L.NI = *Littorina nigrolineata*.

P.2. = Pyramid, site 2

L.S. = *Littorina saxatilis*

K.G. = Kittiwake Gully

L.NE. = *Littorina neglecta*

B.W. = Brazen Ward

L.L. = *Littorina littoralis*

Q.B. = Quarry Beach

L.B.1. = Landing Beach, site 1

L.B.2. = Landing Beach, site 2

DISCUSSION

a GENERAL OBSERVATIONS

One of the first things to be noted was that no specimens of *Littorina littorea* were found. This was surprising as *L. littorea* has been recorded on the Island, at Hell's Gates, Quarry Beach, Jenny's Cove, Lametry Beach (south-west corner) and Ladies Beach (east side) (Picton 1978). In these studies it was found to be confined to the littoral region, under rocks and seaweed. However, work carried out on molluscan hosts of endoparasitic helminths, found 147 specimens of *L. littorea* as compared to 325 of *M. neritoides* and 309 of *L. saxatilis* (Morris 1961), showing *L. littorea* was much more rare than the other species of periwinkle.

The results of this investigation show that there were more than twice as many specimens of *L. arcana* than *L. saxatilis* on the sites covered, 122 females of the first species being identified, and only forty-six of the latter. In some cases, they were found in approximately equal numbers, e.g. Hell's Gates and the south-west facing transect of the Pyramid, but in general, the *L. arcana* population appeared to be larger than that of *L. saxatilis*. On the west facing transect of the Pyramid, only four *L. saxatilis* specimens

were identified as opposed to fifteen *L. arcana*, and these were found in a rock pool 4.5m from the starting point where it was relatively sheltered. This correlates with the findings of Harvey (1948) who found small numbers of *L. saxatilis* in Jenny's Cove and these only where some shelter was available. However, it should be noted that the specimens of *L. saxatilis* which were found were larger than those of *L. arcana*, *L. saxatilis* having an average length of 9mm, and *L. arcana* only 6.5mm. This increased size is probably due to their more sheltered environment.

The survey of Pilot's Quay, a very exposed site, showed *L. arcana* to be dominant over *L. saxatilis*. This was as expected because it has been found that where *L. saxatilis* and *L. arcana* are sympatric, the latter species tends to occupy the most exposed areas (Mill and Grahame 1990a); indeed, *L. saxatilis* tended to be found in the deeper and more sheltered crevices.

At Kittiwake Gully, no specimens of *L. saxatilis* were found, although twenty were found of *L. arcana*. This follows the findings of Mill and Grahame (1990a and b) as this site is relatively exposed, showing the characteristics of an exposed shore (stunted *Fucus* etc) with relatively few natural crevices for shelter.

L. nigrolineata was found to be the dominant species at Hell's Gates, specimens being found from 0m to 15m below the starting point. Very few *L. arcana* and *L. saxatilis* were found here, five and four respectively, and occurring only at the top of the shore. The high numbers of animals being identified as *L. nigrolineata* at this site may be due to the fact that they had very obvious shells with distinctive markings; a yellowy-green shell with definite black stripes, whereas those found at other sites were not so obviously marked, meaning that they had to be identified merely by the presence of the strap-like ridges.

Relatively few specimens of *Littorina neglecta* were identified, only fifty in total, but this is probably not proportional to the population. The specimens that were identified were usually found in empty barnacle shells, and in general they were very well camouflaged as well as being small (3mm greatest length); they were therefore difficult to find. Most were identified by the shell, i.e. globular shape, flattened spire and dark line into the aperture (Mill and Grahame 1990a), but the soft parts of some were examined and the females showed full brood pouches indicating that they were mature. In this case they could be distinguished from *L. saxatilis* due to the fact that they had matured at a much smaller size.

The largest number of winkles found were *Melaraphe neritoides*. These could be easily identified in the field by the shape of the shell and the colour. However, it was also noted that those specimens found on the more exposed sites, namely Pilot's Quay, the Pyramid and Kittiwake Gully, possessed a light coloured band which ran into the aperture. Some also showed red bands on the predominantly black shell. It is not known why this is, but Harvey (1948) also found large numbers of *M. neritoides*, a particularly large population being on Goat Island, which showed a high proportion of striking colour varieties.

Littorina littoralis was found only on the very sheltered shores, these being Quarry Beach and the two Landing Beach sites, although one specimen was found at the Gates. This was as expected as *L. littoralis* feeds on *Fucus* sp. which is abundant at these sites. Indeed the most northern Landing Beach transect showed only this species of periwinkle, the shore being covered with *Fucus* sp.

b ZONATION

The general rule for zonation is that *Melaraphe neritoides* is found in the splash zone, then the rough periwinkle species take over from the *Pelvetia* zone, until *Littorina littorea* becomes prevalent in the barnacle zone. In general this pattern was shown on the shores surveyed during this investigation (with the exception of *L. littorea*). However, the actual pattern is, in fact, much more complex.

M. neritoides was found at the top of the shore in most cases, although none were found on the Landing Beach, possibly due to the fact that here the beach is backed by the Beach Road. Also, at Hell's Gates, only one specimen was found, and this was 15m below the starting point. This could be because the transect was started below the splash

zone, the shore being backed by a sheer cliff, making it impossible to take readings any higher above the chosen transect. Also, on Brazen Ward, only seventeen specimens were found, sixteen being at 0m and one at 12.5m below the starting point. This was as expected, although it seems unusual to have found a single specimen so far down the shore.

Quarry Beach also showed only one specimen, this being at 0m, but, as in the case of Hell's Gates, this could be because the transect was not begun high enough, but again, this was impossible due to the sheer back wall to the beach.

On the exposed sites, namely the Pyramid, especially the site facing due west, and at Kittiwake Gully, *M. neritoides* was found to occur all along the transect, right down to low water level. It is not known why this is and this could be a subject for further investigation. This phenomenon has also been noted by Hiscock and Hiscock (1979) who remarked on an increase in abundance and vertical extent both upwards and downwards of *M. neritoides*. They measured them being 8.4m above chart datum on sheltered sites (e.g. Landing Bay and Brazen Ward) and 15.4m on exposed sites (Lametry and Dead Cow Point).

In Mill and Grahame's paper (1990a), it is said that *Littorina saxatilis* and *L. arcana* occur highest up the shore, tending to be intermingled except on the most exposed sites. They are also said to overlap with *L. nigrolineata* although this species does not seem to extend to the upper limit of the former two. *L. neglecta* is generally found lowest on the shore, living in empty barnacle shells.

In general, this pattern is followed on Lundy. Again, however, there are a few exceptions. For example, at Kittiwake Gully, the barnacles began to appear at 3.5m below the top of the transect, but the first specimens of *L. neglecta* were not found until 6m below, where no barnacles were present. However, only one animal was found here. *L. neglecta* was then found, as expected, in increasing abundance down the shore as the number of barnacles increased.

Brazen Ward probably acts as one of the best examples of zonation of periwinkles, *Littorina arcana* first occurring at 1.5m below the top of the transect, overlapping with, and being taken over by *L. saxatilis* at 3m. This species then extended down to 10m where *L. nigrolineata* was found. *L. neglecta* occurred below this.

The Pyramid transects act as good examples of *L. arcana* becoming dominant over *L. saxatilis* on the very exposed sites. The first transect, facing south-west, shows *L. arcana* appearing at 0m, with *L. saxatilis* not being recorded until 10m further down the shore. The west facing transect shows very small numbers of *L. saxatilis* and those that were present were in a sheltered rock pool.

c COLOUR MORPHS

In general, it was found that the samples of *Littorina arcana* and *L. saxatilis* recorded at the more sheltered sites, e.g. the Landing Beach and Quarry Beach, had dull coloured shells of uniform colour, as compared with those found on sites such as Pilot's Quay and the Pyramid. This could be due to a natural selection process to do with predation. The sheltered shores themselves tended to be of a uniform colour, either brown due to *Fucus* sp. or grey because of the boulders; therefore, brightly coloured animals could be easily picked off.

The Pyramid and Pilot's Quay, however, tend to have more brightly coloured specimens, possibly because the plant growth on these sites consists mainly of bright coloured lichens and seaweeds, thus meaning they are better camouflaged than plain specimens. This idea of camouflage is also given as an explanation of different colour morphs of *L. arcana* and *L. saxatilis* at Robin Hood's Bay, North Yorkshire, in a paper on distribution, abundance and shell morphology of these two species (Dytham *et al* 1990). This could be an area for further investigation.

CONCLUSIONS

Eight species of periwinkle are present on Lundy, these being *Melaraphe neritoides*, *Littorina arcana*, *L. nigrolineata*, *L. saxatilis*, *L. neglecta*, *L. littoralis* (two species) and *L. littorea*, although the latter was not found during this survey. *L. arcana* and *L. saxatilis* were found to occur together except at the most exposed sites where *L. arcana* becomes dominant. Several colour morphs of *L. arcana* and *L. saxatilis* are present on the Island, and *M. neritoides* also exhibits some coloured stripes on the shells of those specimens found on exposed sites, although the shell remains predominantly blue-black. *M. neritoides* is highly abundant on the shores of Lundy, and the species shows a large vertical range. *L. littoralis* is confined to sheltered shores where *Fucus* sp. is abundant.

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