

OBSERVATIONS ON THE FAUNA OF SUBMERGED ROCKS AROUND LUNDY

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Abstract

Lundy offers the opportunity of being able to study the fauna of sublittoral rocks to depths of up to 40 m and in conditions which vary, within a small area, from the most extreme exposure to Atlantic gales to the comparative shelter of the east coast, and from the races of the north and south coasts to the less vigorous tidal streams of the east and west coasts. Observations made during 17 dives around the island show that the sublittoral fauna is rich and varied, there being many Lusitanian (southern) species present. A closer look at the animal communities of the various coasts has revealed clear differences in the composition of the populations related largely to the degree and type of water movement to which they are exposed. In shallow water exposed to vigorous wave activity a limited fauna of short erect or encrusting forms is present whilst in deeper water the variety of animals is much greater and many erect and massive forms are found. The strength of the tidal streams causes important differences in the composition of the deep water communities and in the strong currents off the south coast there are many suspension feeders which often grow to a massive size, while on the sheltered east coast the number of such animals is reduced and specimens are usually small but quieter waters or lack of competition allow some animals not found on the south coast to thrive. The task of mapping the major communities around Lundy can be assisted by the observations of amateur divers.

Introduction

Marine zoological investigations carried out around Lundy have so far been confined to the shore (Anon. 1948, Harvey 1950, 1951); these studies have indicated the effect of differences in exposure and substrate topography on littoral communities of plants and animals at different sites around the island. The corresponding work on the intertidal marine algae has been supplemented by the diving investigations of Irvine *et al.* (1969).

By using diving equipment it is possible to investigate the effects of various physical and topographical factors on the zonation and distribution of the fauna of submerged rocks around the island, a subject on which little has been published since the early work of Forster (1954, 1955, 1958) and Knight-Jones and Jones (1955) in other parts of Britain. Lundy offers an excellent site in which to carry out such studies since within 8.5 miles of coastline one may investigate sessile animal communities to depths of up to 40 m. in various degrees of exposure to wave action and tidal stream. In this paper I propose to describe the fauna of rocks in two areas exposed to different physical conditions; one off the east coast where tidal streams are comparatively weak and the area is sheltered, and the other off the south and south-west coasts where rocks are exposed to severe wave action and tidal rips.

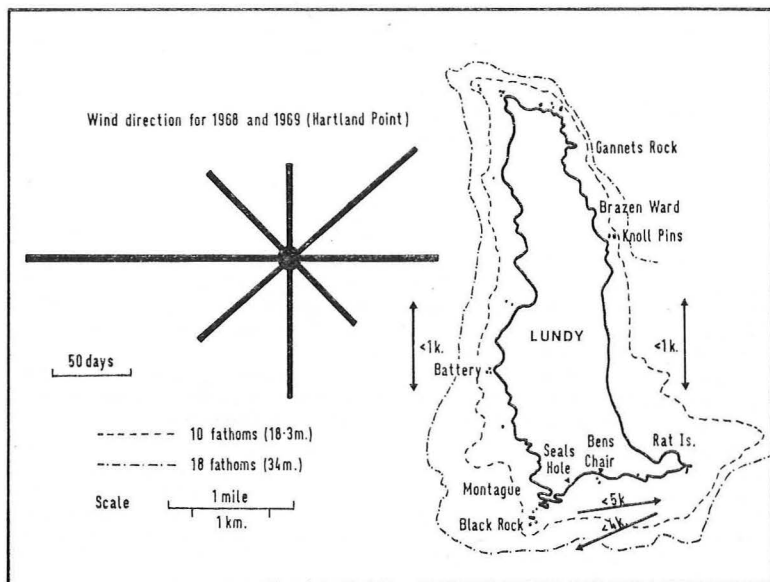
The Marine Environment

Light penetration. Lundy lies in a position where the clear oceanic waters of the Atlantic meet the turbid waters of the Bristol Channel. The island is however, well known for its good underwater visibility and on this basis the oceanic component would appear normally to be dominant. An indication of the clarity of the water is given by the extent of the kelp forest which grows to a depth of 13 m. off Lundy compared to 20 m. off the Scilly Isles but only 6 m off Ilfracombe, N. Devon (own observations).

Temperature. The surface temperature of water around the island ranges from 8°C to 16°C and is probably about one degree higher during the coldest part of the winter and slightly cooler by about 0.5°C during the summer than that of the North Devon coast near Ilfracombe. This regime is very similar to that of the south-west Pembrokeshire coast but compared with that of Scilly or off Plymouth, temperatures are generally lower (C.P.I.E.M. 1962).

Currents. Investigations carried out by Cooper (1961) on the surface currents of the Celtic Sea extend almost as far as Lundy and from this it would appear that the island is affected mainly by the predominantly easterly or north-easterly movement of the North Atlantic Drift as well as by the Lands End Corner Current which in spring sweeps from south Cornwall around north Cornwall towards the Bristol Channel. A Lusitanian stream also exists which originates as an outflow of the Mediterranean, mixes with water in the Gulf of Gibraltar and continues northwards towards the Celtic Sea. The discharge of the Bristol Channel, which includes runoff from the land through several rivers, including the Severn, doubtless affect Lundy waters.

Salinity. C.P.I.E.M. (1962) records the surface salinity of waters in the area of Lundy as varying between 34.5 to 35 o/oo during the year.



Wind. The island lies in an area where westerly winds predominate; figures for Hartland Point 11 miles to the south indicate that about 50% of the winds are from the N.W., W., and S.W. direction where fetch is 3,000 miles and more, whilst 30% of the winds are from the N.E., E., and S.E., where fetch is less, than 100 miles. During 1968 and 1969 at Chivenor (23 miles to the E.S.E.) the wind reached force 7 and more for only 4 hours between 20° and 160°, whilst in the direction 200° to 340° the time for winds of this strength was 153 hours. It is apparent that the west coast receives a tremendous battering from the subsequent wave action whilst the east coast is comparatively sheltered.

Tidal Streams. The tidal streams at the entrance to the Bristol Channel are not strong but their rate increases on approaching Lundy which lies across their path and they divide 3 to 4 miles before reaching the island, passing north and south at about 5 knots at spring tides. Races form at the north end and at the south-west and south-east points (Fig. 1). The east and west coast streams do not exceed 1 knot (Admiralty 1945).

Geography. The rock is of granite except at the south-east tip where it is of slate. Only the granite areas are dealt with; here the high cliffs of the land often continue underwater to depths of 15 to 35 m falling steeply to a sandy plain or

continuing as low rock outcrops dissected by steep gulleys or thrown up into pinnacles thus forming extensive underwater cliffs. Vertical faulting may have occurred in some areas and underwater canyons have been reported.

Sublittoral Investigations

Investigations have been carried out in July 1969 and August 1970; a total of 17 dives have been undertaken. Observations have mainly been confined to areas where fauna is not intermixed and obscured by algae (shaded areas and levels below the kelp forest). The choice of diving sites has been limited by weather and boat availability but it has been possible to make extensive observations on the east coast and on the south and south-west coasts.

Dives have been carried out at the following sites:

East Coast	(Brazen Ward (5-20 m))
7 dives:	(Gannets Rock (11-34 m))
	(Knoll Pins area (0-29 m))
South Coast	(Seals Hole (23-28 m))
5 dives:	(Benjamins Chair (18-21 m))
	(Black Rock (0-17m, 24-36 m))
	(3 dives: Rat Island)
	(1 dive: Battery)
	(1 dive: Montague)

This account is based on notes made during and immediately after the dives, on specimens collected where underwater identification was not possible, and on the many underwater photographs taken during the investigation. Only sessile species have been dealt with in any detail although notes were made on the presence of the larger motile animals.

When diving the depth was measured in feet, using a capillary type depth gauge and the level of the tide noted so that later they could be approximately corrected to depth in metres below the level of Chart Datum.

The profile of the Knoll Pins is based on a drawing and notes made underwater, working from the deepest extent of the rocks to the surface and noting all the common animals within the field of vision (a strip about 80 cm wide). Depths were checked by taking spot readings every few metres using a diaphragm type depth gauge. The profile of the south east coast is a composite diagram built up from notes made on the geography of the area and on the distribution and extent of the fauna.

A General Description of Lundy's Underwater Environment

A comprehensive picture of Lundy's underwater scenery cannot be built up from the small number of sites visited. The 10 fathom (18.3 m) and 18 fathom (34 m) contours are shown in Fig. 1 and from this it can be seen that the precipitous cliffs of the land often continue underwater, especially at the promontories and offshore rocks. The most impressive that was observed was a jagged vertical face off Gannets Rock which dropped from 16 to 34 m. Large boulders commonly litter the base of cliffs and the edge of the main island mass before the sand plain is reached at a depth of 15 metres and more. This plain is itself often broken by large outcrops of rock up to 3 m high.

Off the south coast the areas of rock shelf off gradually from the shore leading to extensive areas of horizontal rock dissected by gulleys or thrown up into pinnacles rising to 5 m above the bottom. The gulleys often contain large areas of coarse shell gravel but I have not reached the sand plain at any of the sites investigated.

On both south and east coasts the kelp (*Laminaria*) forest is dominant on horizontal rock surfaces to a depth of 13 m, and below this down to a depth

of about 18 m there is a cover of red and brown algae, especially *Dictyopteris membranacea*. Within the kelp forest, the fauna is limited largely to under the overhangs and on the vertical surfaces, though even here the encrusting Lithothamnium algae are often dominant. On the extensive vertical surfaces below the kelp forest and on horizontal rocks below the zone of algal domination the almost uniform covering of bryozoa (Sea-mats) is broken up by the many colourful and exotic animals which festoon the rock faces; these are mainly coelenterates (Sea-anemones and 'Corals') and the sponges. The rocks are so completely covered at these depths that competition must be severe amongst the many species of sessile animals.

The colourful animal communities of deeper water together with the often spectacular rock formations produce some of the most fascinating scenery in the British sublittoral. A closer look at this underwater landscape reveals clear differences in the composition of the animal populations to be found at varying depths and at different sites around the island. In order to make an analysis of these assemblages, stations at the east coast and off the south coast have been investigated. These two areas were chosen because of the contrast in the degree of water movement to which they are exposed; an important environmental factor which determines not only the distribution of substrates but also the presence or absence of sessile organisms and even, in some species, their shape. Fig. 1. summarises some of the most important environmental factors including wind and tidal streams; it can be seen that the south and south-west coasts are exposed to a tremendous battering from waves generated by westerly gale force winds having a fetch of over 3000 miles and are also influenced by the extremely strong tidal streams which reach velocities of up to 5k on spring tides. The east coast, on the other hand, is exposed to tidal streams not exceeding 1k and the very few easterly gales have a fetch of less than 100 miles.

By reference to Fig. 2 (particularly the complete profile of the Knoll Pins) and the list below (Table 1) the major animal components of these sessile communities can be seen.

Faunistic Characteristics. The sublittoral fauna around Lundy is rich and varied; representatives of the Lusitanian elements of the Mediterranean-Atlantic fauna such as *Aleyonium couchi*, *Luidea ciliaris*, *Leptopsammia pruvoti*, *Balanophyllia regia*, *Pyrgoma anglicum* have been shown to be present around the island; these elements are generally considered to reach their geographical limits at the western entrance of the English Channel; they also extend to south-west Pembrokeshire so that their presence on Lundy was to be expected. The growth and maintenance of these often colourful animals may be considered the result of a number of factors many of which are obscure. However, it is apparent that the pattern of currents affecting Lundy and described in the introduction, which bring larval forms from the south west, would account for the presence of warm water species, whilst the temperature of Lundy waters, which is fairly high for the British Isles, will allow their survival and reproduction. Also important is the diversity of ecological niches available and the depths to which rocks extend forming many varied habitats leading to the development of a rich variety of animals, many of which are not found in shallow water. The occurrence of two apparently rare species, *Leptopsammia pruvoti* and *Parerythropodium hibernicum*, does not necessarily mean that Lundy is an isolated location since very little scientific investigation has been carried out in other areas in which they may be found. Further diving investigations on the Atlantic coast of Europe may reveal a wider distribution than has previously been possible to record.

Vertical zonation patterns. At the sites studied a distinct vertical zonation of plants and animals has been observed as well as local differences in the composition of the zoned communities. In the sublittoral, this distribution is due partly to the ability of the free swimming larvae to select sites suitable to metamorphose and develop, and further to the capacity of the adult to survive within its zone of abundance the severe competition from other species, possibly better adapted elsewhere to the conditions of light, water movement, substrate and

other factors. Light is of paramount importance in shallow water since competition is mainly from and between algae, which compete amongst themselves according to their ability to survive under different light conditions and crowd out animals except in the shade. Of the other possible factors determining whether particular plants or animals can survive, in the situations studied, wave action is clearly very important. The effect of wave crash and the consequent surge is attenuated at deeper levels, hence shallow water populations must be adapted to survive these stresses if they are to flourish. *Alaria esculenta* often replaces *Laminaria* in such exposed sites whilst amongst the animals one finds the encrusting sponges in shallow water but upright, branching sponges in deeper water; similarly the broad based shallow water *Balanophyllia regia* gives place to the more fragile corals such as *Leptopsammia pruvoti* in deeper water. Encrusting or flexible bryozoans are found in shallow water and the massive calcified colonies of *Pentapora* which are brittle and expose a greater surface more liable to damage by waves are confined to deeper water.

Local distribution of communities. In deep water where the effect of wave action is attenuated and light is reduced to a level where plants cease to be an important competitor with animals the differences in the animal communities of the south and east coasts appear to be related to the strength of tidal streams. Off the south coast where the streams are of high velocity, suspension feeders (sponges, hydroids, *Eunicella*, *Alcyonium*, bryozoa, barnacles) have the advantage of a good food supply, continuous aeration and rapid removal of waste products; at the same time, they are liable to be dislodged if not sufficiently firmly attached or without adequate skeletal support. A species may maintain itself in a strong current by being flexible and bending or twisting with the direction of the current so that sometimes, as in *Eunicella verrucosa*, it becomes aligned perpendicular to the direction of the tidal streams, alternatively it may produce a strong calcified, but brittle, skeleton which will stand up against tidal streams but not the shock pressures of wave crash near the surface, as in *Pentapora foliacea*. The apparent limitation of *Eunicella verrucosa* to the Seals Hole area (of the sites studied) on the south coast is difficult to explain but it may be of significance that this area was outside the influence of the main rip. The part played by skeletal structure and morphology in the differential distribution of many species is exemplified by the two species of *Alcyonium*; a filter feeder with a spicular skeleton. *Alcyonium digitatum* has been observed to be particularly common in strong currents where it grows to a large size while *A. couchi* is confined to areas sheltered from vigorous water movement; Robins (1968) has shown that this is the result of *A. digitatum* having a better developed spicular and hydraulic skeleton than that of *A. couchi*.

In sheltered areas not only is the food supply for suspension feeders reduced but animals are also exposed to siltation, stagnation and possibly an increase in numbers of motile predators. Few areas have been found where rocks are covered in a layer of silt characteristic of extremely sheltered sites but some boulders and rock outcrops in the area of the Knoll Pins are covered in mud and the fauna is consequently reduced. It is dominated by large specimens of *Caryophyllia smithi*, a species which has often been observed to be the sole sessile macrofauna on such rocks in other parts of the British Isles.

From the small number of observations that have been made up to now, obvious differences have been found in the epilithic animal communities living at different sites around the island. It would appear that these differences are due mainly to variation in exposure to water movement; in shallow water the action of swell and surge particularly from Atlantic gales, and in deeper water to the strength of currents to which larvae and adults are exposed. The factors which account for these variations in distribution and morphology have still to be fully elucidated and it is to be hoped that further work around the island will contribute towards this. Valuable observations on these communities can be made by amateur divers having an interest in biology. With the

increasing number of these people staying on Lundy each year, it is hoped that they will be encouraged to report anything of interest and possibly carry out projects of their own. The growing number of diving tourists visiting Lundy each year also brings conservation problems to what is now a paradise to any underwater swimmer. It is essential that divers understand the damage that can be done to these communities by specimen collecting and souvenir hunting and ensure the preservation of this fascinating world for future generations.

Acknowledgments

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Legend

Fig. 1. Diagram to show sites investigated and selected environmental information. (Wind rose constructed from records for Hartland Point, 11 miles south, in the 'Monthly Weather Report'. Tidal streams from Admiralty 1946 and Admiralty Chart 1164. Contours constructed from Admiralty chart A 6582).

Fig. 2. Diagrammatic profiles of submerged rocks at the south coast and the east coast. The south coast diagram is representative of the area studied below algal domination and shows the distribution of the most common members of the sessile animal community. The profile of the Outer Knoll Pin is taken from a drawing and notes made underwater; depths are corrected to metres below the upper level of the *Laminaria* (approximately M.L.W.). On both profiles, the horizontal scale is approximately the same; animals and plants are not to scale and are 'over-crowded'. Only the most common sessile animals in the area are shown.

Table 1. A list of animals which are of interest in the studies carried out at the east and south coasts.

SESSILE SPECIES	COAST		NOTES
	south (exposed)	east (Sheltered)	
PORIFERA (Sponges)			
<i>Pachymatisma johnstonia</i>	++	+	Common at Benjamins Chair on vertical rock. On the east coast only recorded as a 'hat' on <i>Dromia</i> (crab)
<i>Polymastia mammilaris</i>	++	++	On rocks adjacent to sand or mud
<i>Polymastia mammeata</i>	++	+	On horizontal surfaces below the kelp forest. Characterised by the pinnacle-like extremities bearing osculae
<i>Suberites</i> sp.		+	Observed at Brazen Ward on low rock outcrops
<i>Cliona celata</i> (Boring sponge)	+++	++	A very common sponge at all stations below the kelp forest; it grows to massive proportions off the south coast (up to 50 cm across) and is found amongst the carpets of <i>Dictyopteris</i> . On the east coast specimens are small.
<i>Dysidea fragilis</i>	+	+	Occasionally observed on vertical surfaces
<i>Haliclona simplex</i>	+		On vertical surfaces
<i>Raspailia ramosa</i> <i>Axinella polyploides</i> <i>Axinella artica</i>			'Axinellid' sponges are common at all sites, particularly off the south coast but variations in morphology preclude positive identification except in collected specimens.
<i>Axinella infundibuliformis</i>	+	+	The conical form is readily identifiable and has been found at sites on both coasts
CNIDARIA			
HYDROIDS (Sea firs)			
<i>Halecium beani</i>	+	+	Seals Hole
<i>Sertularella polyzonias</i>	++		Black Rock. Probably the major component of the masses of dead hydroid stalks attached to rocks.
<i>Hydrallmania falcata</i>	+		Seals Hole

<i>Nemertesia ramosa</i>	+	+	On the east coast found at sites exposed to the strongest currents (headlands and outcrops), on south coast tops of rocks and horizontal surfaces
<i>Nemertesia antennina</i>	++	++	
<i>Halicornaria pennatula</i>	++		Common in groups at the heads of outcrops
<i>Aglaophenia tubulifera</i>		+	Gannets Rock in large patches on horizontal Rock (18 m)

ANTHOZOA

(Sea-anemones, 'Corals')

<i>Alcyonium digitatum</i> (Dead-men's Fingers)	+++	+	Specimens on horizontal rocks off the south coast are larger with more 'fingers' and are denser (<1/m ²) than on the east coast where they are comparatively uncommon
<i>Alcyonium couchi</i> (=glomeratum)		++	Large isolated clumps are common below the kelp forest on rock outcrops and on the Outer Knoll Pin.
<i>Parerythropodium hibernicum</i>		+	Found at one site only; at a depth of 18 m under an overhang on the north side of the Outer knoll Pin. This species was previously recorded only from Lough Ine (S.W. Cork) but may be recorded as <i>Alcyonium pussillum</i> from South Brittany
<i>Eunicella verrucosa</i> (Sea-fan, Gorgonia)	++	+++	Common on exposed rock outcrops on the east coast, growing on horizontal and inclined surfaces exposed to tidal streams. On the south coast it has been recorded only from Seals Hole where it is very common in 16 m+ amongst fields of <i>Dictyopteris</i>
<i>Epizoanthus couchi</i>		++	Common in clefts and on horizontal surfaces in deep water, possibly confined to areas near the sand
<i>Parazoanthus dixonii</i>		+	Two colonies each covering about 1 sq. m. of rock face in the Knoll Pins area 18 m.
<i>Anemonia sulcata</i> (Snakelocks anemone)		+	Observations indicate that this species is confined to the most sheltered areas

<i>Tealia felina</i> (Dahlia anemone)	+	+	Occasionally observed on rocky outcrops adjacent to and partly covered in, sand
<i>Actinothoe sphyrodeta</i>	++	+	On the south coast colonies of about 100 individuals are often observed on vertical surfaces.
<i>Anthopleura bali</i>		+	Shallow water at Brazen Ward and Gannets Rock, probably confined to sheltered areas amongst algae
<i>Caryophyllia smithi</i> (Devonshire cup coral)	+++	+++	On the east coast it is common on vertical surfaces where densities measured as 80 to 276/m ² , large specimens occur on rock outcrops partly covered in mud. On the south coast it is less common but still occurs in large numbers particularly under overhangs close to the sand
<i>Balanophyllia regia</i> (Scarlet and Gold Star coral)		+	Found only at Brazen Ward (7 m); this is a shallow water coral and this one location is probably not a true indication of its distribution
<i>Leptosammia pruvoti</i>		++	Very common at the east end of the Knoll Pins on vertical surfaces where it is especially dense under overhangs and in a small submarine canyon; this solitary coral has previously been recorded only from the Mediterranean and at Roscoff (S.W. Brittany)
<i>Corynactis viridis</i> (Jewel anemone)	+++	+++	Common at all sites investigated. On the east coast it forms large multi-coloured confluent colonies up to 1 sq. m in area on vertical rocks; on the south coast it is abundant on all surfaces as scattered individuals which in total exceed the densities found on the south coast

ANNELIDA

(segmented worms)

<i>Filograna implexa</i>	++		This worm forms masses of conspicuous intertwining calcareous tubes common on vertical surfaces off the south coast
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CRUSTACEA

Cirripedia (barnacles)

<i>Pyrgoma anglicum</i>	+++	+++	Epizoic on about 50% of <i>Caryophyllia smithi</i>
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<i>Verruca stroemia</i>	++	+	Common in shallow water on exposed vertical and horizontal surfaces at sites. Off the south coast it covers large areas of rock in deep water to the exclusion of other sessile species.
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BRYOZOA
(Sea-mats)

<i>Flustra foliacea</i> (Hornwrack)	++		Occasional dense patches on horizontal rock
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<i>Crisia ramosa</i>	+++	+++	Commonly found on all vertical surfaces
<i>Cellaria sinuosa</i>	+++	+++	

<i>Bugula flabellata</i>	+		Collected at south coast but probably very common
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<i>Pentapora (=Lepralia) foliacea</i>	+++	++	On the east coast this species only grows to a large size on rock outcrops; on the south coast it may reach a diameter of 50 cm on horizontal surfaces
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(Other species of erect branching bryozoa probably are common but only small collections have been made)

MOTILE SPECIES

<i>Palinurus vulgaris</i> (Crawfish)	++	+	Found in deep water. Especially common off Black Rock where it is collected commercially
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<i>Homarus vulgaris</i> (Common lobster)	+		Occasionally found by divers
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<i>Cancer pagurus</i> (Edible crab)	+	+	
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<i>Luidea ciliaris</i> (7-armed starfish)	++		Benjamins Chair
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<i>Marthasterias glacialis</i> (Spiny starfish)		++	Knoll Pins area
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<i>Asterias rubens</i> (Common starfish)	++		Black Rock
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<i>Ophiocomina nigra</i> (Brittlestar)	++		On patches of sand at Seals Hole
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<i>Echinus esculentus</i> (Edible sea urchin)	+	+++	Abounds in large numbers on the east coast amongst the kelp especially in sheltered bays
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<i>Holothuria forskali</i> (cotton spinner)	+	++	Occurs below the kelp forest on the east coast especially on muddy rocks; only 1 specimen off the south coast
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+ present in small numbers

++ common but distribution patchy or found at one site only

+++ abundant