

Report on a sublittoral survey of
Loch Eriboll (Sutherland)

by

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(with a section describing the algae
by S. Hiscock)

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1. Introduction

The main aims of the survey were to describe the range of sublittoral habitats and species present in and near Loch Eriboll (on the north coast of Sutherland, a few miles to the east of Cape Wrath); and also to provide an opportunity for members of the Marine Conservation Society to extend their range of marine biological knowledge and associated skills by taking part in a structured survey. The study was of wider interest in that there appears to have been no previous sublittoral survey of the area. This meant that the proposed rather general, wide ranging and non-specialist survey was quite appropriate.

2. Environmental conditions

Figures 1 and 2 respectively locate Loch Eriboll, and give a large scale map of the survey area. The loch is the northernmost of the series of large deep sea lochs found on the western coast of the Scottish mainland, and in the Hebrides. Unlike nearly all the others it is exposed to the north. Its overall topography is fairly simple, the loch being approximately funnel shaped. There are no rapids, and relatively few islands. The main fresh water input is from the River Hope, and is, rather unusually, situated near to the loch mouth. Overall L. Eriboll can be classified as 'fjord-like' (Earll and Pagett, 1984). The area is of geological interest, being on the edge of the 'Durness limestone'. At the east of the area surveyed there are limestone cliffs with deep caves, and limestone was found in several places in the sublittoral, often heavily bored and fissured (see Fig. 2).

Admiralty chart 2076 covers the area at large scale, the loch having been used as an assembly area for World War Two convoys and still occasionally being used by the Royal Navy as an anchorage. The loch can be divided into three main regions. The wide outer loch extends from Eilean Hoan in the west of Whiten Head to the east, to about the position of the automatic light on White Head. This region is directly exposed to winds from the northern quarter and the shallows generally show signs of strong wave action. The adjacent headlands and north sides of the islands in the mouth can be distinguished as being especially exposed. The middle loch is from the automatic light to the line joining the northern point of Eilean Choraiddh and the south of the Ard Neackie peninsula. The direct fetch of this region is small, but even from our experience in relatively good summer weather, a strong swell may penetrate this far. Finally, the very sheltered inner loch extends to the south from the above line to the head of the loch.

Tidal motion is generally small. A flow of order $\frac{1}{2}$ knot was found in the channel between Eilean Choraiddh and the west shore. Other than very gentle motions, the only other site at which an appreciable tide ($\frac{1}{2}$ - 1 knot) was experienced was off Whiten Head (site 17). The chart also indicates a current of $\frac{1}{2}$ knot around Eilean Cluimrhig.

At the loch mouth exposed bedrock extends to a depth of 25 m or more close to the shore, giving onto pebbles or sand. Moving towards the loch head, the depth of the rock/sediment interface generally decreases (see Fig. 3), and to the south of Ard Neackie the rock occurs as a boulder slope (except for an isolated offshore outcrop at site 28). The region off the east shore between Freisgill Head and Geodha Meiril (sites 19a and 21, Fig. 2) is somewhat anomalous in that there is an extensive plateau of sand, boulder and bedrock outcrops at about 10 - 18 m. No regions of offshore circalittoral rock were located. The sediment in the inner loch is generally soft mud, and this extends to the only part of the middle loch surveyed well away from the shore (site 25). Closer in, muddy sand was found to 20 or 25 m at a number of sites. In the outer loch sand and pebbles were more common.

3. Methods

The survey participants were all amateur naturalists from the membership of MCS, apart from Sue Hiscock, a professional phycologist. Some general funding was provided by NCC, who also loaned a compressor. Sue Hiscock was separately funded by NCC to produce a report describing the marine algae. Apart from this, participants paid their own expenses. The survey was based at the Robertson Research International Field Centre at the Balnakiel Craft Village, about half a mile out of Durness. This accommodation, although fairly basic, provided plenty of working space and was quite satisfactory for our purposes. The diving team consisted of 6 persons for the first week, and was joined by two more (RK and KY) for the second week.

Diving was carried out from two inflatables. The nearest access point to Loch Eriboll from Durness is at Rispond, some 4 miles or so away by road. Rispond has a very sheltered harbour, but unfortunately this dries out for 100+ m for about 6 hours on every tide, which makes planning of diving and boating difficult if much carrying of equipment is to be avoided. The harbour at Portnacon, some 4 miles to the south is usable at all states of the tide. Thus for most of the time Portnacon was used as a base, and Rispond was used mainly to land and pick up and land equipment and personnel. The area is remote - on only two or three days was even a solitary vessel sighted whilst at sea - and clearly safety was a paramount consideration in planning the boating and diving; in particular the boats always operated together and diving was restricted to 'no stop' times. Fortunately the weather was generally good, with a maximum wind strength of force 5 or 6 only being experienced on one or two days. Even so, with water temperatures of 10 or 11 °C the two divers in wet suits became chilled. Sites were selected from examination of the chart, with occasional on-the-spot amendment, to attempt to cover as wide a range of habitat types as possible. Two or three sites were covered each day.

The methods employed were generally similar to those of previous MCS surveys (e.g. Dipper, 1981, 1983). Divers recorded their observations on formica boards, and data were transferred each evening to standard check lists (Appendix 1). These raw data sheets are held separately by NCC. Species were recorded to the best of each individual's ability, and some material collected for later examination. As usual on these surveys, the quality and thoroughness of observations improved after the first few days. There is inevitably some "patchiness" according to the particular skills of those diving any site. Some qualitative faunal abundance estimates were attempted using the scales proposed by Hiscock (1983 - see Appendix 2) with slight modification for the Porifera. This appendix also includes the floral abundance scale employed.

Photographs were taken by a number of participants (NB, GG, SH, DM, JW) and a selection made from these is held by NCC and catalogued in Appendix 6. Gil Green processed some films 'on site', which proved invaluable in calibrating some new photographic equipment!

4. Results: general and faunal survey

4.1 Preamble

The underwater visibility was generally found to improve with distance from the head of the loch (see Table 1) and where the rock extends deep enough for the kelp to be light-limited, there appeared to be a slight dependence of the maximum depth of the kelp on distance from the head of the loch (Fig. 4; see also section 5). The effects of fresh water seemed to be small overall, but at a number of inner and middle loch sites a region of less saline water was observed to a depth of c. 1m.

Sites were numbered in the order in which they were visited (note that sites 9 and 18 are the same; and that site 17 is immediately adjacent to site 8). General site details are given in Table 1. The last column of this table gives information about exposure and substrate according to the following code. A = inner loch, B = middle loch, C = outer loch, D = headlands and north sides of islands in mouth. 1 = bedrock and cliff, 2 = boulder slope, 3 = cobble/pebble/gravel, 4 = sand, 5 = muddy sand, 6 = mud. Brief descriptions of the sites, prepared from the habitat recording forms, are given in Appendix 3. Appendix 4 contains a faunal species list annotated with the sites at which each species was recorded and one or two further comments. This list is compiled mostly from the faunal check lists, with some additions from subsequent examination of colour slides and collected specimens. The algae are described separately by Sue Hiscock, in section 5. In Appendix 5 there are profiles of the sites visited (excepting site 5). The vertical scale is given corrected to Chart Datum, and is believed to be reasonably accurate. The horizontal scale is more qualitative, as a formal transect was only carried out at site 19a. Divers were asked to estimate distance travelled, and in some cases this estimation was supplemented by observations from the covering boat. One or two profiles are composites of slightly different profiles recorded by separate pairs of divers at nearby positions at the same site. Figure 5 gives a more accurate position and approximate indication of the line taken by the divers at each site.

4.2 Major habitat types and faunal communities

Hard substrata

Very exposed bedrock slopes and cliffs

Extensive and spectacular bedrock slopes were found off islands and headlands in the outer loch, extending to depths of 20 m or more (sites 6, 8, 15, 17, 22). Sometimes (e.g. site 6) very large boulders were also present. Sites 9 (see below) and 16 were of similar character, but with a much shallower lower boundary to the bedrock. Grazing action by Echinus varied between severe at sites 6 and 22, through moderate at site 15 (where extensive beds of O. fragilis were present) to negligible at sites 8, 9 and 17. At sites 9, 15 and 16 the rock was limestone, and in places the vertical surfaces were heavily creviced and bored providing a habitat for a rich community of ascideans, sponges (mostly Pachmatisma johnstoni and Haliclona viscosa), ophiuroids, Alcyonium digitatum, Corynactis viridis, hydroids and bryozoans. A similar rich turf, but without the ophiuroids and H. viscosa) was found at sites 8 and 17. Occasional Antedon bifida were also recorded at each of these sites.

The upward facing open rock faces in the lower infra-/upper circalittoral had patches of A. digitatum (common in places) with (at sites 8, 9, 17) a rich faunal turf, including a variety of echinoderms (Asterias rubens, Crossaster papposus, Henricia oculata, H. sanguinolenta, Leptasterias mulleri). Thick growths of Halichondria panicea were present on kelp stipes and the fronds were often heavily colonised by Obelia geniculata. The Dendrodoa/Clathrina association was only found at site 8; this may be attributable to a persistent swell at these exposed sites making investigation of the shallow sublittoral rather troublesome.

Moderately exposed bedrock slopes and cliffs

These were found in the middle loch (sites 1, 2, 3, 7, 10, 12, 13, 19, 20, 21, 32). In places there was a gentle or moderate rock slope, extending to depths between 10 and 24 m, with kelp typically to 10 - 14 m. This slope was sometimes silty, especially below the kelp (e.g. sites 1, 2, 3, 10), and sometimes the silt might be called a sediment layer (site 3). Grazing by Echinus was generally moderate. Common faunal associations were hydroids, M. senile, Ascidia mentula, Cucumaria sp., C. smithii, A. digitatum and A. bifida, the latter two being especially common where the slope became very steep (e.g. sites 10, 12, 32), and on the vertical sides of gullies (site 14).

Brittle stars were sometimes present on the deeper, more gentle, slopes. Sponges were uncommon except at the transitional site 7: P. johnstoni was occasional at site 14 and rare at sites 10, 12, 19; Mxyilla incrustans was rare at several sites; H. panicea encrusted stipes at sites 19 and 20.

Sheltered (fairly) deep bedrock

This was only found at site 28 - a limestone outcrop surrounded by sediment. Some verticals were well creviced, with a population of ophiuroids, A. mentula, C. intestinalis, P. rustica, A. aspersa, A. bifida.

Exposed boulder and cobble slope

In places this was only a narrow band of boulders at the bedrock/sediment interface, with no distinctive fauna. Especially at sites at the mouth of the loch, the boulders were often heavily grazed by Echinus, leaving colourful patches of Parasmittina trispinosa and "Lithothamnion".

Sheltered boulder and cobble slopes

These were found in the inner loch and the south east of the middle loch (e.g. site 11a); usually rather short, extending to c. 4 - 6 m, with sediment below. Rather silty, with thick L. saccharina.

Eroded limestone

At a number of sites heavily creviced and bored limestone was found on approximately vertical rock faces (e.g. sites 8, 9, 15, 16, 17, 28). These supported a rich in-/epi- fauna (see above). Unfortunately, a hammer and chisel was not available to take substantial rock samples.

Rock mills

At site 9 "rock mills" several metres deep and in diameter were found. These also provided areas of deeply creviced limestone, with associated fauna. The bottom c. 1 m of the mills were well scoured.

Mud

Soft mud was encountered at the two deep sites sampled well away from the shore in the middle and inner lochs (sites 25 and 30). In each case

Virgularia mirabilis was found, and Nephrops norvegicus at site 30. Mud was also found below about 10 m at inner loch sites. Areas of algal debris were sometimes present. Patches of Turritella communis were encountered at a number of sites, together with V. mirabilis at site 24. Cerianthus lloydi, Mxyicola infundibulum, Sagartia troglodytes, Liocarcinus depurator, together with hydroids and Metridium senile on occasional pebbles/boulders, were also found, and are probably quite typical of these habitats. The infaunal Amphiuria filiformis was present at site 33.

Muddy sand

This substrate was typical of sediment surveyed in the middle loch, and also above about 10 m in the inner loch. Often well worked, by Arenicola marina, bivalves and Cerianthus lloydi; with algal mats, patches of Turritella communis, hermit crabs, Pecten maximus and Chlamys opercularis. Patches of brittle stars were sometimes found; A. aspersa sometimes were attached to the matted algae. Species diversity was often increased by the presence of pebbles and occasional boulders.

Clean sand

Found at outer loch sites. Poor in fauna, apart from occasional Lanice conchilega and crabs.

Pebbles/small cobble

An extensive, rather species poor, tide swept pebble plain was found at site 17, and to a lesser extent at site 16. The former was dominated by barnacles and hydroids with occasional encrusting bryozoans and Alcyonidium diaphanum. A cobble/pebble plain, apparently with little tidal action, was found at site 12, and there were small patches of pebbles at several other sites.

5. Results: Algal Survey (S. Hiscock).

Lists of the sublittoral algae found during the survey are given in Appendix 7.

5.1. Communities on Bedrock and Large Boulders

Upper Infralittoral

Communities on bedrock and large boulders in shallow water were characterised by a forest of *Laminaria hyperborea* at all sites north of Site 14. At Sites 10, 11b and 34 to the south in increasing shelter inside the loch, dense *Laminaria hyperborea* was present only in a narrow depth band in shallow water (0.5m to approximately 2m at Sites 10 and 11b; 0-0.5m at Site 34), with dense *Laminaria saccharina* below. Further inside the loch *Laminaria hyperborea* was recorded as 'frequent' on bedrock at Site 28. The deepest recorded depth of large *Laminaria hyperborea* plants was at 19.5m, Site 8, with dense forest to 11m. Depth distribution of *L. hyperborea* and other algae is discussed in Section 5.6. Records of kelp stipe epiphytes are given in Section 5.5.

Alaria esculenta was Abundant at Site 9, in a band on steep and vertical rock, extending from the lower shore to around 1.8m.

Foliose algae beneath dense kelp cover were most abundant in shallow water at exposed sites, with generally a small variety of foliose species (Table 2). Present at most sites were *Odonthalia dentata*, *Callophyllis laciniata*, *Delesseria sanguinea*, *Plocamium cartilagineum*, *Cryptopleura ramosa* and *Bonnemaisonia hamifera* (*Trailliella* phase). Encrusting algae (calcareous red, dark red, brown and *Aglaozonia* phase of *Cutleria multifida*) were also present at many sites. *Corallina officinalis* was only recorded from the most exposed site (Site 8), and was Common here. *Odonthalia* was most abundant at exposed sites, particularly in shallow water. *Dictyota dichotoma* was recorded from kelp undergrowth at two semi-sheltered sites only. The effects of grazing, scouring and vertical rock on algal populations are noted below.

Where extensive areas of boulders were surveyed, cover from *Laminaria hyperborea* was generally more open, and *Saccorhiza polyschides* was present at a few sites, notably Site 27 where plants were abundant at 6.5m. Foliose algae on boulders were often similar to kelp undergrowth on bedrock, but more dense beneath the open canopy. Several species found on boulders were characteristic of other 'disturbed' habitats (scoured and grazed bedrock), including *Desmarestia aculeata*, *Laminaria saccharina*, *Saccorhiza polyschides*, *Dilsea carnosus*, *Pterosiphonia parasitica*, *Nitophyllum punctatum* and *Desmarestia viridis*.

Halidrys siliquosa was Occasional on boulders at 2m, Site 11b, and at the two most sheltered sites (Site 29 and 23), where a fringe of *Laminaria saccharina*, *Chorda filum*, *Halidrys*, *Stilophora rhizodes* and *Chordaria flagelliformis* was present on boulders in sand at 0-2m. At the most sheltered sites, the foliose algae flora on boulders was similar to that on cobbles and pebbles (see below)

Lower Infralittoral

The lower limit of dense kelp due to light penetration was established at relatively few sites, with other factors such as lack of suitable substrate also becoming effective at most sites in preventing dense kelp establishing (see Section 5.6.). A well developed lower infralittoral flora was found at only a few sites, notably Site 9, 13 and 10 (Table 3). Together with Site 23, these show a general decrease in number of species towards the inner loch, with encrusting brown and coralline algae becoming dominant on heavily silted bedrock at Site 23. A decrease in species numbers was also noted towards the most exposed sites, where rock surfaces in the lower infralittoral were generally animal-dominated.

5.2. 'Disturbed' Bedrock and Boulder Habitats

Vertical Rock

At exposed sites, vertical rock was animal-dominated, often with encrusting algae beneath, and very few foliose species. Present in this habitat at several sites were *Phyllophora traillii*, *Pterosiphonia parasitica*, *Acrosorium reptans*, a few filamentous red algae and unidentified red sporelings. With increasing shelter, a wider variety of foliose algae was recorded from vertical rock, but with encrusting algae still predominant (Table 4).

Scoured Rock

Bedrock and boulders subject to periodic scour by mobile cobbles, pebbles and sand were found locally at many sites, and rock surfaces were generally covered with encrusting calcareous algae, and a few scour-resistant animals such as *Pomatoceros* and barnacles.

Large boulders at 23-27m, Site 22, had a particularly bare appearance, with abundant encrusting coralline algae and animals. This may be partly due to *Echinus* grazing at this site (see below). At Sites 16 and 21, scoured bedrock at 9m and 5m respectively, had a fairly dense cover of foliose algae, notably of *Desmarestia aculeata* and *Laminaria saccharina*, and a number of other species in lesser abundance (*Brongniartella byssoides*, *Flocamium cartilagineum*, *Kallymenia reniformis*, *Bonnemaisonia asparagoides*, *Nitophyllum punctatum*, *Cryptopleura ramosa*, *Odonthalia dentata*, and *Delesseria sanguinea*). Flat sand-scoured bedrock at 15m, Site 16, had a flora similar to that on vertical rock, with encrusting coralline algae dominant, and *Aglaozonia*, *Acrosorium reptans*, *Lomentaria clavellosa*, *Pterosiphonia parasitica* and the *Halicystis* phase of *Derbesia* sp.

Grazing

Echinus esculentus were frequent or common at many sites, and some sites (Sites 13, 14, 22 and 27) appeared particularly bare, probably as a result of urchin grazing on bedrock and boulders. Encrusting algae were predominant on rock surfaces, with *Trailliella* and a few foliose algae. Kelp stipes were also noticeably bare at these sites, and *Calliostoma ziziphinum* was also frequent at Site 14. At Site 23 at the head of the loch in extreme shelter, *Psammechinus* and chitons were frequent to common on heavily silted bedrock, where encrusting brown and coralline algae were dominant on rock surfaces.

Sand Covered Rock

Several characteristic species were found on sand-covered rock at several sites, particularly in clearings in kelp forest. These included *Halidrys siliquosa*, *Laminaria saccharina*, *Polyides rotundus*, *Furcellaria lumbricalis*, *Ahnfeltia plicata*, *Desmarestia aculeata*, *Desmarestia viridis*, *Phyllophora crispa*, *Phyllophora truncata*, *Ulva* sp. and *Enteromorpha linza*. *Ceramium rubrum* and *Flocamium cartilagineum* were common as epiphytes on other algae at these sites.

5.3. Communities on Cobbles and Pebbles

A wide variety of foliose and encrusting algae was found on cobbles and pebbles in Loch Eriboll (Table 5). Pebbles and cobbles were found at sites with a wide range of exposure from outer to inner loch, and at a range of depths. At some sites extensive areas of pebbles were present, at others pebbles were widely scattered in sediment. Many of the species found were characteristic of this habitat. Species found at five or more sites were *Antithamnion plumula*, *Laminaria saccharina*, *Rhodomela confervoides*, *Chorda filum*, *Desmarestia viridis* and *Cutleria multifida*. Species found only at exposed or semi-exposed sites included *Callophyllis laciniata*, *Antithamnion plumula*, *Porphyra* sp., *Arthrocladia villosa*, *Schmitzia hiscockiana*, *Halarachnion ligulatum*, *Phycodrys rubens*, *Hypoglossum woodwardii*, *Gracilaria verrucosa* and filamentous brown algae. Species found only at sheltered or semi-sheltered sites included *Chorda filum*, *Chordaria flagelliformis*, *Lithothamnion glaciale* (rhodoliths), *Chondrus crispus*, *Asperococcus turneri*, *Polyides rotundus*, *Trailliella*, *Phyllophora crispa*, *Chylocladia verticillata* and *Stilophora rhizodes*. Some of these species were found at more exposed sites on sand-covered bedrock. *Halidrys siliquosa* was recorded at three sheltered sites, but only one exposed. Extensive areas of pebbles at 15m, Site 13 had a particularly interesting pebble flora, including *Naccaria wiggii*, *Sporochnus pedunculatus*, *Arthrocladia villosa*, *Schmitzia hiscockiana*, *Halarachnion ligulatum* and *Cutleria multifida*. *Scinia turgida* was recorded from pebbles at 16m, Site 16.

Rhodoliths of *Lithothamnion glaciale* forming 'hedgehog stones' were Rare or Occasional in sediment in shallow water at four sheltered sites, and *Lithophyllum incrustans* at one sheltered site.

5.4. Communities on Sediments

Most algae found on sediments were attached to stones or shells, and are described in Section 5.3. At some sheltered sites, algae were found unattached in loose-lying mats, and maerl was recorded from three sites.

At Site 11b, unattached brown algae including *Desmarestia viridis*, *Stilophora rhizodes*, *Mesogloia vermicularis* and *Sphacelaria* sp. formed flocculent masses at 2-4m, with some *Trailliella* at 5.5m. At Site 29, dense mats of *Desmarestia viridis*, *Phyllophora crispa* and *Trailliella* were present in monospecific stands at 9m, on sand with dead maerl fragments. At Site 23, *Stilophora* and *Chordaria flagelliformis* were locally abundant on muddy sand at +0.5m.

Maerl (*Phymatolithon calcareum*) was present in fairly sparse patches in hollows in muddy sand, at 2m, Site 29. Mixed live and dead plants were found in a narrow zone at the base of a short slope of boulders in sand. Plants had epiphytic *Trailliella*, *Dictyota dichotoma*, *Gelidium pusillum* and *Sphacelaria* sp. In deeper water at this site (9m), extensive areas of dead maerl fragments were present on top of sand. Unidentified maerl was also recorded from Site 3 at 6.5m ('common'), and Site 28 ('occasional, mostly dead with a few live bits').

Brown diatom films on the surface of sand and mud were noted at some sheltered and semi-sheltered sites (Sites 14, 23, 27, 29 and 31).

No *Zostera marina* was seen during this survey.

5.5. Algal Epiphytes

Kelp stipe flora

Algal epiphytes recorded from *Laminaria hyperborea* stipes are shown in Table 6, together with the depth range recorded for each species.

Polysiphonia urceolata, *Falmaria palmata* and *Membranoptera alata* were recorded only from shallow water, while *Ptilota plumosa* and *Phycodrys rubens* extended almost as deep as the host plants, to 17m at Site 8.

Epiphytes on *Laminaria saccharina* stipes were noted at Site 10 only, where *Cutleria multifida* and young *Laminaria* sp were present at 8m.

Epiphytes on kelp fronds

Obelia dichotoma was dense on kelp fronds at most exposed sites, particularly in deeper water (10-13m). Filamentous brown algae were present on *L. hyperborea*, *L. saccharina* and *Saccorhiza polyschides* fronds at several sheltered and semi-sheltered sites. *Ceramium rubrum* was present on *L. saccharina* at Site 31, and spirorbids Abundant on *L. saccharina* at Site 34.

Epiphytes on *Halidrys siliquosa*

At the two most exposed sites where it was recorded, *Halidrys siliquosa* was relatively clean of epiphytes, but in increasing shelter, *Sphacelaria* sp. was a frequent epiphyte, and *L. saccharina* sporelings at Site 23. Dogfish eggs were recorded on *Halidrys* from two sites, and white ascidians from the most sheltered site (Site 23).

5.6. Algal Depth Limits

Relatively few sites with uninterrupted bedrock slopes into the upper circalittoral were surveyed, particularly in the inner loch. However from the limited data collected (Fig. 6), it is apparent that the lower limits of both foliose algae and kelp are progressively raised from outer to inner loch. The lower limit of foliose algae was around 25m at Site 15; 23.5m at Site 22; and 17m at Site 10. The lower limits of both foliose algae and kelp may be raised by the presence of dense beds of animals, particularly brittlestars, at some of the most exposed sites.

The lower limit of *Laminaria hyperborea* was raised from 19.5m, Site 8 to 17.5m, Site 22, and was Occasional at 15m, Site 13. From Site 13 inwards, the picture is confused, with lack of suitable substrata for *L. hyperborea* at many sites. However at Sites 10, 11b and 34, *L. hyperborea* was confined to a very narrow depth band between 0m and 2m, with dense *Laminaria saccharina* below. *L. saccharina* was dense down to 8m at Site 10, with lower limit at 10.5m. At this site, a sharp increase in slope of the bedrock to near vertical coincided with the change from *L. hyperborea* to *L. saccharina*; however at Site 34 there was no apparent change in substratum with an even slope of cobbles. Although the survey is incomplete, the data suggests that the lower limit of *L. hyperborea* is raised dramatically between Site 13 and 10 (or 34), and replaced below by *L. saccharina*. This phenomenon has been noted in other sealochs (e.g. Loch Sween, Lumb and Hiscock, S. 1986), and appears to form part of a general transition from exposed open coast to sheltered inner loch communities. However the presence of 'frequent' *L. hyperborea* at Site 28, well inside the loch, does not seem to fit this general pattern. This site may be more exposed than its position inside the loch suggests, as it faces the entrance to the loch and has an uninterrupted fetch to the open sea.

5.7. Distribution of Algae

Distribution within Loch Eriboll

The distribution of algal species within Loch Eriboll from the sites surveyed is shown in Table 7. Sites are arranged in order from exposed outer to sheltered inner sites. Several species appear to be confined to exposed and semi-exposed sites (*Acrosorium uncinatum*, *Alaria esculenta*, *Laminaria hyperborea*, *Cryptopleura ramosa*, *Odonthalia dentata*). A larger number of species were found only at semi-sheltered or sheltered sites (*Enteromorpha* sp., *Asperococcus turneri*, *Chordaria flagelliformis*, *Colpomenia peregrina*, *Mesogloia vermicularis*, *Stilophora rhizoides*, *Chylocladia verticillata*, filamentous brown algae and rhodoliths of *Lithophyllum incrustans* and *Lithothamnion glaciale*. Diatoms on sediment were also confined to sheltered sites. *Halidrys siliquosa* was found mainly in sheltered locations, but at two exposed sites in a particular habitat (sand-covered or scoured bedrock). A large number of species were found only in particular habitats, for instance *Naccaria wiggii*, *Scinaia turgida*, *Schmitzia hiscockiana*, *Sporochnus pedunculatus* and *Arthrocladia villosa* were found only on pebbles in deeper water (15-16m).

The distribution of several species of large brown algae in Loch Eriboll is illustrated in Figs 7 and 8.

Distribution in the British Isles

Most of the species recorded were to be expected at this latitude. However, *Naccaria wiggii* and *Schmitzia hiscockiana* are probable northern records for the British Isles. Dixon and Irvine (1977) state that *Naccaria* is widely distributed on western and southern shores but highly sporadic in occurrence, extending northwards to the Isle of Man. There are doubtless new records of *Naccaria* since this publication, but Loch Eriboll is a considerable extension northwards from the Isle of Man. *Schmitzia hiscockiana* has been recorded as far north as St Kilda (Maggs and Guiry, 1985), so is not unexpected in Loch Eriboll. Several other southwestern/western species were present in the flora, and many of these species, previously thought to be confined to southwestern shores, have been shown by recent surveys to extend up the west coast of Scotland and sometimes into the northern North Sea. *Scinaia turgida* for instance is now recorded as far north as the Shetlands (Maggs and Guiry, 1982).

6. Discussion

A reasonable coverage of habitats was obtained, the greatest omission probably being the deeper sediments of the middle and outer lochs. The loch is considerably less complex than, for example, Loch Roag (Dipper, 1983) or Loch Eynort, S. Uist (Dipper, 1985), and the habitats vary fairly uniformly from the sheltered, short boulder slope - muddy sand/mud slope of the inner loch through silty bedrock - muddy sand in the middle loch to clean bedrock and cliffs - sand/pebbles in the outer loch. Additional interest is provided by the limestone outcrops, providing caves, rock mills and bored/creviced rock faces.

Water clarity at sites at the mouth of the loch (e.g. 6, 8, 15, 17, 22) was excellent, and visually these sites were extremely attractive with luxuriant kelp forests and spectacular underwater topography. Epifaunal species diversity was not particularly high, except perhaps for the variety of ascidians. Maximum faunal diversity was probably achieved at Whiten Head (site 8/17) in the lower infralittoral/upper circalittoral. The range of ascidians here was particularly notable.

The effects of grazing by Echinus were marked, but not as severe as, for example, in Loch Roag. (Echinus 'view numbers' are recorded on the raw Habitat forms). Only in a few sites were large areas of lower infralittoral/circalittoral rock faces really scraped clean of all macrofauna apart from Parasmittinia trispinosa. In general, porifera and anthozoa (apart from H. panicea on kelp stipes and A. digitatum) were scarce, as seems to be usual in the NW of Scotland. Indeed, for example, the sponge Myxilla fimbriata which was found at a number of sites in both L. Eynort and L. Roag in the Hebrides was not found in L. Eriboll. There were few, if any, surprises among the fauna recorded, although there were one or two notable omissions. In particular Gibbula magus was only recorded at site 34 - this does appear to be a real effect. In contrast, Calliostoma ziziphinum seemed to be rather more plentiful than usual. There were no large populations of Ascidella aspersa, even in very sheltered conditions. Interestingly, both Henricea oculata and H. sanguinolenta were recorded at several outer loch sites. A hydroid (Eudendrium sp.) was found growing on the uppermost point of Virgularia mirabilis at two deep muddy sites (25 and 30). The sponge Spanioplon armaturum is a probable northern record for the British Isles. Aurelia aurita and Cyanea capillata were commonly seen, the latter at site 15 with what appeared to be a commensal juvenile whiting. Seals were very common, being seen virtually every day either hauled out or in/under the water.

A general summary for the algae is given in Section 5.7.

7. Loch Eriboll: initial assessment of scientific interest and nature conservation value (S Hiscock and D Moss)

This survey was a limited one with only one professional biologist recording the biota present, and is incomplete. Many potentially interesting sites remain unsurveyed; thus the assessment of scientific value and nature conservation interest is an initial one only. However, where possible the usual criteria for evaluation, based on those outlined for terrestrial areas by Ratcliffe (1971), have been used.

Size. Loch Eriboll is some 18 km long, from Whiten Head at the northeastern boundary, to the head of the inner loch and, together with several offshore islands, must have a total coastline of well over 40 km.

Diversity. The diversity of sublittoral habitats, communities and species in Loch Eriboll and its approaches is very high, with a range of bedrock, cobble, pebble and sediment habitats from extremely exposed to very sheltered from wave action, and a corresponding wide range of communities and species. The presence of limestone cliffs with extensive vertical walls, gullies, caves, and deep bedrock near the loch entrance adds considerably to the usual range of bedrock habitats. 'Disturbed' bedrock habitats such as sand-scoured and sand-covered rocks were particularly common. Bedrock extending well below the lower limit of foliose algae was present into the inner loch, enabling comparison of algal lower limits with sites near the loch entrance. Areas of cobbles and pebbles with particularly interesting algal floras were found at several sites. Although the infauna of sediments was not examined in detail, evidence of burrows and shells on the surface suggests a rich fauna at many sites, with sediments ranging from coarse gravel to soft mud. There are no rapids within Loch Eriboll, and this survey recorded no Zostera, and only sparse maerl at a few sites.

Naturalness. To our knowledge, the communities in Loch Eriboll are entirely natural, apart from a few man-made habitats such as the Buoy Chain (site 25), and harbour walls.

Rarity. This is difficult to assess, as so much of the north and west coasts of Scotland remain unsurveyed; however the sublittoral limestone cliffs and caves should probably be regarded as a particularly important feature of Loch Eriboll. Several species rarely recorded for the north of Scotland were found, notably the algae Naccaria wiggii and Schmitzia hiscockiana, at their northern recorded limits in the British Isles.

Fragility. At the present Loch Eriboll shows very few signs of human impact. While we were there a crab boat was operating from Rispond and, in winter, Portnacon is used as an anchorage by larger fishing vessels. Few pleasure craft use the area. Occasional broken crab pots were noticed when diving within the loch, and scallop dredging is known to occur (signs were suspected at site 5). Divers collect scallops in a fairly organized manner. As with most sea lochs and other enclosed areas, Loch Eriboll would be at risk from excessive development of fish farms and sources of water-borne pollutants. During this survey, interest in setting up fish farms was noted from several sources; in particular there is a proposal to moor cages in the deep water to the south of Eilean Choraiddh in the near future. We have no information on the hydrography of the loch and the potential for damage of such enterprises, but given the current pristine condition of the loch, there are clearly opportunities for monitoring their effects. It is unlikely that any large-scale industrial development will take place in Loch Eriboll, due to its extreme remoteness.

Typicalness. This is difficult to assess without more research on the information available for other Scottish sea lochs; however some features of the limestone geology may be unique. The usual gradation of communities from exposed to sheltered within the loch is apparent, with raising of algal lower limits and change of species.

Position in an ecological/geographical unit. Parts of the coastline adjacent to Loch Eriboll are of high botanical and geological interest, particularly the limestone outcrops. Smoo Cave to the west is a well known tourist attraction, with a series of sandy beaches and sand dunes between Loch Eriboll and Kyle of Durness forming a highly scenic stretch of coast which is still largely unspoilt by development. The cliffs near Balnakeil are one of the few locations in the British Isles where Primula scotica grows in abundance in the wild.

Recorded history. Not known.

Potential value. Not known.

Intrinsic appeal. The area around Loch Eriboll and Durness is of high intrinsic appeal for its great scenic value and unspoiled remoteness in the northwest corner of mainland Britain. It is popular in a limited way for tourists who can make the effort to come this far; many of these are foreign tourists in mobile accommodation. The stretch of coastline between the Kyle of Durness and Loch Eriboll in particular must compare scenically with anywhere in mainland Britain.

Research and educational value. In general terms, the educational value must be very limited because of the extreme remoteness and scarcity of public transport. There is a small field station owned by Robertson Research International Ltd at Balnakeil Craft Village (where the survey was based), with self-catering accommodation and bench space. The mouth of the loch and adjacent coastline merit further study; in particular a study directed to elucidating the differences between communities on limestone and those on adjacent rock would be of interest. There is scope for specialist research on littoral and sublittoral sealoch communities as yet completely undisturbed by the effects of fish farming; however this opportunity may not be available for long.

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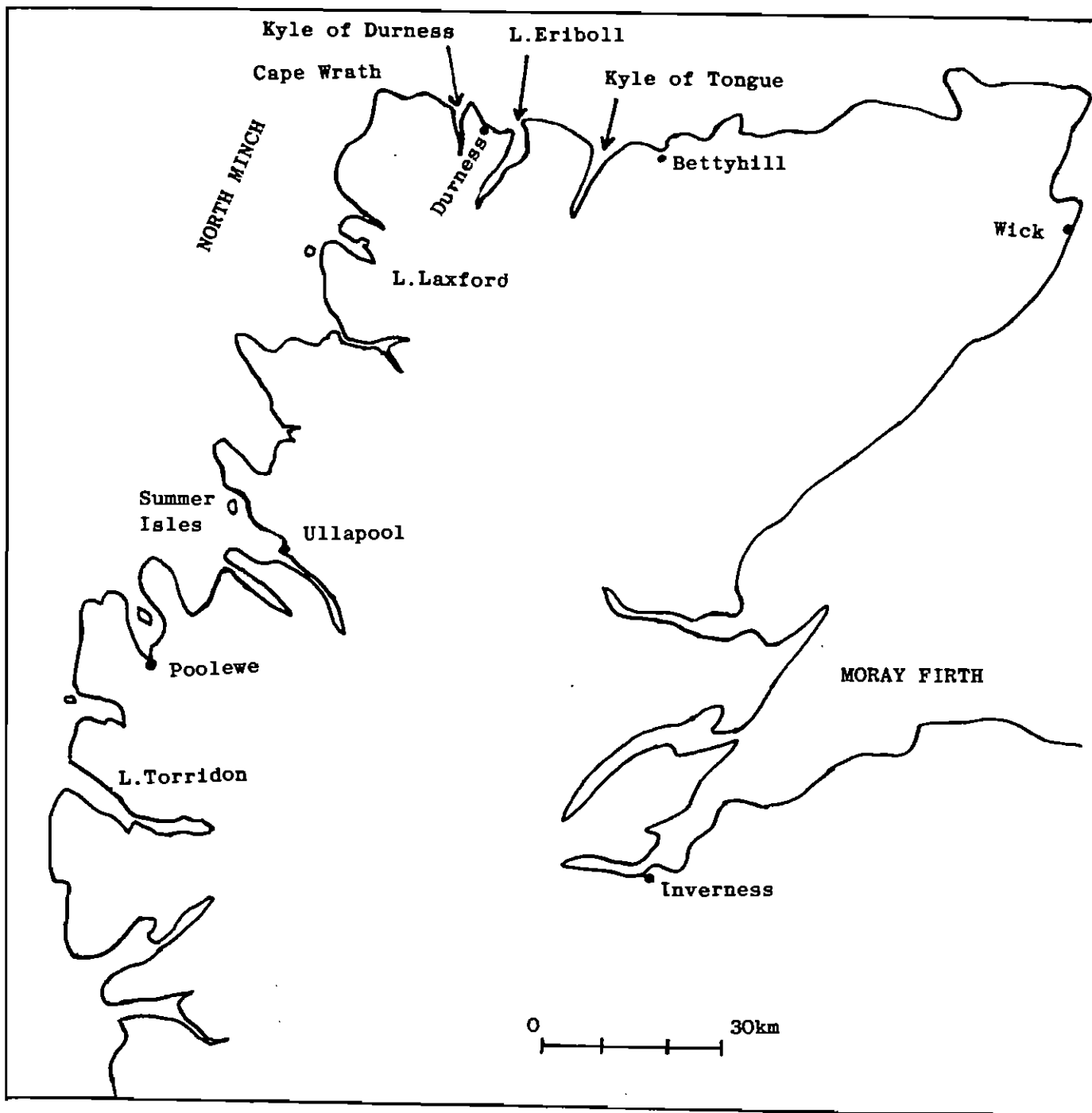


Figure 1. Northern Scotland.

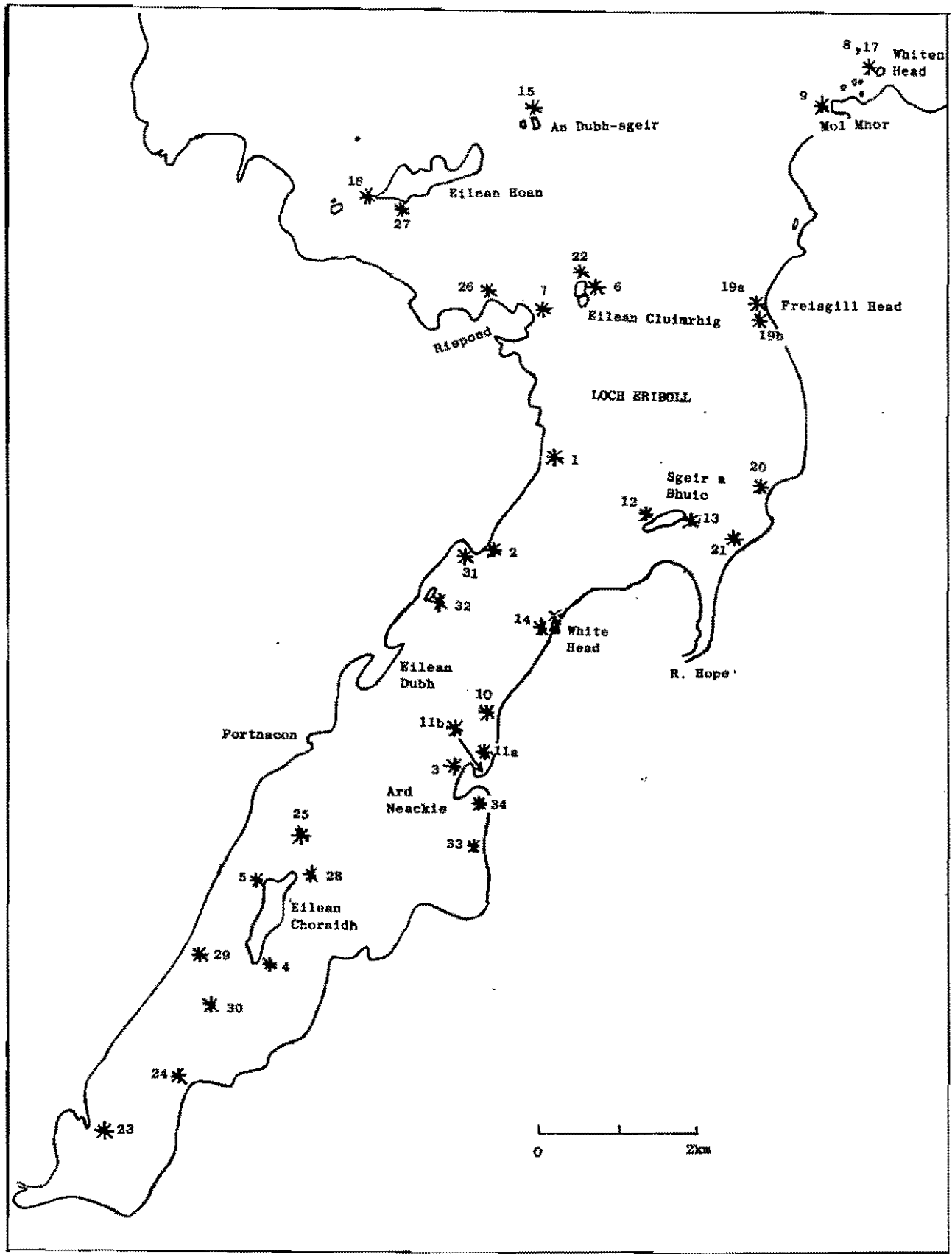


Figure 2. Loch Eriboll.

Figure 3. Depth of rock/sediment boundary against site number, sites ordered by distance from head of loch.

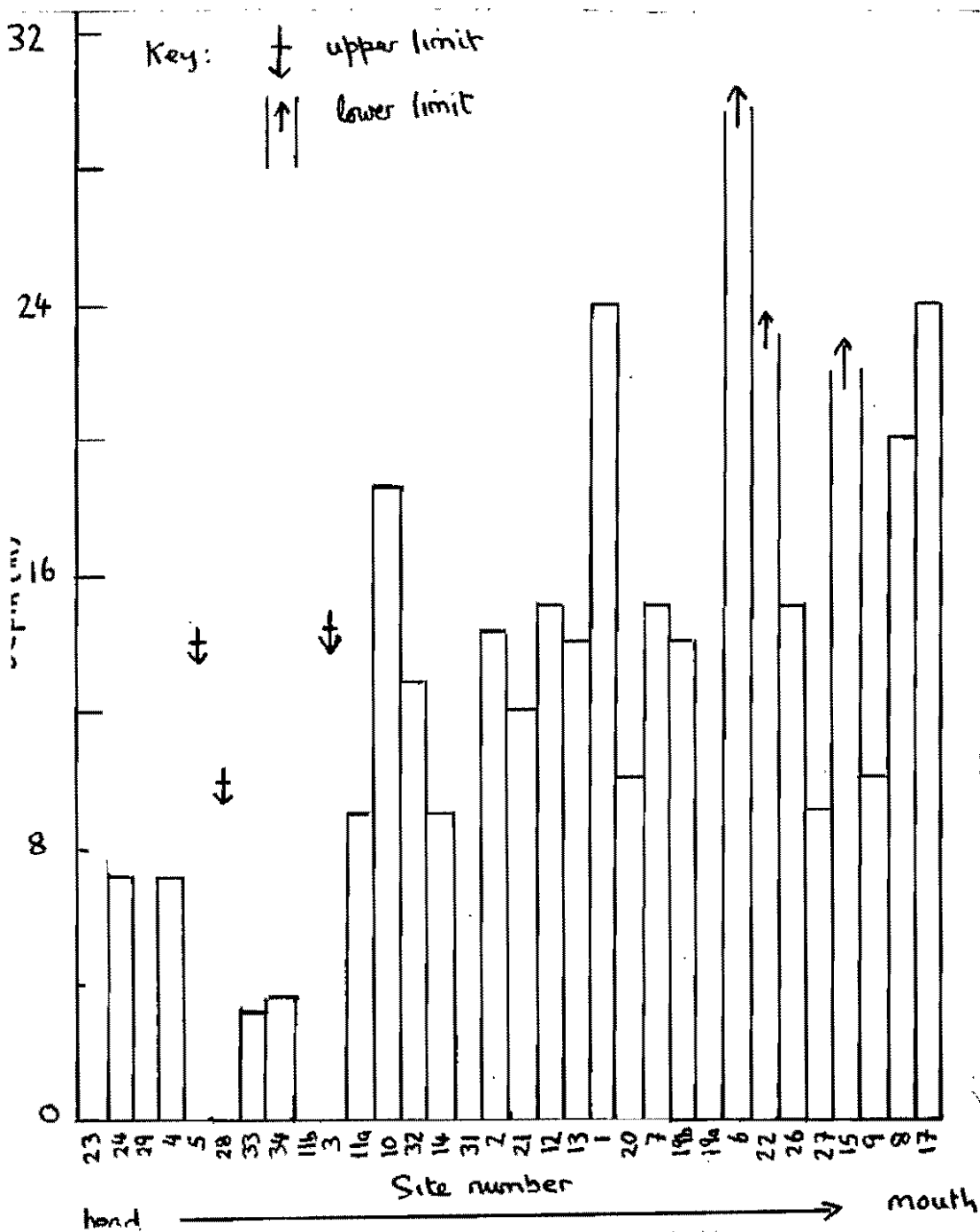
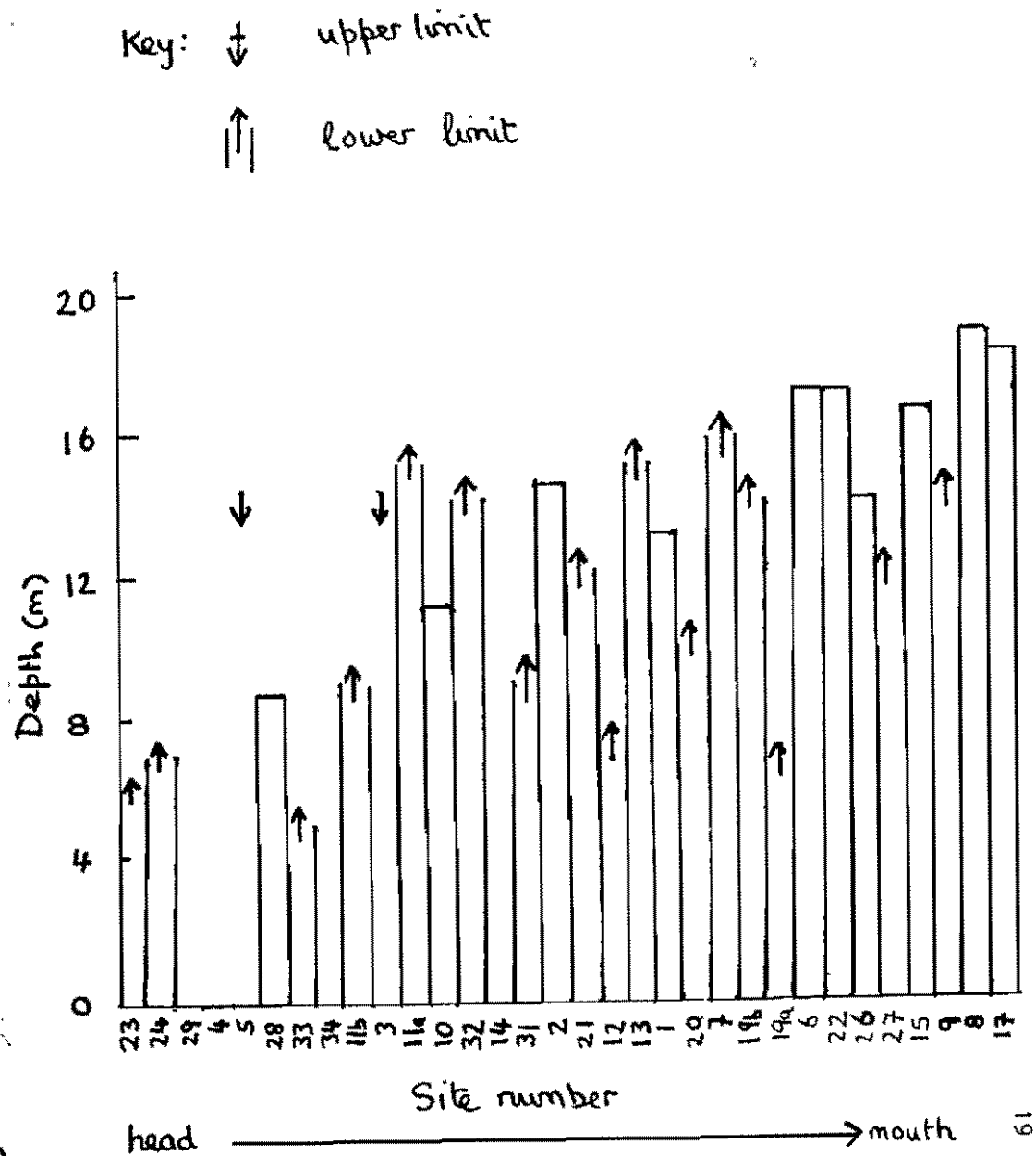


Figure 4. Depth of lowest kelp against site number, sites ordered by distance from head of loch.



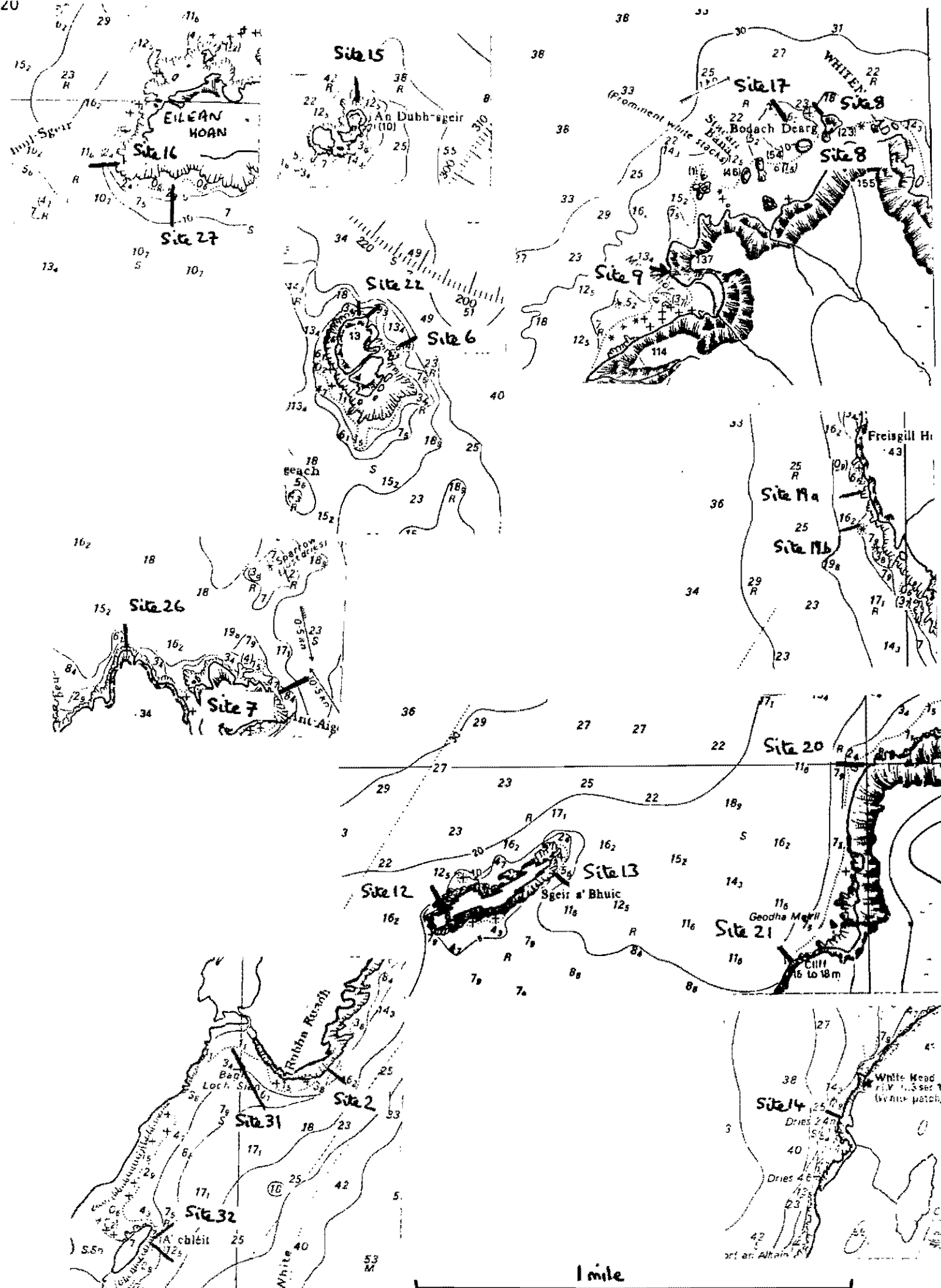


Figure 5. The approximate location of the area surveyed at each site. Sites 2, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 26, 27, 31, 32.

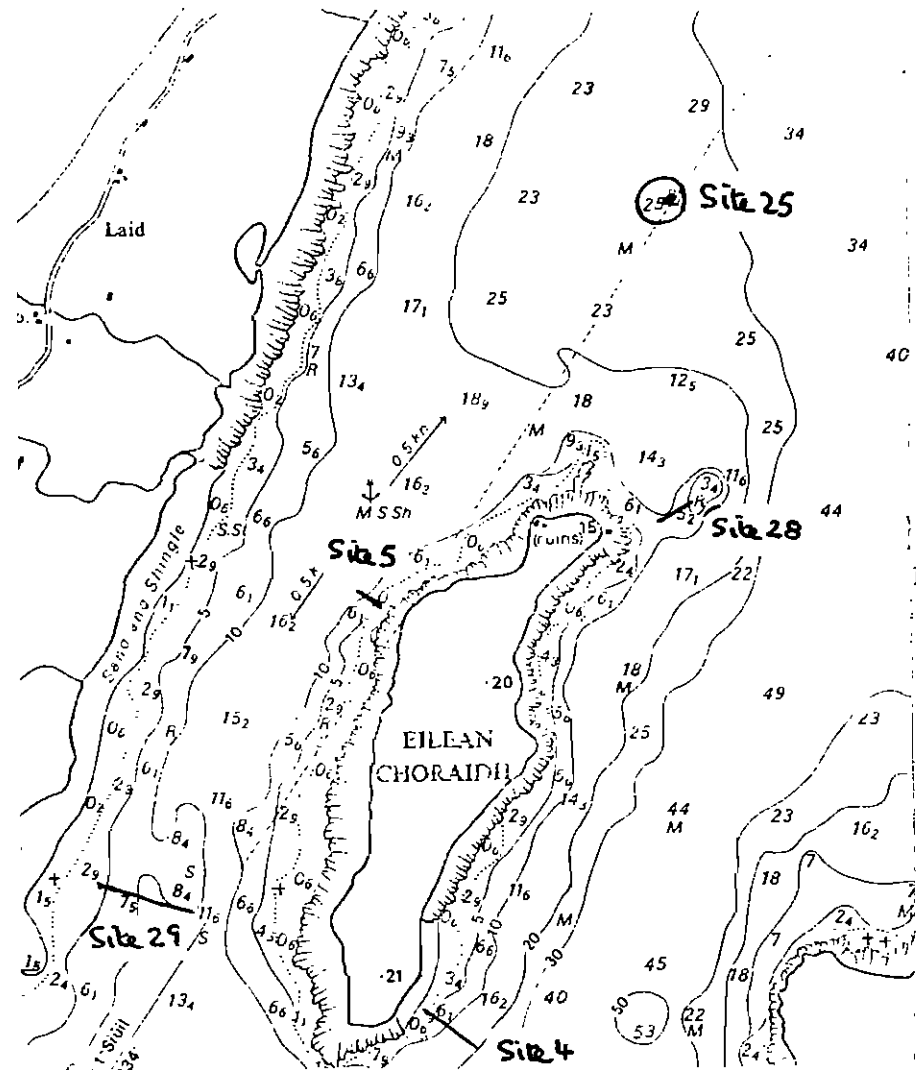
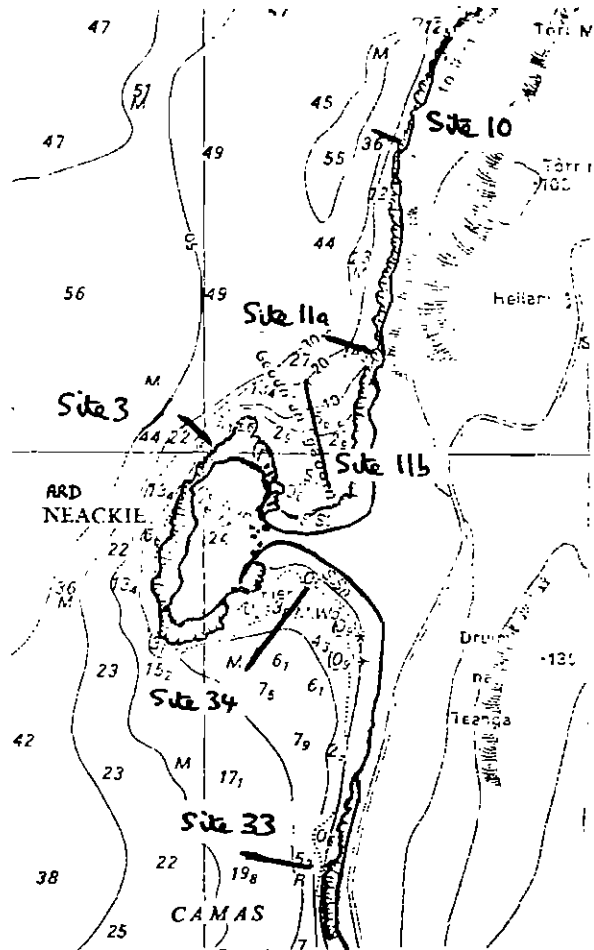
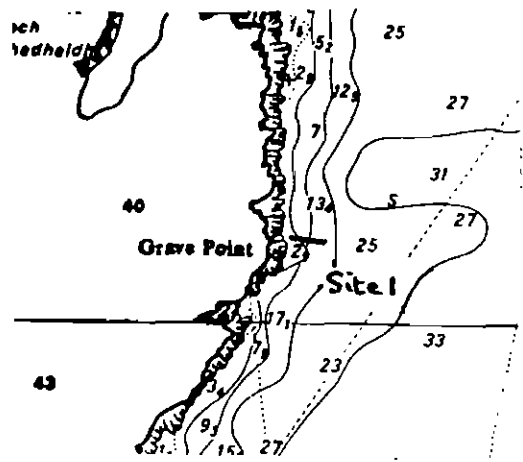
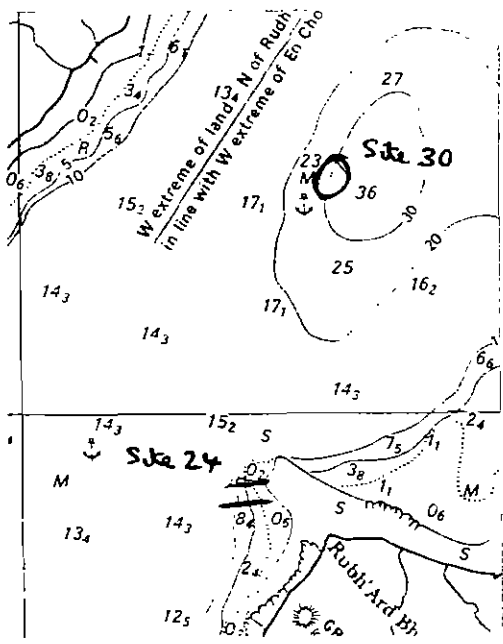
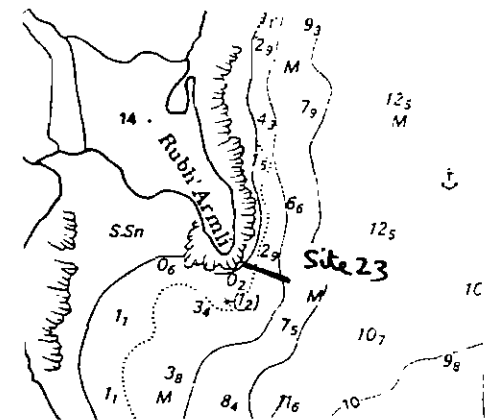


Figure 5(continued). Sites 1,3,4,5,10, 11,23,24,25,28,29,30,33,34.



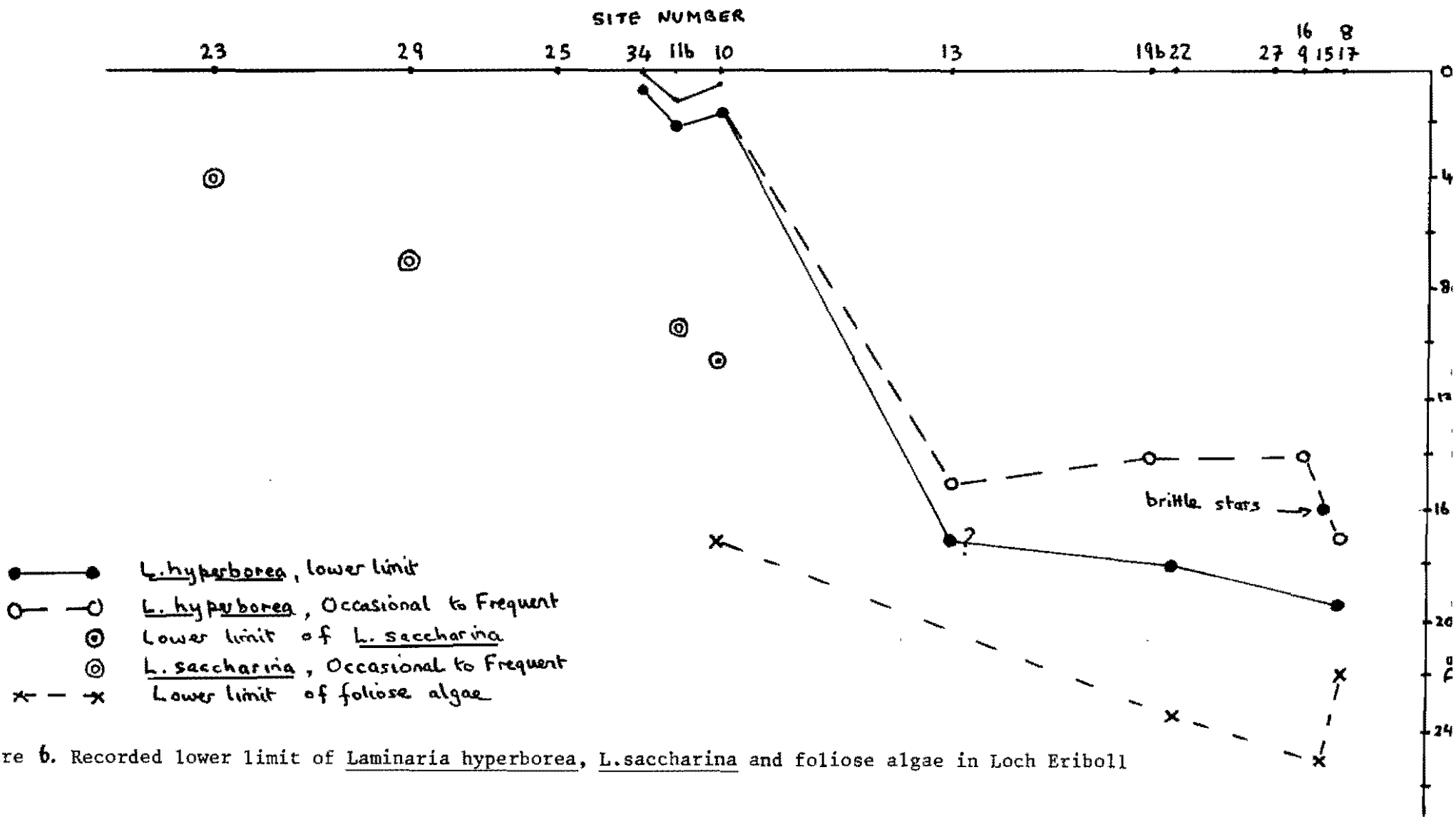


Figure 6. Recorded lower limit of *Laminaria hyperborea*, *L. saccharina* and foliose algae in Loch Eriboll

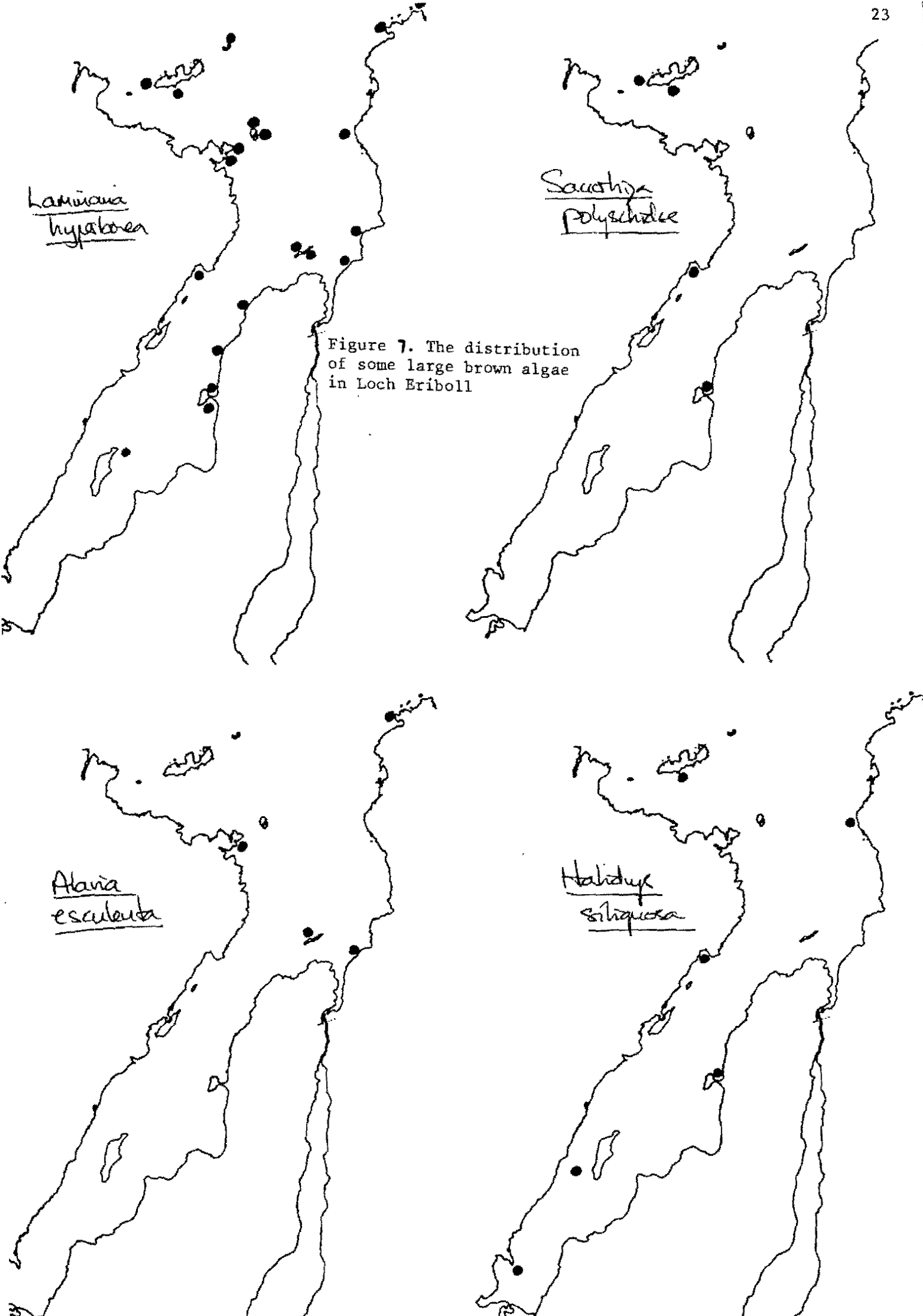
Laminaria
hypoleuca

Sargassum
polyschides

Figure 7. The distribution
of some large brown algae
in Loch Eriboll

Alaria
esculenta

Halidrys
siliquosa



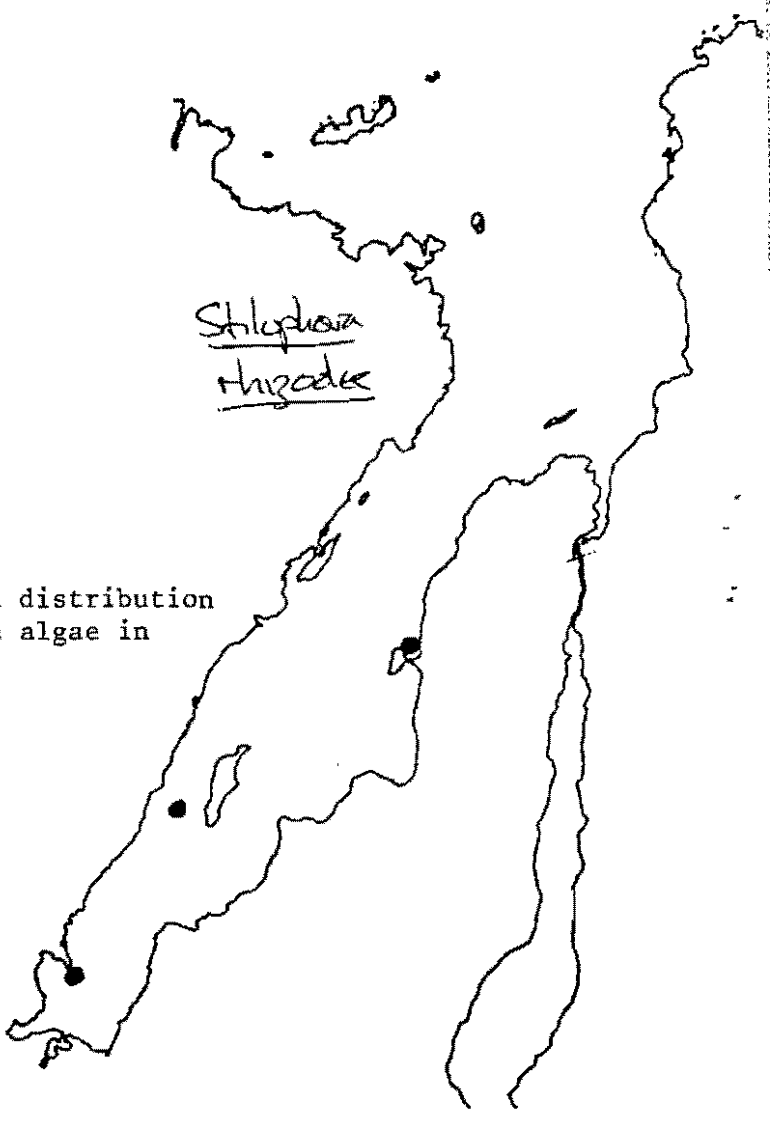
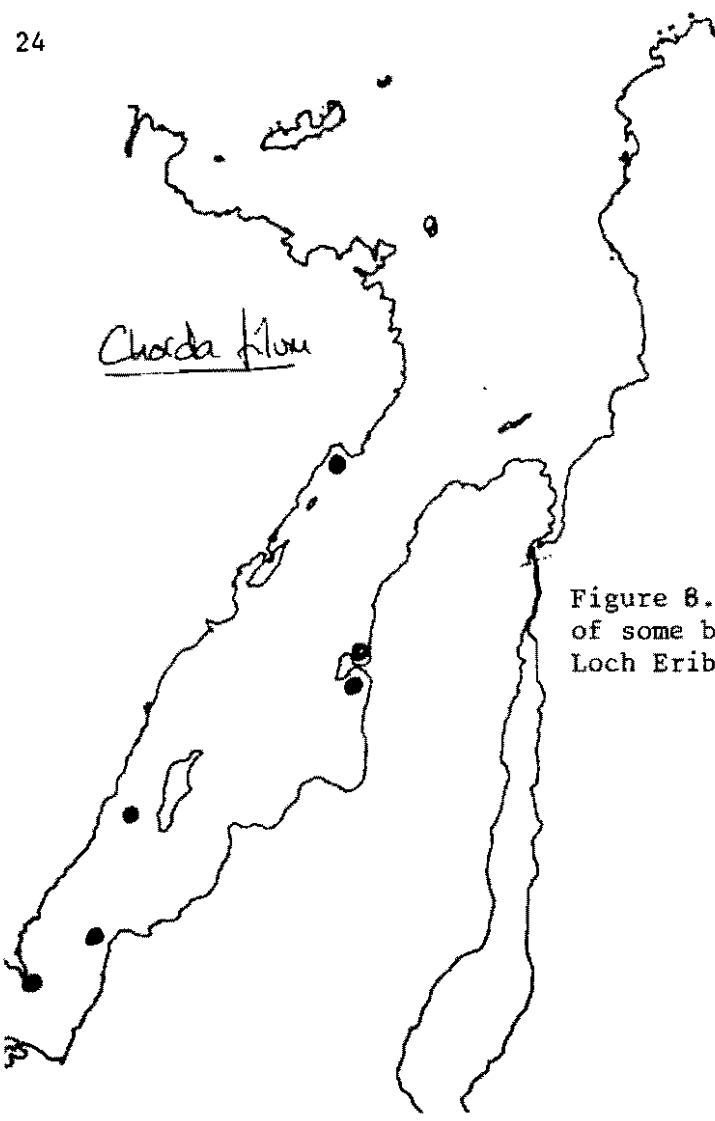


Figure 8. The distribution of some brown algae in Loch Eriboll

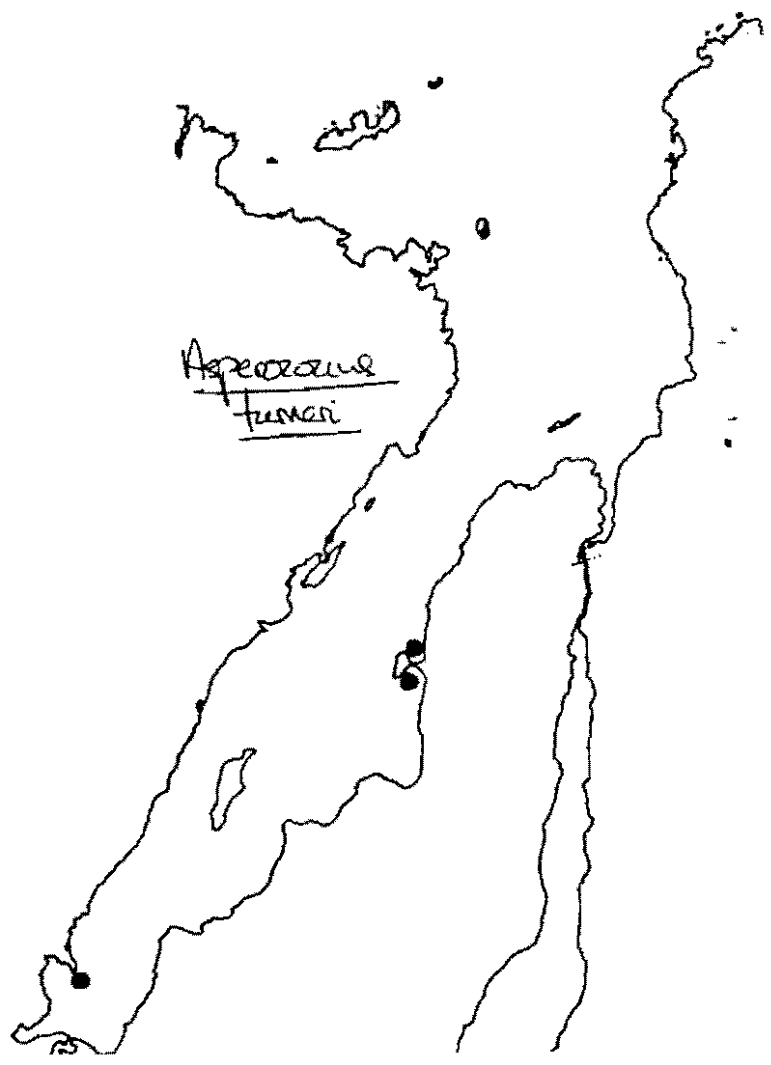
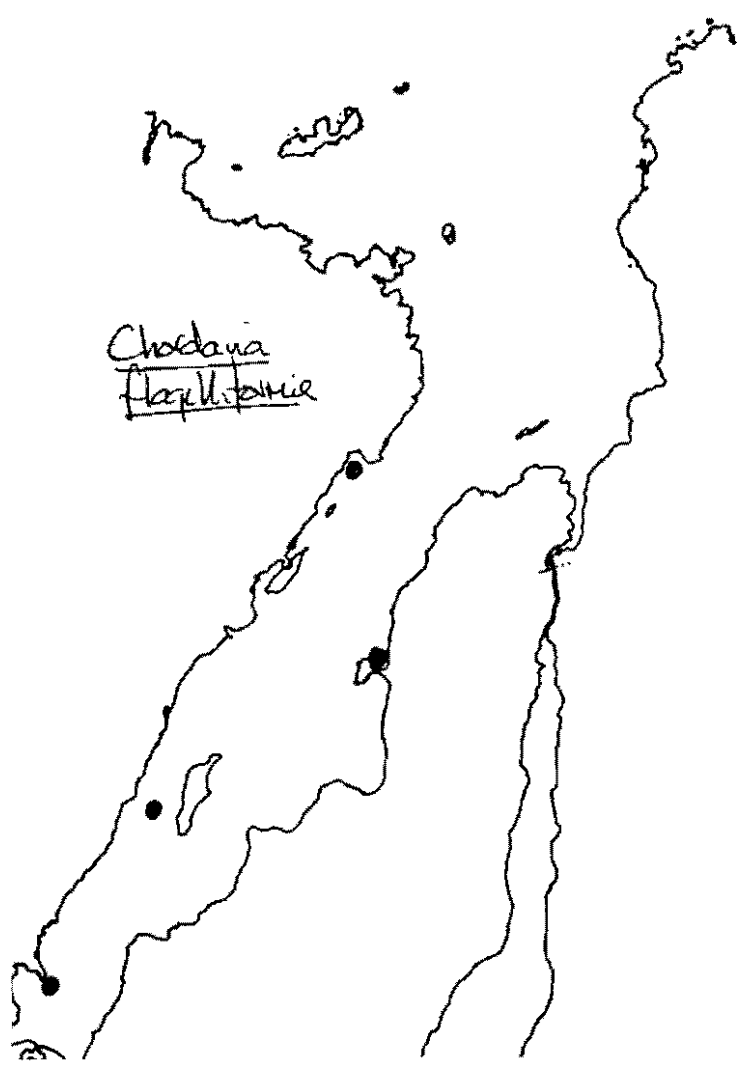


Table 1

Site no.	Date	Site name	Grid ref (NC)	Divers	Depth of rock/sediment interface(m)	Max depth of kelp† (m)	Max depth of dive (m)	Vis(m)	Echinus abundance (max)	Class
1	3/8/86	Grave Pt	458638	DM,NB; JW,RS*,GG	24	13	24.5	4	Frequent	C 1,5
2	3/8/86	Rubha Ruadh	452627	DM,NB; JW,RS*,GG	>13,<16	≥13,<16	24	4	Common/abundant	C 1,5
3	4/8/86	Ard Neackie N	445599	NB,JW; BG,GG,DM	<14	<14	19.5	4-5	Frequent/common	B 1,2,5
4	4/8/86	E Choraidh SE	421575	JW,NB	7		11.5	3		A 1,2,5
5	4/8/86	E Choraidh NW	420584	DM,GG	<14		16	5	Occasional	A 5
6	5/8/86	E Cluimhrig E	463659	DM,GG;NB,JW	>29.5	17	29.5	15	Frequent	D 1,2
7	5/8/86	Ant-Aigeach	458657	DM,JW	c15	>16	16.5	10-12	Frequent	C 1,2,4
8	6/8/86	Whiten Hd(1)	499688	JW,SH;GG,BG NB,DM	19-21	19	20.5	12-15	Rare/occasional	D 1,2,3,4
9	6/8/86	Mol Mhór	494682	JW,SH;BG,GG NB,DM	10	>14	10	12	Rare	D 1,2,4
10	7/8/86	Torr na Bithe	450605	DM,NB;JW,SH	18-19	11	20	6	Frequent	B 1,5
11a	7/8/86	Geodh an Sgadan a	449509	DM,NB	9	>15	16	6	Frequent	B 2,5
11b	7/8/86	Geodh an Sgadan b	448508	SH,JW		>9	9.5	5	Occasional	B 3,4
12	8/8/86	Sgeir a Bhuic NW	470631	DM,NB	15	>7	16	10	Frequent	C 1,2,3,5
13	8/8/86	Sgeir a Bhuic E	475631	SH,JW;BG,GG	14	≥15	15	8-10	Common	C 1,3
14	8/8/86 } 15/8/86 }	Lighthouse	456617	DM,NB;JW,SH BG,GG;RK,KY	9		23.5	9-10	Common	C 1,5
15	9/8/86	An Dubh-sgeir North	456682	DM,KY;RK,NB GG,BG;JW,SH	>22	16.5	22	20	Occasional/ frequent	D 1
16	9/8/86	E Hoan W	436671(5)	DM,NB;JW,SH	11	>12	16	16	Frequent/common	D 1,2,3
17	10/8/86	Whiten Hd(2)	498688	DM,SH	24	17-18	28.5	15	Occasional	D 1,3

*Robert Smith dived for one day only.

†Only given if kelp not limited by available substrate.

Table 1 continued

Site no.	Date	Site name	Grid ref (NC)	Divers	Depth of interface (m)	Max depth of kelp † (m)	Max depth of dive (m)	Vis(m)	Echinus abundance (max recorded)	Class
18	10/8/86	Mol Mhór(2)	494682	RK,KY		see site 9				
19a	11/8/86	Freisgill Hd W	484658	DM,NB;GG,BG	>6.5	>6.5	6.5	10	Frequent	C 1,4
19b	11/8/86	Freisgill Hd S	485656	SH,JW	14	>14	14	10-15	Occasional	C 1,2,3
20	11/8/86	Cnoc nan Gobhar	485635	DM,NB	10	>10	10.5	10-15	Occasional	C 1,4
21	11/8/86	Geodha Meiril	483628	SH,GG,BG	12	>12	13	6	Frequent	C 1,2,4
22	12/8/86	E Cluimhrig N	462661	GG,BG;SH,JW DM,KY;NB,RK	>23	17	23	20	Common	D 1,2
23	12/8/86	Rubh Armlí	400554	SH,JW			10	2		A 1,5
24	12/8/86	Rubh 'Ard Bhaideanach	411561 (5)	DM,NB	7		12	3-4	Rare	A 3,6
25	12/8/86 15/8/86	Buoy Chain	415590 (5)	DM DM,NB;JW,SH	N/A	>10	28	5	Absent	Chain ,6
26	13/8/86	Rispond N	451659	DM,KY;NB,RK	15	14	15.5	15	Frequent/common	C 1,4
27	13/8/86	E Hoan S	440670	SH,JW;BG,GG	9	>12	12	12	Frequent	C 1,2,4
28	13/8/86	E Choraídh NE	427586	DM,NB	<10	8.5	11.5	3-4	Frequent	B 1,5
29	13/8/86	W Channel, E Choraídh	412576	SH,JW	4		11	5-10	Occasional	A 3,5
30	14/8/86	Anchorage, S Basin	414570	DM,NB			30	5	Absent	A 6
31	14/8/86	Bagh Loch Sian	448627	SH,JW	6	>9	10	10	Frequent	B 2,5
32	14/8/86	E Dubh	444620	GG,BG;RK,KY	13	>14	15	15	Frequent	B 1,5
33	14/8/86	Camas an Duin	448589	DM,NB	3		14.5	6-7	Occasional	A 2,5,6
34	14/8/86	Ard Neackie S	448596	SH,JW	3.5		9	10	Frequent	A 2,5

†Only given if kelp not limited by available substrate.

and upper circalittoral

Table 3. Algae recorded from the lower infralittoral on bedrock and large boulders. Sites are arranged in order of increasing shelter inside the loch. Abundance notations refer to the abundance scales in Appendix 11.

SPECIES	SITE						
	16.5-21m. 8	25m. 15	13-14m. 9	23.5m. 22	14-15m. 13	10.5-12m. 10	4-5m. 23
Delesseria sanguinea					+		
Plocamium cartilagineum							
Laminaria saccharina (young)						0	
Callophyllis laciniata							
Odonthalia dentata							
Hypoglossum woodwardii							
Kallymenia reniformis					+		
Acrosorium uncinatum							
Rhodophyllis divaricata	+						
'Aglaozonia'							
encrusting coralline algae							
Dictyota dichotoma							+
Phycodrys rubens							+
Halarachnion ligulatum							
Cryptopleura ramosa							
Compsothamnion thuyoides							
Pterosiphonia parasitica							
Bonnemaisonia asparagoides							
Nitophyllum punctatum							
Rhodophyllis sp. ('big')		R					
'Trailliella'							+
Halopteris filicina							
Antithamnion plumula							
Brongniartella byssoides							
Desmarestia viridis							
filamentous brown algae							
Asperococcus turneri							
encrusting brown algae							
encrusting red algae							D+

Table 4. Algae recorded from sublittoral vertical rock in Loch Eriboll. Sites are arranged in order of increasing shelter inside the loch. Abundance notations refer to the abundance scales in Appendix II

SPECIES	SITE				
	8-12m.	Gully 9-13m.	Cave entrance	4.5-9m.	2-9m.
	9	22	21	14	10
encrusting coralline algae	A	C	A		+
'Aglaozonia'				+	
encrusting brown algae	C	C	+		
Phyllophora traillii					++
Pterosiphonia parasitica	++			0	++
Acrosorium reptans	+				
unidentified red algal sporelings		++			
filamentous red algae		+			
Hypoglossum woodwardii			++		
Lomentaria orcadensis			++		
Cryptopleura ramosa			+		
Laminaria hyperborea				++	
Desmarestia aculeata				++	+
Laminaria sp. (young plants)				++	
Bonnemaisonia asparagoides				++	
'Trailliella'				++	
Desmarestia viridis				++	+
Callophyllis laciniata				++	
Compsothamnion thuyoides				++	
Bryopsis plumosa				++	+
Phycodrys rubens				++	
Antithamnion plumula				++	+
Heterosiphonia plumosa				++	
Plocamium cartilagineum				++	
Dictyota dichotoma				++	
Rhodophyllis divaricata				++	+

Table 6. Epiphytic algae recorded from *Laminaria hyperborea* stipes in Loch Eriboll. Sites are arranged in order of increasing shelter inside the loch. Abundance notations refer to the scales in Appendix II. Also shown are the depth ranges recorded for each species.

SPECIES	SITE												
	8	15	9	22	19b	27	21	13	14	10	11b	31	
<i>Polysiphonia urceolata</i> 0.5 - 1.5m					C			A					
<i>Palmaria palmata</i> 1 - 2.5m					C			+		A			
<i>Membranoptera alata</i> 1 - 3.5m					F	+		+			A		
<i>Cryptopleura ramosa</i> 1 - 8m						+	+	+				+	
<i>Plocamium cartilagineum</i> 1 - 9m					C	+		+					
<i>Ptilota plumosa</i> 0.5 - 17m	A	A	+	A				A		A	A	+	
<i>Phycodrys rubens</i> 0.5 - 17m	+							F	O				
<i>Callophyllis laciniata</i> 17m	+												
<i>Brongniartella byssoides</i> 9.5m					+								
<i>Acrosorium reptans</i> 8m								+					

	8	15	9	22	6	16	19b	7	20	21	27	12	26	13	14	10	11b	31	28	27	24	23	
Rhodophyllis divaricata	+																						
Rhodophyllis sp. ('big')		+	+		+																		
Schmitzia hiscockiana							+																
Scinaia turgida							+																
encrusting coralline algae			+	+		+	+	+		+	+				+	+	+	+	+	+	+	+	+
encrusting dark red algae			+												+	+	+	+	+	+	+	+	+
+ Sik 3 - maerl																							
CHRYSOPHYTA																							
Diatoms indet. (colonial)																							
Diatoms indet. (on sediment)											+					+	+		+		+		+
CYANOPHYTA																							
Blue-green algae indet.	+															+							

APPENDIX 1. RECORDING FORMS

Faunal checklist

Algal checklist

Underwater habitat checklist

Site name..... Depth below CD.....
 Date..... Recorder's name

Species	1	2	3	*
Alcyonella infundibuliformis				
Alcyonella sp				
Ampilectus fucorum				
Aliclona celata				
Asydesia fragilis				
Alichondria panicea				
Amimycale columella				
Aymeniacidon perleve				
Aliclona oculata				
talked tubular Haliclona				
Aliclona sp				
Alathrina complicata <i>coriacea</i>				
Eucosolenia botryoides				
Eucosolenia variabilis				
Yxilla incrustans				
Yxilla fimbriata				
Yxilla rosacea				
Ycale sp				
Achymastisma johnstonia				
Olymastia mamillaris				
Olymastia boletiformis				
Cypha ciliatum				
Pantia compressa				
Auberites carnosus				
Auberites domuncula				
Telligera stuposa				
Telligera rigida				
Aspailia hispida				
Aspailia ramosa				
Euconia nivea				
Thin reddish crust				
HYDROZOA				
Algaephyenia sp				
Bietinaria abietina				
Alfiliculina				
Aphisbetia operculata				
Alecium halecinum				
Abeanii				
Ardallimania falcata				
Ardachtinia echinata				
Archenpaueria pinnata				
Amertesia antennina				
Amertesia ramosa				
Aelia geniculata				
Ammularia setacea				
Artularia argentea				
Artularella polyzonias				
Ammularia indivisa				
Alarynx				
Alvanea capillata				
Alurobranchia pileus				

ANTHOZOA

	1	2	3	*
Alcyonium digitatum				
Anemonia sulcata				
Actinethoe sphyrodeta				
<u>Aurelia aurita</u>				
Cereus pedunculatus				
Cerianthus lloydi				
Caryophyllia smithii				
Corynactis viridis				
Hormathia coronata				
Metridium senile				
Peachia hastata				
Pennatula phosphorea				
Protanthea simplex				
Sagartia elegans var. venusta				
S. elegans v. miniata				
S. elegans v. nivea				
S. elegans v. rosea				
Sagartia troglodytes				
Sagartiogeton lacerata				
Swifteea pallida				
Urticina (Tealia) felina				
T. eques				
Virgularia mirabilis				

ANNELIDA

Arenicola marina				
Bispira volutacornis				
Chaetopterus variopedatus				
Eulalia viridis				
Filograna implexa				
Hydroides norvegicus				
Lanice conchilega				
Myxicola infundibulum				
Pomatoceros triqueter				
Sabella pavonina				
Sabella sp				
Spirorbis sp				
Serpula vermicularis				
Terebellidae				

CRUSTACEA - CIRRIPEDA

Balanus balanus				
B. crenatus				
Elminius modestus				
Verruca stroemia				

CRUSTACEA - DECAPODA

Cancer pagurus				
Carcinus maenas				
Caprellidae				
Galathea strigosa				
Galathea sp				
Goneplax rhomboides				
Homarus vulgaris				

Tick if specimen collected and preserved

DECAPODA (ctd)

	1	2	3	*
lyas araneus				
l.coarctatus				
nachus dorsettensis				
nachus phalangium(dorynchus)				
assidae (tubes)				
locarcinus depurator				
locarcinus puber				
locarcinus sp				
lacropodia sp				
lunida bamffica				
lysidae				
alinurus elephas				
lephrops norvegicus				

MOLLUSCA

omaea sp				
nomiidae				
rtica islandica				
uccinum undatum				
hlamys operculatum				
hlamys sp				
alliostoma ziziphinum				
bibbula cineraria				
umbilicalis				
magus				
atella arctica				
acuna vineta				
tytilus edulis				
odiolus modiolus				
ya arenaria				
l.truncata				
usculus marmoratus				
assarius sp				
leptunea antiqua				
atella sp				
atina pellucida				
ecten maximus				
rivia arctica				
monacha				
urritella communis				

BRYOZOA

Alcyonidium gelatinosum				
Alcyonidium sp				
Bugula sp				
Bellaria sp				
'Crisiidae'				
Electra pilosa				
Flustra foliacea				
Parasmittina trispinosa				
Porcella compressa				
Membranipora membranacea				
Scrupocellaria reptans				
S.scruposa				
Securiflustra securifrons				
Encrusting bryozoa				

ADDITIONAL SPECIES AND NOTES

ECHINODERMATA

	1	2	3	*
Asterina gibbosa				
Asterias rubens				
Antedon bifida				
Astropecten irregularis				
Crossaster papposus				
Cucumaria saxicola				
Cucumaria sp				
Echinus esculentus				
Echinocardium cordatum				
Henricea oculata				
Henricea sanguinolenta				
Henricea sp				
Holothuria forskali				
Luidia ciliaris				
Luidia sarsi				
Marthasterias glacialis				
Neopentadactyla mixta				
Ophiothrix fragilis				
Ophiocomina nigra				
Ophiura albida				
Ophiopholis sp				
Porania pulvillus				
Parastichopus tremulus				
Solaster endeca				
Psammechinus miliaris				
Ophiura texturata				

ASCIDIACEA

Ascidella aspersa				
A.scabra				
Ascidia mentula				
A.virginea				
Botryllus schlosseri				
Botrylloides leachii				
Ciona intestinalis				
Clavelina lepadiformis				
Dendrodoa grossularia				
Diazona violacea				
Diplosoma spongiforme				
Diplosoma listerianum				
Didemnidae				
Molgula manhattensis				
Polyclinum aurantium				
'Polyclinidae'				
Polycarpa pomaria				
'hard leathery'				

PISCES

* Tick if specimen collected and preserved

SITE NAME:DEPTHm. below CD

Date:Recorders Name.....

CHLOROPHYTA

	1	2	3	4	5	6
Bryopsis plumosa						
Cladophora sp.						
Codium sp.						
Enteromorpha sp.						
Ulva sp.						

PHAEOPHYTA

Alaria esculenta						
Asperococcus turneri						
Chorda filum						
Colpomenia sinuosa						
Cutleria multifida						
Desmarestia aculeata						
D.ligulata						
D.viridis						
Dictyopteris membranacea						
Dictyota dichotoma						
Furcellaria lumbricalis						
Halidrys siliquosa						
Himantalia elongata						
Laminaria digitata						
L.nyperborea						
L.saccharina						
Pseudolithoderma extensum						
Sacchoriza polyschides						
Spermatochnus paradoxus						
Sporochnus pedunculatus						

RHODOPHYTA

Acrosorium reptans						
Acrosorium uncinatum						
Ahnfeltia plicata						
Antithamnion plumula						
Apoglossum ruscifolium						
Asparagopsis armata						
Audouinella floridula						
Bonnemaisonia asparagoides						
Bonnemaisonia hamifera						
B.hamifera (Trailliella)						
Brongniartella byssoides						
Calliblepharis ciliata						
Callithamnion sp.						
Callophyllis laciniata						
Ceramium rubrum						
Chondrus crispus						
Chylocladia verticillata						
Corallina officinalis						
Cordylecladia erecta						
Cruoria sp.						
Cryptopleura ramosa						
Cystoclonium purpureum						
Delesseria sanguinea						
Dilsea carnososa						
Furcellaria lumbricalis						
Gigartina stellata						
Gracilaria verrucosa						
Griffithsia corallinoides						
G. flosculosa						
Halarachnion ligulatum						
Heterosiphonia plumosa						

Heterosiphonia plumosa

Hypoglossum woodwardii

Kallymenia reniformis

Lomentaria articulata

L. clavellosa

L. orcadensis

Membranoptera alata

Meredithia microphylla

Myriogramme bonnemaisonii

Nitophylum punctatum

Odonthalia dentata

Palmaria palmata

Phycodrys rubens

Phyllophora crispa

P. pseudoceranoides

Phyllophora sp.

Plocanium cartilagineum

Plumaria elegans

Polyides rotundus

Polyneura gmelinii

Polysiphonia sp.

Porphyra sp.

Pterosiphonia parasitica

Ptilota plumosa

Rhodomela confervoides

Rhodophyllis divaricata

Rhodophyllis sp.

Rhodymenia pseudopalmata

Schottera nicaeensis

Scinaia turgida

'Lithothamnia'

'Maerl'

► SITE LOCATION

Surface map of site, for EXACT relocation: the dive route transit marks etc/or a copied map can be stuck here.

MCS NUMBER _____

► SITE NAME _____

► SITE NUMBER _____

► AREA/ NEAREST TOWN _____

► COUNTRY _____

O.S. GRID REF.

--	--	--	--	--	--	--	--	--	--

E-W N-S

or LAT. LONG.

--	--	--	--	--	--	--	--	--	--

► DATE (or observations)

--	--	--	--	--	--	--	--	--	--

► NAME _____
Of recorder

► ADDRESS & PHONE _____

► DIVE TIME IN _____ BST/GMT ◀

► DIVE TIME OUT _____

► DURATION _____

► DEPTH RANGE Actual _____

► DEPTH RANGE Corrected to Chart Datum _____

DIVE TYPE

► SHORE DIVE BOAT DIVE

► SPOT DIVE DRIFT DIVE

TRANSECT DIVE

► What distance did you cover?
_____ (Metres)

Instructions Fill in, tick or delete each section denoted by a black triangle ► Please write, or print clearly.

COASTAL TYPE

► OPEN COAST

LARGE ESTUARY

SHELTERED SEA

► Describe the coastal type
(e.g. Ria, Sea loch, lagoon, headland)
(bay, island, pass, harbour, pier)

TIDAL STREAM

► FROM CHART

VERY STRONG (6 knots →)

STRONG (3-6 kts)

MODERATE (1-3 kts)

WEAK (less than 1 kt)

V.WEAK (enclosed bays)

► From Underwater observations

STRONG DETECTABLE

NONE DETECTED

ROCK TYPE

Describe: _____

From: Igneous/Metamorphic/Limestone/Sandstone/Mudstone/Slate/Shale/Other/ ?

WAVE ACTION

V.EXPOSED (Prevail.W & S)

EXPOSED (Prevail.Westerly)

SEMI-EXPOSED (Strong W.frq)

SHELTERED (Strong wst.rare)

V.SHELTERED (Fetch < 20km)

EX.SHELTERED (Fetch < 3km)

WATER COLUMN

► SALINITY: FULL SEAWATER

VARIABLE LOW

► Freshwater at surface Yes/No
(Delete as appropriate)

► Thermocline present Yes/No
Depth _____ (Metres)

► Visibility (horizontal) on seabed _____ (Metres)

► Protection

Does the site have any protected status at present? Yes - No

Describe: _____

► Human impact

(e.g. Pollution, outfalls, scallop dredging, urchin collecting,...)

Is there any? Yes - No

Describe: _____

► Other records

Species: Yes - No ref: _____

Photo: Yes - No ref: _____

Other: describe _____

► REFS

References to site, interesting features etc.

► REPORT Describe the site in your own words Sea bed type, cover and species: were there any particularly interesting aspects of the coastal features, habitats or species? What were the outstanding features of this site? Was the site like any others of this survey?

Is the checklist complete?

INSTRUCTIONS: The checklist and dive profile should be used together. For separate stations (depth zones) where observations were made use a new column. **SCORE** your observations 1 = rare, less than 10%, 2 = secondary 10-30%, 3 = predominant 30+.

Survey station/habitat		Survey station/habitat	
DEPTH BELOW CHART DATUM		DEPTH BELOW CHART DATUM	
SEABED BEDROCK..... LARGE BOULDER 50cm+..... SMALL BOULDERS 25-50cm..... COBBLES 5-25cm..... PEBBLES 0.5-5cm..... GRAVEL..... COARSE SAND..... FINE SAND..... MUD..... ARTIFICIAL (e.g. wood, metal) Describe..... OTHER Describe..... BIOLOGICAL (e.g. kelp, maerl) Describe.....		TOPOGRAPHY SEDIMENT FEATURES UNIFORM SEDIMENT PLAIN..... SMOOTH FEATURELESS SURFACE..... RIPPLED SURFACE..... SEDIMENT WAVES height..... WORKED SURFACE..... TUBES..size..... BURROWS size..... MOUNDS..size..... IS THE SEDIMENT ? CLEAN..... MUDDY..... MIXED UP..... UNIFORM..... containing shell.....	
TOPOGRAPHY INCLINATION OVERHANG..... VERTICAL..... V. STEEP 40-80°..... STEEP 40-20..... SHALLOW less than 20..... HORIZONTAL PLAIN.....		HUMAN DEBRI Describe..... COVER inanimate. OF ROCK SILT/SAND which, how much? Describe..... OF SEDIMENT Describe.....	
ROCK FEATURES OUTCROP..... UNBROKEN ROCK..... BROKEN ROCK..... TERRACES width > 2m..... LEDGES width < 2m..... ROCK WALL (dimensions) Cliff..... Describe..... GULLY (dimensions) (Surge?) Describe..... FISSURES..... CREVICES (hand sized)..... CAVE (dimensions) Describe..... Boulders SLOPE stable..... SCREE..... MOBILE COBBLES..... SCOURED WALL (height)..... OTHER Describe.....		COVER PLANT & ANIMAL PLANTS - DOMINANT COVER (Score) KELPS..... MEADOW Describe..... MAT..... CRUST..... OTHER Describe..... ANIMAL - DOMINANT COVER (Score) LARGE COLONIES (e.g. Alcyonium) Describe..... TURFS (e.g. hydroid, bryozoan) Describe..... OTHER Describe..... GRAZERS: Echinus Number/view OTHERS:	

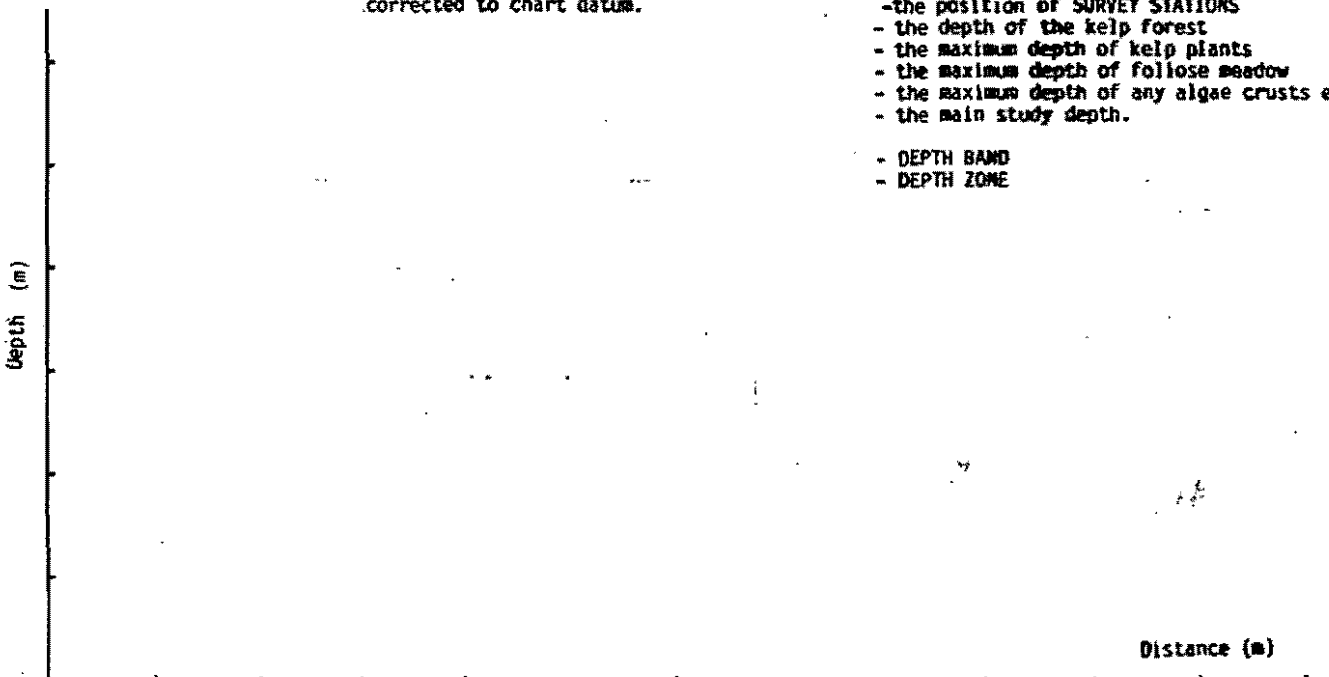
Site Profile

Give distances in metres and depths corrected to chart datum.

Where relevant mark on the profile

- the position of SURVEY STATIONS
- the depth of the kelp forest
- the maximum depth of kelp plants
- the maximum depth of foliose meadow
- the maximum depth of any algae crusts etc
- the main study depth.

- DEPTH BAND
- DEPTH ZONE



Distance (m)

APPENDIX 2

Scale for the interpretation of abundance notations.
(Reproduced from Hiscock 1983).

ANIMALS

1. Large solitary species and colonies. * For instance, ~~solitary sponges~~, Alcyonium digitatum, hydroid clumps, large anemones, Pentapora foliacea, Cellepore pumicosa, echinoderms, large solitary tunicates.

ABUNDANT One or more per 0.1 m².
COMMON One or more per 1 m².
FREQUENT Less than 1 per m² but more than about 20 individuals observed.
OCCASIONAL About 3-20 observed.
RARE One or two observed.

2. Small solitary species. For instance, Grantia compressa, small anemones, Caryophyllia smithi, Antedon bifida, small solitary tunicates.

ABUNDANT One or more per 0.01 m².
COMMON One or more per 0.1 m².
FREQUENT One or more per m², scattered patches.
OCCASIONAL Less than one per m², scattered small patches.
RARE Widely scattered individuals, one or two small patches.

3. Small colonial species and crustose species. For instance, encrusting sponges, Corynactis viridis, small hydroids, Polydora ciliata, beds of Mytilus edulis, barnacles, bryozoa, encrusting tunicates.

ABUNDANT Large confluent colonies with more than 50% cover. More than 100 per 0.01 m².
COMMON Many small or a few large patches with 10% to 50% cover. One or more per 0.01 m².
FREQUENT Scattered patches less than 10% cover overall. One or more per 0.1 m².
OCCASIONAL Scattered small patches less than 1% cover overall. One or more per m².
RARE Widely scattered very small patches or individuals. Less than one per m².

ALGAE

Kelps.

ABUNDANT Plants mostly less than 50 cm apart. Difficult to swim between.
COMMON Plants 50 cm to 1 m apart.
FREQUENT Plants 1 to 2 m apart. Easy to swim between.
OCCASIONAL Plants more than 2 m apart, zone still apparent.
RARE Few plants present.

Foliose or filamentous undergrowth species.

ABUNDANT More than 20% cover over most of area.
COMMON Less than 20% cover but many plants present throughout zone.
FREQUENT Less than 20% cover and distribution patchy or scattered plants present throughout zone.
OCCASIONAL Scattered plants present.
RARE Few plants seen in dive.

Kelp stipe flora.

ABUNDANT Plants dense on most stipes.
COMMON Plants present on most stipes but not dense.
FREQUENT Distribution patchy, plants may be dense on some stipes, absent on others.
OCCASIONAL Few plants on many stipes.
RARE Only few plants seen during dive.

Crustose species.

ABUNDANT More than 50% cover.
COMMON More than 20% cover.
FREQUENT More than 5% cover.
OCCASIONAL Less than 5% cover. Few scattered large patches or many small patches.
RARE Few patches seen.

* For massive sponges the following scheme has been proposed, and should be used here.

Rare	1-4	specimens	per	site	in	30	minutes.
Occasional	5-24	"	"	"	"	"	"
Frequent	25-49	"	"	"	"	"	"
Common	50-99	"	"	"	"	"	"
Abundant	More than 100	"	"	"	"	"	"

APPENDIX 3: SITE DESCRIPTIONS

Site 1

Bedrock, gradually descending in steps, with occasional boulders and gullies, to a plain of rippled, slightly muddy, sand at about 24 m. A thin scattering of sand was present on the rock (below c. 14 m at least), amounting to nearly 100% cover on approximately horizontal surfaces. L. hyperborea present to 12 or 13 m, with scattered Echinus. Ophiuroids quite frequent on the sediment, especially O. nigra and O. texturata; Ensis shells present.

Site 2

This site was sampled between about 8 and 13 m, and 16 and 24 m, missing the bedrock-sediment transition. From 8 m there was stepped/terraced bedrock with initially thick L. hyperborea, which thinned out and stopped at about 12 m. The 'steps' continued to about 13 m. Below 16 m was a moderate sediment slope, at first mostly medium sand and pebbles with beds of O. fragilis plus a few O. niger above 18 m. Deeper the sand became muddier. The rock was well grazed by Echinus, but Antedon was often thick on the vertical faces, together with some Alcyonium.

Site 3

A near vertical bedrock cliff from about 4 m with thick L. hyperborea, becoming a gentle boulder slope. From about 12 or 13 m, there was a gentle slope apparently of fine, slightly muddy, sand with occasional boulders, descending at intervals by bedrock steps c. 15 - 25 cm high. It seems likely that a bedrock terrace underlies the sediment; this formation appeared to continue beyond the 20 m depth surveyed. The bedrock steps were creviced, and provided niches for a variety of animals, esp. O. fragilis, but also C. smithii and occasional sponges. A variety of crabs, including Ateleyclus rotundatus, were present.

Site 4

2 - 3 m high bedrock cliffs with L. hyperborea, descending to a fairly gentle boulder/cobble slope with tatty, silt-covered, L. saccharina and long ropes of C. filum. Below 6 or 7 m, a muddy sand slope with broken shell, at first overhung by L. saccharina, then covered for a while with loose, decaying small algae. Occasional pebbles, some with attached foliose algae; a number of small C. opercularis and P. maximus present.

Site 5

A gently sloping muddy fine sand bottom, with large patches of algal detritus. At first the sediment was loose and amorphous with little life (result of scallop dredging?). A region of firmer sediment with occasional small boulders was found in slightly shallower water. Generally a site with a very poor fauna. (No profile).

Site 6

Depths of 16 - 30 m only were sampled. From 16 to c. 20 m very gently sloping bedrock, with a few very large boulders and some small crevices. Small (0.5 m) L. hyperborea, with fronds thickly covered with Obelia, at about 1 m^{-2} ; one with attached squid eggs. Stipes and rock surfaces well grazed by large Echinus (c. 0.5 m^{-2}). Occasional C. smithii, C. lepadiformis and starfish. Below about 20 m a steep slope of bedrock and very large boulders, very well grazed by Echinus, with little encrusting animal life except for P. trispinosa and patches of Flustra and Securiflustra. The dive was notable for the sighting of a large common skate, wing span estimated at 1.5+ m, passing c. 3 m overhead.

Site 7

A gentle slope of boulders, rock outcrops and clean coarse sand patches from c. 16 m to c. 10m, the proportion of bedrock and the slope both increasing until a steep, almost vertical, rock wall (with crevices and deep gullies) was encountered above c. 10 m.

Luxuriant L. hyperborea with many epiphytes on the rock wall, with healthy growths also on the lower rock outcrops. The tops of some boulders were encrusted with Cutleria multifida (agloazonia). Echinus quite common, but there was still a reasonable covering of bryozoans and other encrusting fauna on steep parts of the cliff.

Site 8/17 (part)

Diving close to the islet (Bodach Dearg) below c. 11 m found fairly spectacular scenery of bedrock, with rock walls from 1 - 5 m high, and vertical-sided gullies. At depths between 19 and 21 m, depending on position, clean rippled sand or gravel/small pebbles were encountered. The bottom c. 0.5 m of the rock was well scoured, and the zone immediately above dominated by barnacles and Pomatoceros. Kelp was dense at 11 m, and extended to c. 18 m. The deeper bedrock surfaces, both vertical and upward facing, were dominated by a wide variety of animals, notably a number of species of colonial ascidians, Alcyonium, Antedon, hydroids and bryozoans; H. panicea quite common on kelp stipes. Echinus comparatively sparse - typically 2 or 3 per view in 12 - 15 m visibility. Henricia oculata and H. sanguinolenta both present.

Another pair of divers was placed in the bay (see chart, Fig. 5) and encountered a slope of large boulders, with clean shelly gravel between. The boulders were well grazed by Echinus; "Lithothamnion" was conspicuous. Patches of Antedon were found. (See also entry under site 17).

Site 9 (+ 18)

Site at base of sea cliff near entrance to cave at mouth of loch. Outside of the cave, a steeply sloping/vertical bedrock cliff to c. 12 m, ending in an overhung 'cave' at c. 13 or 14 m. To 8 m, the rock was dominated by kelp and foliose algae, and then by Alcyonium and other encrusting fauna. At 13 - 14 m, a jumble of rock and large boulders, giving irregularly onto a sandy plain. Near and at the entrance to another, sea level, cave were two rock mills, 3 - 4 m deep by 2 - 3 m diameter, their bottoms containing small boulders, sand and algal detritus. The walls were thickly encrusted with bryozoans and colonial tunicates, except for a scour zone at the bottom. Another, larger and more irregular, mill was found c. 30 m from the cliff.

The cave shelved upwards in smoothly faulted slabs, the verticals in places almost totally covered with green H. panicea, A. fucorum and colonial tunicates. Near CD the faunal cover become barnacles with a few small Mytilus. Echinus scarce except below c. 13 m.

Site 10

A somewhat varied topology, varying according to exact line of 'transect'. Basically a steep and vertical/overhung bedrock slope to 17 - 18 m, with boulder/cobble patches on some ledges and sandy patches on others. Boulders/cobble extending in places for about 2 m below the bedrock. Dense L. hyperborea at the top of bedrock, in places giving way to L. saccharina; lower limit of kelp at c. 10 m, with foliose algae continuing to c. 17 m. Metridium and Alcyonium present, esp. on shallower overhangs; a patch of Aurelia scyphistoma; some Antedon. A fairly steep muddy slope with Cerianthus below the rock face.

Site 11a

A continuous boulder slope to c. 4 m, the boulders then thinning out to c. 7 - 9 m. Below this, a slope of muddy sand with small rectangular pebbles, levelling out at c. 16 m. Kelp to 4 m, giving way to small algae. Hydroids on small stones on sediment; mats of D. aculeata and some D. ligulata.

Site 11b

A north facing bay of steeply sloping clean pebbles in the littoral, with pebbles and sand predominant in the sublittoral, the sediment becoming finer as it proceeded downwards. A few boulders in shallow water with "broad fronded" L. hyperborea and L. saccharina. Dense patches of P. maximus were encountered t c. 2 m. Tralliella covering pebbles at 5 - 6 m. Below c. 9 m, dense beds of L. saccharina. Hermit crabs ubiquitous.

Site 12

Flat to moderately sloping bedrock with thick L. hyperborea on upward surfaces, cut by 1 - 2 m high by c. 2 m across, vertical-sided, gullies running parallel to the shore. Colourful animal cover on walls (Alcyonium, etc.), boulders with Alaria on floor. A 3+ m vertical rock cliff, with abundant Alcyonium and bryozoans on the upper part. Lower on the cliff, grazing by Echinus was evident, but thick patches of Antedon were present. At the base of the cliff a 30 - 45° cobble slope, giving onto a slightly muddy, well worked, sand slope with cobble and numerous small pebbles (with algae and hydroids) at c. 16 m. Moving north away from the island, the proportion of sand increased, and it became less muddy. Fauna generally poor on this plain.

Site 13

Broken bedrock from c. 0.5 to 10 m, with many gullies; thick L. hyperborea with fairly dense stipe flora in the shallows, but increasingly grazed by Echinus below c. 2.5 m. At 9 - 10 m the bedrock becomes smooth, with a (?) glaciated appearance, the kelp thinning to a park. Alcyonium, occasional sponges, C. smithii, Antedon, etc. present. The slope flattens and becomes cobble and boulder with gravel patches at 14 - 15 m. An extensive area of pebbles, with interesting flora; scattered boulders with occasional kelp.

Site 14

Broken bedrock from 1 - 4 m with many gullies and fissures, mostly running approximately parallel to the shore. Dense kelp with grazed undergrowth on upward facing surfaces. From c. 4.5 m to 9 m a vertical cliff (intersected in one place by a steep sided gully), the cliff and vertical faces of gullies dominated by Alcyonium, and with other animal cover. The wall ends on a gentle, fine sand, slope (slightly muddy close to the rock), well worked, with empty Ensis shells on the surface and numerous L. depurator just buried. Occasional rock outcrops, 1 - 2 high, with Alcyonium, Metridium and L. hyperborea quite close to the cliff. The slope eventually steepens, to more than 25 m, with lessening evidence of infaunal activity.

Site 15

Steep bedrock slope with a thick L. hyperborea forest, thinning to a park, well covered with Obelia, and halting at 17 - 18 m. A fairly dense mat of O. fragilis, with some O. niger, covering the lower rock faces, and crawling up the kelp stipes. Gullies, running approximately down-slope, one with about 3 m high vertical sides, very well fissured and bored (limestone), with rich fauna (esp. O. fragilis, Haliclona sp., Pachymatisma, a wide variety of ascidians and bryozoans). Bottom of gully containing small boulders, with bottom of sides scoured. A spectacular site, visibility about 20 m.

Site 16

A densely kelp-covered plateau at 2 - 3 m adjacent to the shore, cut into 'peninsulas' and approximately rectangular islands, by vertical sided/overhung gullies. The gully sides are richly encrusted by ascidians, sponges, Alcyonium, ophiuroids and bryozoans. At the foot of the rock/gully complex at c. 11 m a shallow boulder slope, with occasional bedrock outcrops, gradually thinning out, the size of the boulders decreasing to cobble, with increasing sandy patches, to at least c. 16 m. Occasional L. saccharina. An O. fragilis bed in channel at c. 16 m; is a continuation of that at site 15?

A number of seals in the area, one or two persistently appearing in the gully system. Generally a very scenic site.

Site 17

An extensive tide swept (1 knot on chart) plain of pebbles and small cobbles offshore, from 28.5 to 24 m. Barnacles, hydroids and some encrusting bryozoans present. At 24 m a narrow band of much smaller pebbles adjacent to a bedrock slope, which is dominated by Flustra and Securiflustra immediately above a narrow scour zone. Above this zone the rock is dominated by Alcyonium, colonial ascidians, etc, with foliose algae above about 22 m and kelp starting at about 19 m, the latter rapidly becoming dense. H. panicea thickly encrusts some stipes. (See also entry under site 8).

Site 18

See site 9.

Site 19a

the only site on which a formal transect along a line was performed. Bedrock slope with occasional boulders to c. 5½ m, with L. digitata, L. hyperborea, L. saccharina and occasional sponges, flattening to sand (Halidrys) with bedrock outcrops and ridges bearing L. hyperborea.

Site 19b

A fairly steeply sloping rock pinnacle (drying at LW) with thick kelp, flattening out somewhat at about 6 m onto a gentle slope of boulders, bedrock outcrops and patches of coarse sand with kelp on the rock.

Site 20

Bedrock terraces descending from about 1.5 to 9.5 m, with a gully about 1 m deep at the base of each step. Dense L. hyperborea on upward facing surfaces, with quantities of foliose red algae on the stipes. Vertical gully walls were not very rich in fauna (effect of scouring?). Flattened cobbles present at the base of the bedrock, decreasing in size over 3 or 4 m horizontal distance, with L. hyperborea giving way to L. saccharina, before reaching an extensive rippled clean sand plain with gravel in hollows.

Site 21

Sea cliff with cave to about 8 m into cliff; mouth at about 1½ m. Back of cave of scoured bedrock; Mytilus and barnacles, together with nudibranch eggs, on sides. Outside, a bedrock and boulder slope giving onto a clean sand plain with Arenicola at c. 13 m. Cobbles with D. aculeata at edge of sand.

Site 22

A varied topography, the exact dive profile depending on the entry point. Bedrock descending via ledges and steep slope/cliff to 25+ m in places, elsewhere a slope of large, jumbled boulders from a depth of 17 m or so. A luxuriant L. hyperborea forest with many urchins, but quite thick growths of epiphytic algae. Occasional vertical-sided gullies, walls with Alcyonium, ascidians, bryozoans. Verticals often dominated by Alcyonium, Antedon, Clavellina, and Carophyllia, but elsewhere well grazed with little except encrusting bryozoans, esp. Parasmittina, and "Lithothamnion". Boulders rather bare. Again excellent visibility, 15 - 20 m.

Site 23

A gentle slope, sampled below c. 3 m. Sandy mud with occasional bedrock supporting long-froned L. hyperborea. Then an area of sandy mud, well worked by Arenicola with some Sabella. Low ridges of bedrock parallel to the shore, c. 10 - 20 m across, supporting numerous large (to 58 mm diameter) Psammechinus. Patches of Cerianthus; hermit crabs numerous everywhere.

Site 24

Cobble and pebble slope, occasional muddy sand patches, almost totally obscured by very tatty and silty L. saccharina being consumed by numerous L. littorea. By 6 m the pebbles had decreased in size and given way to a mud slope with many discarded/broken shells (Modiolus, Chlamys,...) and patches of Ceramium rubrum mat. Slope flattening out at c. 12 m, with Virgularia at densities to about 1 m^{-2} .

Site 25

Anchor chain of large naval mooring buoy, in about 27 m. Thick L. saccharina on underside of buoy, persisting to about 10 m; sparse brown algae persisting to about 14 m. Numerous small Anomiidae at 10 - 13 m, occasional small attached Chlamys opercularis and patches of Mytilus. The fauna becomes poorer as depth increases. A thin growth of hydroids, giving way to barnacles, with a number of Onchidoris bilamellata, spawning. Soft worked mud at bottom, with occasional Virgularia, some 'topped' by Eudendrium sp. The buoy reportedly has been in place for less than a year.

Site 26

A steep bedrock slope/cliff descending to a sand plain at 15 m. In places there were large boulders at the bottom of the bedrock. L. hyperborea on upward facing surfaces, thick nearer surface. Alcyonium common on some verticals, also hydroid/bryozoan turf and ascidians. Other verticals, and boulders, well grazed by Echinus. A scour zone immediately above the sediment, fringed above by Pomatoceros. At edge of sand a fringe of kelp debris. Sand rather bare except for Arenicola casts; worn kelp stipes scattered on the sand. About 100 m from rock face a zone of foliose algal debris. A very large shoal of saithe feeding on extremely dense sand eels over sand near edge of rock.

Site 27

Broken bedrock slope to about 5 m with thick L. hyperborea and L. saccharina; giving onto a rippled coarse sand slope with occasional small rocky outcrops; Arenicola present in patches. About 50 m to the west, a fairly gentle slope of boulders and bedrock outcrops interspersed with sand from c. 3.5 to 9 m with L. hyperborea, L. saccharina and S. polyschides. Slope continuing to 12 m, with boulders and cobble (with L. saccharina and L. hyperborea becoming scarcer).

Site 28

At 10 m a gentle slope of soft, silty mud (slightly sandy in places) with many small brown and red algae, mostly unattached but a few attached to shells and v. small pebbles. A scattering of dead maerl present, together with a few live pieces, and thick patches of Turritella shells, c. 50% containing live animals. As swam NE, an area of angular pebbles to c. 5 cm across was encountered. Eventually, at c. 11.5 m, a large limestone outcrop, 3 - 4 m high, was found. The bottom of the sides of the outcrop were vertical/overhung to 1 - 2½ m, with a shallow cave. The rock was well bored and creviced, with O. fragilis, Ciona, A. mentula, Antedon, etc. Quite thick L. hyperborea present on upward facing surfaces.

Site 29

Gentle slope in the channel between island and mainland. Muddy sand, with cobble and L. saccharina to c. 4 m. C. filum, patches of live and dead maerl, Arenicola, Cerianthus, Turritella and eventually Pecten at about 11 m.

Site 30

Divers followed a NE course over about 150 m, from 18 to 30 m, from the SE corner of the anchorage in the S. basin. Soft mud, with patches of Virgularia, some again surmounted by Eudendrium sp., at densities to c. 1 m⁻². Metridium on occasional small boulders. At 28+ m a few Nephrops.

Site 31

Cobble/boulder slope to 6 m, with L. hyperborea and L. saccharina. Flattening out to a gentle slope, muddy sand with coarse sand and pebble patches, and, at 10 m, a rock outcrop with L. hyperborea. The sediment well worked by bivalves and dense Arenicola.

Site 32

Crevice, near vertical rock face (limestone?) from c. 6 to c. 10 m, below a L. hyperborea forest. Thick Alcyonium and hydroid/bryozoan turf present with many Antedon. In places there is a short boulder slope with kelp or shelly gravel band at the base of the cliff. Then an extensive, gentle, muddy sand slope to 15 m (where dives finished), well worked by bivalves, Arenicola and Myxicola, with occasional L. saccharina on small boulders and foliaceous red algae on buried shell fragments. Hermit crabs common on the sediment.

Site 33

A gentle slope, surveyed from c. 0.5 m to 14.5 m. Below 10 or 11 m a bottom of soft mud, with pebbles and shell debris, partially covered by small algae with adherent A. aspersa. From c. 10 to 3 m the sediment is a firm muddy sand, very well worked especially by Arenicola; Pecten present. Occasional small boulders supported L. saccharina. A narrow band of cobble gives onto a boulder slope above 3 m, with a dense covering of L. saccharina.

Site 34

A steep slope of small boulders and cobble from 0 - 4 m supporting L. digitata, L. hyperborea (cape form) and L. saccharina. Flattening out to a gentle muddy sand slope to 12 m, well worked by bivalves and Arenicola with an area of closely packed Arenicola mounds close to the boulders. An area of thick algal debris was encountered.

APPENDIX 4: FAUNAL LIST

PORIFERA

- Amphilectus fucorum (8, 9, 15, 16). Possibly under-recorded, as shallow kelp forest not consistently sampled.
- Clathrina coriacea (7, 8, 13, 16, 22, 26, 28). Few genuine surge gullies found.
- Cliona celata (1, 8, 15, 22, 26). Only a few individuals seen.
- Halichondria panicea (2, 7, 8, 9, 15, 16, 17, 19a, 19b, 20, 26). Widespread, especially on kelp stipes. Large sheets, some of green form, in cave at site 9.
- Haliclona viscosa (15, 16)
- Hymedesmia paupertas (6)
- Leuconia nivea (15)
- Leucosolenia sp. (10)
- Leucosolenia complicata (8, 19a, 21, 22, 26)
- Leucosolenia variabilis (9)
- Microcionid (22)
- Mycale macilenta (24). On C. opercularis.
- Myxilla incrustans (3, 7, 8, 10, 17, 19a, 26, 28). Only occasional specimens seen, nearly all on vertical rock in outer loch.
- Oscarella lobularis (6)
- Pachymatisma johnstonia (7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19a, 28). Widespread at rocky outer loch sites, but rarely numerous.
- Scypha ciliatum (3, 19a, 19b). Only seen on kelp stipes.
- Spanioplon armaturum (11a)
- Suberites domuncula (5, 27, 33). On C. opercularis.
- Suberitiid (11a). On C. opercularis.

Some material is held by D Moss.

COELENTERATA: HYDROZOA

- Abietinaria abietina (13)
- Campanularia flexuosa? (28)
- Companularia turrita? (25)

- Campanularia verticillata (3)
- Campanularia volubilis? (2, on H. beanii; 15, on N. ramosa; 17, on S. cupressina)
- Clytia johnstoni (28)
- Diphasia rosacea (9)
- Dynamea pumila (8)
- Eudendrium annulatum (25?, 30)
- Eudendrium annulatum / ramosum (25, 30). On V. mirabilis
- Eudendrium annulatum / arbuscula (25)
- Eudendrium rameum (28)
- Eudendrium ramosum (1, 3)
- Filellum serpens (?) (28). On Obelia sp.
- Gonothyrae gracilis (25)
- Halecium beanii / halecium (15)
- Halecium halecium (2?, 10, 14?, 17, 26)
- Halecium labrosum ? (25)
- Halecium plumosum (1)
- Hydractinia echinata (11b, 23, 24, 30, 33). On hermit crabs, probably under-recorded.
- Hydrallmania falcata (7, 8)
- Lafoea sp. (8, on Obelia sp.; 17, on H. halecium; 22, on S. polyzonias; ?28, on E. rameum). (17), (22), (24). Widespread.
- Nemertesia antennina (1, 2, 3, 4, 5, 6, 8, 10, 12, 14, 15, 17, 22, 24). Widespread.
- Nemertesia ramosa (1, 2, 3, 5, 10, 24, 30, 33). Widespread.
- Obelia dichotoma (Cornelius, 1975) (4, 7?, 8, 10, 11a?, 12, 15?, 23, 25, 26?, 30)
- Obelia geniculata (1, 3, 4, 6, 7, 8, 9, 11a, 12, 14, 15, 16, 17, 19a, 19b, 20, 21, 22, 24, 26, 27, 28, 31, 32, 34). Thickly covering kelp fronds at many sites, especially towards bottom of kelp zone. In several places all colonies covering a frond were red due to the presence of an endozoic alga (?Acrochaetium infestans, cf. White & Boney, 1976).
- Perigonimus miniatus? (30)
- Plumularia catharina (3, 5, 11a)

- Plumularia pinnata (1, 8, 10, 12, 14, 23)
Plumularia similis (9)
Sertularella polyzonias (9, 15, 16, 22, 28)
Sertularella fusiformis / tenella (8). On O. dichotoma
Sertularia cupressina (17)
Sertularia sp. (3). On O. dichotoma.

Some material is held by NCC.

COELENTERATA: SCYPHOZOA

- Aurelia aurita (3, 4, 7, 12, 15, 19a, 26, 32, 33). Often seen in water column, probably under-recorded.
Aurelia aurita (Scyphistoma) (10)
Cyanea capillata (3, 8, 15, 17, 19a, 22, 26, 27, 32, 33). Often seen in water column, probably under-recorded.

COELENTERA: ANTHOZOA

- Alcyonium digitatum (1, 2, 3, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19a, 19b, 20, 21, 22, 26, 28, 32, 33). Widespread, locally common on verticals/overhangs, even well within the loch.
Caryophyllia smithii (1, 2, 3, 6, 7, 8, 9, 10, 13, 22, 26, 28, 32)
Cerianthus lloydii (10, 14, 27, 29, 30, 31, 32, 34). Patchily distributed on muddy sediments within loch.
Corynactis viridis (8, 16). In very localized patches at mouth of loch.
Metridium senile (1, 5, 9, 10, 12, 14, 15, 16, 26, 30). On overhangs, and in isolated rock among sheltered sediment.
Sagartia elegans v. miniata (8, 9, 12, 14, 17)
Sagartia elegans v. rivea (8, 17)
Sagartia elegans v. rosea (8, 9)
Sagartia elegans v. venusta (2, 17)
Sagartia elegans (v. unspecified) (10, 13, 14)
Sagartia troglodytes (30)

Urticina felina (2, 6, 7, 8, 9, 10, 12, 14, 15, 17, 20, 22, 26).
Widespread at rocky unsheltered sites, but never
common.

Virgularia mirabilis (24, 25, 30). Probably widespread on deeper sediments
within loch.

ANNELIDA

Aphrodite aculeata (32)

Arenicola marina (8, 11a, 11b, 14, 21, 23, 26, 27, 29, 30, 31, 32, 33,
34)

Bispira volutacornii (31)

Chaetopterus variopedatus (2, 3, 33). Probably under-recorded.

Filograna implexa (8, 9, 12, 13)

Lanice conchilega (2, 3, 12, 14, 20, 26, 27, 29, 32)

Myxicola infundibulum (11a, 28, 30, 31, 32, 33, 34)

Platynereis dumerilii (3, 24, 25)

Pomatoceros triqueter (1, 2, 3, 5, 6, 7, 8, 9, 10, 11a, 12, 13, 14, 15, 16,
17, 19a, 19b, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32,
33). Probably ubiquitous.

Sabella pavoninca (31), (34)

Sabella sp. (23, 25)

Serpula vermicularis (11b, 24, 28, 33)

Stylochoplana pallida (17)

Terebellidae (14, 32, 33, 34). Tentacles visible on surface.

CRUSTACEA - CIRRIPEDA

"Barnacles" (5)

Balanus balanus (9, 25)

Balanus ceratus (8, 17, 23, 24, 25, 26). Barnacles obviously under-
recorded.

CRUSTACEA - DECAPODA

<u>Atelecyclus rotundatus</u>	(2, 3)
<u>Cancer pagurus</u>	(3, 5, 6, 8, 9, 10, 12, 13, 14, 15, 17, 18, 20, 26, 28, 30, 32, 33). Widespread but never common.
<u>Carcinus maenas</u>	(5, 9, 11a, 14, 23, 24, 28, 30, 31, 34)
<u>Galathea strigosa</u>	(2, 3)
<u>Galathea</u> sp.	(1, 3, 9, 12, 14, 17). Under-recorded.
Hermit crabs	(1, 2, 3, 5, 11a, 11b, 12, 14, 17, 19a, 20, 23, 24, 28, 30, 32, 33). Widespread, often numerous locally.
<u>Homarus vulgaris</u>	(9, 11b, 15, 20). Surprisingly rare.
<u>Hyas araneus</u>	(2, 3, 5, 8, 14, 20, 24, 26, 28, 32, 33). Often occasional on kelp.
<u>Inachus dorsettensis</u>	(3, 5, 11a, 28, 29, 33)
<u>Inachus</u> sp.	(32)
<u>Liocarcinus puber</u>	(1, 2, 3, 7, 8, 9, 10, 11b, 12, 13, 15, 17, 19a, 26, 27, 28, 32). Widespread, never numerous.
<u>Liocarcinus</u> sp.	(4)
<u>Macropodia</u> sp.	(14, 28)
<u>Macropodia ?longirostris</u>	(11b)
<u>Macropodia rostrata</u>	(33)
<u>Munida bamffica</u>	(3)
<u>Nephrops norvegicus</u>	(30)
<u>Porcellanus longicornis</u>	(3, 4, 12). Under cobble - under-recorded.
'Shrimps'	(8, 12, 18, 24, 28)

CRUSTACEA - OTHER

Caprellidae	(5, 10, 14, 28). Under-recorded inevitably.
<u>Idotea baltica</u>	(20)

CHELICERATA - PYCNOGONIDA

<u>Endeis spinosa</u>	(1, 8, 15)
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MOLLUSCA

<u>Anomiidae</u>	(1, 2, 10)
<u>Aporrhais pes-pellicani</u>	(14, 23, 28)
<u>Arctica islandica</u>	(1)
<u>Buccinum undatum</u>	(1, 2, 3, 11a, 11b, 14, 20, 23, 24, 27, 28, 29, 30, 32, 34).
<u>Calliostoma ziziphinum</u>	(1, 6, 7, 8, 9, 10, 11a, 12, 14, 15, 16, 17, 19a, 20, 22, 26, 27, 28, 29, 31, 33, 34). Widespread, often the commonest gastropod grazer - but never "common".
<u>Capulus ungaricus</u>	(4)
<u>Chlamys opercularis</u>	(1, 2, 4, 5, 11a, 23, 24, 25, 28, 32). Never numerous. Small specimens attached to chain at site 25.
<u>Chlamys varia</u>	(11a)
<u>Chlamys</u> sp.	(11b, 24, 31, 32, 34). Probably <u>C. opercularis</u> .
<u>Eledone</u> sp.	(27)
<u>Gibbula cineraria</u>	(4, 5, 6, 7, 9, 10, 11a, 14, 20, 22, 26, 28, 33). Never numerous.
<u>Gibbula umbilicalis</u>	(34)
<u>Gibbula magus</u>	(34). Seemingly a real (and surprising) absence.
<u>Gibbula</u> sp.	(11b, 27, 31)
<u>Lacuna vineta</u>	(20, 24)
<u>Lepidochitona cinereus</u>	(4)
<u>Leptochiton asellus</u>	(3, 11a, 14, 28)
<u>Littorina littorea</u>	(11b, 24). Common at site 24. Also abundant in the littoral at Eilean Hoan.
<u>Modiolis modiolis</u>	(4, 5, 12, 23, 24)
<u>Mya truncata</u>	(27, 32)
<u>Mytilus edulis</u>	(9, 25)
<u>Natica</u> sp.	(33)
<u>Patella</u> sp.	(19a). Obviously under-recorded; most dives on bedrock did not approach CD.
<u>Patina pellucida</u>	(2, 17, 19a, 19b, 20, 22)
<u>Pecten maximus</u>	(4, 10, 11a, 11b, 14, 23, 28, 29, 31, 32, 33). Some dense patches encountered.
<u>Pododemus squamula</u>	(4, 25)

<u>Trivia arctica</u>	(8)
<u>Trivia monacha</u>	(7, 8, 9)
<u>Turritella communis</u>	(28, 29). Dense patches encountered, of mixed live and empty shells.
'Chiton'	(1, 2, 30, 33)
(Shells)	
<u>Arctica islandica</u>	(2, 3, 30)
<u>Dosinia exoleata</u>	(25, 28, 33)
<u>Ensis arcuatus</u>	(20, 29)
<u>Ensis</u> sp.	(1, 2, 3, 10, 11b, 14, 26, 28, 32, 33, 34)
<u>Pecten maximus</u>	(30)
<u>Spisula solida</u>	(21)
<u>Turritella communis</u>	(5, 28), and other, unrecorded, sites. Many housing hermit crabs.
<u>Venerupis pullastra</u>	(24)
<u>Venus casina</u>	(2)
(Eggs)	
Squid	(2, 6)
Whelk	(1)
<u>Opisthobranchia</u>	
<u>Aplysia punctum</u>	(8, 9)
<u>Archidonis pseudoargus</u>	(9)
<u>Dendronotus frondosus</u>	(2, 14)
<u>Doto</u> sp.	(2, 8, 10)
<u>Jorunna tomentosa</u>	(16)
<u>Facelina bostoniensis</u>	(17, 25)
<u>Lomanotus geneii</u>	(3, 24)
<u>Onchidoris bilamellata</u>	(21, 25)
<u>Polycera quadrilineata</u>	(21)

Tritonia hombergii (8)

(Eggs)

Onchidoris bilamellata (21, 25)

'Dorid' (17)

BRYOZOA

Alcyonidium 'diaphanum' (8, 12, 15, 17, 26)

Bugula flabellata (8, 9, 14, 17, 22, 26)

Bugula sp. (8, 9, 17, 22). Probably mostly B. flabellata.

Callopora aurita (4)

Callopora lineata (3, 20)

Cellaria fistulosa (1)

Cellaria sp. (3)

Cellepora pumicosa (7, 17, 22)

Celleporella hyalina (7, 8, 9, 16, 20)

Cribilina annulata (16)

Crisia eburnea (17)

'Crisiidae' (4, 15)

Cylindroporella tubulosa (16)

'Cyclostomata' (7)

Electra pilosa (2, 3, 7, 8, 9, 11a, 11b, 12, 15, 16, 17, 19a, 20, 21, 22, 24, 26, 28, 31, 32, 34). Widespread on kelp stipes and, especially, on red algae, often almost completely covering D. sanguinea.

Escharella immersa (3, 8, 16)

Escharoides coccinea (8)

Flustra foliacea (6, 8, 17, 22). On deep rock.

Membranipora membranacea (1, 2, 3, 11b, 15, 16, 17, 19b, 22, 26, 27, 31, 34). Widespread, but rarely common, on kelp fronds.

Microporella ciliata (8)

Omalasecosa ramulosa (3). Base of Nemertesia, probably under-recorded.

Smittoidea reticulata (3)

- Parasmittina trispinosa (1, 4, 6, 7, 8, 14, 22, 26). Probably also recorded under 'unidentified encrusting bryozoa'. Covering large areas of deep, heavily grazed rock, e.g. site 6.
- Porella compressa (6)
- Scrupocellaria reptans (14)
- Scrupocellaria scruposa (8, 12, 15)
- Securiflustra securifrons (6, 8, 17, 22). On deep rock.
- Tricellaria ternata (15)
- Tubulipora lobifera (16)
- Umbonula littoralis (20)

'Unidentified encrusting bryozoa' (6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19a, 20, 22, 26)

'Turf' (32)

ECHINODERMATA

- Amphiura filiformis (33)
- Amphipholis squamata (23)
- Asterias rubens (1, 2, 6, 7, 8, 9, 10, 11a, 11b, 12, 14, 15, 16, 19a, 19b, 20, 21, 22, 23, 25, 26, 27, 28, 30, 31, 32, 33, 34)
- Antedon bifida (1, 2, 6, 7, 8, 9, 10, 11a, 12, 13, 14, 15, 16, 17, 21, 22, 26, 28, 32). Widespread, often occurring in dense, localized, clumps.
- Astropecten irregularis (14, 27, 28, 33). Rare.
- Crossaster papposus (2, 6, 8, 9, 11a, 14, 17, 20, 22, 26, 28)
- Cucumaria saxicola (1, 13, 15)
- Cucumaria sp. (7, 10, 13, 19a). Probably mostly C. saxicola.
- Echinus esculentus (1, 2, 3, 5, 6, 7, 8, 9, 10, 11a, 11b, 12, 13, 14, 15, 16, 17, 19a, 20, 21, 22, 24, 26, 27, 28, 29, 31, 32, 33, 34). Almost universal. Grazing from severe (e.g. site 6), to insignificant.
- Echinocardium cordatum (14, 25, 27, 34)
- Henricia oculata (8, 22). Scarce, on exposed, fairly deep bedrock.
- Henricia sanguinolenta (3, 9, 12, 14, 17, 19a, 20, 22, 26, 28, 30)

<u>Henricia</u> sp.	(3, 7, 8, 9, 10, 13, 15, 16, 22, 26). Probably nearly all <u>H. sanguinolenta</u> .
<u>Leptasterias mulleri</u>	(7, 8, 9, 15, 20, 26)
<u>Marthasterias glacialis</u>	(1, 6, 8, 9, 14, 22, 26). Infrequent.
<u>Neopentadactyla mixta</u>	(12)
<u>Ophiothrix fragilis</u>	(2, 3, 8, 9, 12, 15, 16, 19a, 24, 28). In extensive beds at sites 15 and 16, otherwise common in limestone crevices.
<u>Ophiocomina nigra</u>	(1, 2, 3, 6, 8, 15, 16, 17)
<u>Ophiopholis aculeata</u>	(15, 16, 28)
<u>Ophiopholis</u> sp.	(12, 14, 29). All <u>O. aculeata</u> ?
<u>Ophiura albida</u>	(1, 7, 11a, 12, 14, 26, 27, 28, 32, 33)
<u>Ophiura texturata</u>	(1)
<u>Porania pulvillus</u>	(6, 22). Solitary specimens. Eating <u>A. digitatum</u> at site 21.
<u>Psammechinis miliaris</u>	(1, 22, 23). Common at site 23.
<u>Solaster endeca</u>	(1, 7, 8, 22, 26). Single specimens only.
'Brittlestars'	(34)
ASCIDIACEA	
<u>Ascidea conchilega</u>	(1, 3). Probably under-recorded because of under-boulder habitat.
<u>Ascidia mentula</u>	(1, 3, 5, 10, 11a, 22, 28, 34)
<u>Ascidia virginea</u>	(1, 10)
<u>Ascidella aspersa</u>	(3, 4, 5, 10, 11a, 24, 25, 26, 28, 33). Never abundant.
<u>Aplidium punctum</u>	(8, 9)
<u>Aplidium proliferum</u>	(8, 9, 16)
<u>Botryllus schlosseri</u>	(3, 8, 9, 10, 12, 14, 15, 16, 17, 19a, 20, 21, 22, 26, 28). Often in lobes on kelp stipes.
<u>Ciona intestinalis</u>	(2, 3, 15, 16, 26, 28)
<u>Clavellina lepadiformis</u>	(1, 2, 6, 7, 8, 9, 10, 12, 14, 19a, 21, 22, 26, 32)
<u>Corella parallelogramma</u>	(3, 5, 10)
<u>Dendrodoa grossularia</u>	(8, 11a)




















<u>Didemnidae</u>	(8, 9, 15, 16, 17, 26)
<u>Diplosoma spongiforme</u>	(8, 12, 26)
<u>Diplosoma listerianum</u>	(9, 19a)
<u>Diplosoma</u> sp.	(10, 21)
'hard leathery'	(4, 16)
<u>Lissoclinum perforatum</u>	(8, 9, 12, 15, 16, 17, 26)
<u>Molgula</u> sp.	(8)
<u>Polycarpa rustica</u>	(8, 9, 15, 16, 17, 19a, 28). Usually in crevices in sides of limestone verticals.
<u>Polyclinum aurantium</u>	(8, 9, 17, 20)
<u>Sidnyum elegans</u>	(9)
<u>Sidnyum turbinatum</u>	(8)
<u>Synoicum pulmonaria</u>	(8, 17)
<u>Trididemnum tenerum</u>	(16)
PISCES	
<u>Agonus cataphractus</u>	(14, 34)
<u>Callionymus</u> sp.	(1, 12, 20)
<u>Eutrigla gurnardus</u>	(14)
juvenile flatfish	(1, 14, 27)
juvenile gadoids	(2, 6, 8, 9, 23, 26)
<u>Labrus bergylta</u>	(6, 9, 10, 14, 22)
<u>Labrus mixtus</u>	(6, 10, 22)
<u>Molira molira</u>	(2, 6)
<u>Pholis gunnellus</u>	(3, 10, 11a, 11b, 17, 26, 28, 31, 32, 33)
<u>Pipefish</u>	(14)
<u>Pleuronectes platessa</u>	(32, 34)
<u>Pollachius pollachius</u>	(22)
<u>Pollachius virens</u>	(14, 21, 26, 27). Very large shoal at site 26.
<u>Pollachius</u> sp.	(15)

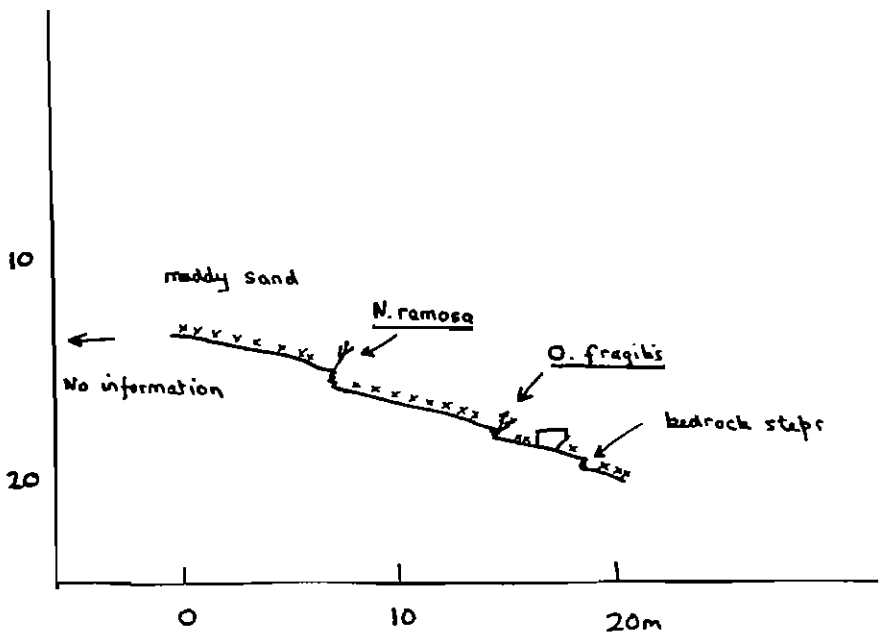
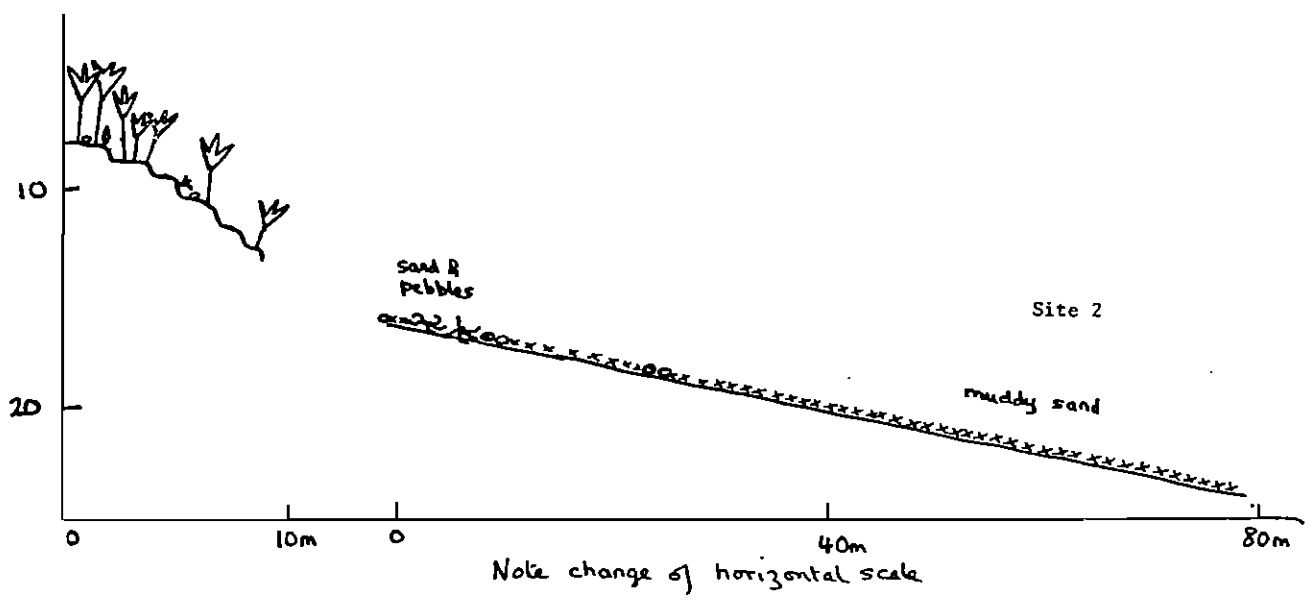
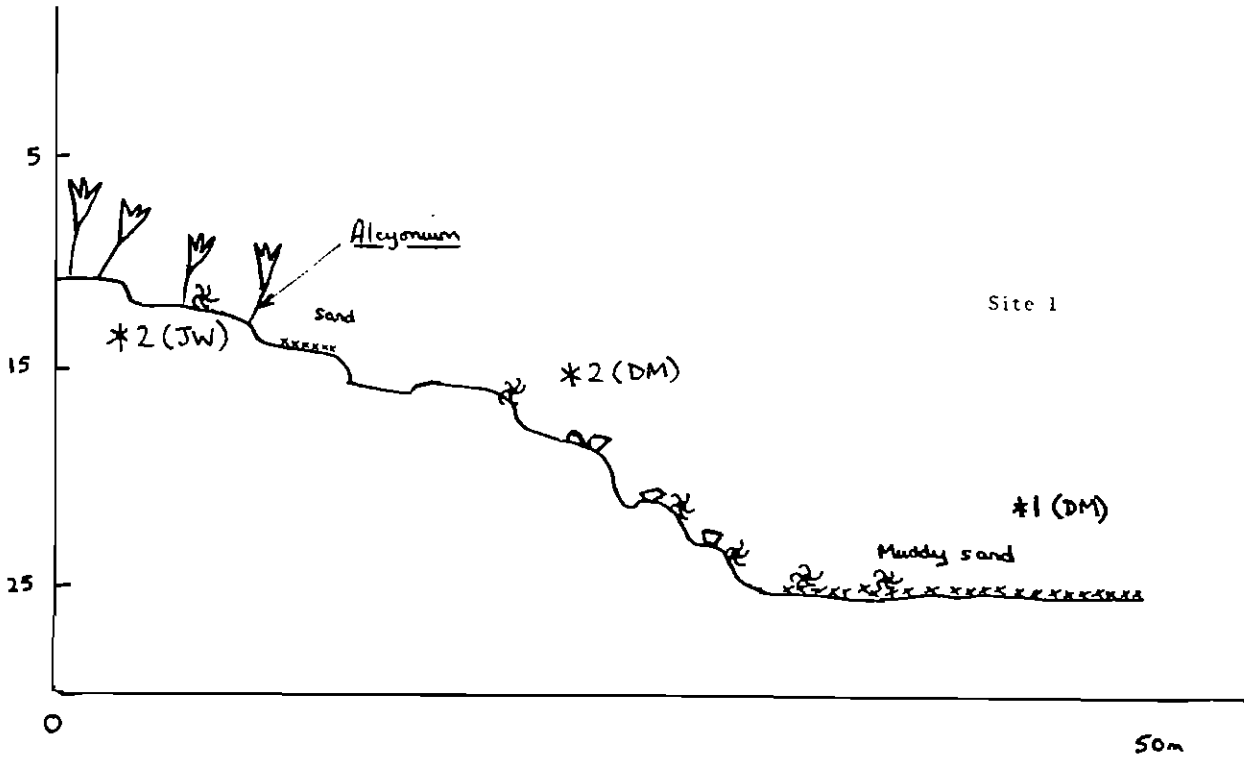
<u>Pomatischistus</u> sp.	(1, 11b, 26, 27, 32)
<u>Rajis bata</u>	(6)
Sandeels	(8, 20, 26)
"Scorpion fish"	(11b, 19b, 31)
<u>Scylliorhinus canicula</u>	(28)
<u>Scylliorhinus</u> sp. eggs	(11b)
<u>Thorogobius ehippiatus</u>	(13)
Weaver	(34)

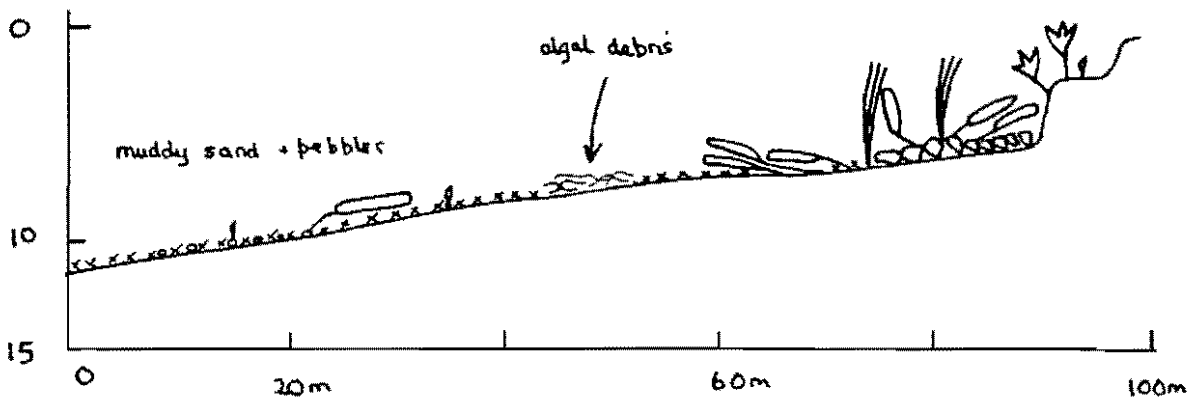
APPENDIX 5. SITE PROFILES

Schematic profiles are provided for all sites, except site 5. Vertical scales are in metres, corrected to CD, taken from depth gauge readings. Horizontal scales are estimated. Labels of the form *2(DM) refer to the habitat zone of the raw data sheets of the indicated.

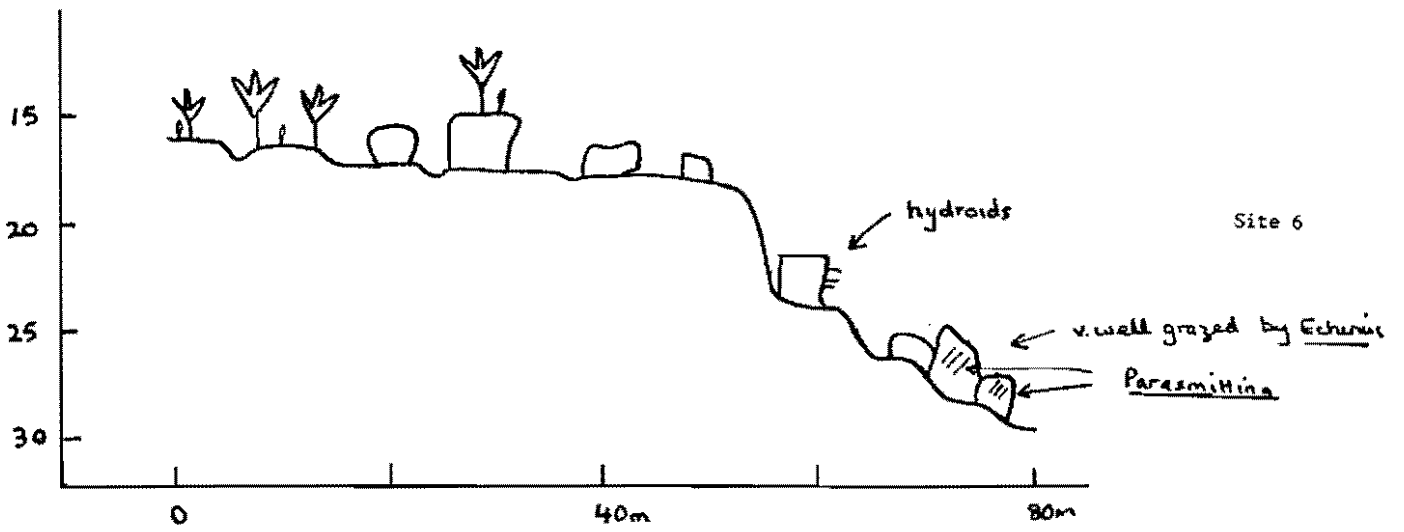
Key

	<u>Laminaria digitata</u>		<u>Laminaria hyperborea</u>
	<u>Laminaria saccharina</u>		<u>Saccorhiza polyschides</u>
	<u>Alaria esculenta</u>		<u>Halidrys siliquoa</u>
	foliaceous red algae		<u>Chorda filum</u>
	algal debris		algal mat
	maerl		brittle star bed
	<u>Virgularia mirabile</u>		<u>Antedon bifida</u>
	sediment		boulders
	cobble/pebble		bedrock
	<u>Pecten maximus</u>		

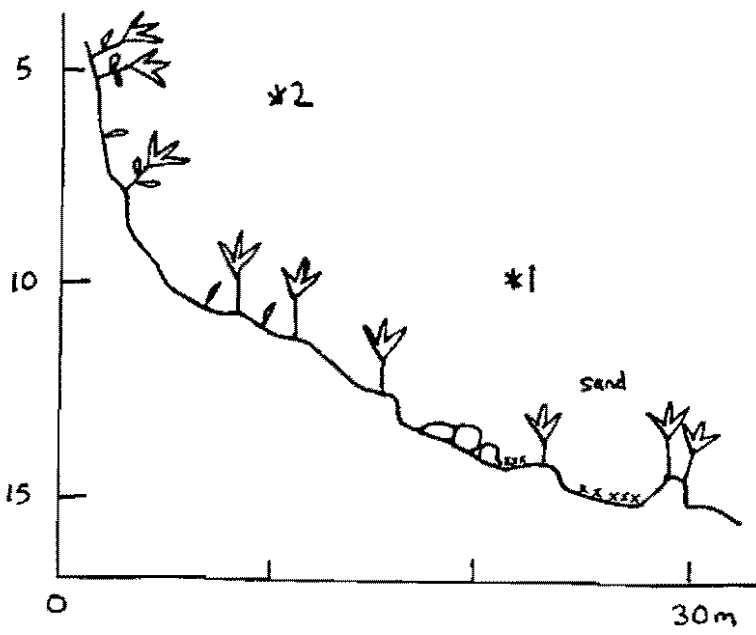




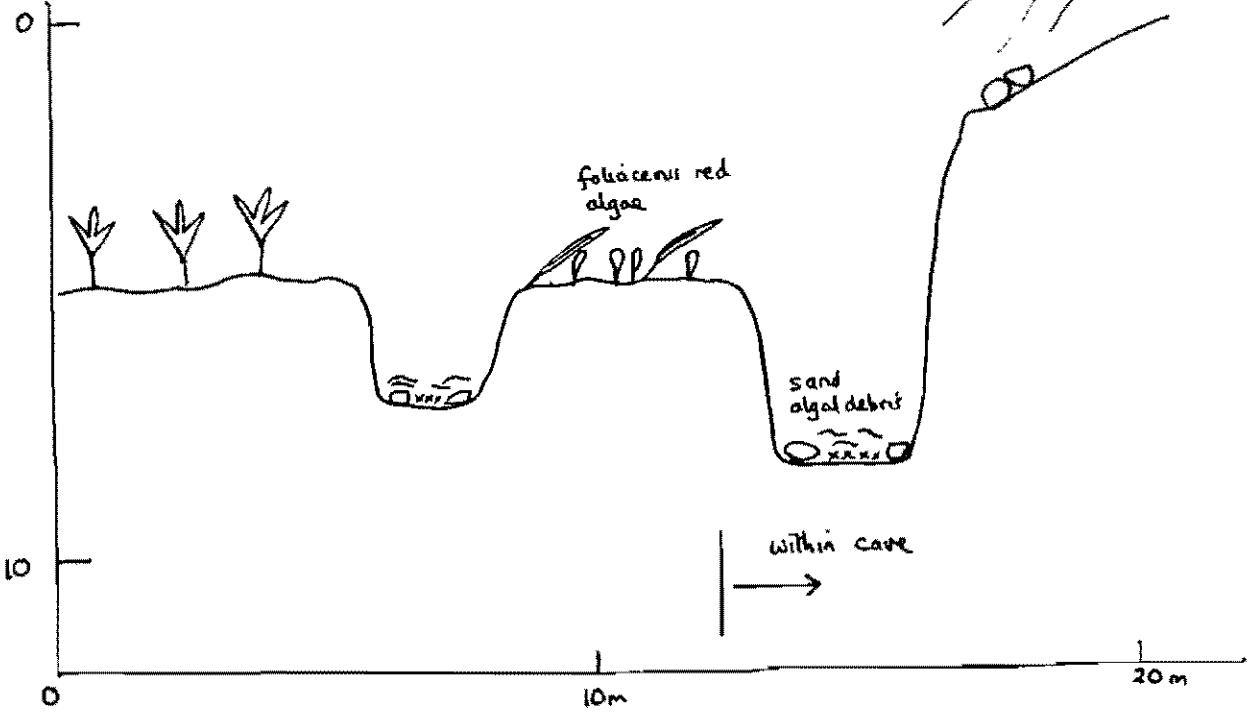
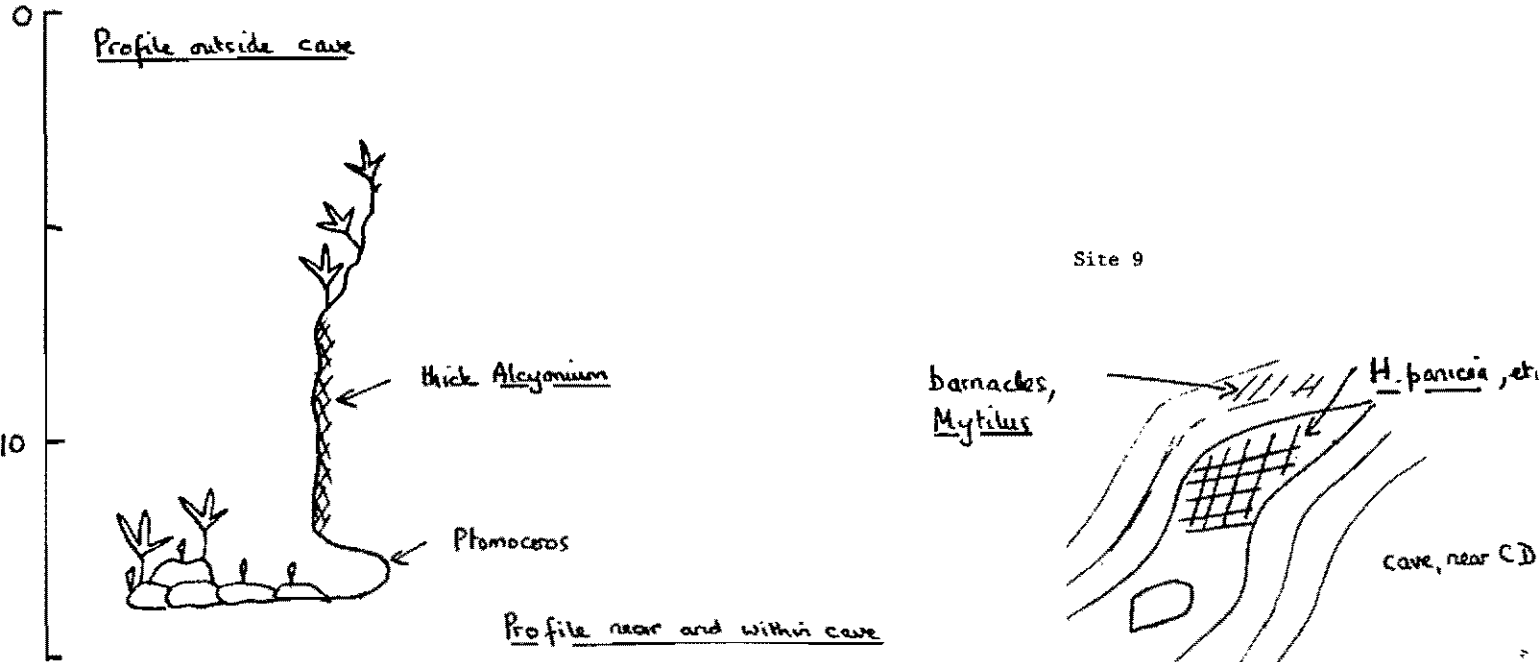
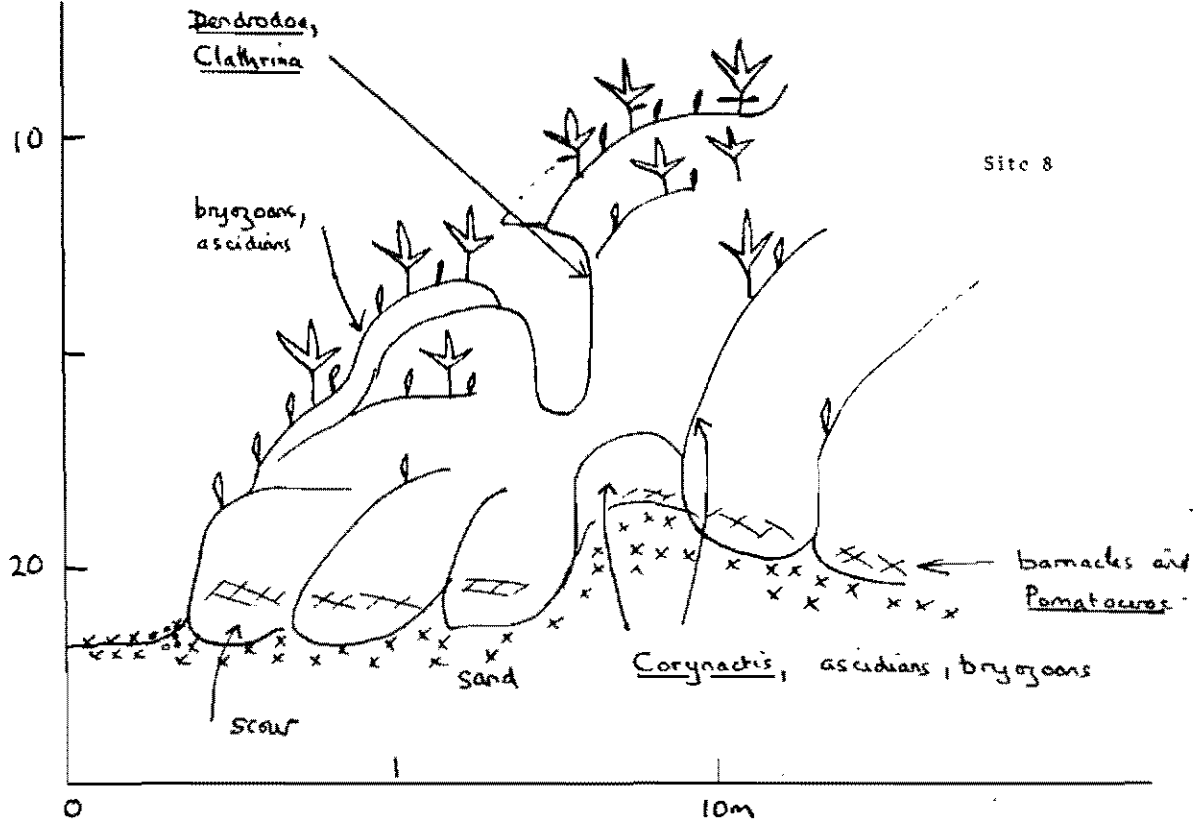
Site 4

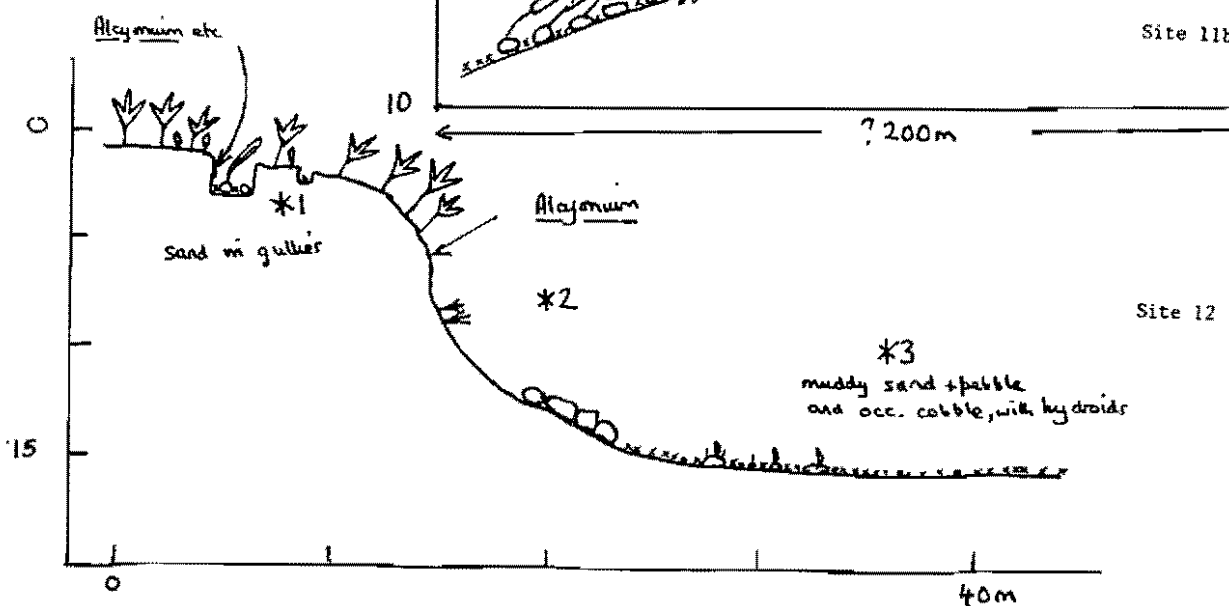
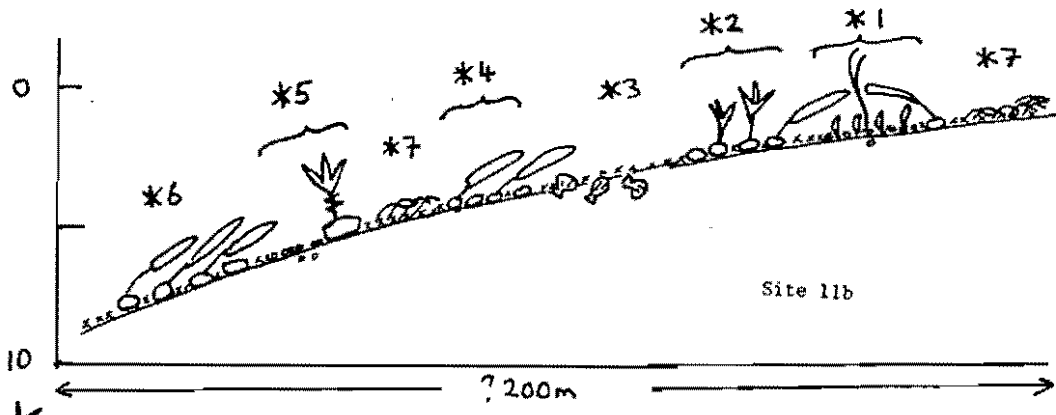
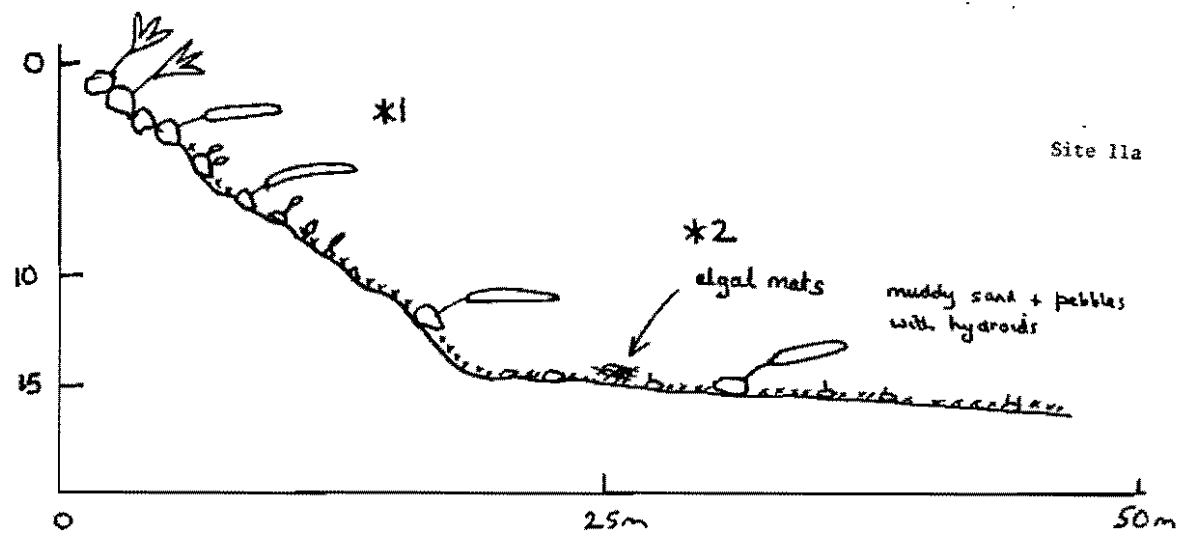
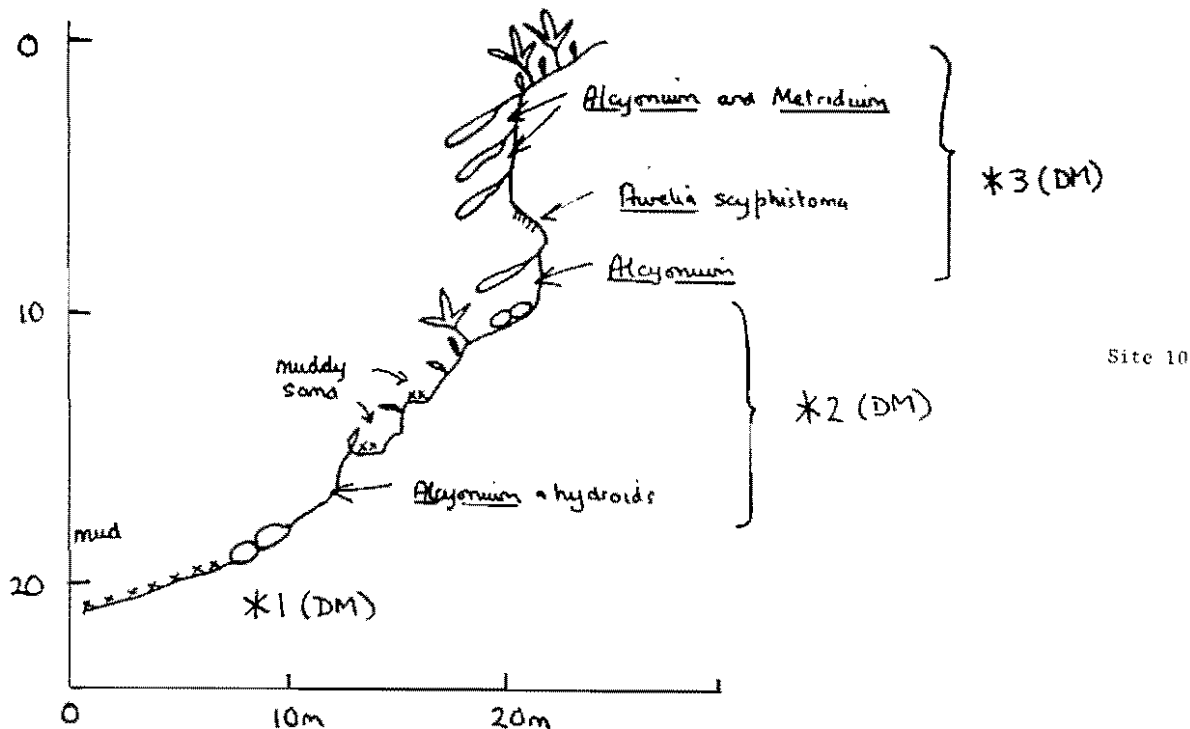


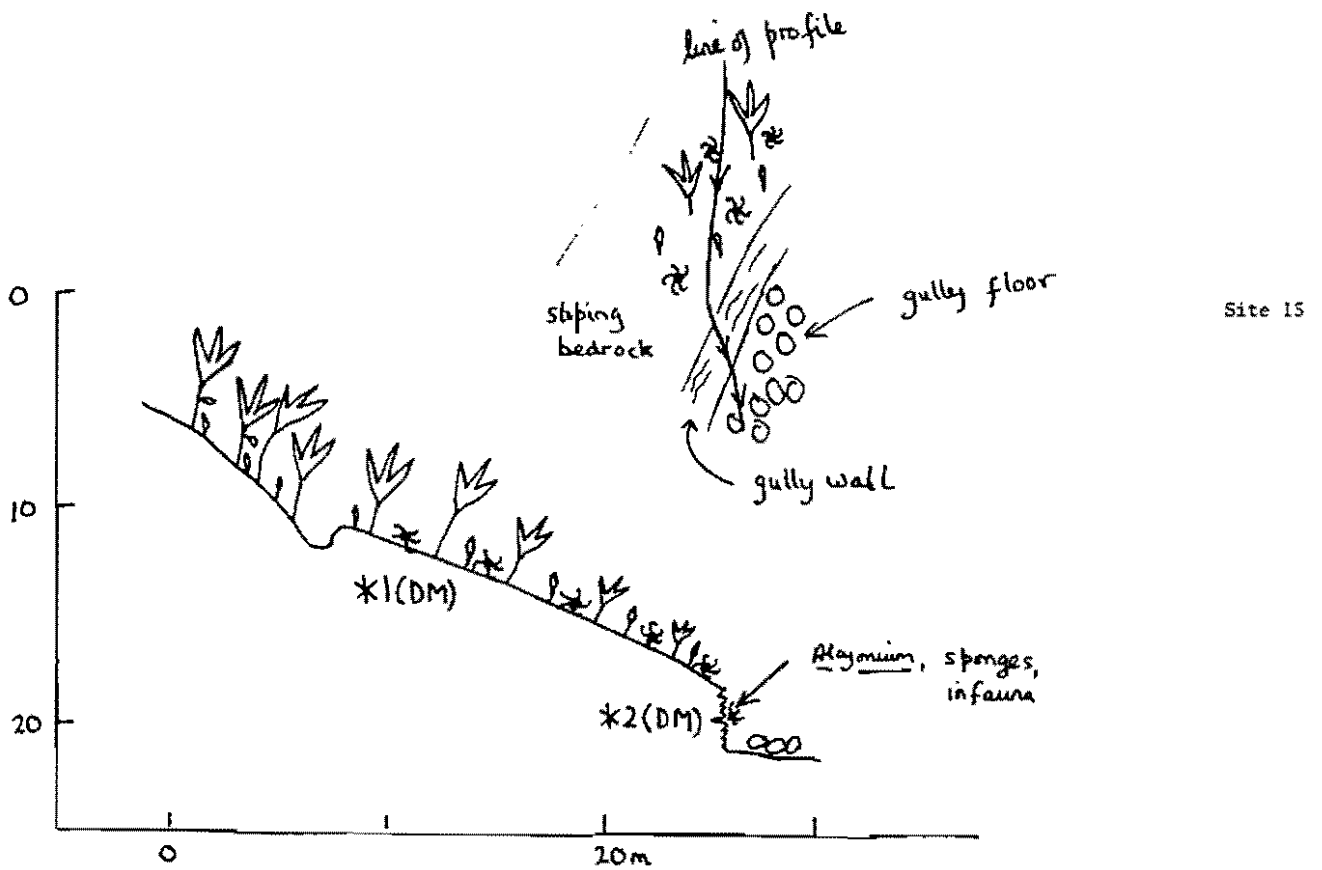
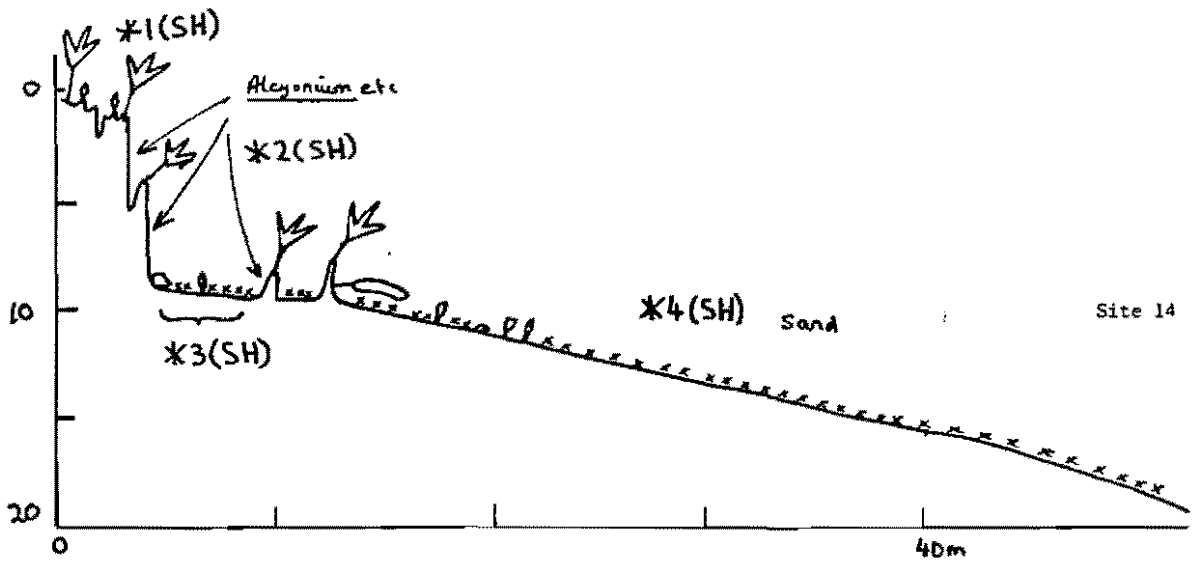
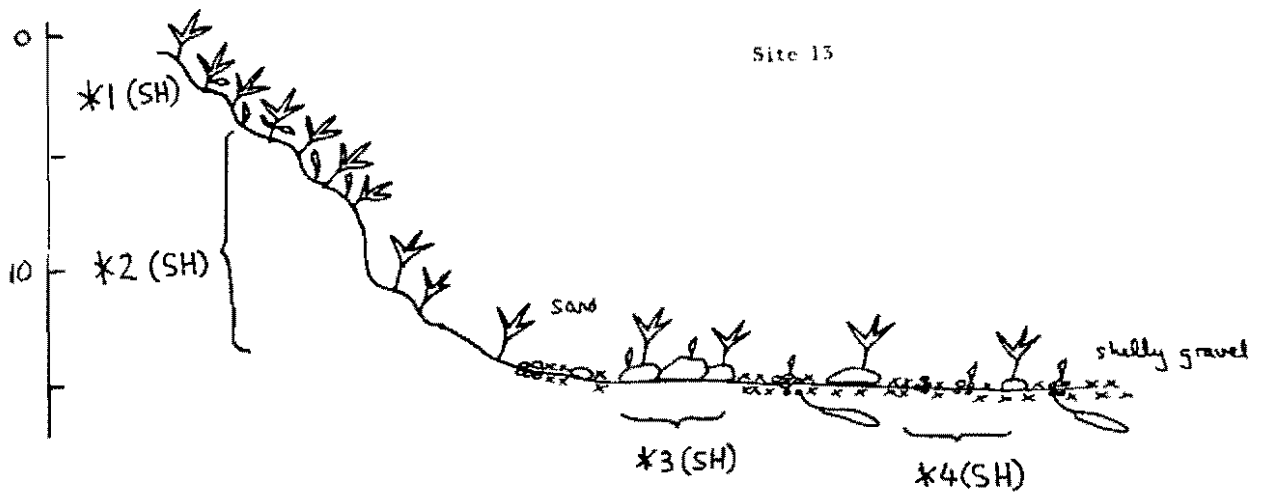
Site 6

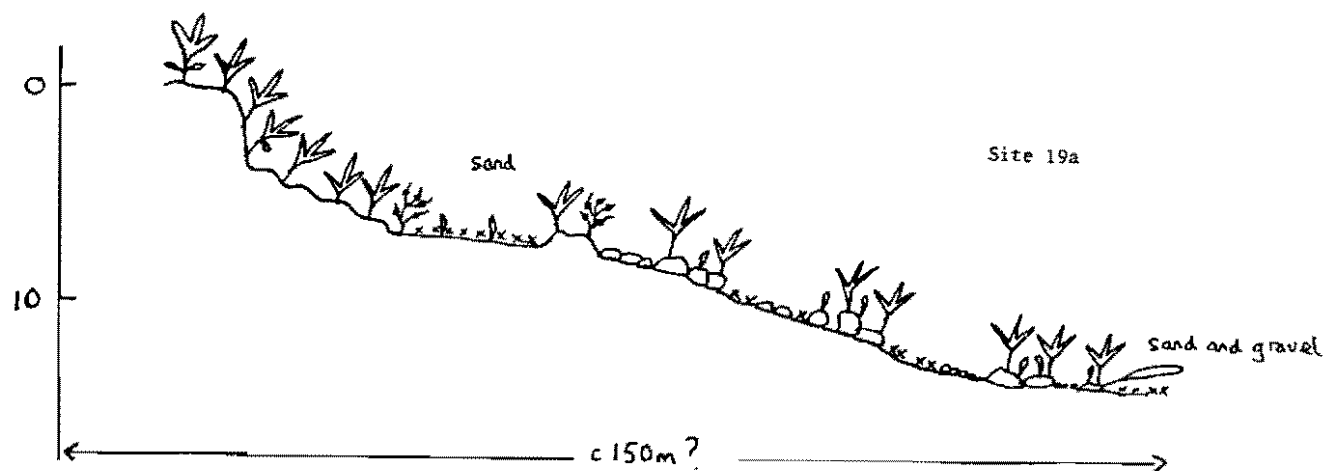
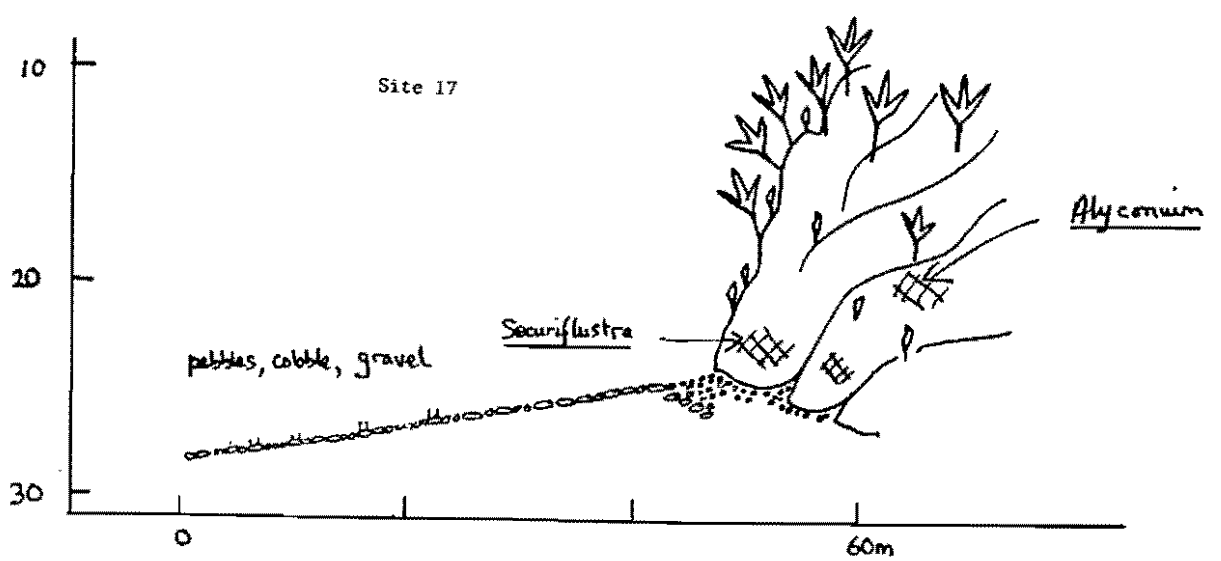
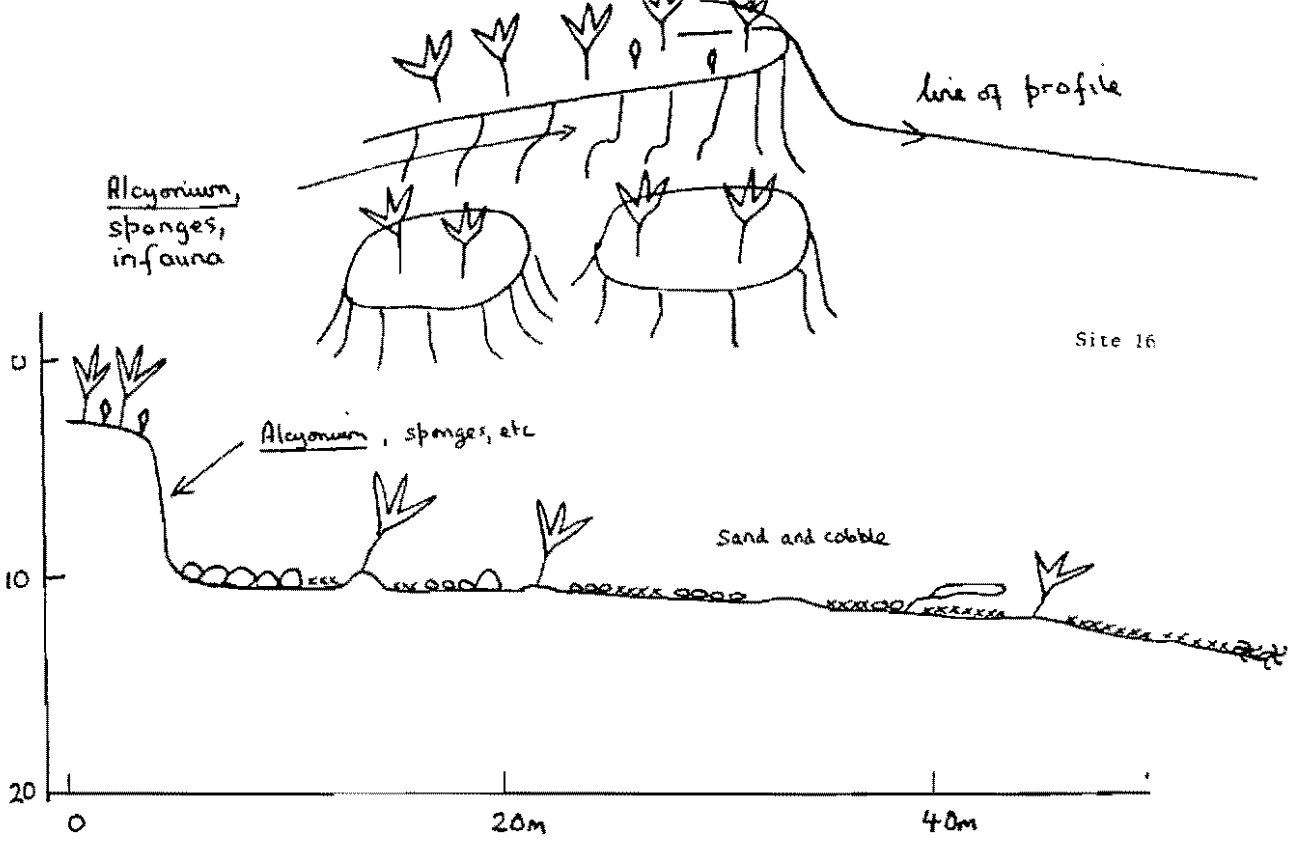


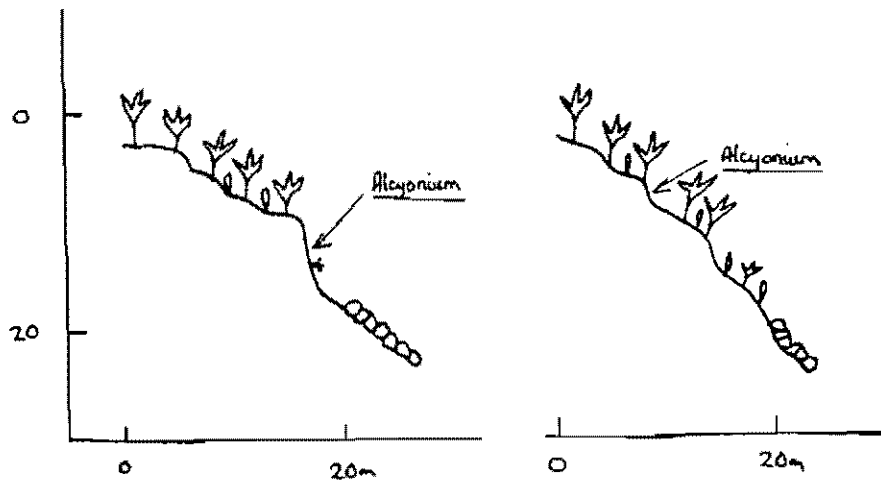
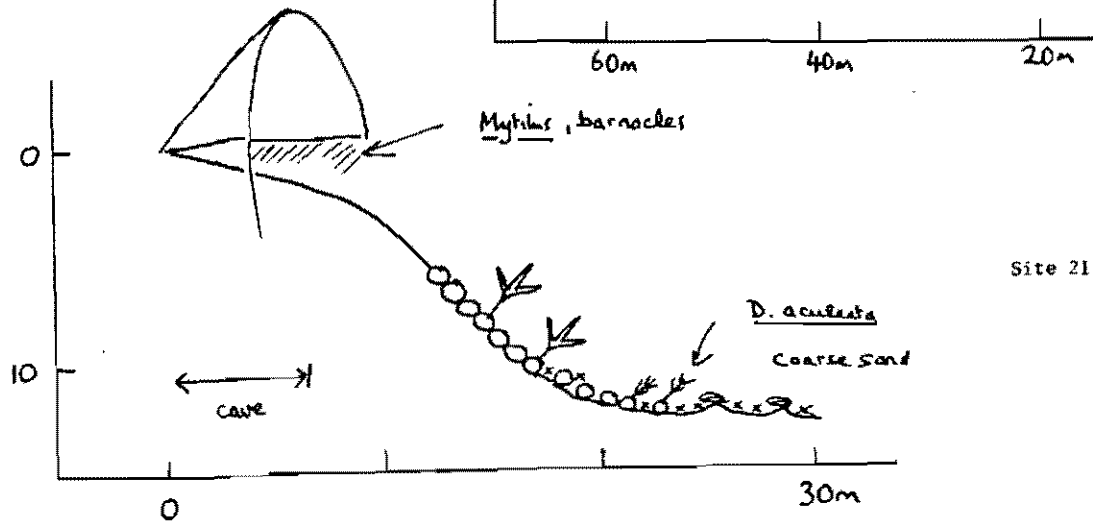
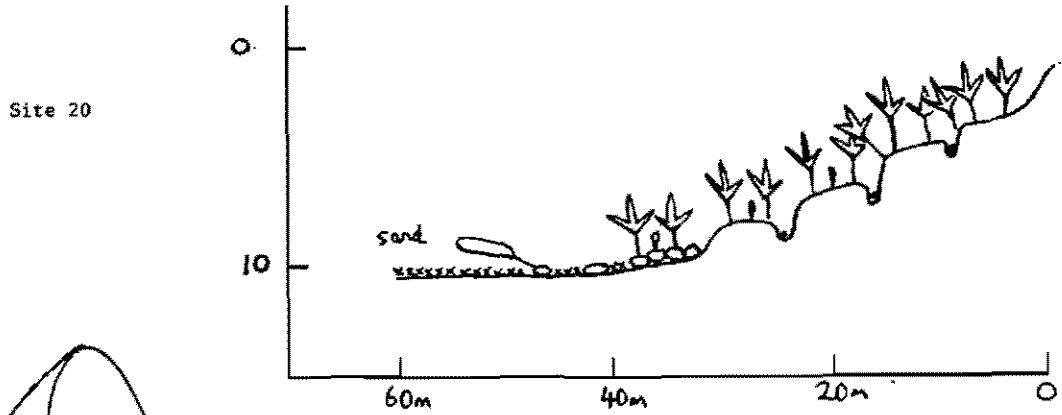
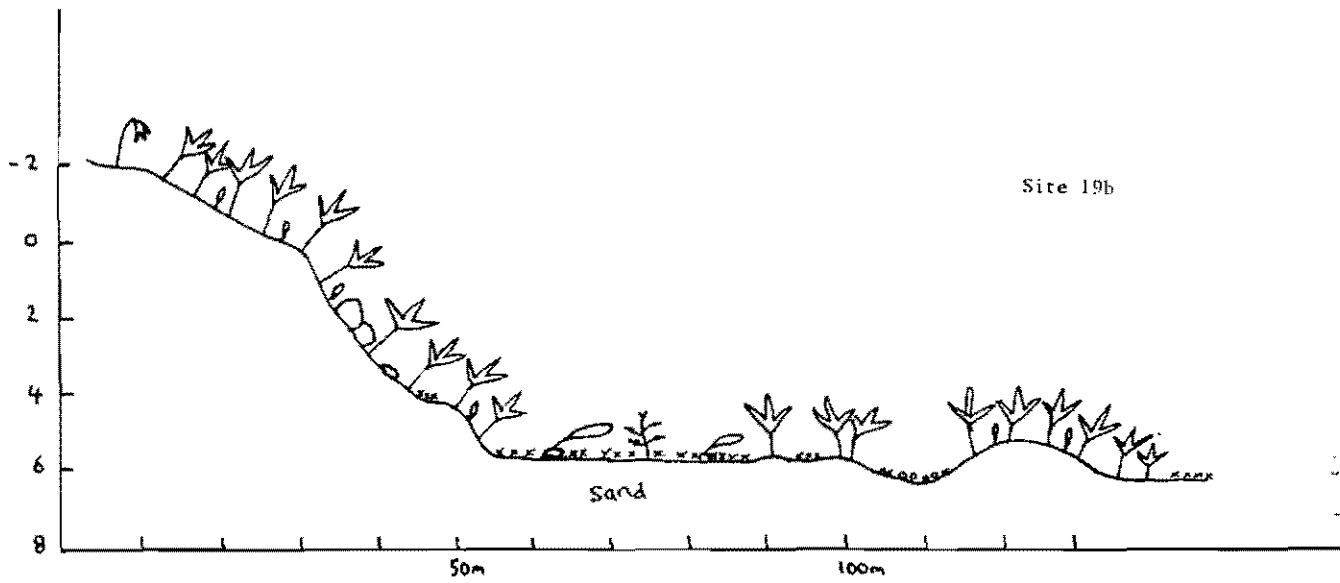
Site 7



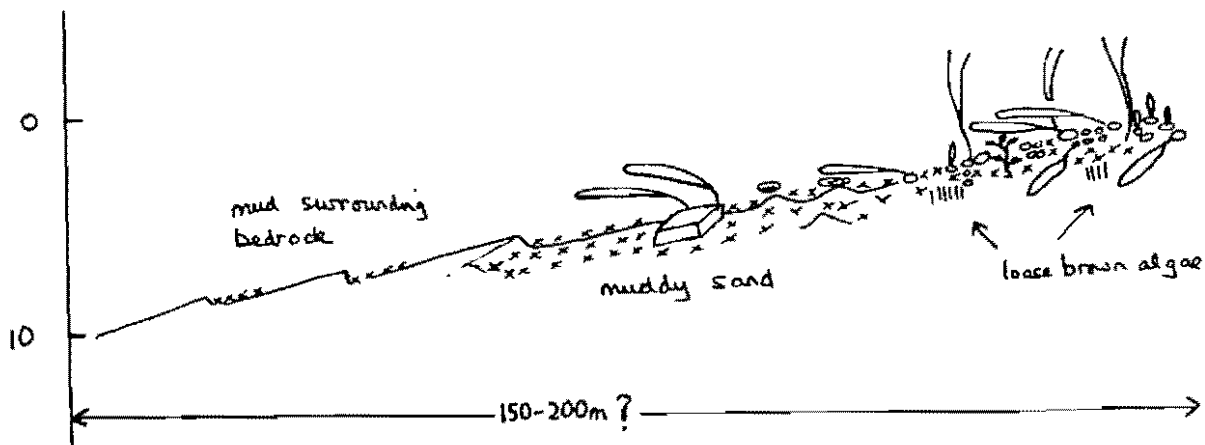




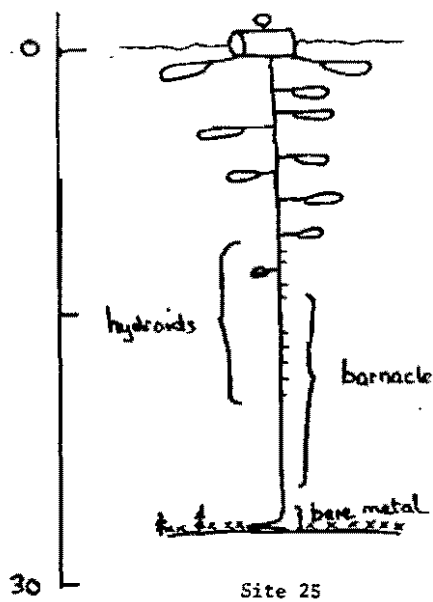
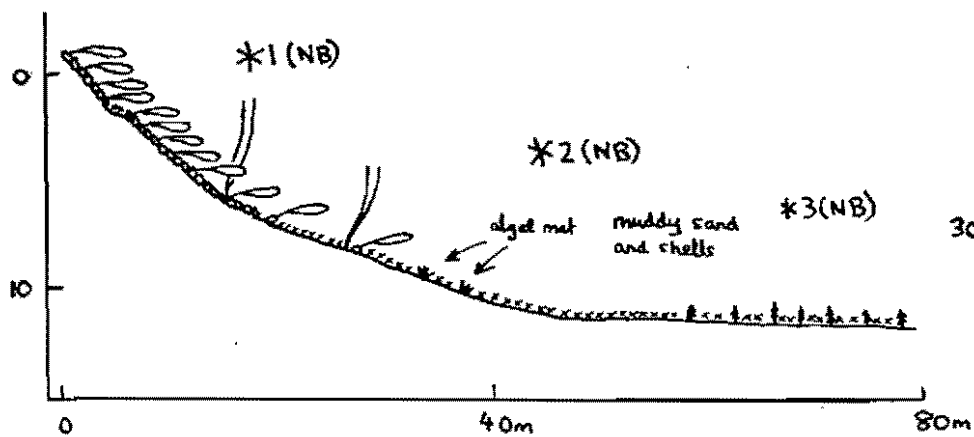




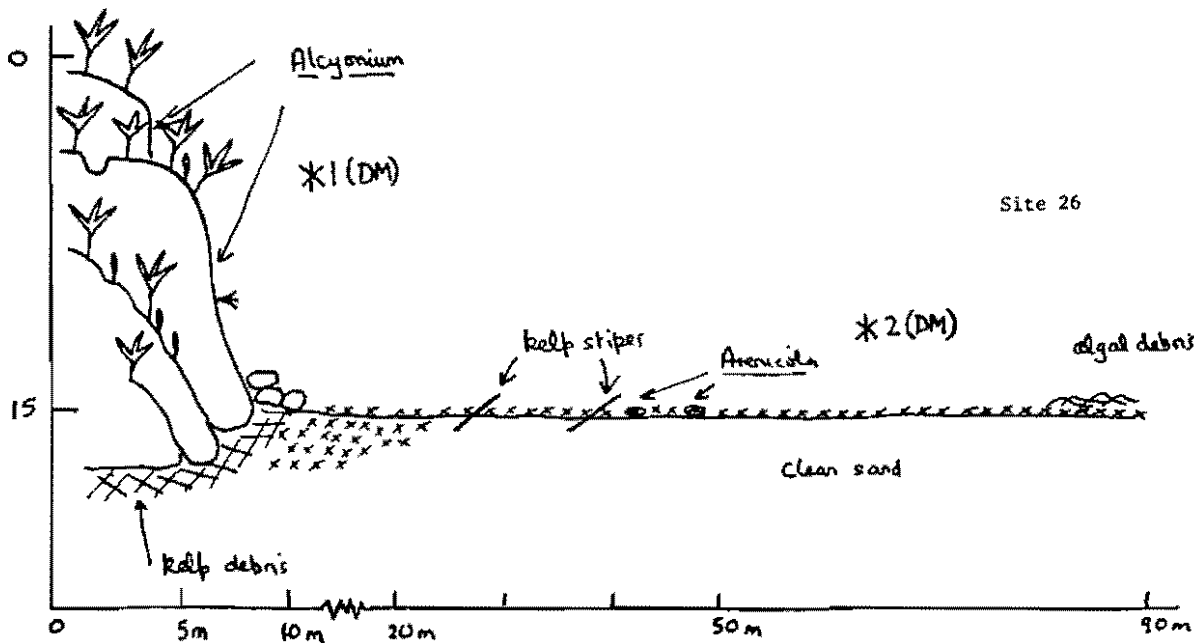
Site 23

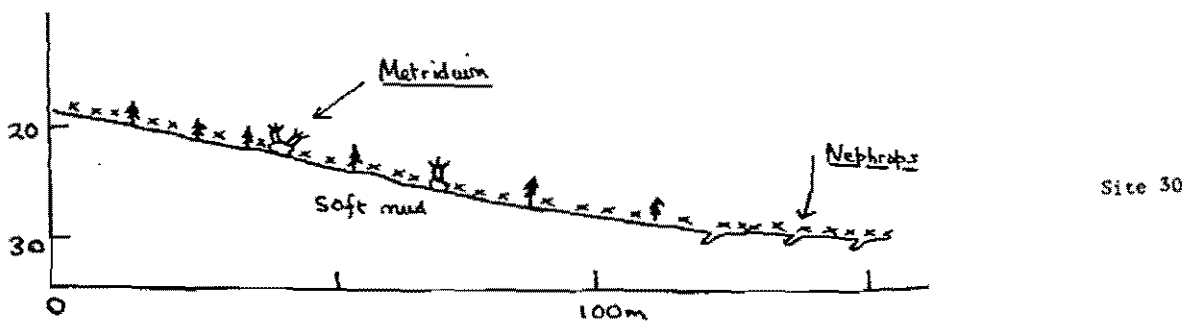
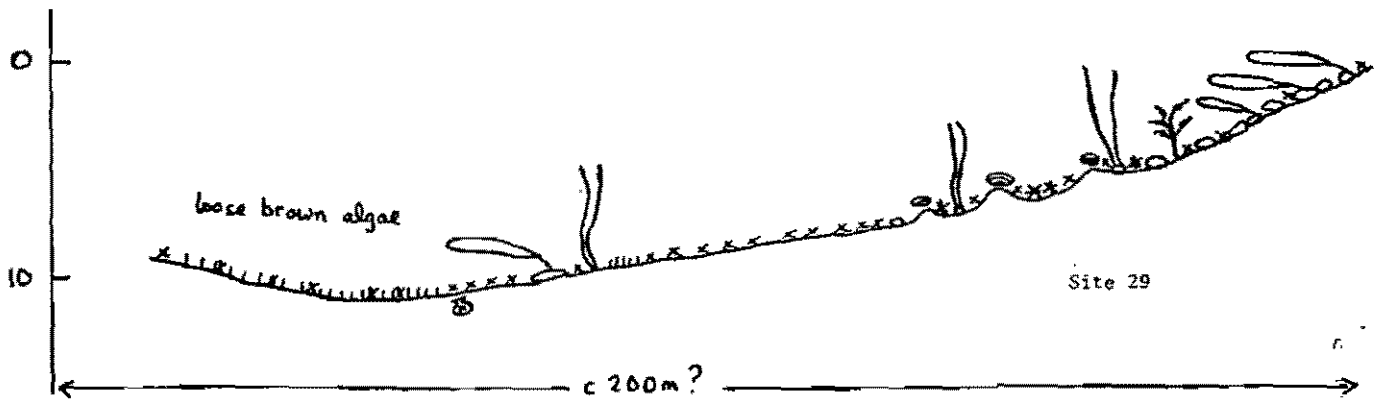
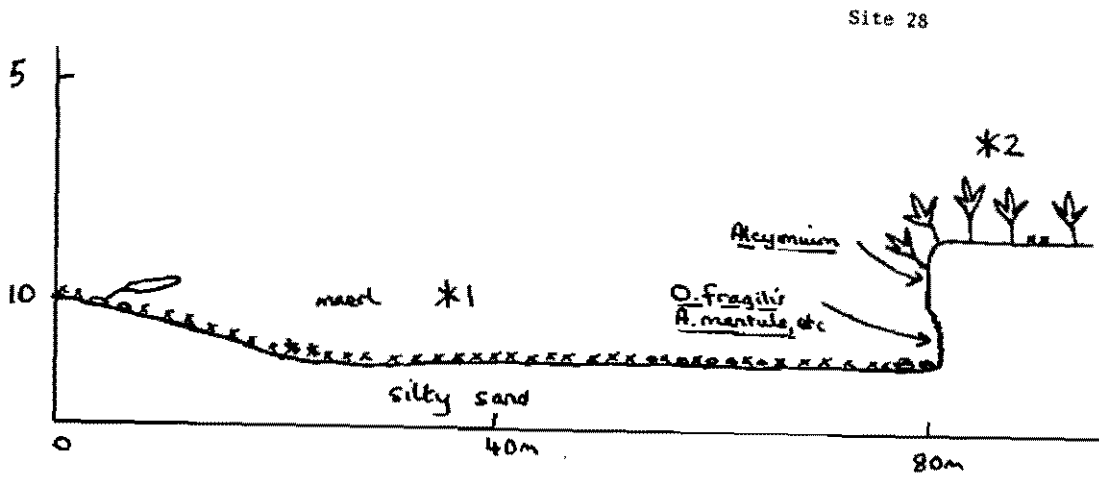
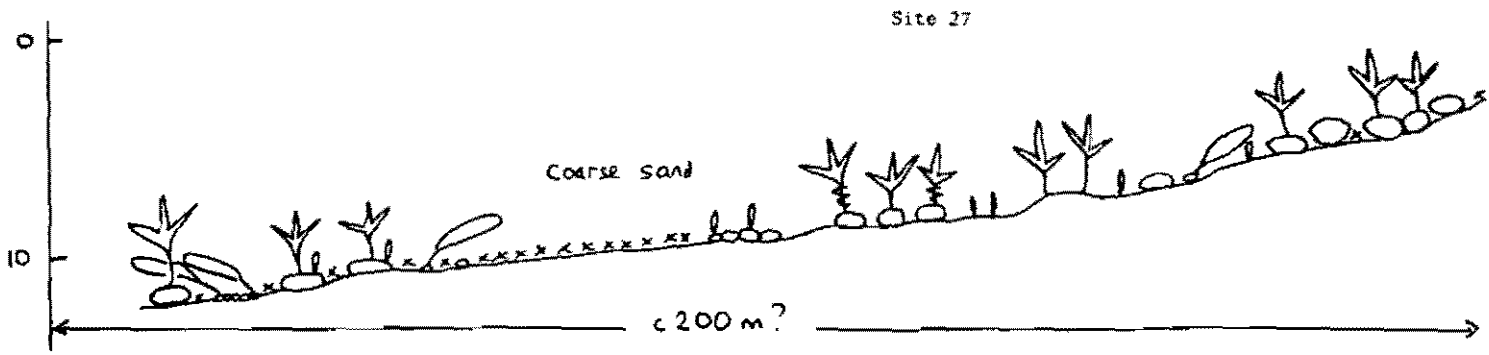


Site 24

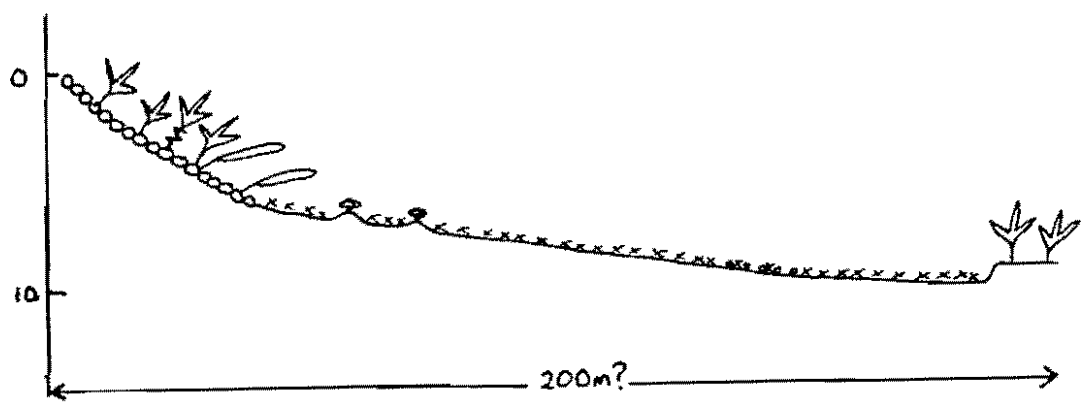


Site 26

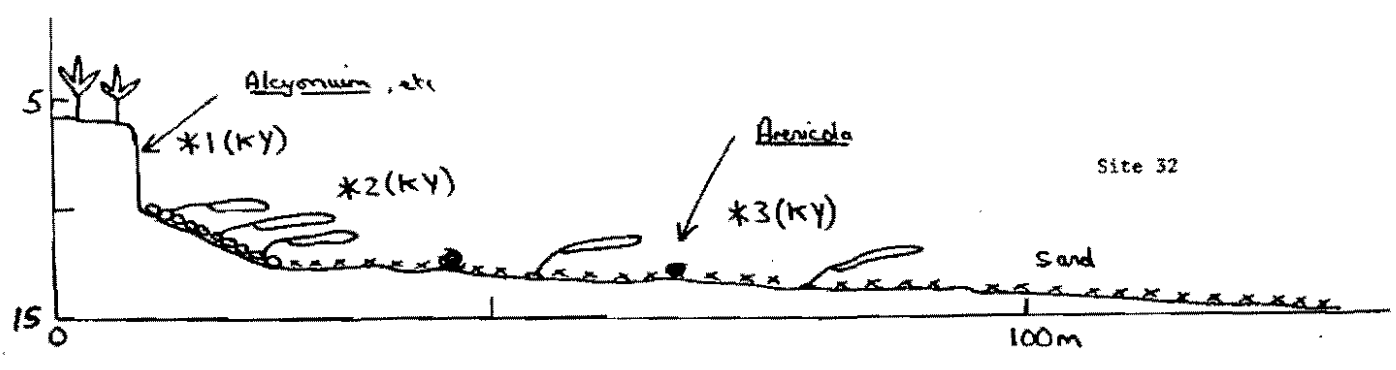




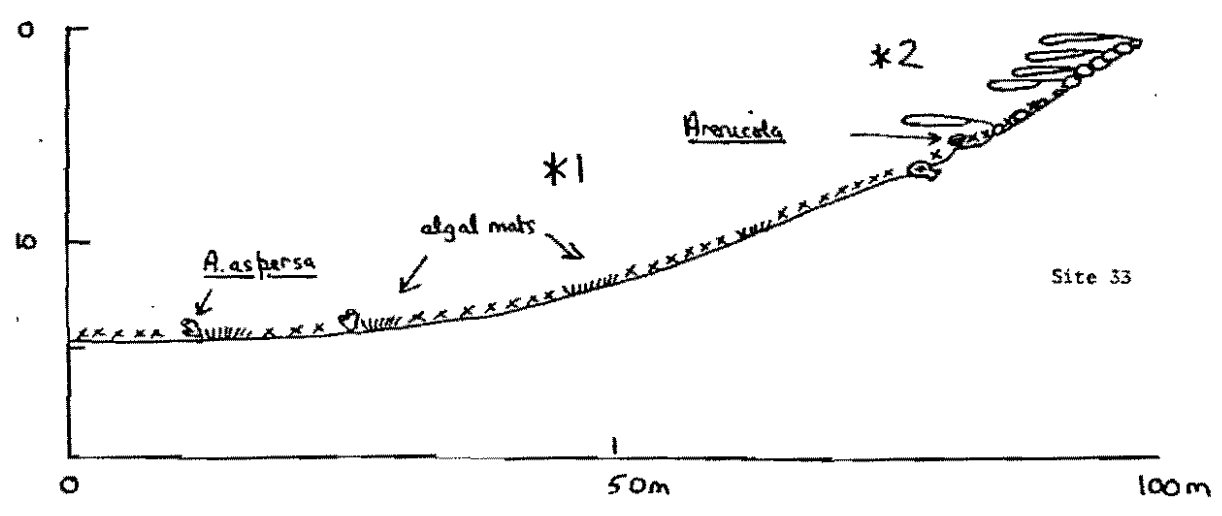
Site 31



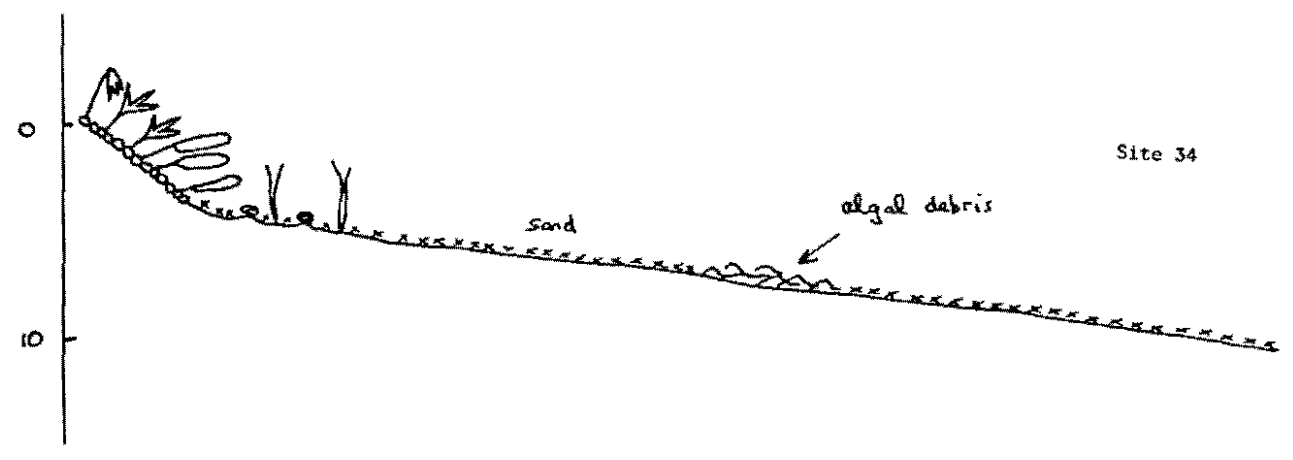
Site 32



Site 33



Site 34



APPENDIX 6: SLIDE CATALOGUE

Slide No.	Site No.	Photographer	Description
LE1	1	DM	<u>Nemertesia</u> sp.
LE2	1	GG	<u>E. pilosa</u> on red alga.
LE3	1	GG	<u>C. smithii</u> and <u>Pomatoceros</u> .
LE4	2	DM	Obelia on kelp frond and squid eggs, c. 16 m.
LE5	2	DM	Rafted kelp, squid eggs and <u>O. niger</u> , c. 16 m.
LE6	3	DM	<u>Liocarcinus</u> ? <u>depurator</u> .
LE7	3	DM	<u>Plumularia</u> sp.
LE8	3	DM	Ophiuroids in creviced rock ledge, c. 16 m.
LE9	3	DM	<u>Liocarcinus</u> <u>puber</u> .
LE10	3	GG	Brittle stars, etc, c. 16 m.
LE11	3	DM	<u>Corella</u> <u>parallelogramma</u> .
LE12	3	DM	<u>Lomanotus</u> <u>geneii</u> , c. 15 m.
LE13	6	JW	Lower kelp forest, c. 15 m.
LE14	6	JW	Lower kelp forest, c. 15 m.
LE15	6	JW	<u>Echinus</u> on circalittoral rock, c. 19 m.
LE16	6	DM	<u>Echinus</u> , <u>Clavellina</u> , lithothamnion, <u>Parasmittina</u> <u>trispinosa</u> , c. 25 m.
LE17	6	DM	Lower extremity of kelp; squid eggs, <u>Echinus</u> , c. 19 m.
LE18	6	DM	<u>Flustra</u> etc, circalittoral, c. 26 m.
LE19	6	DM	Grazed circalittoral rock with <u>Flustra</u> and <u>Clavellina</u> , c. 25 m.
LE20	7	DM	<u>Parasmittina</u> , <u>Clavellina</u> etc, c. 8 m.
LE21	7	DM	<u>Leptasterias</u> <u>mulleri</u> , <u>Clavellina</u> and encrusting fauna.
LE22	7	DM	<u>Calliostoma</u> on kelp frond.
LE23	7	DM	Boulder top with ? <u>Tralliella</u> , c. 12 m.
LE24	8	GG	Boulder area, <u>Crossaster</u> etc, c. 18 m.

LE25	8	GG	Boulder area, <u>Echinus</u> , c. 18 m.
LE26	8	DM	<u>Diplosoma</u> sp., c. 16 m.
LE27	8	DM	Rock and kelp holdfast, c. 16 m.
LE28	8	DM	Turf, <u>A. digitatum</u> etc, c. 18 m.
LE29	8	DM	Turf, <u>A. bifida</u> , <u>Amphilectus fucorum</u> , c. 16 m.
LE30	8	DM	Turf, <u>Corynactis</u> , <u>H. panicea</u> .
LE31	8	DM	Ascidian turf: <u>Polyclinum aurantium</u> , <u>Polycarpa rustica</u> , <u>Aplidium proliferum</u> , c. 17 m.
LE32	8	DM	<u>Lissoclinum perforatum</u> etc, c. 17 m.
LE33	8	SH	Turf, <u>Crossaster</u> , residual kelp, c. 18 m.
LE34	8	SH	<u>Antedon</u> , <u>Alcyonium</u> , <u>Securiflustra</u> , c. 19 m.
LE35	8	SH	Turf, c. 19 m.
LE36	8	SH	Ascidian turf with <u>Synoicum pulmonaria</u> , c. 19 m.
LE37	8	SH	Scour zone at edge of pebbles, c. 21 m.
LE38	8	SH	Turf at edge of scour zone, c. 20 m.
LE39	8	DM	Kelp stipes with <u>H. panicea</u> , c. 15 m.
LE40	9	SH	Algal undergrowth, c. 4 m.
LE41	9	SH	'Cave' walls, c. 11 m.
LE42	9	SH	<u>Alcyonium</u> , <u>Pachymatisma</u> etc, c. 6 m.
LE43	9	SH	<u>Filograna</u> and <u>Alcyonium</u> , c. 11 m.
LE44	9	SH	General view: <u>Alcyonium</u> , kelp, c. 9 m.
LE45	9	GG	Grazed rock.
LE46	9	DM	<u>H. panicea</u> etc. in surface cave, c. 2 m.
LE47	9	DM	Barnacles at c. CD in cave.
LE48	9	DM	Turf in cave: <u>A. proliferum</u> , bryozoans, c. 6 m.
LE49	10	SH	<u>Metridium</u> , etc.
LE50	10	SH	Schizophistoma larvae on overhang, c. 4 m.

LE51	10	SH	<u>Metridium</u> , c. 14 m.
LE52	10	SH	Boulder/mud interface, c. 18 m.
LE53	10	SH	Turf with <u>Nemertesia ramosa</u> and <u>C. smithii</u> , c. 13 m.
LE54	10	DM	Turf with <u>Ascidia virginea</u> .
LE55	10	DM	Grazed rock with <u>Echinus</u> and <u>C. smithii</u> , c. 14 m.
LE56	10	DM	Rock/sand interface, c. 18 m.
LE57	11a	DM	<u>Chlamys opercularis</u> .
LE58	11a	DM	<u>Crossaster</u> , kelp debris, c. 16 m.
LE59	11a	DM	Algal debris, etc, c. 16 m.
LE60	11a	DM	Silty kelp ("cape"?).
LE61	11b	SH	Algae/pebbles, c. 2 m.
LE62	11b	SH	<u>Homarus vulgaris</u> .
LE63	13	SH	Pebble substrate, c. 15. m.
LE64	14	GG	<u>Alcyonium</u> , turf on vertical rock face.
LE65	14	DM	Base of kelp forest, c. 4 m.
LE66	14	DM	Gully wall fauna, c. 5 m.
LE67	14	DM	Base of kelp forest.
LE68	14	DM	<u>Hyas</u> on sand, c. 13 m.
LE69	14	DM	Pipe fish on sand, c. 19 m.
LE70	15	DM	Crevice fauna: <u>Polycarpa rustica</u> , <u>Lissoclinum</u> / <u>Didemnum</u> sp., <u>B. schlosseri</u> , <u>B. leachii</u> , c. 20 m.
LE71	15	DM	Gully wall: <u>Pachymatisma</u> etc, c. 20 m.
LE72	15	DM	Brittle star bed, kelp stipe, <u>Halichondria</u> , c. 16 m.
LE73	15	SH	Brittle star bed, c. 15 m.
LE74	15	SH	Brittle stars.
LE75	15	SH	Gully wall: <u>Pachymatisma</u> etc.
LE76	15	JW	Brittle star bed, <u>Alcyonium</u> etc.
LE77	16	DM	Crevice fauna.

LE78	16	SH	Brittle stars on sand, c. 17 m.
LE79	16	SH	Cave in limestone, c. 6 m.
LE80	16	JW	Limestone gully and kelp, c. 8 m.
LE81	16	DM	<u>B. leachii</u> , <u>Trididemnum tenerum</u> (?) and crevice fauna.
LE82	16	JW	Creviced limestone, c. 7 m.
LE83	16	DM	<u>Haliclona viscosa</u> , <u>P. rustica</u> , etc, c. 7 m.
LE84	16	DM	Brown algae on cobble, c. 11 m.
LE85	17	DM	<u>Lissoclinum perforatum</u> , <u>P. rustica</u> .
LE86	17	DM	<u>Facelina bostoniensis</u> .
LE87	17	DM	<u>Eudendrium</u> sp. (?)
LE88	17	DM	<u>Polyclinum aurantium</u> .
LE89	17	DM	<u>Polycarpa rustica</u> .
LE90	17	SH	<u>Alcyonidium diaphanum</u> , <u>Polycera quadrilineata</u> , c. 28 m.
LE91	17	SH	<u>Pholis gunnellus</u> , c. 28 m.
LE92	17	SH	Hydroid, ? <u>Obelia</u> sp., c. 28 m.
LE93	17	SH	General view, cobble, c. 28 m.
LE94	17	SH	Lower infralittoral rock fauna, c. 16 m.
LE95	17	SH	Circolittoral rock: <u>Clathrina</u> , <u>Henricia oculata</u> , c. 16 m.
LE96	19b	JW	Kelp forest.
LE97	19b	SH	Scorpion fish, kelp stipes, c. 11 m.
LE98	19b	SH	Gravel, cobble, c. 11 m.
LE99	20	DM	<u>Lacuna vineta</u> on <u>Desmarestia</u> .
LE100	20	DM	Kelp and sand, c. 10 m.
LE101	20	DM	Kelp and sand, c. 10 m.
LE102	21	SH	<u>Arenicola</u> mounds, c. 6 m.
LE103	21	SH	Cave wall: <u>Onchidoris bilamellata</u> and eggs, <u>Diplosoma</u> sp., <u>Leucosolenia complicata</u> .

LE104	22	DM	Epiphytes on kelp stipe.
LE105	22	DM	Kelp holdfasts etc, c. 8 m.
LE106	22	SH	<u>Clathrina</u> .
LE107	22	DM	Microcionid.
LE108	22	DM	Grazed wall. (?) <u>Porania</u> , eating <u>Alcyonium</u> , c. 18 m.
LE109	22	SH	<u>Flustra</u> , <u>Nemertesia</u> , c. 20 m.
LE110	22	SH	Large boulders, c. 24 m.
LE111	22	SH	<u>Marthasterias</u> , eating <u>Echinus</u> (?)
LE112	22	SH	<u>Cyanea capillata</u> .
LE113	22	SH	Grazed rock, kelp and young gadoids, c. 14 m.
LE114	23	JW	<u>Arenicola</u> cast, hermit crab.
LE115	23	JW	<u>Echinus</u> , <u>Psammechinus</u> , on sediment.
LE116	23	SH	<u>Serpula</u> tubes.
LE117	23	SH	Burrowing anemone.
LE118	23	SH	<u>Sabella</u> , c. 2 m.
LE119	24	DM	<u>Virgularia mirabilis</u> , c. 12 m.
LE120	24	DM	<u>C. opercularis</u> with <u>M. macilenta</u> , c. 10 m.
LE121	24	DM	Hermit crabs.
LE122	24	DM	Algal mat, c. 9 m.
LE123	24	DM	<u>Hyas</u> (?) <u>araneus</u> on sediment, c. 7 m.
LE124	24	DM	Grazing <u>L. littorea</u> , c. 1 m.
LE125	25	SH	Underside of buoy.
LE126	25	SH	<u>Mytilus</u> on chain.
LE127	25	DM	Buoy chain, limit of algae (c. 15 m).
LE128	25	DM	Buoy chain: <u>Onchidoris bilamellata</u> and eggs.
LE129	25	DM	Buoy chain: <u>C. opercularis</u> and <u>F. bostoniensis</u> .
LE130	26	DM	Turf: <u>B. flabellata</u> , <u>Diplosoma</u> , etc, c. 5 m.

LE131	26	DM	Turf: <u>B. schlosseri</u> , <u>Diplosoma</u> , etc., c. 5 m.
LE132	27	SH	Algae on sand, c. 6 m.
LE133	27	SH	<u>Eledone</u> , c. 9 m.
LE134	27	SH	<u>Eledone</u> , c.u.
LE135	27	SH	Algae on sand, c. 9 m.
LE136	28	DM	<u>Turritella communis</u> on sediment, c. 11 m.
LE137	28	DM	<u>Carcinus maenas</u> on sediment, c. 11 m.
LE138	28	DM	Algal mat with <u>A. mentula</u> , c. 11 m.
LE139	28	DM	<u>Echinus</u> and kelp debris, c. 11 m.
LE140	28	DM	Eroded limestone and fauna, c. 9 m.
LE141	28	DM	Eroded limestone and fauna, c. 9 m.
LE142	28	NB	<u>Calliostoma</u> , ophiuroids on eroded limestone.
LE143	29	SH	<u>Arenicola</u> mounds, c. 8 m.
LE144	29	SH	Maerl, sand, ... , c. 2 m.
LE145	30	DM	<u>Virgularis mirabilis</u> , c. 24 m.
LE146	31	JW	<u>Crossaster papposus</u> .
LE147	31	JW	General habitat - sand plain.
LE148	31	SH	Algae on sediment.
LE149	31	SH	Shell debris, <u>Asterias</u> feeding, c. 8 m.
LE150	31	SH	<u>Macropodia</u> sp.
LE151	32	GG	Turf: <u>Caryophyllia</u> etc.
LE152	33	NB	<u>Natica</u> sp.
LE153	34	JW	<u>Cerianthus lloydii</u> .
LE154	34	SH	<u>Pleuronectes platessa</u> , c. 5 m.
LE155	?	NB	Hermit crab with <u>Adamsia</u> .
LE156	tank	NB	<u>Lomanotus genei</u>
LE157	27	JW	Hermit crab.

APPENDIX 7

List of sublittoral algae found at sites surveyed around Loch Eriboll August 2nd to 16th. Nomenclature follows that in Parke and Dixon 1976 unless otherwise stated. Species are listed in alphabetical order under the main groups. Species are annotated with site number, and depth and habitat information. Abundance notations beginning with a capital letter refer to the scales given in Appendix II. 'Kelp' refers generally to *Laminaria hyperborea*.

CHLOROPHYCEAE

- Bryopsis plumosa* - 10, 14. Rare on steep or vertical bedrock from 2-9m.
Derbesia sp. ('Halicystis' phase) - 16. Occasional on flat, sand scoured bedrock at 15m.
Enteromorpha linza - 27. Frequent in sandy clearings in kelp forest at 3.5m
Enteromorpha sp. - 24, 34. Rare at Site 24; Frequent on cobbles at +0.5m at Site 34.
Ulva sp. - 27, 31. Frequent, in sandy clearings in kelp forest or on stones and shells in extensive sediment, 3.5-9m. On grazed bedrock and boulders at 1m.

PHAEOPHYCEAE

- Alaria esculenta* - 9, 12, 21, 26. Dense plants forming a quite wide zone from the lower shore down to approximately 1.8m at Site 9. Occasional on cobbles at 5m at Site 21. Locally common in lowest part of a gully at Site 26.
Arthrocladia villosa - 14, 16. Occasional on stones and shells in sand, pebbles and gravel, and mobile cobbles, from 8.5-16m.
Asperococcus turneri - 11b, 23, 34. Occasional or Frequent unattached, or attached to stones and shells in sand. On silty bedrock at Site 23. 2-5.5m
Chorda filum - 11b, 23, 24, 29, 31, 34. Occasional to Common on pebbles in sand and mud. Prostrate on sand at Site 31, and Occasional on boulders at Site 34. 0-5.5m; most abundant around 2m.
Chordaria flagelliformis - ?11b, 23, 29, 31. Frequent (Abundant at Site 23) on pebbles and boulders in sand, or unattached. +0.5-3m.
Colpomenia peregrina - ?11b. On pebbles in sand, 2m.
Cutleria multifida (sporophyte) - 10, 13, 14, 16, 19b, 29, 31. Rare to Frequent on stones and shells in sand, or on mobile cobbles. Rare on *Laminaria saccharina* stipes at 10.5m, Site 10. 8-15m.
Cutleria multifida (gametophyte 'Aglaozonia' phase) - 7, 8, 9, 10, 13, 14, 16, 19b, 22, 23, 28, 31, 34. Rare to Abundant, encrusting on boulder tops and bedrock, particularly on grazed or scoured surfaces, and surfaces heavily shaded by kelp. Also found on steep or vertical rock, and on pebbles. Present on ascidians at 16.5m, Site 8. 0.5-16.5m.
Desmarestia aculeata - 7, 10, 11b, 12, 14, 16, 21, 27, 28, 29, 34. Abundant on mobile cobbles or scoured bedrock; Occasional to common on vertical rock, in sandy clearings in kelp, and on pebbles in sand. 2-9m.
Desmarestia viridis - 7, 10, 11b, 12, 13, 14, 19b, 20, 27, 28, 29, 31, 34. Occasional to Frequent on cobbles and pebbles, and unattached on sediment.

On bedrock where grazed or next to sand. Forming loose-lying mats at 9m at Site 29. 2-11.5m.

Dictyota dichotoma - 6, 9, 10, 11b, 12, 13, 14, 21, 26, 27, 28, 29, 31. Rare to Frequent on bedrock and boulders beneath kelp, also on pebbles. An epiphyte on *Phymatolithon calcareum* (maerl) at 2m at Site 31, and unattached on sediment at 3-4m, Site 11b. 1-14m.

ectocarpoids - 10, 11b, 21, 34. Usually on other algae, particularly *Saccorhiza polyschides* and other kelp fronds, and *Desmarestia aculeata*. On sediment at Site 27. 2-10.5m.

Halidrys siliquosa - 11b, 19b, 23, 27, 29, 31. Occasional or Frequent on boulders in sand, or on sand-scoured bedrock. +0.5-6.5m.

Halopteris filicina - 13. Rare beneath open kelp, on ridged bedrock at 8m.

Laminaria digitata - 34. Abundant on cobbles at +0.4m.

Laminaria hyperborea - 6, 7, 8, 9, 10, 11b, 13, 14, 15, 16, 19b, 20, 21, 22, 26, 27, 28, 31, 34. Dense forest in outer loch area, with lower limit of plants at 19.5m, Site 8 and 18m, Site 22. At Sites 10, 11b and 34, a dense zone of plants with cape fronds was present in shallow water (above 2m), with dense *Laminaria saccharina* below. Absent from sites at extreme inner end of loch (Sites 23, 24 and 29). 0-19.5m. For further discussion of distribution and epiphytes, see relevant sections in the text.

Laminaria saccharina - 8, 10, 11b, 14, 16, 19b, 20, 21, 23, 24, 27, 28, 29, 31, 34. Present throughout the survey area in various amounts. Dense forest in shallow inner loch areas, replacing *Laminaria hyperborea*. In outer loch areas, generally present only on 'disturbed' bedrock, and on unstable substrata. Young plants Frequent at 19.5m, Site 8. 0-19.5m. For further discussion of distribution and epiphytes, see relevant sections in the text.

Laminaria sp. (young) - 10, 13, 14, 16, 19b, 20, 31. Occasional to Common on cobbles and pebbles, and in kelp undergrowth. On *Laminaria saccharina* stipes at 10.5m, Site 10. 2-16m.

Mesogloia vermicularis - 11b, 23. Occasional, on pebbles in sand or unattached, 1-2m.

Pseudolithoderma extensum - 10, 11b, 13, 14, 19b, 21, 23, 27, 29, 31. Probably present at all sites, and probably also recorded as 'encrusting brown algae'. Particularly abundant on silted bedrock and boulders, on steep and grazed bedrock, and on cobbles in sand and mud. 0.5-17m and below.

Saccorhiza polyschides - 11b, 16, 27, 31, 34. Occasional to abundant on boulders and cobbles. 1-11m. For further discussion on distribution and epiphytes, see relevant section in text.

Sphacelaria plumosa - 28. One specimen collected from between 7.5m and 11m.

Sphacelaria sp. - 11b, 16, 29, 31. Occasional to Frequent on pebbles in gravel, and epiphytic on maerl and as balls on *Halidrys siliquosa*.

Sporochnus pedunculatus - 13. Occasional on pebbles at 15m

Stilophora rhizodes - ?11b, 23, 29. Occasional or Frequent on mobile substrata, or unattached. +0.5-7m.

encrusting brown algae - 11, 22, 23, 27. On bedrock near cave entrance, and on pebbles in sand, 2.5-4.5m.

thin brown/red crusts - 23. On silt covered bedrock 4-10m.

RHODOPHYCEAE

- Acrosorium reptans* - 9, 13, 16. On vertical and sand-scoured rock, and kelp stipes. 8-15m.
- Acrosorium uncinatum* - 8, 9, 19b. Occasional or Frequent on boulders and steep bedrock. 1-19m.
- Ahnfeltia plicata* - 11b, 27. Occasional on cobbles beneath dense *Laminaria saccharina*, in sandy clearings in the kelp forest, and on stones on sand plain. 3-6m.
- Antithamnion plumula* - 13, 14, 16, 19b, 20, 27, 29. Occasional to Frequent on cobbles, pebbles and gravel, and stones and shells in sand. Also occasionally found on bedrock, including vertical rock. 1.5-16m.
- Apoglossum ruscifolium* - 11b. On boulders in sand at 2m.
- Bonnemaisonia asparagoides* - 9, 10, 12, 13, 14, 16, 19b, 20, 21, 27, 31. Occasional or Frequent on boulders and pebbles. On bedrock beneath open kelp, on steep rock and the tops of bedrock ridges. Usually found in deeper water. 4.5-15m.
- Bonnemaisonia hamifera* ('Trailliella' phase) - 9, 10, 11b, 13, 14, 22, 23, 28, 29, 31, 34. Frequent to Abundant on bedrock and boulders, often most abundant between 10m and 15m. Also on cobbles and pebbles, with large areas on pebbles at 5-6m, Site 11b. Abundant in loose mats on sediment at 9m, Site 29. Epiphytic on *Phymatolithon calcareum* (maerl) at 2m, Site 29. Probably present at most sites in small amounts. 0-15m.
- Brongniartella byssoides* - 10, 13, 14, 16, 19b, 26. Occasional to Frequent on bedrock and boulders, in kelp undergrowth and on deeper rock, and on scoured or grazed bedrock. On kelp stipes at 9.5m, Site 19b. 2-16.5m.
- Callophyllis laciniata* - 6, 8, 9, 12, 13, 14, 16, 19b, 20, 21, 27, 28, 31. Larger plants Occasional to Frequent on kelp holdfasts and stipes, and bedrock and boulders beneath kelp, 1-17m. Young plants Occasional to Common on pebbles and mobile cobbles, 8.5-15m.
- Ceramium rubrum* - 11b, 19b, 24, 27, 29, 31. Occasional to Frequent on other algae and on pebbles in sand. Common in unattached mats at Site 11b (2m) and Site 24. 2-9m.
- Chondrus crispus* - 11b, 24, 29, 31. Rare or Occasional on pebbles in sand, 1-2m.
- Chylocladia verticillata* - 11b, 29, 34. Rare or Occasional on stones in sediment, or loose on sediment. On the back of a live *Chlamys* at 9m, Site 29. 2-5.5(9)m.
- Compsothamnion thuyoides* - 6, 9, 10, 13, 14, 16. Occasional or Frequent on bedrock, boulders and pebbles, usually in deeper water. 4.5-17m.
- Compsothamnion ?gracillimum* - 26.
- Corallina officinalis* - 8. Common beneath dense kelp at 11.5m.
- Cryptopleura ramosa* - 7, 9, 10, 11b, 13, 16, 19b, 20, 21, 22, 27, 31. Frequent on bedrock, boulders and kelp stipes. Growing as 'balls' on sand at 6m, Site 27. 0.5-14m.
- Cystoclonium purpureum* - 11b, 27, 29, 31. Occasional on pebbles in sand, 3-9m.
- Delesseria sanguinea* - 7, 8, 9, 11b, 12, 13, 14, 16, 19b, 20, 21, 22, 26, 27, 28, 34. Occasional to Common on bedrock and boulders beneath kelp, and below the kelp lower limit. The deepest recorded foliose red alga at 23.5m, Site 22. Tiny sporelings (?*Delesseria*) Common on mobile cobbles at 8.5m, Site 16. 0-23.5m.

- Dilsea carnosa* - 11b, 27, 31. Occasional on boulders and pebbles in sand, 1-8m.
- Furcellaria lumbricalis* - 19b. On sand-scoured rock at 6.5m.
- Gelidium pusillum* - 29. Epiphytic on *Phymatolithon calcareum* (maerl) at 2m.
- Gracilaria verrucosa* - 14, 27. Frequent on stones and shell in sand, or embedded in sand. 9-9.5m.
- Griffithsia corallinoides* - 29. Drift plant at 9m.
- Halarachnion ligulatum* - 9, 13, 19b. Rare or Occasional on boulders and pebbles. 11-14m.
- Heterosiphonia plumosa* - 10, 27. Occasional on steep bedrock and boulders 0-8m.
- Hypoglossum woodwardii* - 8, 9, 13, 19b, 21, 27. Rare to Occasional on boulders, cobbles and pebbles. Frequent on steep bedrock near a cave entrance at 2-3m, Site 21. (2)6-19m.
- Kallymenia reniformis* - 8, 12, 13, 14, 16, 27. Occasional to Frequent on bedrock beneath kelp, 2-16.5m.
- Lithophyllum incrustans* - 23. Occasional on stones in muddy sand, +0.5m-1m
- Lithothamnion glaciale* - 11b, 23, 29, 31. Rare or Occasional on stones in sand, often as rhodoliths. +0.5-8m.
- Lomentaria clavellosa* - 7, 16. On flat sand-scoured bedrock at 15m, Site 16.
- Lomentaria orcadensis* - 21. Frequent on steep bedrock near cave entrance at 2-3m.
- Membranoptera alata* - 11b, 13, 19b, 20, 27. On kelp stipes. Co-dominant at Site 11b. 1-5m
- Naccaria wiggii* - 13. Occasional on pebbles at 15m. A possible northern distributional record for this species (see text).
- Nitophyllum punctatum* - 7, 9, 13, 14, 16, 19b, 20, 21, 26, 27, 31. Occasional to Frequent on pebbles and gravel, or on grazed or scoured bedrock. 1-16m.
- Odonthalia dentata* - 8, 9, 12, 13, 16, 19b, 20, 21, 22, 27, 31. Occasional to Common on bedrock and boulders beneath kelp, and in clearings in the kelp on scoured bedrock, boulders and cobbles. Common in kelp undergrowth at 11.5m, Site 8, and 0.5m, Site 13. 0.5-19m.
- Palmaria palmata* - 10, 12, 13, 19b, 20, 27. On *Laminaria hyperborea* stipes in shallow water. Dominant at 0.5- 1.5m Site 10 and Common at 1-1.5m Site 19b. 0.5-2.5m.
- Phycodrys rubens* - 6, 7, 8, 9, 10, 13, 14, 19b, 20, 23, 26, 27, 28. Occasional to Frequent, on kelp stipes, down to 17m at Site 8. Occasional to Frequent on boulders, cobbles and pebbles, usually in deeper water (11-15m). Occasional on vertical rock in shallower water (4.5-9m), and on silt-covered bedrock at 4-4.5m, Site 23.
- Phyllophora crispa* - 19b, 27, 28, 29, 31. Rare to Occasional on sandy bedrock and on stones in sand, 2-11m. Dense unattached mats on sediment at 9m, Site 29.
- Phyllophora pseudoceranoides* - 21. Rare in kelp undergrowth in shallow water.
- Phyllophora traillii* - 6, 9, 10, 28. Frequent on vertical rock, 7.5-12m.
- Phyllophora truncata* - ?11b, 27. Rare on boulders and stones in sand, 2-3.5m.
- Phymatolithon calcareum* - 29. Sparse patches of live and dead maerl in hollows in sand at 2m, at base of short boulder and sand slope. Dead maerl

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only at 3m. Extensive areas of dead broken maerl fragments on top of sand at 9m.

Plocamium cartilagineum - 7, 8, 9, 10, 11b, 12, 13, 14, 16, 19b, 20, 22, 26, 27, 28, 29, 31, 34. Frequent to abundant at many sites, and in a wide variety of habitats including bedrock, boulders, cobbles, kelp stipes and other algae, pebbles in sand, and unattached on sediment. Particularly abundant at 4.5m, Site 9, on steep and vertical bedrock beneath open kelp. 0.5-19.5m.

Polyides rotundus - 11b, 19b, 27, 31. On sand-scoured bedrock and pebbles in sand, 2-6.5m.

Polysiphonia elongata - 31. Occasional on shelly sand, 11m.

Polysiphonia nigrescens - 31. Frequent on pebbles at 1m, and on shells on sediment at 11m.

Polysiphonia urceolata - 13, 19b, 20, 28. Common to Abundant on kelp stipes at 0.5-1.5m. Occasional on grazed bedrock at 2.5m. 0.5-7.5m.

Porphyra purpurea - 27. Occasional in sandy clearings in the kelp at 5-6m; Frequent on extensive rippled sand at 9m.

Porphyra sp. - 13, 16. On cobbles, pebbles and gravel 11.5-16m. Common on pebbles and gravel at 16m, Site 16.

Pterosiphonia parasitica - 9, 10, 13, 14, 16, 31. Occasional on bedrock and boulders, beneath open kelp or on vertical, scoured or grazed surfaces. 1-16m.

Ptilota plumosa - 8, 9, 10, 11b, 12, 13, 15, 20, 22, 26, 31. On *Laminaria hyperborea* stipes, usually Common or Abundant, particularly in shallow water (0.5-4m). On stipes at 17m, Site 8. 0.5-17m.

Rhodomela confervoides - 13, 14, 20, 21, 24, 27, 28, 29, 31, 34. Occasional or Frequent on cobbles, pebbles and shells in sand. 1-15m.

Rhodophyllis divaricata - 8, 10. At 16m, Site 8; on vertical rock at 4-5m, Site 10. 4-16m.

Rhodophyllis sp. ('big') - 6, 9, 10, 15. Rare or Occasional on boulders in deep water, 13-17m.

Schmitzia hiscockiana - 13, 19b. Rare or Occasional on pebbles, 11-15m.

Scinaia turgida - 16. Occasional on pebbles in gravel, 16m.

encrusting coralline algae ('lithothamnia') - 7, 9, 10, 11b, 13, 14, 16, 19b, 21, 22, 23, 27, 28, 29, 31, 34. Probably present at all sites in varying amounts. Particularly abundant on grazed, scoured and vertical bedrock, and in gullies and the entrance to caves. On silt-covered bedrock in inner loch areas. Also on cobbles and pebbles. Present from 0m to at least 27m; Abundant at 27m, Site 22, on ?grazed bedrock.

encrusting dark red algae - 9, 10, 11b, 13, 14. Frequent to common on bedrock beneath kelp or on silted, steep or grazed surfaces. 0.5-17m.

maerl (see also under *Phymatolithon calcareum*) - 3, 28. At 6.5m, Site 3 ('common'); 'occasional' at Site 28, mostly dead with a few live bits, 7.5-11.5m.

CHRYSOPHYTA

Diatoms indet. (colonial) - 10, 14. On vertical rock at 2m, Site 10; On mobile cobbles at 8.5m, Site 16.

Diatoms indet. (on sediment) - 14, 23, 27, 29, 31. Forming a brown film on the surface of sand and mud, 5-10m.

CYANOPHYTA

Blue-green algae indet. - 8, 14. On *Pachymatisma johnstonia* at ca. 12m, Site 8; on *Alcyonium digitatum* at 4.5-9m, Site 14.