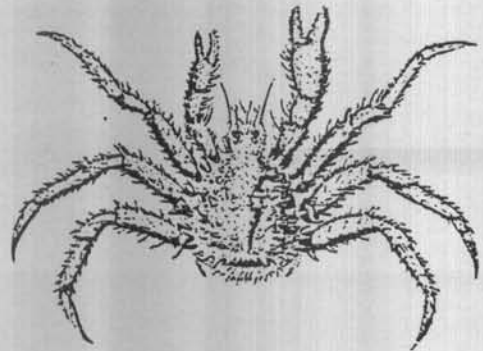
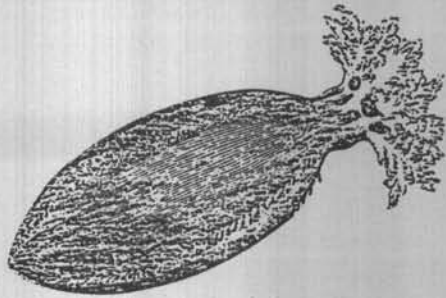


A SUBLITTORAL SURVEY OF SHETLAND, 1987

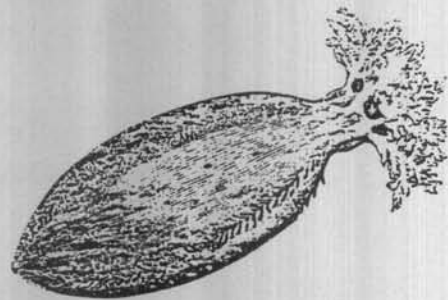
David Moss & Graham Ackers



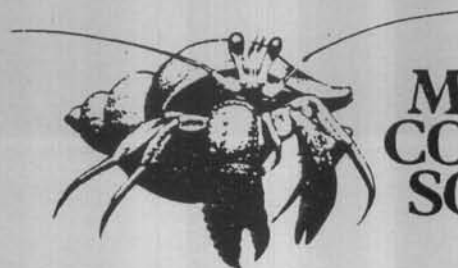
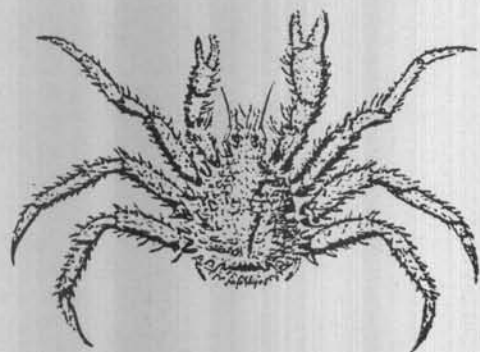
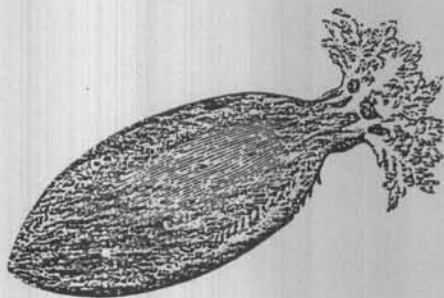
EUROPEAN YEAR
OF THE ENVIRONMENT

**SHETLAND
AMENITY TRUST**


**NATURE
CONSERVANCY
COUNCIL**



Sullom Voe Terminal



**MARINE
CONSERVATION
SOCIETY**

1. Introduction

Shetland has a special position in the history of British marine biology. In the mid-19th century a Dredging Committee was set up with a directive to "thoroughly examine the invertebrates of the deep sea" off Shetland. This led to the publication of very detailed accounts of the marine fauna of the area, which was found to be rich and interesting (e.g. Jeffreys, 1868). A summary is given in Earll (1982). In some ways the area seemed to represent a meeting of northern and southern species. Interest in the region was rekindled by the prospect of the oil industry establishing itself in Shetland in the 1970's. These studies were largely, but not entirely, confined to the sheltered voes and the relatively shallow sublittoral on the exposed coasts. They showed that, in contrast to the experience of the Victorian dredging operations in the deep basins (see Fig. 1), the fauna of predominantly rocky habitats in the shallow sublittoral was relatively impoverished. The flora was also found to be less diverse than in northern Scotland and Orkney. See, for example, Earll (1982) and Irvine (1974).

The 1987 Marine Conservation Society Survey was intended to investigate a wider range of exposed rocky habitats with some emphasis on those towards the limits easily attainable with SCUBA techniques. The survey was scheduled for the fortnight immediately preceding a visit by NCC's Marine Nature Conservation Review Team, and it was intended that the MCS investigation should also provide some preliminary information for the MNCR survey. The survey also agreed to make a faunal collection for the Lerwick Museum, to produce a 'semi-popular' report for distribution in Shetland, and to compile a set of photographic slides illustrating the sublittoral marine life around Shetland for several local organizations.

Besides the usual aims of diving marine biological surveys - to increase our understanding of some aspect of sublittoral biology - Marine Conservation Society surveys of this type provide an opportunity for members of MCS to extend their range of marine biological knowledge and associated skills by taking part in a structured survey. The range of recording ability possessed by participants at the beginning of such a survey is typically large, ranging from 'novice' to those who have participated in previous activities of this type and who have reasonable competence in recording.

Whilst in Shetland two members of the team (GA and DM) gave a short interview to Radio Shetland, and illustrated slide talks to the Shetland Field Society.

Some financial support was provided by NCC (who also loaned a compressor), The Shetland Amenity Trust, The Shetland Oil Terminal Advisory Group and The Shetland Oil Terminal. The latter also allowed us to use a 5 m Sea Rider and a Land Rover. The balance of the expenses were paid by the participants.

The responsibilities for writing this report were split between GA and DM as follows. GA originated the descriptions of the animal groups in Sections 4.3.2 to 4.3.12, and DM originated the remaining material and was responsible for overall editing and compilation.

2. Environmental conditions and geography

Shetland lies some 120 miles north of the Scottish mainland. Its geographic isolation and northerly latitude (approximately that of Bergen) is rarely appreciated by those living in the south of the British Isles, nor is the linear dimension of the island group (approximately 70 miles from Sumburgh Head to the north of Unst). Because of the heavily indented coastline (over 900 miles in

length), no point is more than 3 miles from the sea. The topography of the islands has been greatly influenced by the ice ages, although most of the voes are drowned river valleys rather than true fjords formed directly by ice action (Ronas Voe is an exception). Berry and Johnston (1980) give a good popular account. The steep cliffs frequently continue as sharply sloping sublittoral profiles, resulting in relatively deep water very close to the shore.

A number of Admiralty charts cover the area at various scales; for general purposes numbers 3281, 3282 and 3283 at a scale of 1:75000 give complete coverage. Shetland lies in the North Atlantic Drift and so the water temperatures rarely become very low, and the annual variation is small, with bottom temperatures ranging from c. 7°C to c. 10°C (MAFF, 1981). The sea water is of the 'oceanic' type. The mean wind speed is high, and only Bell Rock and the Butt of Lewis around the UK record more hours of gales a year than Shetland. Thus the wave exposed outer coasts and offshore islands, where the effects of winter storms can be expected to be apparent to depths of 30 m or more, form an abrupt contrast to the sheltered conditions obtaining in the voes. This is particularly noticeable in the distribution of the sediment - in the voes soft sediment may extend up to Chart Datum, whereas on exposed coasts bedrock or boulder slopes often extend well beyond 30 m. The tidal range around the islands is quite small (1-2 m), but high water on the east coast occurs some 1½-2 hours after that on the west, which results in very strong tides (to 7 or 8 knots on the chart) in parts of Yell Sound. Outside of Yell Sound and Bluemull Sound tidal streams are generally much slower. The oceanic water, absence of any large river systems with associated sediment transport, together with the lack of industrialization, contribute to a high water clarity, and visibilities of over 20 m were estimated on a number of occasions.

3. Methods

The participants in the survey were all amateur naturalists from the membership of MCS, apart from Teresa Bennett from NCC who dived with the team for the first six days. The survey was based at the Voxter Centre, an extremely comfortable Field Centre established by the Shetland Islands Council, conveniently situated near the village of Brae, a fairly central location for access to sites in north and central Shetland. The diving team varied between 8 and 11 members, and we had the services of a non-diving cook who also undertook some identification work.

Most of the diving was carried out from an inflatable and a 5 m Sea Rider. A fishing boat was hired for the outing to Out Skerries. Because of the wide geographic distribution of sites it was necessary to tow and launch the boats every morning and retrieve them in the evening. Whereas this proved no problem with the inflatable, which could readily be launched from any convenient beach, the much heavier Sea Rider, with its rigid keel and permanently attached 70 hp engine, required a good slip. These were scarce and not always very conveniently placed, and these logistical problems influenced and restricted somewhat the choice of diving sites. For reasons of safety, diving was restricted to 'no stop' times, and the boats were operated together, except for a period of 2 days when the team split, with four members taking the inflatable to dive around Unst. Fortunately the weather was reasonably good for most of the fortnight, and wind strengths high enough to seriously restrict the choice of diving sites were only experienced on 4 or 5 days. Nevertheless air and water temperatures were quite low (typically 9-12°C and 8°C respectively) and the two divers in wetsuits became rather chilled. Sites were selected from examination of the charts, reports of previous surveys and the local knowledge of one of the team (RG).

The methods employed were generally similar to those of previous MCS general surveys (e.g. Dipper, 1981, 1983; Moss, 1986). Divers recorded their observations whilst underwater on Formica boards, and data were transferred at lunch times and in the evenings onto duplicated checklists (Appendix 1). Some 'SeaSearch' forms were also completed. Raw data sheets are held by NCC. Species were recorded to the best of each individual's ability, and some material was collected for later examination and identification, either at base or later by experts on the relevant groups. Photographs were also taken by a number of divers. Recording skills varied widely between members of the team and, as is usual on such trips, the overall standard of recording improved considerably after the first few days. Some groups were more thoroughly recorded than others, because of individuals' personal interests. This was certainly true of the nudibranchs, and would have been true of the sponges had more been present! Whereas the record of the more conspicuous fauna is probably reasonably complete, the absence of a diver with a sound knowledge of marine algae meant that algal records are extremely patchy, and do not provide a consistent set of observations. Quantitative abundance estimates into classes 'abundant', 'common', 'frequent', 'occasional' and 'rare' were attempted using the scales proposed by Hiscock (1983, see Appendix 2), with a slight modification for the Porifera. Occasionally only 'present' was recorded, however.

4. Results

4.1 Preamble

Information on the site names, locations, depth surveyed, underwater visibility and Echinus abundance is given in Table 1. With the exception of the Unst sites, for which the team was split for two days, sites are numbered in chronological order. An attempt at a broad classification of major habitat indicators is given in Table 1 according to the following scheme: class A is very exposed (open coast, offshore island), class B is exposed with some shelter (mouth of voes, etc) and class C is fully sheltered (well within the voes). A numerical code between 1 and 6 is also given: 1 = infralittoral bedrock, 2 = circalittoral bedrock, 3 = infralittoral boulder slope, 4 = circalittoral boulder slope, 5 = infralittoral sediment, 6 = circalittoral sediment. Brief descriptions of the sites are given in Appendix 3. All depths are corrected to Chart Datum.

Because little diving was done within the voes, a gradation of water clarity/kelp distribution with distance from the open sea cannot be sought. However, if the mean depth of the lower limit of the kelp is calculated for each of the classes A, B and C, the results are 19.4 m, 17.1 m and 13.6 m respectively. Only upper limits for the depth of the deepest plants were available at a few of class A and B sites, where either the rocky substrate (which large kelp plants need to live on) ended before the kelp did, or where the divers did not reach the kelp limit. However, these sites do not greatly affect the averages. The lowest kelp was usually Laminaria saccharina at class C sites, and L. hyperborea elsewhere. Whilst hardly conclusive, this does suggest the usual sort of trend of vertical extent of kelp with water clarity - see also the discussion in Section 4.3.1.

Appendix 5 contains a summary of the algal records. Because of the rather unsystematic manner in which this group was recorded, abundance data has not been given, except for the coralline encrusting algae ("Lithothamnion"). Appendix 6 gives the detailed faunal records (names mostly following the MCS Species Directory; Howson, 1987), and Appendix 4 contains profiles of all the sites visited. In Appendix 4 the vertical scale is believed to be reasonably accurate, but the horizontal scale is far more qualitative, as no formal

transects along a line were performed. Divers were asked to estimate horizontal distances covered, and once or twice this information was supplemented by observations from the covering boat. In one or two cases two profiles are given where pairs of divers found significantly different profiles when diving quite close together. For a few sites the profiles are composites of two or three similar profiles. In each case the aim has been to represent the general conditions found, rather than to make an accurate 'map' of the area. Finally, Figure 2 gives a more accurate position and approximate indication of the line taken by the divers for each site and Appendix 7 is a catalogue of the slide set assembled for NCC.

4.2 Major habitat types and animal communities

A very crude classification of some parameters relevant to habitat is given in Table 1. In this section an attempt is made to describe in slightly greater detail the more frequently encountered habitats and their associated faunal communities. Only a 'broad brush' description is essayed - clearly many micro-habitats exist and would be described by a more detailed survey. Echinus is not usually mentioned specifically - it could be common in any of the habitats or communities described except for sediments (4.2.7/8) and animal 'turf' (4.2.9).

4.2.1 Steep/vertical/overhung rock faces in exposed sites

Typically these had an abundant but low-diversity fauna whose main components were the soft coral Alcyonium digitatum, the keelworm Pomatoceros lamarckii (ex triqueter), with growths of the fine calcareous tubeworm Filograna implexa sometimes occurring between the Alcyonium colonies. Patches of the bryozoan Parasmittina trispinosa were also present. The feather star Antedon bifida frequently occurred near the top edge of small vertical/overhung faces, and the starfish Leptasterias mulleri was occasionally found clinging to the rockface. Hydroids, especially Kirchenpaueria pinnata, were sometimes present and if the rock was at all creviced, the arms of the brittle star Ophiopholis aculeata could be seen. Very good examples of this habitat occurred at Sanda Stour SE (site 4), W. Skerry E (8) and Stoura Skerry (28), as well as many others.

4.2.2 Infralittoral, moderately inclined bedrock

This usually supported a forest (occasionally a 'park', if deeper) of the kelp Laminaria hyperborea, sometimes with an admixture of Saccorhiza polyschides. (At Muckle Roe S an almost pure stand of S. polyschides was found). The rock between the kelp stipes was frequently grazed bare except for pink encrusting coralline algae. Foliose red algae occurred rather sparsely on the bedrock, but were often abundant epiphytically on Laminaria stipes. The jewel anemone Corynactis viridis was sometimes present on vertical surfaces such as gully sides, and the dahlia anemone, Urticina felina, in crevices. This habitat was common at class A and B sites, for example Muckle Roe S (site 2), Sanda Stour (4), Swarbacks Skerry (11), Ness of Queyfirth (27b), Stoura Skerry (28), The Drongs (30), amongst others.

4.2.3 Sheltered boulder slopes

These were found in the voe sites, and were short, usually extending to c. 6-10 m below CD. Typically they supported a dense growth of Laminaria saccharina but had no distinctive fauna. (Mavis Grind, site 40, was an exception, with the boulder/sediment boundary extending to c. 14 m in places, well below the depth at which Laminaria saccharina grew prolifically. Here there was a boulder fauna of the ascidians Ascidia mentula and Ascidella

aspersa; the spider crab, Hyas araneus, and A. bifida were also present. A bedrock cliff was also present at this site).

4.2.4 Exposed boulder slopes

The habitats described in this section vary from steep (c. 45°) slopes to what might be described as 'inclined plains'. The size of the boulders varies from football- to car-sized.

At a number of the exposed sites dived, the bedrock slope eventually gave way to a steep boulder slope. At the more exposed sites this usually happened below the depth at which kelp occurred in significant quantities, but at the semi-exposed sites 27a and 33b the boulder slope extended from c. CD and supported a kelp forest. At Hagdale Ness (17) a kelp park extended to c. 24 m on boulders. Below the influence of the kelp, encrusting coralline algae, and sometimes encrusting red algae, often covered much of the boulder tops. At other sites, notably Stoura Skerry (28) Alcyonium was common on boulder tops. The vertical/overhung faces often had a Pomatoceros/Alcyonium fauna, as described in Section 4.2.1.

The black brittle star, Ophiocomina nigra, was sometimes present in quite large numbers. When the slope was less steep, patches of coarse sand or shell gravel were present between the boulders (cf. sites 2 and 28). The anemone U. felina was sometimes recorded and, at site 2, numbers of a burrowing holothurian were seen. Other typical fauna included starfish and the squat lobster Munida rugosa.

At one or two sites (e.g. Ramna Geo, 32a) the boulders were very large, and adjoined so as to provide many large recesses. At site 32a these sheltered cuckoo and ballan wrasse and juvenile gadoids, as well as the ascidia A. mentula.

4.2.5 Stable pebble/cobble

This habitat was generally found at fairly deep sites, often exposed to current (e.g. Norvick Hevda (15), Hagdale Ness (17), Bluemull Sound (19), Hoo Stack N (21), Ling Ness SW (23), Little Holm N (26), Vaila: Tower (41)). Encrusting coralline algae were particularly noted at the relatively shallow site 15, and the pebble plain at site 17 was recorded as 'rather barren'. Elsewhere hydroids (including dense Sertularia argentea with associated caprellids and amphipods at site 19) and ophiuroids were typical of the fauna, with both O. nigra and O. fragilis occurring over the substrate and O. fragilis and O. aculeata beneath the pebble/cobble. In some places encrustations of Pomatoceros were frequent. At site 21 Strongylocentrotus droebachiensis was recorded, together with Ciona intestinalis and Alcyonium. The crevice fauna was not sampled systematically.

4.2.6 Flat/gently sloping circalittoral bedrock

This was usually the continuation of a bedrock slope that extended from CD, but was often levelling out by 20-30 m, e.g. sites 20, 26, 29, 37 amongst others. Typically low rock ridges, smooth or jagged, would have patches of coarse sand or shell gravel between. Vertical faces would have the habitat described in 4.2.1. The brittle stars O. nigra and O. fragilis were frequently present, sometimes in large quantities especially if the area was current swept (e.g. Little Holm N, site 26). Other starfish were also often seen. The horse mussel, Modiolus modiolus, frequently was found in small patches on both horizontal rock surfaces and on the sediment. These clumps constituted a distinct microhabitat, supporting hydroids and brittle stars inter alia.



Diving at Giant's Leg
(site 35) [DM]

Kelp, Laminaria
hyperborea, with sea mat
Membranipora membranacea
[DM]



Sponge, Mycale sp., on valve
of queen scallop Aequipecten
opercularis [DM]

Hydroid, Kirchenpaueria
pinnata [GD]



4.2.7 Sheltered muddy substrates

These were found in the voes (class C sites). Besides soft mud, shell gravel and pebble were also present. The algae Chorda filum and Ulva sp. were often attached to pebbles and shell fragments in the shallows. Occasional specimens of the kelp L. saccharina were found on the sediment attached to pebbles and sometimes to the horse mussel Modiolus modiolus. The latter occurred in small clumps, giving some stability to the substrate. Clumps of the sea squirt A. aspersa were often present, attached to Laminaria stipes, stones, Modiolus and debris. At Flotta (site 38) several specimens of the large black sea cucumber Cucumaria frondosa were recorded.

4.2.8 Exposed sediment

Exposed sediment plains were rare, as at exposed sites a rock/sediment boundary was not usually reached. In Burra Firth (Unst) at site 15, barren fine sand was reported at c. 20 m, and at E. Lunna Voe (33b) coarse sand worked by bivalves including Ensis, and with the edible crab Cancer pagurus and the scallop Pecten maximus, was present. More usually, exposed sediment occurred in small patches (see section 4.2.6). At sites 12 and 13 quite large areas of clean shell gravel occurred, broken up by bedrock outcrops and boulders. The latter supported kelp, but the sediment was fairly barren, except for algae growing on pebbles, and hermit crabs.

4.2.9 Animal 'turfs'

These were only found at two sites - both on shaded, nearly vertical rock, extending a few metres downwards from Chart Datum. This community is probably present wherever the shade of caves or arches discourage the growth of algae, and wave action on steep/vertical rock surfaces in shallow water make life difficult for Echinus. However such habitats, although probably not uncommon in areas of nearly vertical sea cliff (e.g. Bressay, Noss, Lunna Ness, etc) were not much investigated. Giant's Leg (site 35) provided us with the best example, with a thick turf of foliaceous bryozoans, hydroids and colonial ascidians - Botrylloides leachii, Diplosoma sp., Clavelina lepadiformis, Didemnids and Polyclinids, including the only record of Aplidium proliferum. The anemones Sagartia elegans and Metridium senile (juvenile/dwarf form) were also quite common here. A 'thin' ascidian/sponge/bryozoan turf was also reported from E. Lunna Voe (33b).

4.3 Description of species

4.3.1 The seaweeds

A systematic recording and description of the marine algae was not attempted. The species list compiled (Appendix 5) is rather haphazard, the less conspicuous species only being recorded when a specimen happened to be collected. Nevertheless a few general remarks can be made.

The clarity of the water at the more exposed sites naturally extended the infralittoral zone (where algae are a significant part of the ecosystem) to greater depths than in most of the British Isles. Of the three divisions of macroscopic marine algae the Phaeophyta, or brown seaweeds, contain the largest and most prominent species, and some were present at all sites.

The deepest record of the kelp Laminaria hyperborea was at 26 m BCD (at Hols Hellier and Stoura Skerry, sites 14 and 28 respectively), and a kelp park extended to 24 m at South Holms SW (site 16). Except at some of the more sheltered sites, the lowest kelp was usually Laminaria hyperborea.

The distribution of kelp limits with exposure class is discussed in section 4.1. However, among the class A sites taken alone, and also among the class B sites, there was a considerable variation in the depth of the kelp limit. If the class A and B sites taken together are grouped according to the reported abundance of the Common Sea Urchin Echinus esculentus, then sites with abundance 'occasional' or 'frequent' have a mean lowest recorded depth of kelp of 20.1 m, whereas those with abundances of 'common' or 'abundant' have a mean depth of 17.1 m. Whilst these statistics are hardly conclusive they do suggest the effects of water clarity and perhaps Echinus grazing pressure in the vertical distribution of the kelp.

Saccorhiza polyschides is another large kelp plant, distinguished by its flattened stipe and 'bubbly' holdfast. It was reported from six sites, usually mixed in with L. hyperborea. At Muckle Flugga S (site 2), on one dive profile L. hyperborea extended to 9 or 10 m BCD, and then there was an abrupt change at this depth to an almost pure stand of S. polyschides, which continued downwards to the end of the kelp zone. A similar zonation, with slightly varying transition depth, was found by other pairs of divers at this location. The Sugar Kelp, Laminaria saccharina, was found both attached to rock and on sheltered sediment attached to quite small pebbles, shells, etc. It is thus rather more widespread than the previously mentioned species, which need bedrock or quite large boulders to provide a secure attachment for a mature plant, but usually occurs in smaller quantities. It was recorded from 21 sites.

Of the smaller brown seaweeds, Desmarestia aculeata, was conspicuous at several sites, forming a thick 'meadow' between c. 23 and 25 m at Longa Skerries (site 29). This species often had a very heavy encrustation of the Hairy Sea Mat, Electra pilosa, which made it appear greyish white from a distance.

The red seaweeds (Division Rhodophyta) are usually smaller than the browns, but nevertheless are a conspicuous part of the marine flora. Encrusting coralline algae ('Lithothamnion'), forming a pinkish stone-like covering on rocky surfaces, was reported from nearly all sites (and the omissions are almost certainly due to inadequate records). It clearly benefited from being one of the few encrusting organisms capable of withstanding the heavy grazing by Echinus, and at some locations the deeper rock was bright pink/purple with extensive encrustations. It only occurred in small patches at the sheltered vee locations.

Foliose red algae were rarely common on bedrock, but were often abundant on the stipes of L. hyperborea. Phycodrys rubens and Membranoptera alata were the most evident of these species, often heavily coated with the bryozoan E. pilosa. Phycodrys formed a dense 'meadow' at Ness of Queyfirth (site 27b) on a pebble slope between c. 14 and 18 m. Phycodrys was sometimes found with its fronds very finely dissected - this is a typical northern growth form. Other red algae noted included Callophyllis cristata, typically a northern species although found in England and Wales, and the rather inconspicuous Schmitzia hiscockiana; the latter appears to be the first record from Shetland for this recently discovered species. Specimens of the hydroids Abietinaria abietina often appeared red with an unidentified microscopic growth of red algae, and at site 20 the hydroid Sertularia argentea contained the endozoic red alga Audouinella infestans.

Encrusting 'mats' or 'crusts' of both red and brown algae were recorded from a number of locations. Collection and identification are both rather difficult

and most remain unnamed. However the brown 'crust' Aglaozonia parvula and the red 'fuzz' Trailliella imbricata were recorded.

The other Division of large marine algae - the green Chlorophyta - contains plants which are usually found in shallow water or intertidally; many are also relatively inconspicuous and difficult to identify. Only a few records were compiled for this group.

4.3.2 Sponges

Sponges are a common and conspicuous element of the sublittoral fauna to the west and south of the British Isles. To the north and east the diversity of species and the numbers of specimens are both less. Shetland is no exception to this pattern in the shallow sublittoral, although historical records suggest a richer fauna beyond diving depths. Only twelve named species were recorded (one or two others are yet to be identified), the records typically consisting of occasional specimens found at a few sites only. Even the ubiquitous breadcrumb sponge, Halichondria panicea, was recorded as common at only one site, growing on the stipes of the kelp Laminaria hyperborea at Swarbacks Skerry (site 11). It was also found on kelp stipes at Muckle Flugga (site 12) and The Drongs (site 30), as well as on rock substrates at five other sites.

Only three other conspicuous 'massive' species were recorded at more than one site. Haliclona viscosa grows as a purple cushion with conspicuous oscular 'chimneys', and favours clean oceanic water of the type found around Shetland. Even so, it was only found at four sites. Myxilla incrustans grows as a yellow cushion, with oscules frequently in rows, and possesses a distinctive surface of labyrinthine channels crossed by cobweb-like strands of tissue. It was recorded from six locations. Pachymatisma johnstonia is a large grey sponge, with oscules opening flush with the surface and arranged in rows. In much of western and northern Britain it is common at clear water sites. In our survey it was recorded from only three sites. One northern and eastern species typically of deeper water, Isodictya palmata, was found at Hoga Ness, site 18.

The above mentioned species are all fairly conspicuous members of the Demospongiae, containing siliceous spicules. There were also occasional sightings of thinly encrusting members of this group, which are almost impossible to identify 'in the field' (i.e. underwater!). However two species occurred on a very specific substrate - the upper valve of the Queen Scallop, Aequipecten (ex. Chlamys) opercularis. This mollusc is common on the sedimentary sea bottom found in the sheltered voes. This type of site was mainly avoided on this survey and there are relatively few records. It is possible that these two species could be the most common sponges occurring in the shallow sublittoral of Shetland. The purple crust is Mycale sp., and the orange crust Suberites domuncula.

Four species of the class Calcarea (with calcareous spicules) were found. As they tend to be less conspicuous than the members of the class Demospongiae described above, specimens may well have been overlooked at some locations. The lacy white encrustations of Clathrina coriacea were recorded from seven sites, sometimes in their classical surge gully habitat in association with the small red sea squirt Dendrodoa grossularia. Leucosolenia spp., which are difficult to separate in the field, were recorded from six sites. The two small purse sponges, Scypha ciliata and Grantia compressa, were found at two and one sites respectively.

4.3.3 Hydroids

Hydroids are colonial animals living attached to inanimate or animate substrates. They consist of tiny tentacled polyps assembled in feather shaped colonies, which can vary in size from a few millimetres up to several centimetres. Many are relatively conspicuous underwater to the careful observer, and in Shetland are a significant component of the sessile fauna. The identification of hydroids often requires low powered microscopic examination to determine the arrangement and structure of the polyps and reproductive bodies, but frequently the colony shape enables in situ identification. Hydroids found in Shetland with a distinctive colony form include Nemertesia spp., Halecium halecium and Thuiaria thuja. The ease with which Nemertesia antennina can be identified underwater probably explains why it was recorded from fourteen sites. The most frequently recorded species, from eighteen sites, was Kirchenpaueria pinnata, an elegant and delicate feather shaped colony up to 10 cm in height, often seen with reproductive capsules bunched up the main stem. Obelia geniculata is typically about 1 cm in length. Despite its small size, it is easily recognisable underwater because it typically and commonly grows on the fronds of kelp plants. It was nearly always present where kelp was found, although it was recorded from only fourteen sites. Another hydroid with a distinctive habitat is Hydractinia echinata, which grows as a crust on gastropod mollusc shells occupied by hermit crabs. The individual polyps are erect and only a few millimetres in height, giving the shell a characteristically hairy appearance.

It is probable that other small species were overlooked by the survey. Also, team members were not equally proficient at recognizing even the prominent species underwater, and subsequent recording then depended on samples arriving safely back in the laboratory. Nevertheless, more than twenty more-or-less conspicuous hydroid species were recorded from thirty-five sites, and as such they were frequently an important component of the sessile fauna. Most of the species are distributed around most of the British Isles, with the notable exception of Thuiaria thuja (the "bottle brush" hydroid), which is rare in the south.

4.3.4 Anthozoans

Anthozoans include the soft corals (octocorals), sea anemones and stony corals. Of the ten soft corals occurring in the British Isles, only one was found. Alcyonium digitatum, or Dead Man's Fingers, occurs in great abundance, and is by far the most commonly encountered sessile animal growing on hard substrates. Indeed, at open water sites, vertical rock faces can be smothered with its white and orange colonies.

Almost equally widespread, but occurring in very much smaller numbers, is the Plumose Anemone, Metridium senile. This large and conspicuous animal, with fine, feathery tentacles, occurs in several colour varieties. It was usually found singly, or in groups of two or three. However, at Giant's Leg (site 35) a vertical rock face was covered with clones of a juvenile or dwarf form.

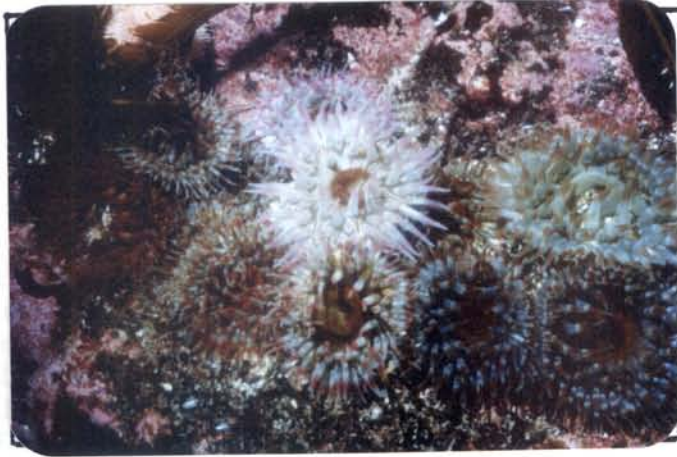
Another frequently encountered sea anemone is the beautiful Dahlia Anemone, Urticina felina. This attaches to a hard substrate, which can, however, be buried in gravelly sediments. A typical habitat for the animal is at the point where rock gives way to sediment.

An anemone which specifically burrows in soft sediments is Cerianthus lloydii, which secretes and lives in a 'parchment' tube. It is probably widespread around Shetland, although only recorded from nine of the sites visited on this survey, which did not examine many sheltered, soft sediment, locations. The only other burrowing anemone found, Peachia cylindrica, was recorded from one site only. Adamsia carciniopodus, another anemone with a very specific habitat - the back of the hermit crab, Pagurus prideauxi - was recorded from three sites.



Soft coral, Alcyonium digitatum, with tubeworm Filograna implexa and bottle brush hydroid Thuiaria thuja [DM]

Dahlia anemones, Urticina felina [DM]



Stone crab, Lithodes maja [DM]

Lesser octopus, Eledone cirrhosa [RS]
Sepiella atlantica



All the anthozoans mentioned above are distributed fairly widely in the NE Atlantic. However, four species were found which have their centres of distribution around SW Britain and further south. Thus they are certainly near their northerly distribution limits in Shetland. The Devonshire Cup Coral, Caryophyllia smithii was the most widespread, being found at 22 sites, albeit typically in small numbers. The attractive Jewel Anemone, Corynactis viridis was rarer, being recorded from five places. It always occurs in aggregations of individuals all of the same colour. The Daisy Anemone, Cereus pedunculatus, was recorded from three sites only. Finally, Hormathia coronata was identified from photographs from Ness of Sound S (site 36), and this is probably the first Shetland record for the species.

A total of 14 anthozoans were recorded, representing a fauna of average diversity.

4.3.5 Planktonic life

Marine animals live in a variety of habitats, one of the most important being the water column itself. Planktonic animals (and plants) are those organisms living in the open water, and that have insufficient mobility of their own to avoid being dispersed at the mercy of the winds and tides. Although this survey was primarily concerned with the benthic, or bottom dwelling organisms, it was impossible not to notice the rich planktonic life during descents and ascents. Most plankton is microscopic and so not readily observable in the field, but several larger species were seen in the clear Shetland waters.

Most conspicuous were four species of jellyfish. The Common Jellyfish, Aurelia aurita, was recorded at 23 sites. Two species of Lion's Mane Jellyfish were also frequently seen - the reddish-yellow Cyanea capillata and the blue-white Cyanea lamarckii, at 21 and 11 sites respectively. Apart from colouration these species are similar in appearance, possessing fine streaming tentacles up to 4 metres in length, which are capable of catching prey throughout a large volume of water and also of inflicting painful stings on the unwary swimmer (or diver!). The fourth species, Rhizostoma octopus was observed once only, at Giant's Leg (site 35).

Hydroids possess a planktonic medusae stage of their development, two species being particularly conspicuous. One measuring about 2 cm in diameter, whitish in colour, resembling a small jellyfish, was observed in thousands at some sites. Less frequent but no less distinctive, was the pale brown bell-shaped Leuckartiara nobilis.

Comb jellies, or Sea-gooseberries, are oval or rounded translucent animals, with rows of fine bearing cilia that glisten iridescently in the light. They were seen at several sites, the predominant species being Beroe cucumis.

Salps are planktonic tunicates (q.v.) which form chains of sexual individuals. One species was seen at a number of sites; they are very fragile and attempts at identification proved unsuccessful.

4.3.6 Polychaete worms

There are several hundred species of marine bristle worms in the British Isles. However, the vast majority are only recorded as a result of collecting samples of sediments and sessile benthic flora and fauna. Species readily identifiable in situ, by sight, are relatively few, and tend to be tube-dwellers.

By far the most common species observed was Pomatoceros lamarckii. This animal resides in a calcareous tube of up to 2 cm in length, attached to rock. Indeed, many free rock surfaces were typically covered with a 'crust' consisting of thousands of contiguous and even overlapping individuals. Frequently the white calcareous tube was itself covered with an encrusting species of green algae. The other significant rock dwelling species was Filograna implexa, inhabiting aggregations of lacey thin white calcareous tubes. The calcareous tubes of Serpula vermicularis were also occasionally recorded (three sites).

Worms from the terebellomorph group were recorded from most sites. These worms are 'naked' in that they have no hard tube in which to hide; they live in crevices and under cobbles and small boulders, but announce their presence by protruding long, white filamentous tentacles along the substrate to catch food. These tentacles are very contractile, and quickly disappear into the crevice if disturbed. It is quite likely that all observations related to the same species, but unfortunately specimens eluded capture for verification.

Other polychaete worms seen inhabited tubes or burrows in soft sediments. Lugworm (Arenicola marina) casts were noted at five sites. The Sand Mason worm, Lanice conchilega, with its tube of cemented sand grains and fan-shaped top, was recorded from six locations. Another sedentary worm was Myxicola infundibulum with its characteristic circular head palps, visible on the surface of muddy substrates.

4.3.7 Crustaceans

The Crustacea have the largest number of representatives of any phylum in British waters, with over 2000 species. The majority are small, and will go unrecorded in any area without detailed sampling of the plankton and benthos. We recorded about 30 species of crustacea, not all of which were identified to species.

Barnacles can form extensive crusts over rock surfaces. Balanus crenatus was recorded as 'common' at three sites. Balanus balanus was recorded as "common" at two sites, and "abundant" at Hols Hellier (site 14). 'Barnacles' (unspecified) were recorded at a number of other sites - probably they were ubiquitous.

Swarms of mysid shrimps were seen occasionally when diving, hovering about half metre above the substrate, normally close to small caves or similar shelter. They are small, slender animals, about one centimetre long, and not identifiable to species unless collected. Mysid swarms were recorded as "frequent" at Sanda Stour SE (site 4), and "abundant" at S Isle of Gletness SE (22).

Amphipods are also small, shrimp-like animals common in samples. Only one species was encountered that was distinctive enough to identify in the field: Dyopetos porrectus, recorded from eight sites, lives in family groups along thin "whips". These whips are excreted by the amphipods themselves, and are attached typically to rock or hydroids. It is this distinctive and unique habitat, rather than the animals themselves, which render this species so recognisable underwater.

A group of amphipods known as caprellids, or ghost shrimps, are common on animal turf such as hydroids and sponges. Again, they are too small to identify to species in the field, but they were noted at six sites. At Bluemull Sound (site 19) they occurred in swarms of literally millions, attached to vast carpets of the hydroid Sertularia argentea.

Most of the crustaceans recorded belonged to the Decapoda - crabs, lobsters, shrimps, etc. Most frequently recorded was the edible crab, Cancer pagurus, from 34 sites. However, despite this widespread distribution, it was only observed in small numbers in sizes near to the commercially takeable limit. Another commercially important species, the lobster Homarus gammarus, was recorded from two sites only, South Holm SW (site 16) and Vailla; Tower (site 41).

Several other species of crab were encountered including the shore crab, Carcinus maenas from six sites in shallow water, and the swimming crabs Liocarcinus puber from thirteen sites on rock, and L. depurator from eleven sites on soft sediment. The commonest spider crab was Hyas araneus from twenty-two locations. This is a robust and conspicuous species, unlike spider crabs of the genera Inachus and Macropodia, which are small and delicate in habit (and frequently well camouflaged), and thus recorded less frequently.

Three species of squat lobster were found. The colourful Galathea strigosa appeared to be very common, and was recorded from sixteen sites. This species is normally cryptic in habit, being confined to crevices during daylight hours, so its apparent audacity on Shetland was of interest. Galathea squamifera (drabber in appearance) was only recorded from six sites. The long clawed Munida rugosa is often found beyond diveable depths, but extends into shallower waters in the northern parts of the British Isles. When encountered, its normal habit is to 'guard' a small cave or crevice, with claws directed aggressively at the intruder. It was recorded from nine locations.

Hermit crabs were common, and recorded from thirty-two sites, but rarely identified to species. Similarly with prawns and shrimps, which were recorded from twenty-four sites.

For the southern based naturalist, the most pleasing encounters were those with the Stone Crab Lithodes maia. Possessing eight, rather than ten pairs of legs, this is not a 'true' crab, but is related more closely to the hermit crabs. However, it is a large, conspicuous and spiny animal which does have a superficial resemblance to a large spider crab. At the thirteen sites recorded, it was seen typically in ones and twos only, often clinging to irregular vertical bedrock faces. This is a deep water species, only apparently coming into shallower waters in the British Isles in Shetland.

4.3.8 Molluscs

The five major "groups" (not of equivalent taxonomic status) of molluscs encountered were the chitons, single-shelled ("prosobranch"), nudibranchs (or sea slugs), bivalves, and cephalopods (octopus and cuttlefish).

Chitons are small molluscs, resembling legless woodlice, that clamp onto rock surfaces. Despite their size, they were reasonably conspicuous, often being one of the very few organisms on "lithothamnion" encrusted rock. Ecologically, they are important, and were recorded from twenty-five sites. Identification in the field was not possible, but samples collected and identified included Callochiton septemvalvis (site 28), Tonicella marmorea (31) and Leptochiton asellus (32a).

A large proportion of the shelled (prosobranch) snails are too small to record in situ. However, there are a significant number remaining that are conspicuous and characteristic components of the sublittoral fauna. Three limpets were recorded. Patella vulgata, the common shore limpet, was recorded only fortuitously at two sites. Smaller limpets (including Tectura (ex Acmae) testudinalis and T. virginea, but they were not always differentiated) occurred like the chitons, on rock surfaces encrusted with "lithothamnion". These were

recorded from eight sites. Finally, the widespread blue-rayed limpet (Helcion pellucidum) which usually occurs on kelp, was recorded from eight locations.

Two species of top shell were found. The Painted Top Shell, Calliostoma zizyphinum was the most frequently recorded mollusc, from thirty-four sites. Its relatively large size and colourful shell makes it easy to spot, and it is clearly one of Shetland's most common and conspicuous marine animals. The other top shell, Gibbula cineraria, is smaller and less colourful, but still quite conspicuous, often being found on kelp plants. It was also widespread, being recorded from twenty-two sites.

The two species of cowrie found feed on compound ascidians. Trivia arctica, with a plain whitish shell, was recorded from five sites. The almost identical Trivia monacha is distinguished by three dark blotches on its shell, and was recorded from three sites.

Buccinum undatum, the Common Whelk, lived up to its name, being recorded from twenty-nine sites. This noticeable species has a ribbed shell, but in Shetland a certain degree of variation was noted both in shell shape, and sculpture. The Red Whelk, Neptunea antiqua, with a smoother shell, has a more northerly distribution than the Common Whelk. It was recorded from nine sites.

The third group of molluscs, sea slugs or nudibranchs, have no shell, and are typically small and brightly coloured. Because of their attractiveness, they are searched for specifically by some diving naturalists, although many species are only a centimetre or less in length. Around 40 species of nudibranch were known from Shetland, of which fifteen were recorded on this survey. In addition, five further species appear to be new records for Shetland, although they do not represent an extension to existing geographical distribution limits. These species are Lomanotus genei (from Swarbacks Skerry, site 11), Onchidoris luteocincta (Linga SW, site 3), Doto dunnei (Hildasay NW, site 7 and Little Holm NE, site 24), Polycera faeroensis (six sites) and Eubranthus pallidus (Little Holm NE, site 24).

The most frequently recorded nudibranch was Polycera quadrilineata (fourteen sites), a small white and yellow species that is found on kelp fronds feeding on the encrusting sea mat Membranipora membranacea. Similarly coloured, but having a different and distinctive form, is Limacia clavigera. This feeds on several species of encrusting sea mat, and was recorded from thirteen places.

The large Tritonia hombergii feeds exclusively on Dead Man's Fingers (Alcyonium digitatum) which are present around Shetland in abundance. Although it was recorded from ten sites, it was often seen only in small numbers of small specimens. When feeding on Dead Man's Fingers, it is well camouflaged so as to resemble its prey, and so may have been overlooked. Another large species, the Sea Lemon Archidoris pseudoargus, was recorded from only eight sites - not unexpectedly as its sponge prey is infrequent around Shetland.

Two sea slug species that do not belong to the nudibranch group are Aplysia punctata and Hermaea bifida. The former is the large Sea Hare, found commonly but sporadically round the British Isles. Here, only one specimen was found, at South Holm SW (site 16). The latter is a beautiful and elegant sea slug which was found on red seaweeds in samples collected from Linga SW (site 3).

Most bivalve molluscs live buried in sediments, and so were rarely recorded, although note was sometimes made of the presence of their empty shells. Scallops, however, live on the surface of sediments. The Great Scallop, Pecten maximus was recorded from six sites. The smaller Queen Scallop, Aequipecten (ex Chlamys) opercularis was recorded from twelve sites, sometimes carrying an

encrusting sponge (q.v.) on the upper valve. This scallop was frequently seen "swimming", by rapidly opening and closing its valves to generate jets of water.

Mussels attach themselves to substrates by secreting tough byssus threads, and often form clumps resulting from this mode of attachment. The large Horse Mussel, Modiolus modiolus, was observed at eighteen sites, normally aggregated on horizontal surfaces, both on bedrock and soft sediment, thus providing a habitat for other species to exploit. The Common Mussel, Mytilus edulis, was found to be distinctly uncommon, being found at five sites.

The fifth group of molluscs, the cephalopods, comprises the free swimming squid, cuttlefish and octopus. The Lesser Octopus, Eledone cirrhosa, is the only octopus occurring in the shallow waters around Shetland; it was seen at three sites. The Common Cuttlefish, Sepia officinalis, was recorded once only, at Hoo Stark N (site 21).

4.3.9 Bryozoans

Bryozoans, or Sea Mats, exist in a variety of forms, but they are mainly either encrusting or foliaceous.

Two white encrusting forms were encountered frequently on algae. Membranipora membranacea was recorded from twenty one sites, growing on kelp fronds. It was very conspicuous in this habitat, and in places colonies were so extensive that forests of kelp would display more white colouration than their natural olive brown. Electra pilosa, from ten sites, did occur on kelp, but also on other algae and other substrates. In places it encrusted epiphytic red algae on kelp stipes so thickly that they appeared greyish white.

Parasmittina trispinosa is an orangeish calcareous encrusting bryozoan, recorded from twenty sites, typically as "frequent" or "common". It is one of the few organisms to withstand the grazing pressures of the Common Sea Urchin, Echinus esculentus, and consequently can be very conspicuous on relatively bare, grazed rock surfaces.

At many locations around the British Isles bushy bryozoans often form a "turf" over stable rock faces, sometimes in association with hydroids. Such turfs were conspicuously uncommon in Shetland, probably on account of grazing pressure from Echinus and competition from algae, which could penetrate to 25 metres or more in the clear waters. One site, the inside of the arch at Giant's Leg (site 35), was shaded from the light so algal growth was restricted, and there were few Echinus, presumably because it was exposed. Here, a bryozoan turf was present, including the species Bugula sp., Crisia sp., Scrupocellaria sp., Securiflustra securifrons and Eucratea loricata.

Bryozoans can be comprehensively recorded only by the systematic collection and identification of samples of likely animate and inanimate substrate. (For example, on one small piece of rock that was sent away for expert examination, 13 species of encrusting bryozoans were identified!) Although this was not attempted during this survey, an impression was formed that the bryozoan fauna of Shetland was relatively impoverished, even compared with that of northern Scotland.

4.3.10 Echinoderms

The echinoderms, or "spiny skinned" animals, are an exclusively marine group, normally possessing radial symmetry, and with a water vascular system that is unique in the animal kingdom. Unlike many other groups of marine animals, they

are reasonably conspicuous underwater, and many species can be identified in situ. In general, the echinoderm fauna tends to become richer to the west and north of the British Isles, and poorer to the east and south. Shetland is particularly rich, with 28 species recorded during this trip, many occurring in large numbers at many sites. There are five echinoderm groups, which will be discussed separately.

The feather star, Antedon bifida was widespread, and recorded from 28 sites. Although this is the only feather star found commonly in shallow water, two other deep water feather star species have been seen recently in Scottish waters, but have not to date been confirmed as being seen during this survey.

Thirteen of the sixteen British shallow water starfish were found. The Common Starfish, Asterias rubens, was the most widespread and common, occurring on all substrates, and in a variety of colours and sizes. Whereas in England and Wales the colour is usually a brownish orangey yellow, many Shetland specimens were distinctly brown or green. Its close relative, the smaller but similar Leptasterias muelleri, is a northern species and was recorded from ten sites. It is more consistent in colour and habitat than Asterias, being mauve, and found on rock (often vertically inclined and encrusted with red calcareous algae). Another close relative, the Spiny Starfish, Marthasterias glacialis, was found at seven places. It is more characteristic of western coasts further south in Britain.

Astropecten irregularis is a British starfish which burrows into soft sediments. It was recorded on sediment at eight sites. Another sediment dwelling species is Luidia sarsi, found at two sites only. It tends to live in deeper water, only coming to within diving depths in the north of the British Isles. Luidia ciliaris is similar, but is distinguished by having seven (rather than five) arms. This large predatory animal was found at five sites.

Hippasteria phrygiana is a large, cushion-like starfish with a northerly distribution. It is rare in British waters, so it was pleasing to find one specimen at Giant's Leg (site 35). Although commoner in the north, the Red Cushion Star, Porania pulvillus is more widespread; it was recorded from twenty sites in Shetland. The 'common' Cushion Star, Asterina gibbosa is smaller and confined to the shore or very shallow water. Thus, although it was recorded from only two sites on this survey, it is probably widespread on Shetland shores.

Both British shallow water species of sunstars were common. The Purple Sunstar, Solaster endeca and the Common Sunstar Crossaster papposus were recorded from twenty-eight and thirty-six sites respectively.

Two species of Blood Star Henricia, occur in the British Isles, and are extremely difficult to tell apart without very close examination of their dorsal spines. H. sanguinolenta is a northern species in the British Isles, and was recorded from twenty three sites. H. oculata is a southern form, which may occur as far north as Shetland but it was not positively recorded. Another northern, and uncommon species, Stichastrella rosea, was found at three sites - only one or two specimens were seen.

The third echinoderm group, the brittle stars, are normally conspicuous underwater, but not always easy to identify. It is likely, therefore, that some species were overlooked, but four were recorded very frequently, often in great numbers. As its name implies, the Crevice Brittlestar, Ophiopholis aculeata, characteristically lives in crevices, or under cobbles, with only its arms protruding. It is a very common and characteristic species in Shetland, and was recorded from twenty-two sites. The Common Brittle Star, Ophiothrix fragilis, also resides in crevices and under cobbles sometimes, but more commonly occurs



Sunstar, Solaster
endeca [GD]

Echinus esculentus,
flanked by
Strongylocentrotus
droebachiensis [GD]



Black brittle stars,
Ophiocomina nigra, with
arms in feeding position
[DM]

Solitary sea squirt,
Polycarpa pomaria
[RS]



out in the open, on rock or sediment, sometimes forming dense beds. Such concentrations are often found in current exposed areas, such as Little Holm N (26). This species was recorded from thirty-two sites. The Black Brittle Star, Ophiocomina nigra, also forms dense beds on occasion: it was recorded from twenty-nine sites. Albino specimens were frequently observed. At Sanda Stour (4), a number of these brittle stars were observed feeding on the tentacles of a dead Lion's Mane Jellyfish. The smallest brittle star found frequently was Ophiura albida, which was recorded from twenty-four sites, but in smaller numbers than the three preceding species.

Sea urchins are approximately spherical animals with a hard shell (or 'test') bearing spines. Some are burrowing species, which were not specifically looked for during this trip. Others live in the open, on inanimate or animate substrate, and three of the four shallow water British species were found in Shetland. One, the Common Sea Urchin, Echinus esculentus, was the most abundant large mobile animal found, being recorded from all forty-three sites, living on all habitats, although rare on fine sediments. It feeds on encrusting animals and plants, and juvenile forms of foliaceous species. This extensive grazing is a dominant ecological influence in Shetland, as well as at other northern and western sites in Britain, and significantly reduces the faunal and floral diversity. Other mobile species are not affected, but bedrock scenery is dominated by only a few species which are able to withstand the grazing pressure. It was noticed at several current swept sites that individuals were small - presumably larger specimens would be swept away.

The Green Sea Urchin, Psammechinus miliaris is distributed around most of the British Isles, but is not often encountered in large numbers. This small urchin was recorded from five sites on this trip.

The most exciting find was the discovery of a large population of the Northern Sea Urchin, Strongylocentrotus droebachiensis at Hoo Stack N (site 21). This was a flattish, or gently sloping site, with a substrate including flattish cobbles. The urchins were present in quite large numbers, often clumped together, some feeding on kelp debris, and considerably outnumbering the ubiquitous Common Sea Urchin. The Northern Sea Urchin is rare south of Shetland, and obviously very sparsely distributed around Shetland itself.

The final group of echinoderms are the sea cucumbers, which are bilaterally symmetrical, and shaped as their name implies. Most species live either buried in sediment, or in rock crevices with only their tentacles protruding. They were observed at several sites, but often not identified to species. The most distinctive species encountered lives out in the open, and was recorded from six sites. This is Cucumaria frondosa, known as Pudding on account of its ample proportions! It possesses enormous bushy tentacles, which were retracted in most of the specimens observed. This species was usually seen on a rocky substrate, but at Flotta (site 38) occurred on fairly soft sediment.

4.3.11 Sea squirts

Sea squirts, or ascidians, are sessile, bag-like animals, with inhalant and exhalant siphons through which they respectively take in food bearing water and vent it after filtration. Sea squirts may be either solitary or colonial. The Shetland fauna is reasonably diverse with seventeen species being recorded, but low in numbers, plausibly as a result of Echinus grazing.

The attractive colonial Light Bulb Tunicate, Clavelina lepadiformis, was recorded from seventeen sites. Another attractive species, with a soft gelatinous body, Ciona intestinalis, was found at twenty-six sites. The Gas Mantle Ascidian, Corella parallelogramma, as its scientific name implies, has a rectangular body, which is transparent. It was recorded from fourteen sites.

Asciidiella aspersa occurs typically in clumps on stable sediment bottoms and rock in sheltered locations. On sediment it is relatively immune from Echinus grazing, and was the only sea squirt recorded as "common", at three of the nine sites at which it was found. The similar, but larger, Ascidia mentula is found typically on vertical rock faces and at the mouths of crevices, and was recorded from fifteen sites. The related, crevice/under cobble-dwelling Ascidia conchilega was noted from two sites. Ascidia virginea, with a clean, milky white test, was found at seven locations.

The Star Ascidian, Botryllus schlosseri, is a compound sea squirt with its zooids in star-like arrangements. It is common around the British Isles, and recorded from nineteen sites in Shetland. Botrylloides leachi is similar, but with zooids arranged in meandering lines. This species was found at seven sites.

Colonial tunicates often form part of a 'turf' of encrusting animals in Scottish waters. Such assemblages were rarely found during this survey, but at Giant's Leg (site 31) the colonial species Diplosoma sp. and Aplidium proliferum were present, together with other unidentified species.

4.3.12 Fish

A total of twenty-four fish species were recorded, with a number of others seen but not identified. Fish seen by divers tend either to be benthic, rock dwelling species, or free swimming territorial fish, such as wrasse. Pelagic and sediment dwelling species tend to be under-recorded.

The most frequently observed fish was the Common Dogfish, Scyliorhinus canicula, seen in ones and twos at seventeen sites.

The only species of clingfish known to occur in Shetland, Diplecogaster bimaculata, the Two-spotted Clingfish, turned up in samples. This species clings to substrates with a suction pad formed by its pelvic fins, and the specimens accidentally collected were rather small.

Relatively few cod-like species ("gadoids") were encountered. Frequently, however, shoals of small gadoids were seen, but could not be named. Shoals of Saithe, Pollachius virens, were seen at sixteen sites, and Pollack, P. pollachius at four sites. A particularly dense shoal of Pollachius sp. was recorded at Swarbacks Skerry (11). Although both species are distributed around the British Isles, the former is commoner in the north, and the latter in the south. These species are very commonly seen by divers, as are Bib, Trisopterus luscus, which surprisingly was recorded only once (32b), presumably because the species is nearing its northern limit of distribution in Shetland. The related Poor-cod, T. minutus, which has a similar distribution was seen at three sites. A more frequent gadoid was the ling, Molva molva, seen as single individuals at eight sites.

Small Scorpion Fish were seen in rocky areas, often camouflaged to blend in with the pink colouration of the encrusting coralline algae. Both common species were encountered; the Long Spined, Taurulus bubalis, and the Short Spined, Myoxocephalus scorpius, each at eight sites.

The five common British species of wrasse are distributed all around the British Isles. However, three species, the Rock Cod, Corkwing and Goldsinny, were not seen during this survey. The large Ballan Wrasse, Labrus bergylta, was found at seven sites, and the beautiful Cuckoo Wrasse, L. mixtus, at five sites. The latter species was recorded as 'frequent' at Ramna Geo (site 32b); otherwise both species were 'rare'.

Five species of blenny-like fish were recorded. The inquisitive Tompot Blenny, Parablennius gattorugine is distributed from the Mediterranean to the western and northern coasts of Scotland, but is not recorded from Shetland in the literature. It was, therefore, particularly gratifying to record a specimen from W Skerry E (site 8), although it was also found during the NCC survey of 1986. Shetland certainly represents the most northerly distribution of this species. In contrast, the large and ugly Wolf Fish, Anarhichas lupus, does have a northerly distribution, but was only recorded once, at Mavis Grind (site 40). A solitary species, it is probably more frequent beyond diving depths. Yarrell's Blenny, Chirolophis ascanii and the Viviparous Blenny, Zoarces viviparus are also northern species, recorded from three and one sites respectively. The Butterfish, Pholis gunnellus, was rather more common, being recorded from thirteen locations.

The goby fauna of Shetland appears, from the literature, to be very poor. The Two Spot Goby, Gobiusculus flavescens is a small, but quite conspicuous, midwater shoaling fish found above kelp and other algae. It was only recorded at Mavis Grind (site 40). The only other goby likely to be encountered is the Sand Goby, Pomatoschistus minutus. Although not recorded during this survey it was found by the NCC team in 1986.

Sediment living flatfish are notoriously under-recorded on this type of survey, so it is not particularly surprising that there was only one record of Brill (Scophthalmus rhombus) and three of Plaice (Pleuronectes platessa). However, even the rock-dwelling Topknot (Zeugopterus punctatus) was only seen three times.

On the whole, the Shetland fish fauna as recorded by divers appears a little impoverished relative to other areas of Britain. The diversity is probably "average", but numbers of specimens seen were low, only Saithe being at all common.

5. Discussion and conclusions

No single survey can claim to be a "survey of Shetland" - the length of coastline and diversity of habitat is far too great. Surveys of limited areas of the Scottish coast have sometimes tried to make some sort of assessment of the intrinsic and relative interest and importance of the area in question. The results presented above are clearly too limited for any such attempt to be made here. Earll (1982) gives a great deal of background material, and NCC's current Marine Nature Conservation Review will provide a very much more detailed appraisal. The following remarks will inevitably be somewhat subjective and limited in scope.

The clarity of the water and the steep rocky sublittoral profiles, together with the often prolific and colourful marine life, resulted in some spectacular diving. A few sites can be mentioned as being particularly scenic. W Skerry E (site 8) rose dramatically from deep water to an isolated offshore skerry, with steep faces carrying heavy growths of Alcyonium beneath a kelp forest. At

Spindle (9) there were steep rock slopes with a sharp submerged rock pinnacle. Steep rock faces, in one place forming an 'amphitheatre', again carried massive encrustations of soft coral at Stoura Skerry (28) at Out Skerries.

At Ness of Hillswick (31) there was a system of 2 or 3 m wide, steep-sided canyons intersecting more or less at right angles, with still more Alcyonium encrusted vertical faces. Ramna Geo (32a) provided a steep slope of precariously balanced massive boulders with overhangs and 'caves'. Although we visited The Drongs (site 30), adverse sea conditions meant we were unable to dive the reportedly more spectacular west side. The northernmost sites, at Muckle Flugga, were scenically rather disappointing, probably because the heavy swell restricted diving to the lee (eastern) side of the skerries. In contrast, Tittley et al. (1976) refer to a nearby vertical substrate to 30+ m on Muckle Flugga - presumably on the west side.

In contrast, the diversity of species (as opposed to the abundance of single species) of the flora and fauna was low. Plausibly this can largely be attributed to the effects of Echinus grazing pressure. In addition, many of the species commonly found on the west coast of Scotland are reaching the northern limit of their distribution around this latitude. The appearance of a few "northern" species, with centre of distribution nearer the Arctic, does not compensate for the loss of the 'southerners'. Echinoderms are the one group of animals to which these remarks do not apply - they were diverse and plentiful (see Section 4.3.10). Presumably the unusual species dredged by the Victorians are still present, tantalizingly beyond diving depths. 'Northern' species which were recorded include the echinoderms Hippasteria phrygiana, Strongylocentrotus droebachiensis, Cucumaria frondosa and the somewhat less unusual Stichastrella rosea; the stone crab Lithodes maja, the hydroid Thuiaria thuja, and the sponge Isodictya palmata. C. frondosa and L. maja were relatively widespread, whereas S. droebachiensis was recorded from only one site, where it was common, and was not present at Munger Skerries (37), only about 0.5 km south of where it was recorded by Earll (1982) at Torvolds Geo. This urchin has been recorded from other, scattered sites (Earll, 1982, R. Gallacher, pers. comm.). Only single specimens of H. phrygiana and I. palmata were found.

In contrast, probable northern records for the British Isles were established for a number of species. These included five species of nudibranchs (see section 4.3.8), although these do not represent an overall extension of the geographic range of these species. However, the solitary record of the anemone Hormathia coronata does appear to give a real northward extension of its range.

The small red alga, Schmitzia hiscockiana, also appears to be a new record for Shetland, although this is no surprise as this recently discovered species had previously been found at St Kilda (Maggs and Guiry, 1985) and Loch Eriboll (Moss, 1986). A more thorough study of the algae at the more exposed sites might be expected to find additional new records (cf. Tittley et al., 1975). Other 'southern' species found at the northern limits of their established ranges include the Cup Coral, Caryophyllia smithii, the Jewel Anemone, Corynactis viridis, the Daisy Anemone, Cereus pedunculatus, and the Tompot Blenny, Parablennius gattorugine.

In some ways certain absences are more worthy of comment. The large and conspicuous anemone Bolecera tuediae is not uncommon at places in the east coast of Scotland, and is distributed over the North Atlantic to the Arctic Circle. It was not recorded, however. The delicate anemone Protanthea simplex is a 'northern' species which has recently been shown to be common in sea lochs on the west coast of Scotland, and is also found in Scandinavia. Although this survey did not concentrate on the voes, neither it nor previous surveys have

A SUBLITTORAL SURVEY OF SHETLAND, 1987

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recorded the animal. The small stalked sponge Haliclona urceolus has a similar distribution - it has not been found either. The fleshy sea mat, Alcyonidium diaphanum, was only recorded once, in marked contrast to the northern Scottish coast and Orkney. The paucity of the sponge fauna compared with that of northern Scotland and even Orkney is striking. Although many of the species found in Orkney were present, only a very few specimens were usually found, even in 'likely' habitats. It was also rather surprising how few edible crabs, Cancer pagurus of commercially takeable size were seen; very few were 'large'. Even more striking was that the lobster, Homarus gammarus was only recorded twice, although most of the diving was at rocky sites, some of which might, prima facie, have been expected to provide suitable habitats. In slight contrast, Earll (1982) recorded H. gammarus from 9 of 36 sites, diving mostly from the shore in 1974. Berry and Johnston (1980) record landings of 289 cwt in 1955 rising to 3495 cwt in 1962, "followed by an inevitable decline". Anecdotal evidence also suggests a recent decline in landings.

Given the variety of the sites dived, it is difficult to pick out the 'best buys' in terms of biological interest. However, the following might be 'worth a further look'. The exposed sites with a steep rocky substrate were generally rather lacking in biological interest, but perhaps W Skerry E (8) can be mentioned as, inter alia, the site where the Bottle Brush hydroid, Thuiaria thuja, was most common. Giant's Leg (35) provided a rapid variation of habitat within a small area, including shaded vertical rock faces with a luxuriant animal turf, exposed Alcyonium dominated rock faces, boulders etc. Several species were recorded only from this site. There appear to be several other places nearby where shaded shallow rock faces might be found, and the area would repay further investigation. A number of other sites of interest were associated with fairly deep, relatively flat, hard substrates, often exposed to some current. These included Bluemull Sound (19), Hoo Stack SE (20), Hoo Stack N (21), (the latter having a population of S. droebachiensis outnumbering Echinus), Ling Ness SW (27) and Little Holm E and N (25 and 26). Mavis Grind (site 40) was different to any other site, having a steep, quite deep boulder slope and a small bedrock cliff in an extremely sheltered situation (the cliff was only cursorily examined because of lack of time). Of the other sheltered sites investigated, Flotta (38) was perhaps the most interesting, with quite high faunal diversity, including C. frondosa.

In conclusion, a number of sites scattered around northern and central Shetland were sampled to depths of c. 30 m. A few of these were around the deep water basins favoured by the Victorian dredgers, although we only managed to dive two adjacent sites on the edges of the region bounded by Whalsey, Lunna Ness, Yell and Fetlar. The rich and diverse fauna dredged during the last century seems to be restricted to beyond depths readily accessible by SCUBA techniques. Faunal diversity appears, on limited evidence, to increase when competition from algae and Echinus is reduced.

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Table 1. SUMMARY OF SITES

Site no.	Site name	Date	Grid ref +	Divers	Depth range surveyed(m)	Depth of rock /sediment bdy	Max depth * of kelp(m)	Vis (m)	Echinus abundance	Class
1	Mouth of Voxter Voe	25/7/87	360700	CA,HB,SB,TB, JC,GD,SH,RS	7-20	-	12	5	R	C5,6
2	Muckle Roe S	26/7/87	307626	CA,HB,SB,TB,JC, GD,RG,SH,DM,RS	0-26	-	15	7	C	B1,3,4
3	Linga SW (Busta Voe)	26/7/87	350635	CA,HB,SB,TB,JC, GD,SH,DM,RS	2-25	6	15	6-10	O	C3,5,6
4	Sanda Stour SE	27/7/87	346413	CA,GA,HB,SB,TB, JC,GD,SH,DM,RS	9-30	-	15	20+	C	A2,4,(6)
5	Oxna SE	27/7/87	353366	CA,HB,SB,JC	14-19	25-30	c.12	20	C	A3,4,6
6	Linga E (ex Hamnavoe)	28/7/87	365395	HB,DM	3-18	7	±	10-12	F	B3,5,6
7	Hildasay NW	28/7/87	354410	SH,RS	14-20	-	15	20+	F	A1,2
8	W Skerry E	28/7/87	353(5) 337	SB,DM,RS	9-31	-	13	20+	F	A1,2,4
9	Spindle	29/7/87	295647	SB,DM	13-26	-	20	15-20	C	A1,4
10	Moo Ness	29/7/87	292652	HB,SH,RS	3-18	-	18	15	C	A1,4
11	Swarbacks Skerry	29/7/87	291621	HB,SB,SH,DM, RS	3-26	-	24	10-20	C	A1,2
12	Muckle Flugga E	28/7/87	HP607197	TB,GD	5-18	16	±	15	C	A1,5
13	Rumblings E	28/7/87	HP604192	GA,JC	8-11	-	±	15	C	A3,5
14	Hols Hellier	28/7/87	HP627178	TB,GD	19-27	26	>26	?	O	A1,6
15	Norwick Hevda	28/7/87	HP625171	JC,GA	18-20	18?	±	15	F	B1,5
16	South Holms SW	29/7/87	HP571102	TB,JC	18.5-24.5	-	24.5	?	F	A1
17	Hagdales Ness	29/7/87	HP575091	GA,GD	14-24	24	>24	15	C	A1,3
18	Hoga Ness	29/7/87	HP557005 (drift N)	TB,JC	5-14	12?	>15	?	O	B3
19	N of Hoga Ness	29/7/87	HP555012 (drift N)	GA,GD	24-34	25	24	15	F	B1,6
20	Hoo Stack SE	30/7/87	507518	SB,HB,SH,DM,RS	9-26	-	17	15-20	F	A1,2
21	Hoo Stack N	30/7/87	504(5) 521(5)	GA,TB,JC,GD	18-26	-	±	20	O	A5/6
22	S Isle of Gletness	30/7/87	476487	SB,HB,SH,DM	8-23	-	c.16	12	F	A1,2
23	Ling Ness SW	30/7/87	45(4-5) 508	GA,JC,GD,RS	7-24	18	18	10-20	O	B1,2,6
24	Little Holm NE	31/7/87	405863	GD,RS	17-23	-	22	10	F	A2
25	Little Holm E	31/7/87	405862	GA,JC	19-25	24	23	18	F	A3,4,6
26	Little Holm N	31/7/87	404868	CA,SB,SH,DM	23-31	30	24	8-15	F	A1,2,6
27a	Ness of Queyfirth a	31/7/87	373825	GD,RS	10-20	-	±	15	F	B1,5
27b	Ness of Queyfirth b	31/7/87	372824	CA,SB,DM	3-20	14-18	±	8-15	F	B1,3,5
28	Stoura Skerry (Out Skerries)	2/8/87	689710	CA,GA,HB,SB,JC, GD,RG,DM,RS	11-32	-	26	15-20	F	A1,2,4
29	Longa Skerry (Griff Skerry)	2/8/87	625618	"	17-35	31	22	15-20	F	A1,2,(6)
30	Drongs	3/8/87	260(5) 755(5)	"	5-24	-	16	15-20	C	A1,2,4
31	Ness of Hillswick	3/8/87	278744	"	13-23	-	12	15-20	C	A1,2,4
32a	Ramna Geo a	4/8/87	502698	CA,GA,SB,DM	24-29	29-30	18	20	A	B3,4,6
32b	Ramna Geo b	4/8/87	501609	HB,JC,GD,RG,RS	14-26	c.22	16	12	C	B4,6
33a	E Lunna Voe a	4/8/87	489689	GA,SB	9-33	33	19	20+	C	B3,4,6
33b	E Lunna Voe b	4/8/87	488689	HB,RG	1-18	18	16	15	O	B3,4,6
34	Vidlin Voe (The Backs)	4/8/87	483673	CA,GD,DM,RS	16-20	-	±	15	O	C5,6
35	Giant's Leg	5/8/87	515357	CA,GA,HB,SB, JC,GD,RG,DM,RS	(-1)-23	-	20	12-20	C/O	A1,3,4

Table 1 (continued)

Site no	Site name	Date	Grid ref	Divers	Depth range surveyed(m)	Depth of rock /sediment bdy	Max depth of kelp(m)	Vis (m)	Echinus abundance	Class
36	Ness of Sound S	5/8/87	470385	GA,HB,SB,RG	4-22	-	17	10-15	C	A1,2,4
37	Munger Skerries	5/8/87	473390	CA,JC,GD,DM,RS	3-19	-	14	10-15	C	B1,2,4
38	Flotta	6/8/87	378459	CA,HB,GD,DM	4-20	5	15	10-12	C	C1,5,6
39	Russa Ness	6/8/87	369473	SB,JC,RG,RS	11-25	11	16	8-15	O	C1,5,6
40	Mavis Grind	6/8/87	341683	CA,HB,SB,GD, RG,DM	0-19	10-14	±	8	O	C1,3,5,6
41	Tower, Vaila	7/8/87	21 (8-9) 469	SB,GD,RG,DM	14-31	-	16	15-25	A	A1,2,4
42	Rusna Stacks	7/8/87	210467	CA,GA,HB,JC,RS	19-30	-	17	20-25	C	A1,2
43a	Ronas Voe a	7/8/87	292811	SB,JC,RG,RS	(-1)-21	-	±	8	?	C5,6
43b	Ronas Voe b	7/8/87	297812	CA,GA,HB,GD,DM	(-1)-24	3	10	10	O	C3,5,6

* If not obviously affected by lack of suitable substrate. Only 'mature' plants included.

† HU unless otherwise stated.

± Not available.

() Minor component (last column).

Key to last column(see text also):

A = very exposed(islands,headlands, etc), B = exposed(mouth of voes, etc), C = sheltered (within voes);

1 = infralittoral bedrock, 2 = circalittoral bedrock, 3 = infralittoral boulder(slope), 4 = circalittoral boulder(slope), 5 = infralittoral sediment, 6 = circalittoral sediment

Deep water basins dredged
by the Victorians. ■

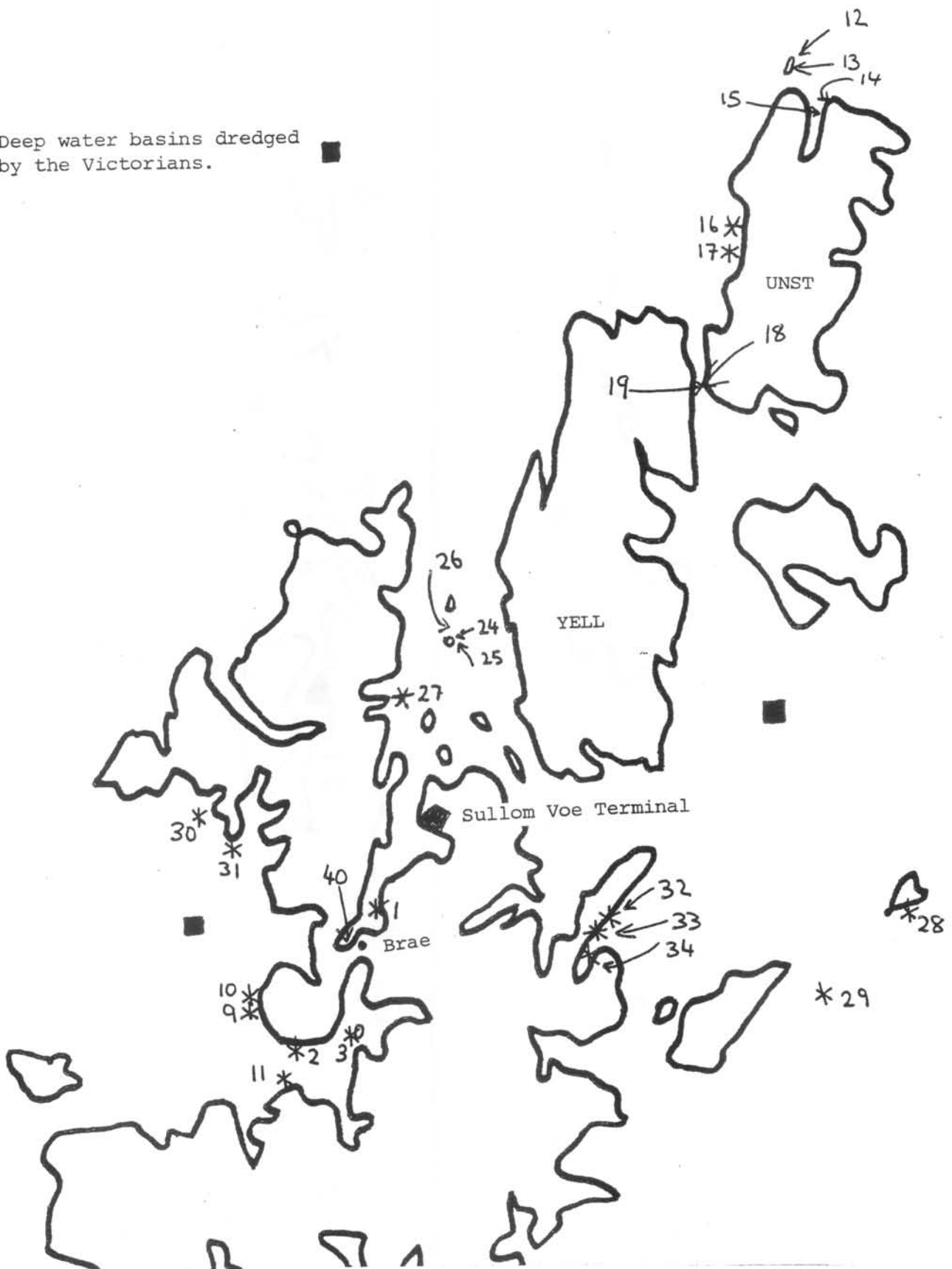


Figure 1. North Shetland, showing the survey sites.

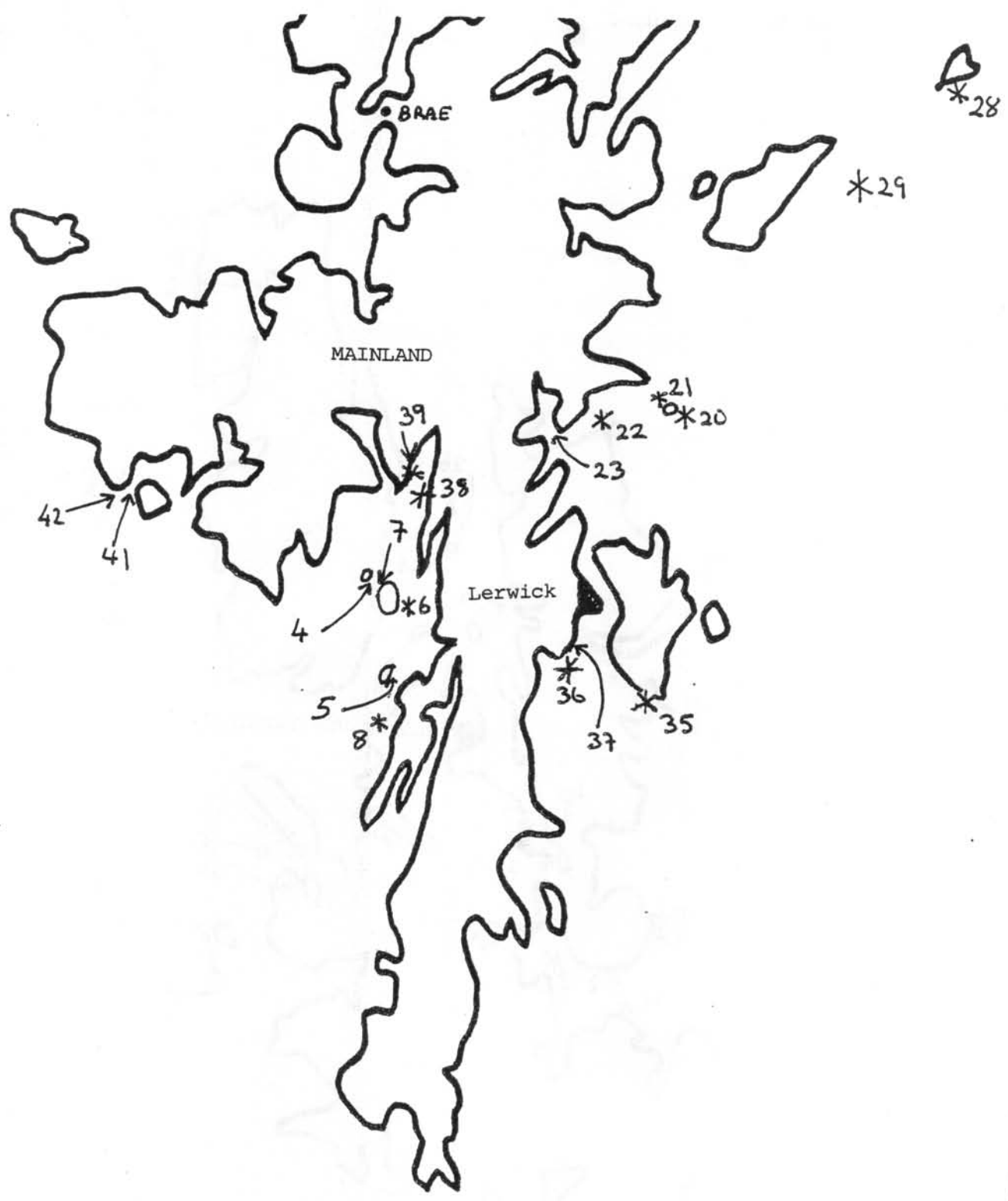


Figure 1 (ctd). South Shetland, showing the survey sites.

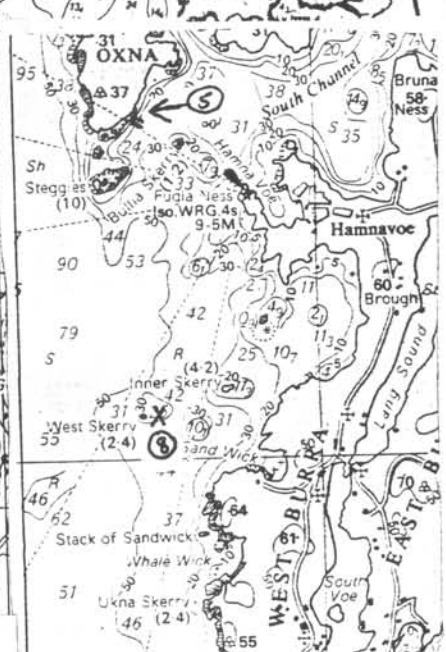
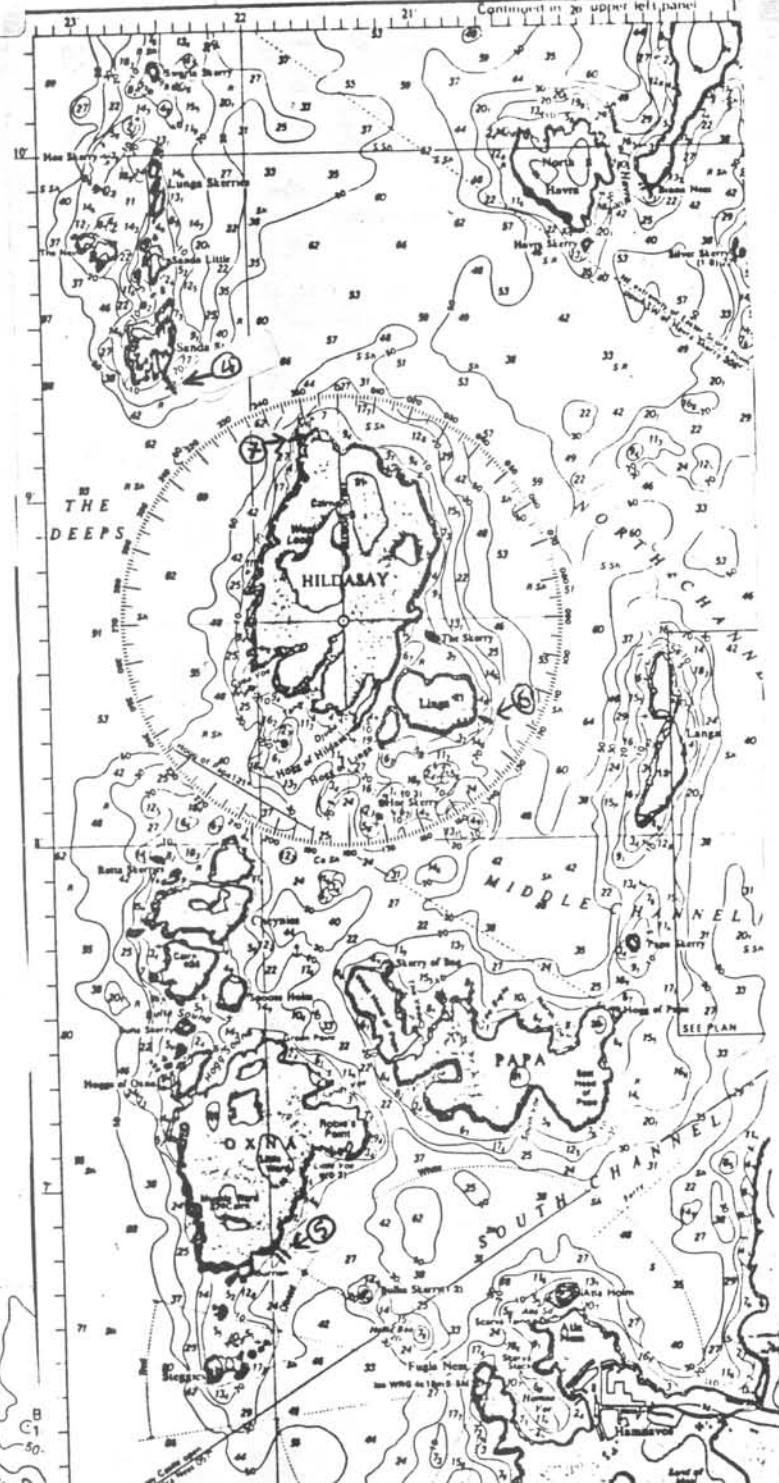
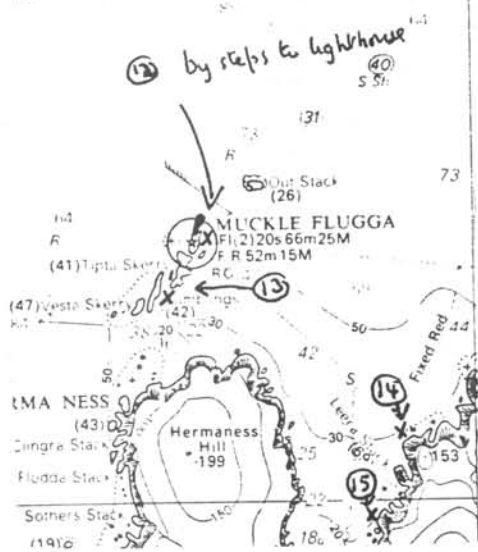


Figure 2. The location of sites 1 - 15, 40.

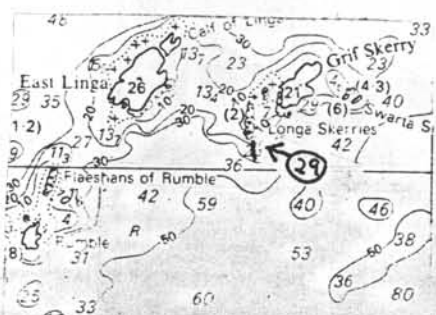
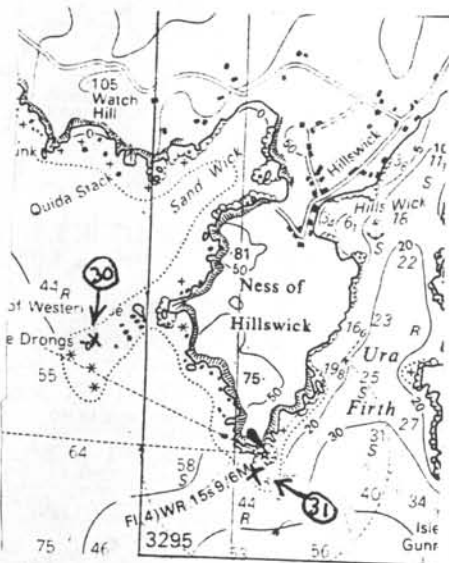
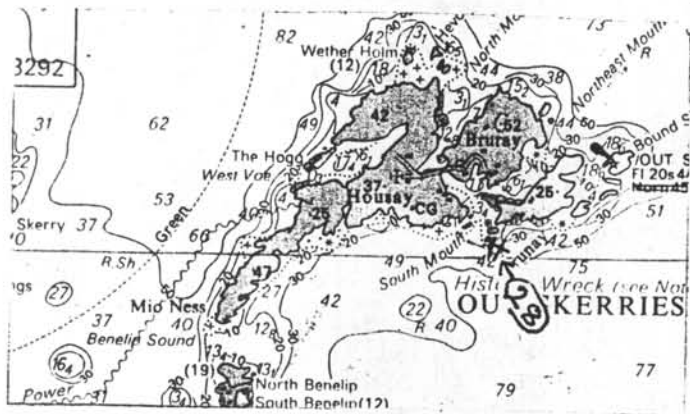
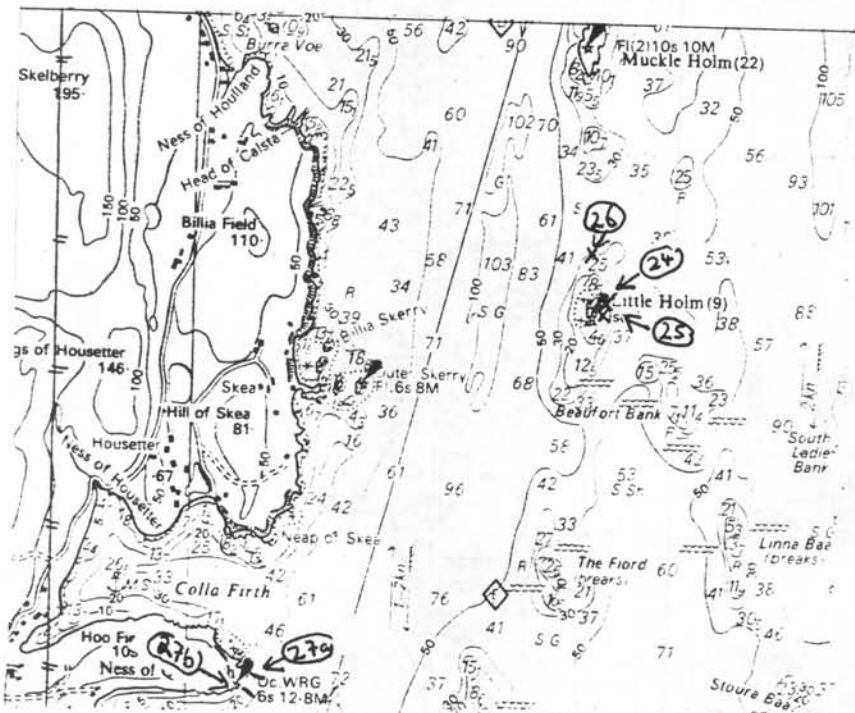
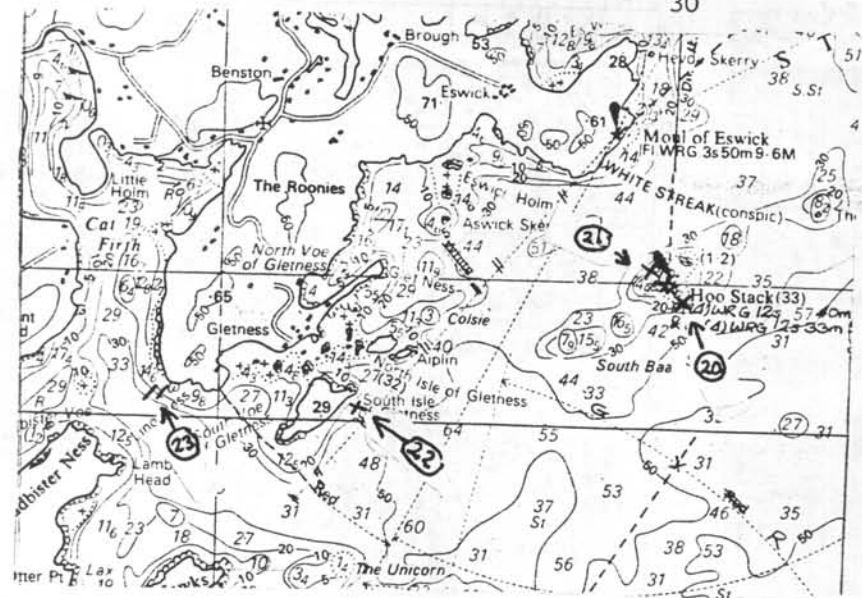


Figure 2(ctd). The location of sites 16 - 31.

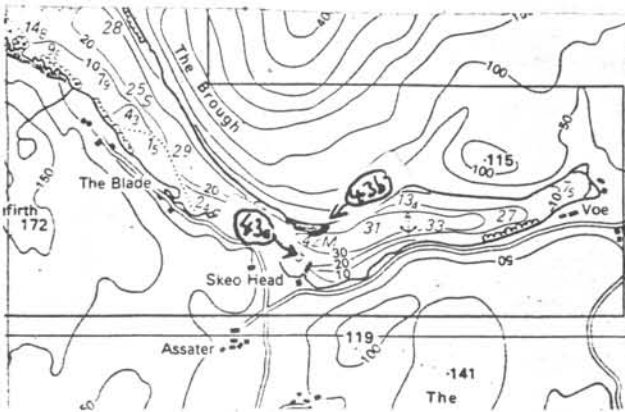
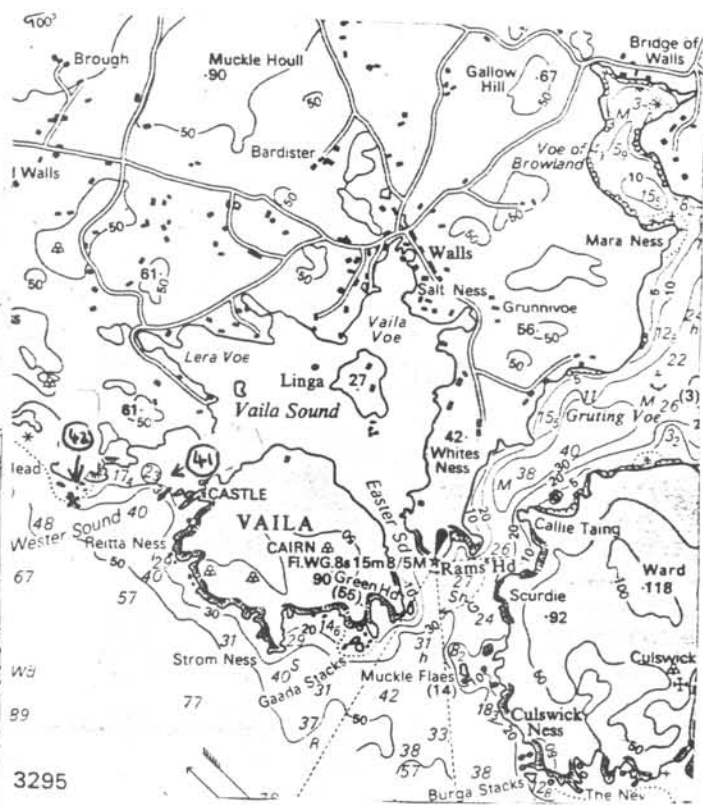
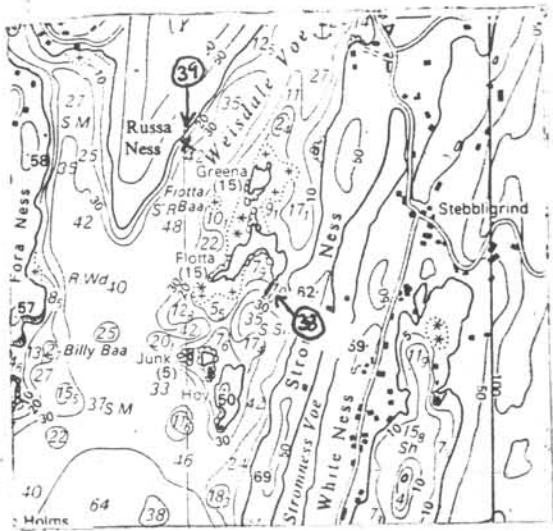
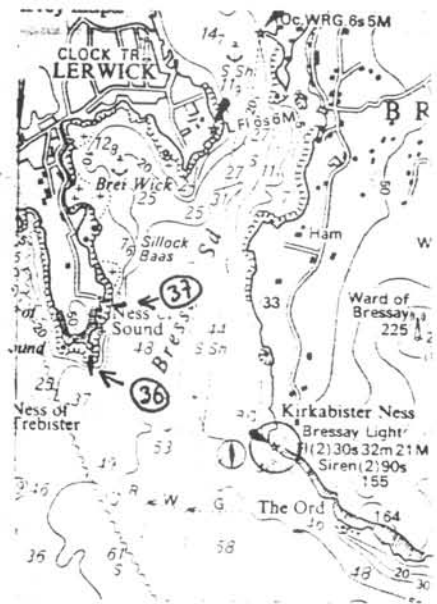
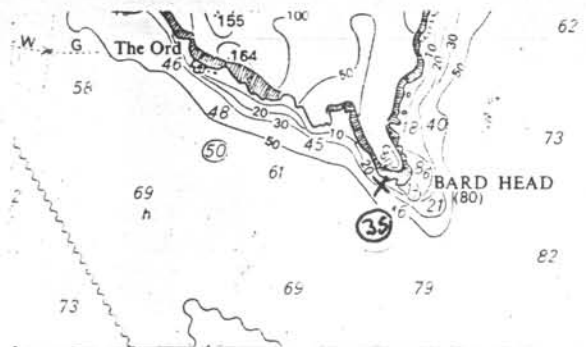
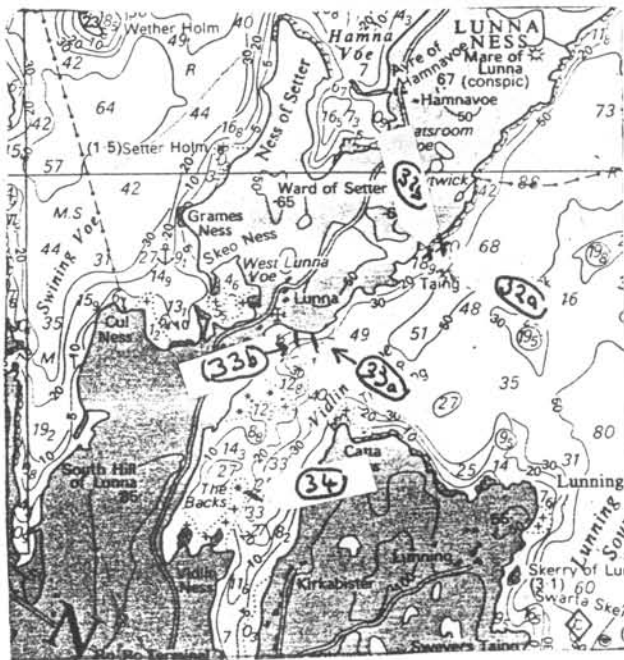


Figure 2(ctd). The location of sites 32 - 39, 41,42,43.

- (i) Habitat form
- (ii) Faunal checklist (the full version is reproduced here; a shortened form was also used.
- (iii) Algal checklist.

► 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.

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

D V

► DATE (Or observations)

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

► NAME _____
Of recorder

► ADDRESS & PHONE _____

► DIVE TIME IN _____ BST/GMT ◀

► DIVE TIME OUT _____

► DURATION _____

► DEPTH RANGE Actual _____
Corrected to Chart Datum

► DEPTH RANGE _____

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. freq)

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?

were made, use a new column. SCORE your observations 1 = rare, less than 10%, 2 = secondary, 10 - 30%, 3 = dominant, 30+.

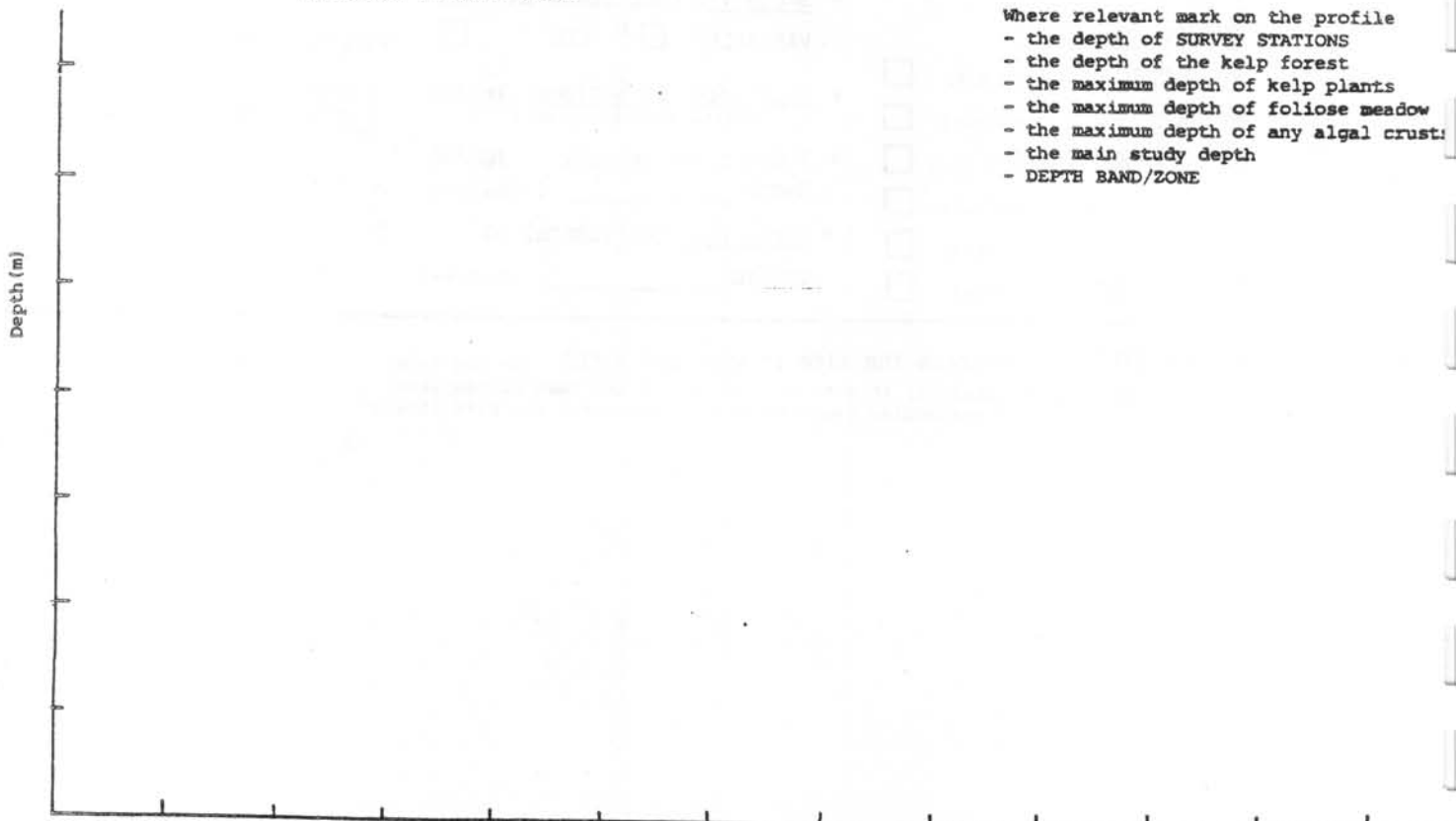
Survey station/habitat

Survey station/habitat

Survey station/habitat				Survey station/habitat			
DEPTH BELOW CHART DATUM				DEPTH BELOW CHART DATUM			
<u>SEABED</u> BEDROCK..... LARGE BOULDER 50cm+..... SMALL BOULDERS 25-50cm..... COBBLES 5-25cm..... PEBBLES 0.5-5cm..... GRAVEL..... COARSE SAND..... FINE SAND..... MUD..... ARTIFICIAL(eg wood,metal). Describe..... OTHER..... BIOLOGICAL(eg kelp,maerl). Describe.....				<u>SEDIMENT FEATURES</u> UNIFORM SEDIMENT PLAIN.... SMOOTH FEATURELESS SURFACE RIPPLED SURFACE..... SEDIMENT WAVES(give ht).... WORKED SURFACE..... TUBES (size?)..... BURROWS (size?)..... MOUNDS (size?)..... IS THE SEDIMENT ? CLEAN..... MUDDY..... MIXED UP..... UNIFORM..... CONTAINING SHELL..... SOFT?FIRM..... (Band test ?).....			
<u>TOPOGRAPHY</u> <u>INCLINATION</u> OVERHANG..... VERTICAL..... V. STEEP 40-80deg..... STEEP 20-40deg..... SHALLOW less than 20deg .. HORIZONTAL.....				<u>HUMAN DEBRIS</u> Describe.....			
<u>ROCK FEATURES</u> OUTCROP..... UNBROKEN ROCK..... BROKEN ROCK..... TERRACES width>2m..... LEDGES width < 2m..... ROCK WALL (give dimension) Describe..... GULLY (give dimensions)... (Surge/steep or open sided Describe..... FISSURES..... CREVICES (hand sized).... CAVE (give dimensions).... Describe..... BOULDER SLOPE(stable).... SCREE..... MOBILE COBBLES..... SCOURED WALL(give height). OTHER..... Describe.....				<u>COVER inanimate</u> <u>OF ROCK</u> SILT?SAND -which,quantity? Describe..... <u>OF SEDIMENT</u> Describe.....			
				<u>COVER: PLANT & ANIMAL</u> <u>PLANTS-Dominant cover(score)</u> KELP..... MEADOW..... Describe..... MAT..... CRUST..... OTHER..... Describe..... <u>ANIMAL-Dominant cover(score)</u> LARGE COLONIES(eg Alcyonium) Describe..... TURFS(eg hydroid,bryozoan) Describe..... OTHER..... Describe..... GRAZERS:Echinus-number/view Others.....			
				<u>BIOLOGICAL ZONE*</u>			

SITE PROFILE

Give distances in metres and depths corrected to chart datum



- Where relevant mark on the profile
- the depth 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 algal crust
 - the main study depth
 - DEPTH BAND/ZONE

* 1 = SUBLITTORAL FRINGE, 2 = UPPER INFRA-LITTORAL, 3 = LOWER INFRA-LITTORAL

Site name

Date

Recorder's name

Depth below CD

	1	2	3	4	5	*		1	2	3	4	5	*
PORIFERA - CALCAREA							<i>Cyanea capillata</i>						
<i>Clathrina coriacea</i>							<i>Cyanea lamarckii</i>						
<i>Leucosolenia complicata</i>							<i>Haliclystus auricula</i>						
<i>L. variabilis</i>							<i>Lucernaria quadricornis</i>						
<i>Leucosolenia sp.</i>							<i>Pleurobranchia pileus</i>						
<i>Scypha ciliata</i>													
<i>Scypha compressa</i>							COELENTERATA - ANTHOZOA						
PORIFERA - DEMOSPONGIAE							<i>Actinia equina</i>						
<i>Amphilectus fucorum</i>							<i>Actinothoe sphyrodeta</i>						
<i>Cliona celata</i>							<i>Adamsia carcinopados (palliata)</i>						
<i>Cliona sp. (boring)</i>							<i>Alcyonium digitatum</i>						
<i>Halichondria bowerbankii</i>							<i>Anemonia sulcata</i>						
<i>H. panicea</i>							<i>Caryophyllia smithii</i>						
<i>Haliclona oculata</i>							<i>Cereus pedunculatus</i>						
<i>Haliclona viscosa</i>							<i>Cerianthus lloydii</i>						
<i>Haliclona sp.</i>							<i>Corynactis viridis</i>						
<i>Mycale contarenii</i>							<i>Edwardsia claparedii</i>						
<i>Mycale sp.</i>							<i>Metridium senile</i>						
<i>Myxilla incrustans</i>							<i>Protanthea simplex</i>						
<i>M. fimbriata</i>							<i>Sagartia elegans v. mineata</i>						
<i>Microcionidae</i>							" v. nivea						
<i>Ophlitaspongia seriata</i>							" v. rosea						
<i>Oscarella lobularis</i>							" v. venusta						
<i>Pachymatisma johnstonia</i>							<i>Sagartia troglodytes</i>						
<i>Polymastia boletiforme</i>							<i>Sagartiogeton laceratus</i>						
<i>Polymastia mamillaris</i>							<i>S. undatus</i>						
<i>Porifera indet.</i>							<i>Urticina felina</i>						
<i>Raspailia hispida</i>							<i>Virgularia mirabilis</i>						
<i>R. ramosa</i>													
<i>Stelligera rigida</i>							NEMERTEA						
<i>S. stuposa</i>							<i>Lineus sp.</i>						
<i>Suberites carnosus</i>							<i>Lineus longissimus</i>						
<i>S. domuncula</i>							<i>Lineus ruber</i>						
COELENTERATA - HYDROZOA							<i>Nemertea indet.</i>						
<i>Abietinaria abietina</i>							<i>Tubulanus annulatus</i>						
<i>A. filicula</i>													
<i>Bougainvillia ramosa</i>							ANNELIDA - POLYCHAETA						
<i>Dynamena pumila</i>							<i>Amphitrite sp.</i>						
<i>Eudendrium sp.</i>							<i>Aphrodite aculeata</i>						
<i>Halecium halecium</i>							<i>Arenicola marina (casts)</i>						
<i>Hydractina echinata</i>							<i>Chaetopterus variopedatus</i>						
<i>Hydroidea indet.</i>							<i>Filograna implexa</i>						
<i>Kirchenpaueria pinnata</i>							<i>Myxicola aesthetica</i>						
<i>Lafoea sp.</i>							<i>M. infundibulum</i>						
<i>Nemertesia antennina</i>							<i>Polydora sp.</i>						
<i>N. ramosa</i>							<i>Pomatoceros sp.</i>						
<i>Obelia dichotoma</i>							<i>Sabella pavonina</i>						
<i>O. geniculata</i>							<i>Sabellidae indet.</i>						
<i>Obelia sp.</i>							<i>Serpula vermicularis</i>						
<i>Plumaria setacea</i>							<i>Spirorbinae indet.</i>						
<i>Schizotricha frutescens</i>							<i>Terebellidae indet.</i>						
<i>Sertularella polyzonias</i>													
<i>Sertularia argentia</i>							CRUSTACEA - BARNACLES						
<i>Thuiaria thuia</i>							<i>Balanus balanus</i>						
<i>Tubularia sp.</i>							<i>B. crenatus</i>						
							<i>Balanus sp.</i>						
COELENTERATA - SCYPHOZOA							<i>Sacculina carcini</i>						
<i>Aurelia aurita</i>							<i>Semibalanus balanoides</i>						
<i>Chrysaora hysoscella</i>							<i>Verruca stroemia</i>						

* Tick this column if specimen preserved

STATION	1	2	3	4	5	*
CRUSTACEA - MYSIDACEA AMPHIPODA						
Mysidacea indet.						
Amphipoda indet. (tubes)						
Caprellidae indet.						
Jassidae indet.						
CRUSTACEA - DECAPODA						
Atelecyclus rotundatus						
Anapagurus hyndmanni						
Cancer pagurus						
Carcinus maenas						
Crangon crangon						
Eballia tuberosa						
Galathea sp.						
Galathea squamifera						
G. strigosa						
Homarus gammarus						
Hyas araneus						
Hyas coarctatus						
Inachus dorsettensis						
Inachus sp.						
Liocarcinus depurator						
Liocarcinus puber						
Liocarcinus sp.						
Macropodia rostrata						
M. tenuirostris						
Macropodia sp.						
Munida rugosa						
Nephrops norvegicus (burrows)						
Paguridae indet.						
Pagurus bernhardus						
Pagurus prideux						
Palaemon serratus						
Pandalus montagui						
Porcellanus longicornis						
'Shrimps'						
Pycnogonids						
MOLLUSCA - CHITONS						
Acanthochitona crinitus						
Leptochiton asellus						
'Chitons'						
MOLLUSCA - PROSOBRANCHIA						
Acmaea sp.						
Apporhais pespelicani						
Buccinum undatum						
Calliostoma zizyphinum						
Gibbula cineraria						
G. magus						
Gibbula sp.						
Lacuna parva						
Lacuna vincta						
Littorina littorea						
Natica sp.						
Neptunea antiqua						
Patella sp.						
Patina pellucida						
Trivia arctica						
Trivia monachus						
Turritella communis						
MOLLUSCA - 'NUDIBRANCHS'						
Acanthodoris pilosa						
Aeolidia papillosa						
Aplysia punctata						
Archidoris pseudoargus						
Cadlina laevis						
Dendronotus frondosus						
Doridacea indet.						
Elysia viridis						
Limacia clavigera						
Onchidoris bilamellata						
Philine sp.						
Polycera quadrilineata						
Tritonia sp.						
MOLLUSCA - BIVALVIA						
Aequipecten opercularis						
Anomiidae indet.						
Arca tetragona						
Arctica islandica						
Cerastoderma sp.						
Chlamys opercularis						
Circomphalus (Venus) casina						
Dosinia sp.						
Ensis arcuatus						
Ensis sp.						
Hiatella arctica						
Lutraria lutraria						
Modiolus modiolus						
Mya arenaria						
Mya sp. (siphons)						
Mya truncata						
Mytilus edulis						
Tellina sp.						
Venerupis pullastra						
BRYOZOA						
Alcyonidium diaphanum						
Alcyonidium sp.						
Bicellaria bicellaria						
Bryozoa indet. (crust)						
Bugula flabellata						
Bugula sp.						
Cellepora pumicosa						
Cellaria sp.						
Crisiidae						
Electra pilosa						
Flustra foliacea						
Membranipora membranacea						
Omalosecosa ramulosa						
Parasmittina trispinosa						
Scrupocellaria scruposa						
Scrupocellaria sp.						
Securiflustra securifrons						
'Turf'						
ECHINODERMATA - CRINOIDEA						
Antedon bifida						
Antedon petasus						
ECHINODERMATA - STELLEROIDEA						
Acrocnida brachiata						
Amphiura filiformis						
Asterias rubens						
Astropecten irregularis						
Crossaster papposus						
Henricia sanguinolenta						
Henricia sp.						
Leptasterias mulleri						
Luidia ciliaris						
Luidia sarsi						
Marthasterias glacialis						
Ophiactis balli						
Ophiocoma nigra						
Ophiopholis aculeata						
Ophiotrix fragilis						
Ophiura albida						
Ophiura texturata						
Ophiuroidea indet. (arms)						
Porania pulvillus						
Solaster endeca						
ECHINODERMATA - ECHINOIDEA						
Echinocardium cordatum						
Echinus esculentus						
Psammechinus miliaris						
Strongylocentrosus drobachiensis						
ECHINODERMATA - HOLOTHUROIDEA						
Cucumaria frondosa						
Leptasynapta inhaerens						
Pawsonia (Cucumaria) saxicola						
Sea cucumber indet.						
CHORDATA - ASCIDIACEA						
Aplidium punctum						
A. proliferum						
Ascidia conchilega						
A. mentula						
Ascidia sp.						
A. virginea						
Ascidella aspersa						
A. scabra						
Botryllodes leachii						
Botryllus schlosseri						
Ciona intestinalis						
Clavellina lepadiformis						
Corella parallelogramma						
Dendrodoa grossularia						
Didemnidae indet.						
Diplosoma listerianum						
D. spongiforme						
Lissoclinum perforatum						
Molgula sp.						
Polycarpa pomaria						
Polyclinidae indet.						
Polyclinum aurantium						
Synozium pulmonaria						
'hard leathery indet.'						

Myxocephalus scorpius
 Pholis gunnellus
 Pleuronectes borealis
 PISCES
 Gadidae indet.
 Gobiidae indet.

Site Name Survey depth (below CD)

Date Recorder's name

STATION	1	2	3	4	5	6	Comments
CYANOPHYTA							
Beggiatoa sp.							
RHODOPHYTA							
Acrosorium reptans							
Antithamnion plumula							
Brongniartella byssoides							
Callithamnion sp.							
Callithamnion tetragonum							
Callophyllis cristata							
Callophyllis laciniata							
Ceramium rubrum							
Ceramium sp.							
Chondrus crispus							
Chylocladia verticillata							
Compsothamnion thuyoides							
Corallina officinalis							
Corallinaceae indet. (pink encrusting = 'Lithothamnion')							
Cruoria pellita							
Cruoria rosea							
Cryptopleura ramosa							
Cystoclonium purpureum							
Delesseria sanguinea							
Dilsea carnosa							
Furcellaria lumbricalis							
Gracilaria verrucosa							
Griffithsia corallinoides							
Griffithsia flosculosa							
Halarachnion ligulatum							
Heterosiphonia plumosa							
Hypoglossum woodwardii							
Kallymenia reniformis							
Laurencia hybrida							
Lithothamnion glaciale							
Lomentaria articulata							
Lomentaria clavellata							
Lomentaria orcadensis							
Membranoptera alata							
Myriogramme bonnemaisonii							
Nitophyllum punctatum							
Odonthalia dentata							
Palmaria palmata							
Phycodrys rubens							
Phyllophora crispa							
Phyllophora pseudoceratoides							
Phyllophora truncata							
Phymatolithon calcereum							
Plocamium cartilagineum							
Plumaria elegans							
Polyides rotundus							
Polysiphonia brodiaei							
Polysiphonia elongata							
Polysiphonia sp.							
Polysiphonia spiralis							
Porphyra mineata							
Porphyra sp.							
Pterosiphonia parasitica							
Ptilota plumosa							
Rhodomela confervoides							

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, Cellepora 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 descriptionsSite 1. Mouth of Voxter Voe

This site, situated on the east side of Sullom Voe, was surveyed from c. 8-20 m, as a 'warm-up'; the description is compiled from relatively incomplete records.

A quite gently inclined muddy, shelly sand slope, becoming muddier with depth, with patches of pebbles and shells. Significant quantities of L. saccharina were present above c. 12 m; with P. miliaris grazing on the kelp. Modiolus was plentiful below c. 15 m, with 'common' A. aspersa, O. fragilis and hermit crabs. Pebbles/small cobbles were found on the sediment below c. 18 m.

Site 2. Muckle Roe S

The substrate was a continuation of low cliffs and offshore rocks on the south side of Muckle Roe, where Swarbacks Minn joins the open sea.

This topologically complex site was dived by all the team. A moderate/steep bedrock slope descended in ledges, gullies and 'lumps' before giving way to a cobble/boulder slope with coarse sand patches at depths between about 11 and 18 m. The boulder region continued downward from 24 m (the maximum depth dived) without apparent change, on one profile at least. One very deep gully, its narrower end blocked by large boulders, with two or three small caves, was found. A. digitatum was quite thick on overhangs, but elsewhere was infrequent at this site, in contrast to many of the other rocky sites investigated. On one profile, above c. 9 or 10 m, the kelp forest was predominantly of L. hyperborea, with a very abrupt change to nearly all S. polyschides below this depth. The deepest S. polyschides was at c. 15 m, and juvenile L. saccharina were seen to c. 20 m. Elsewhere the transition from L. hyperborea to S. polyschides appeared to occur at slightly different depths, but was always quite sharp. At c. 17 m an extensive covering of red alga - ? Ralfsia ? - was present, as was a brown algal crust. O. nigra was common on boulder slopes below c. 20 m, with many albinos. M. rugosa, L. ciliaris, U. felina and ?N. mixta were seen amongst the boulders. All rock surfaces were well grazed by Echinus, with extensive colourful patches of encrusting coralline algae.

Site 3. Linga S.W. (Busta Voe)

Linga is a small island situated in Busta Voe.

A boulder slope extended to c. 6 m BCD, on coarse sand, supporting a mixed P. saccorhiza, L. hyperborea and L. saccharina forest; the P. saccorhiza plants had a thick coating of fine, filamentous, brown algae. Below 5 m the kelp was nearly all L. saccharina. At c. 6 m a distinct step occurred, and thereafter a sandy, becoming increasingly muddy, inclined plain descended to deeper than 24 m. A few small boulders were present at the top of the plain, and the sediment was stabilized by clumps of Modiolus. Scattered shell fragments and empty shells, notably of Ensis sp. were present. Individuals of L. saccharina and L. hyperborea persisted until c. 17 m. At this depth the slope flattened somewhat and Modiolus became rarer, and they were absent by 22-23 m. Burrowing holothurians were 'frequent'; O. aculeata and O. fragilis were associated with Modiolus. M. rugosa was present beneath the isolated boulders below the kelp forest.

Site 4. Sanda Stour SE

Sanda Stour is a small island exposed to the S and SW, with low steep cliffs and geos on its south side.

The site was surveyed from c. 9-30 m BCD. Bedrock descended fairly steeply via vertical faces to c. 3 m high, shallow gullies and ledges, until becoming first bedrock outcrops with boulders, and then a boulder slope. The latter continued below 30 m to the limits of visibility (which was in excess of 20 m). Patches of shell gravel were present between the boulders. A. digitatum was frequent, especially on steeply inclined surfaces, and some vertical/overhang surfaces were covered with a thick 'Pomatoceros crust'. The kelp (mainly a mixture of L. saccharina and P. saccorhiza) extended to c. 15 m, but was still relatively sparse at c. 9 m. Encrusting coralline algae covered most rock surfaces. O. nigra formed sparse beds over many rock surfaces below c. 15 m, and in this region an encrusting red alga was 'frequent'. A. rubens and U. felina were 'frequent', the latter being predominantly found in regions of shell gravel.

Site 5. Oxna SE

This site was close to the exposed southern shore of a low island c. 1 mile to the NW of Hamnavoe.

A boulder slope with occasional bedrock outcrops gave way to a flat area of coarse sand at c. 25-30 m. L. hyperborea and L. saccharina were dense above c. 9 m. Rock surfaces were well grazed by Echinus, with extensive encrusting coralline algae and patches of A. digitatum. 'Pomatoceros crusts' were also present. Generally a rather species-poor site.

Site 6. Linga E (ex. Hamnavoe)

Linga is an island name which occurs several times around Shetland. This Linga is a small island to the east of Hildasay (site 7), and distinct from site 3. The site was sheltered by Hildasay to the west and by Mainland in other directions.

A boulder slope with mixed kelp species extended to 7 m. A much more gently inclined, fine shelly sand with mud, slope extended from this depth to and beyond the survey limit at 19 m. The deepest L. saccharina plant was found at c. 12 m; C. filum and foliaceous algae were present below the boulder slope, especially between 7 and 10 m, attached to empty shells, etc. The sediment was well worked by A. marina, Ensis, etc, and A. rubens was 'common'. A reddish brown algal mat occurred on the deeper sediment. Echinus was 'frequent' throughout.

Site 7. Hildasay NW

Hildasay is a small island off the west coast of Mainland, to the north of Hamnavoe; the west coast is fully exposed to the SW and W.

Steeply sloping bedrock, with terraces and occasional boulders extended to beyond the range of vision (c. 20 m) at 20 m BCD. A light covering of silt was present on some surfaces. The rock was very well grazed by 'frequent' Echinus. Large clumps of A. digitatum were present, and groups of A. bifida. 'Occasional' S. elegans and U. felina were seen.

Site 8. West Skerry E

This skerry lies nearly a kilometre west of West Burra, and rises steeply from deep water.

A spectacular, predominantly vertical, rock face extended from 12 m to c. 30 m. Below this depth boulders were also present, a steep slope continuing to the limit of vision (visibility in excess of 20 m). The rock was broken by gullies and ledges, with boulder patches on the latter. A forest of L. hyperborea and S. polyschides was present above c. 12 m, the lowest kelp plant was found at c. 15 m. Epiphytic algae on L. hyperborea (mainly M. alata) appeared greyish white because of massive colonization by E. pilosa. Dense colonies of A. digitatum were present on vertical/steeply sloping surfaces, with clumps of F. implexa between. Other surfaces below the kelp zone were largely covered with encrusting coralline algae and P. trispinosa, with some patches of 'Pomatoceros crust'. Echinus was 'frequent', Galathea sp. was present in crevices, T. thulia was 'frequent' at the open mouths of crevices and narrow gullies, and other hydroids, especially A. abietina, were 'frequent' on the deeper bedrock. Ophiuroid arms emerged from crevices, and a variety of asteroids were recorded.

Site 9. Spindle

The exposed west coast of Muckle Roe comprises rugged, nearly vertical cliffs, with steep sided geos and stacks of which 'Spindle' is one.

A very rugged terrain, surveyed from c. 13 to 26 m. A wide gully in a bedrock slope ran directly down-slope, with large boulders in its bottom. A L. hyperborea forest was present, the fronds appearing white with M. membranacea; the deepest plant was at c. 20 m. Below c. 22 m a gentle slope of large boulders, with coarse shell sand between, continued to the limits of vision from 26 m (visibility 15-20 m). The sides of the boulders were covered with thick colonies of A. digitatum, F. implexa, 'Pomatoceros crust', occasional C. intestinalis, and encrusting coralline algae and a dark red encrusting alga dominated the boulder tops. Amphipods on 'whips' (Dyopedos porrectus) were 'frequent', and O. nigra and O. fragilis 'occasional'. A c. 10 m high rock pinnacle, c. 6 m in diameter was found with its base at c. 20 m, with A. digitatum and foliaceous red algae on its vertical faces.

Site 10. Moo Ness

A headland some hundreds of metres north of Spindle.

A steep bedrock cliff extended to 17 m, with dense L. hyperborea to c. 14 m, and then dense cover of A. digitatum with 'occasional' F. implexa. Below 17 m a gentle slope of large (some 'house-sized') boulders on coarse sand extended to the range of visibility. A. digitatum and 'Pomatoceros crust' were common on the vertical faces of the boulders, but the remaining surfaces were well grazed by Echinus. A variety of asteroids were present, and 'rare' C. smithii.

Site 11. Swarbacks Skerry

This site is on the south side of the entrance to Swarback Minns, exposed to the W and NW.

Near the shore a blunt pinnacle rises to c. 7 m leaving a steep sided gully, with coarse sand at the bottom, between itself and the shore. To seaward a steep bedrock slope, with more gently sloping ledges, continues beyond the survey limit of c. 26 m BCD, but the mean slope had by then become quite shallow. Echinus was frequent on all gently sloping surfaces, O. nigra was 'common' on the deeper upward facing rock, and a red encrusting alga was 'common' there. Dense colonies of A. digitatum dominated the steep rock below

c. 10 m; above this depth a L. hyperborea forest (the stipes thick with epiphytic red algae, the fronds very clean) began rather abruptly. The deepest kelp plant was found at c. 24 m, and L. hyperborea was sparsely present on gently sloping surfaces between 10 and 24 m. Small C. pagurus were 'common' in the gully between the pinnacle and the shore. A dense shoal of Pollachius sp. was present.

Site 12. Muckle Flugga E

The east side of a very exposed island - almost the northernmost point of the British Isles.

Fairly steeply inclined bedrock extended from c. 5 m to 14 or 15 m BCD, with channels and shallow sided gullies. A forest of L. hyperborea was present, giving way to L. saccharina near the bottom of the rock slope. This rock was often covered with encrusting calcareous and brown algae, the latter being predominant. Foliose algae were scarce (D. sanguinea) except on the kelp stipes. A few C. smithii were found on creviced rock just above the sediment; U. felina was 'frequent' there. A fairly gentle slope of rippled shell gravel extended from the base of the rock slope to 18 m, with bedrock outcrops and a patch of cobble with algal debris. A. esculenta and L. saccharina was found on these outcrops; the area was generally rather barren apart from hermit crabs.

Site 13. Rumblings, Muckle Flugga

A flat site, with large boulders interspersed with open expanses of gravel and shell gravel. The boulders were encrusted with pink/purple coralline algae between the stipes of 'abundant' L. hyperborea. The effects of Echinus grazing were very visible, and few flora or fauna were present on horizontal surfaces. Some vertical surfaces had S. elegans, A. digitatum and Pomatoceros sp., L. saccharina and occasional Ulva sp., A. esculenta and foliaceous red algae were present on pebbles in the gravel patches.

Site 14. Hols Hellier

A headland, completely exposed to the N, near the mouth of Burra Firth, Unst.

The site was surveyed between 19 and 27 m BCD. A steep bedrock slope with gullies and ledges extended to c. 26 m, and then there was a gentle slope of rippled clean sand with rock outcrops. A L. hyperborea forest was present to 20 m, and foliose algae and kelp persisted to the bottom of the rock slope. A. digitatum was 'frequent'. A little sand was present on the rock outcrops surrounded by sediment; they were covered by B. balanus, 'common' A. digitatum, together with 'Botryllus'. A. punctum, C. lepadiformis and C. smithii were all recorded. Young kelp plants were also present, and a few foliose red algae. Echinus was 'occasional' throughout.

Site 15. Burra Firth

This site was c. 1 km to the south of Hols Hellier, off a small headland on the east side of Burra Firth.

The dive commenced at c. 20 m BCD on fine, waved sand, apparently devoid of surface fauna. Dark patches of 'coarse' mud were present, and loose flocculent algae occurred in patches. Nearer the shore a flat, horizontal, apparently very stable plain of small boulders and cobbles was encountered. Encrusting

coralline algae were present on upward facing surfaces. At 20 m occasional L. hyperborea were found, and by 19-18 m there was a sparse kelp park. Pomatoceros was frequent in patches on the boulders; small A. rubens and ophiuroids were 'occasional', but surprisingly few Echinus were seen. O. aculeata was 'common' under the boulders. An isolated bedrock outcrop, with A. digitatum on its sides, was found at the end of the dive.

Site 16. South Holms SW

South Holms are a group of small islands on the west coast of Unst.

The area surveyed, between 18.5 and 24.5 m BCD, was a steep bedrock slope, with a deep crevice. A wide gully running across the slope at c. 21.5 m divided a steeply sloping/vertical zone from a more gentle gradient. L. hyperborea was present everywhere except in the gully, forming a forest on the upward facing surfaces above 18 m and thinning out somewhat to a 'dense park' at 24 m. The upward facing rock surfaces were covered with encrusting algae, mainly pink coralline but also some brown and red. Cobbles and algal debris were present at the bottom of the gully. Vertical surfaces had 'frequent' A. digitatum, 'Pomatoceros crust' was 'common/abundant'. U. felina was present in crevices, Echinus 'frequent'.

Site 17. Hagdale Ness

This is a headland on the west coast of Unst some 1 km south of South Holms.

A flat pebble region adjoined a flattish area of large boulders and bedrock at 24 m. The pebbles appeared barren, but the boulders and bedrock supported a L. hyperborea park, as well as foliose and encrusting red algae. A slope of large and small boulders extended upwards from this region, between c. 22 and 17 m, with a kelp forest. Above 17 m there was bedrock, with vertical faces to c. 2 m high and horizontal cracks. The fauna was generally rather sparse, except for 'common' Echinus.

Site 18. Hoga Ness

This and site 19 were in the relatively sheltered tidal sound between Yell and Unst.

A drift dive, covering some hundreds of metres approximately parallel to the shore. A moderate slope of boulders on sand was present between 5 and 14 m (the survey limits), with occasional patches of cobbles and pebbles on sand. Above c. 5 m there was a bedrock slope. L. hyperborea was 'abundant', with L. saccharina and S. polyschides also recorded. Rock surfaces were covered with pink and brown encrusting algae. The stipes had the usual flora of M. alata, C. lacineata, P. rubens, C. ramosa, but there were few foliose algae on rock surfaces. H. panicea encrusted many stipes, at 5 m. Echinus was 'occasional'; U. felina and C. pedunculatus occurred in the sand.

Site 19. Bluemull Sound

A fast drift dive approximately S to N towards the centre of Bluemull Sound. Most of the substrate consisted of stable cobbles or pebbles with occasional small boulders, at c. 25-34 m BCD. Echinus were frequent, but consistently small (a consequence of the strong current?), and S. argentea was 'abundant', supporting an abundant fauna of caprellids and amphipods, but otherwise the

fauna was poor. Towards Unst at the northern end of the drift the substrate sloped upwards to an area of massive bedrock outcrops with very dense A. digitatum. The deepest L. hyperborea was found at 24 m BCD, and there was a kelp park by 20 m. "The site was surveyed at considerable speed and in a short time; it was very interesting and would repay further study" (GA).

Site 20. Hoo Stack SE

Hoo Stack is a rugged island, a kilometre or more south of Eswick, to the NE of Lerwick.

A rugged bottom, with a fairly gentle mean slope below c. 18 m, and a steeper one at an adjacent profile between c. 5 and 20 m. Features included bedrock ledges, 'saw-toothed' areas (see site profile), rock outcrops with overhangs, and gullies with coarse sand at the bottom. Towards the south, as depth increased the mean inclination of the bottom became more nearly horizontal, but substantial rocky outcrops were still present. The more nearly horizontal rock faces appeared bluish-mauve from their encrustations of coralline algae, and grazing by 'frequent', 2-4 cm diameter Echinus was very noticeable. O. nigra were thinly scattered and small clumps of Modiolus with associated O. fragilis were present. The steeply inclined surfaces had many crevices, with protruding ophiuroid arms. Pomatoceros and A. digitatum dominated many of the steeper rock surfaces. A. bifida was 'frequent' in clumps, usually at the top edge of nearly vertical/overhung faces. L. hyperborea was present to c. 18 m BCD, and rather tatty foliose algae persisted to 25 m. Many ctenophores, salps, A. aurita and Cyanea spp. were present in the water column.

Site 21. Hoo Stack N

A sediment-free, clean, flattish/gently sloping bottom (upwards to the S towards Hoo Stack) of cobbles, pebbles and some small boulders. In places patches of coarse sand/shell gravel were visible. Free surfaces were encrusted with pinkish/purple coralline algae. Echinoderms were the dominant component of the fauna. Abundant S. droebachiensis were recorded, sometimes forming clumps in physical contact, often feeding on algal debris: Echinus was 'occasional'. A sparse bed of O. nigra overlaid the surface and O. aculeata and O. fragilis were also 'common'. Pomatoceros was 'common', Modiolus 'frequent/common', B. undatum 'frequent'. Large colonies of A. digitatum occurred at c. 3 m intervals; C. intestinalis was 'occasional'. It seems probable that many crevice dwellers were overlooked in the limited time available.

Site 22. S Isle of Gletness SE

The site was surveyed between c. 8 and 23 m BCD. The substrate was rugged, with bedrock outcrops and (esp. deeper than 20 m) terraces and low ridges, forming open sided gullies to c. 2 m wide. The mean slope was quite gentle, flattening further below 20 m. Large and small boulders were present between outcrops and on terraces, and coarse sand, pebble and cobble were found in gullies and also forming an area of plain at c. 20 m. The area was moderately well grazed by Echinus, with A. digitatum present on overhangs and verticals. O. nigra was 'frequent', Pomatoceros crust was found on some overhung rock faces, and A. bifida and hydroids were often found at the upper edge of these faces. Modiolus were found in clumps of 12-20 on the gully bottoms, and also on horizontal surfaces (e.g. terraces), with associated O. fragilis.

Site 23. Ling Ness SW

Diving took place in the channel at the mouth of Cat Firth. The only exposure is to the SE.

This site was investigated by two pairs of divers whose range from the shore did not quite overlap. In shallower water (7-10 m) a steep bedrock slope with a L. hyperborea forest was present. Moving deeper the substrate became bedrock outcrops and boulders, the latter becoming smaller with increasing depth. The coarse sand present between the boulders increased in proportion until, at depths of c. 18 m or more, the bottom was a gentle slope of coarse sand and cobble. Modiolus was present on the sand, especially deeper. Ophiuroids were present in the rock crevices.

Somewhat further out in the mouth of the firth the bottom was almost horizontal, and consisted of pebbles, cobbles and patches of gravel surrounding low bedrock outcrops; it seems likely that in places a layer of loose sediment/pebble thinly covered bedrock. Modiolus was present in small clumps. Hydroids were also found, probably an indication of significant current action.

Site 24. Little Holm NE

Little Holm is a small rocky island lying in the middle of the northern part of Yell Sound. It has an unbroken fetch to the north.

A steep slope (c. 45°) of rugged bedrock from c. 17 to 23 m, with cracks and occasional small gullies. A few boulders and coarse sand particles were also present. Kelp extended to c. 20 m. A significant current was noted. The rock was moderately well grazed by Echinus; nevertheless hydroids were 'frequent'. O. nigra was recorded as 'common', and A. bifida was present.

Site 25. Little Holm E

Between c. 19 and 25 m there was a slope of very large boulders, with a wide variety of habitats (cliffs, crevices, terraces), with smaller boulders, pebbles and occasional small patches of shell gravel. By 25 m the slope had flattened out to a slightly inclined area of small boulders and shell gravel. L. hyperborea extended as a park to 23 m. O. nigra was 'common', especially on the deeper, flatter terrain. Modiolus was frequent in patches everywhere, with O. aculeata arms appearing between the Modiolus, and also from beneath cobble and small boulders. Hydroids were frequent, as was Echinus; A. bifida 'common'.

Site 26. Little Holm N

A bedrock slope of moderate inclination extended between c. 22 and 30 m BCD, well covered with encrusting coralline algae (L. hyperborea occurring to c. 24 m), with few gullies above c. 28 m. Below this depth the slope flattened out, with 'bowls' and gullies containing coarse sand/shell gravel, cobble and small boulders. Some vertical and overhung faces, quite heavily creviced, were present. 'Pomatoceros crust' occurred on some of them. A. digitatum was 'frequent', mostly on the tops of rock ridges. O. nigra and O. fragilis were both frequent, forming sparse beds, especially where the substrate was approximately horizontal. (The former predominantly on sand, the latter on bedrock). A red encrusting alga was 'frequent' below c. 28 m.

Site 27. Ness of Queyfirth

This is a headland on the south western side of Yell Sound.

- 27a) The site was surveyed below 10 m BCD. A boulder slope flattened with increasing depth, and the proportion of coarse sand steadily increased from c. 10% at 10 m until at 20 m the substrate was predominantly coarse sand with scattered pebbles. O. nigra was abundant on the sand, thinning out with decreasing depth. Modiolus was 'common' in discrete clumps, with O. fragilis arms emerging; many empty shells were also present. Large discrete colonies of A. digitatum were present on the cobble; also clumps of hydroids. L. saccharina persisted to c. 20 m.
- 27b) At 20 m there was a gentle slope of muddy coarse sand, with occasional cobbles and pebbles with sparse, tatty L. hyperborea and L. saccharina. Patches of a brown algal mat were present on the sediment. The slope became steeper as the slope was ascended, and the proportion of pebbles/cobbles/small boulders increased. A few Modiolus were present. A distinct Phycodrys rubens meadow occurred between c. 14 and 18 m. Above 10 m bedrock outcrops and large boulders were present, with coarse, fairly clean, sand between them, thickly covered with L. saccharina. Rugged bedrock, forming some isolated pinnacles, occurred above 8 m BCD, covered with a L. hyperborea forest. The rock between the holdfasts was well grazed, leaving a covering of encrusting coralline algae.

Site 28. Stoura Stack

Stoura Stack lies at the entrance to the harbour on Out Skerries. It is a steeply sloping rock, exposed to the south.

Three pairs and a trio of divers sampled this site, descending within an area less than about 100 m across. The details of the substrates encountered varied quite widely. Two profiles are shown in Appendix 4. Common features were the steep bedrock slope, with gullies and pinnacles, in shallower water, with a stable boulder slope below. The bedrock/boulder interface varied between c. 23 and 28 m. The deepest kelp plant was recorded at 26 m, and above 20 m L. hyperborea and some S. polyschides formed a forest. A. digitatum dominated many of the steep/vertical bedrock faces (with F. implexans also present) and was 'common' on the tops of the deeper boulders, together with a red algal crust. Hydroids were also present on these boulders. 'Pomatoceros crust' covered other vertical/overhung faces. Corynactis was present on the vertical walls of some of the shallower gullies. The whole area was moderately well grazed by Echinus, with encrusting coralline algae being 'common'.

Site 29. Longa Skerries

Longa Skerries lie off Griff Skerry, which comprise an exposed group of small islands/rocks to the south of Whalsay.

This site was also investigated by all the divers in the team. Seven covered the depth range 17-31 m BCD, and their reports fit together quite well; the other pair descended into somewhat deeper (although nearby) water, and it is not clear how the area they examined connects with that seen by the other divers.

A moderate bedrock slope descended via terraces, steep-sided gullies and occasional small pinnacles from c. 17 to c. 30 m. The inclination to the horizontal began to decrease at c. 25 m, and by 30 m there was a gentle slope of low bedrock outcrops, sometimes forming ridges with coarse sand between.

L. hyperborea was present above a depth of c. 23 m, and from c. 23-25 m there was a D. aculeata meadow, with odd plants persisting until c. 28 m. These plants were very heavily encrusted with E. pilosa, to the extent that they appeared greyish white. A. digitatum was 'common', in clumps on ridge tops and vertical surfaces (not continuous as in site 28). O. nigra was 'common' on deeper rock and sand.

The pair of divers who first reached bottom at c. 32 m found a rock pinnacle, with a quite steep slope. Fauna were sparse, with c. 50% bare rock. A. digitatum was the predominant animal; 'Pomatoceros crust' was also common and there were c. 15 cm diameter masses of F. implexa. Crevices contained Galathea sp.

Ctenophores and salps were 'common' in the water column.

Site 30. The Drongs

The Drongs are a spectacular group of stacks about a kilometre from the nearest point of the shore to the south of Esha Ness.

This site was investigated by all the team. Because of the NW sea, diving was restricted to the NE side of the main stacks and the reportedly more spectacular underwater scenery of the west side could not be approached. The substrate investigated by 7 of the divers was similar and will be described first. The other pair (slightly to the south) found somewhat different conditions.

Rock descended to the east from a bedrock platform at c. 5 m, via deep (5-7 m high walls) and wide gullies, and terraces, to depths in excess of 20 m. Large boulders were present in gully bottoms. The vertical walls were dominated by A. digitatum, with some large patches of 'Pomatoceros crust', L. hyperborea formed a forest on most upward facing surfaces to c. 15 m, but was absent from steeply inclined/vertical faces. A brown algal crust (?Aglaozonia) was present on rock surfaces at c. 15 m. U. felina and S. elegans were present, the latter in cracks in deeper upward facing surfaces. Below c. 20 m the mean slope flattened, with 'saucers' in the bedrock full of large and small boulders. Occasional pinnacles rose 8-10 m. Much of the region was covered with a fuzzy red alga (?Trailliella) often with little other organic material apparent. Echinus was everywhere 'common' - up to 40 per 'view'.

The other pair of divers commenced their dive close to the NE face of the main stack. They found a site of large boulders on pebble and gravel at c. 12 m BCD. The boulders were covered with L. hyperborea and encrusting coralline algae, but little else. The pebbles supported large stands of D. aculeata with occasional L. saccharina. A bedrock outcrop and cliff was found, the latter dominated by A. digitatum. At the foot of the cliff, at c. 13 m, there was a slope of small boulders.

Site 31. Ness of Hillswick

The site is within a hundred metres of the exposed headland, and is clearly subject to heavy wave action.

The area consisted of intersecting, wide (typically 3-4 m) almost vertical sided gullies, with walls 8-10 m high. At one intersection were remains of an 1890's wreck. The gully walls had occasional ledges, slightly overhung regions and many holes (to c. 30 cm diameter and c. 1 m depth) and crevices. Small boulders were present on the gully floors. A. digitatum provided nearly total cover on the walls, apart from patches of 'Pomatoceros crust'. Clumps of up to a dozen

U. felina were present on the ledges. The holes/crevices provided shelter for G. strigosa, O. aculeata, C. pagurus and several species of fish. F. implexa and C. viridis were also present. Although Echinus was 'frequent', its grazing impact seemed less significant than at many other sites visited. A spectacular site visually.

Site 32. Ramna Geo.

Ramna Geo is on the SE side of Lunna Ness. The sites were immediately under the steep cliffs.

32a) From c. 16 m to 29-30 m a steep, rather precarious looking, slope of large boulders (2+ m across) provided many overhangs and crevices. An isolated area of steeply sloping bedrock was also found in this zone. Above c. 16 m there was a bedrock cliff, with a kelp forest above c. 15 m. Below c. 29 m the slope flattened, and the boulders became smaller (0.5-1 m) with coarse shelly sand/gravel between them. The area was very well grazed by many small Echinus. 'Pomatoceros crust' occurred on overhangs and some vertical faces of boulders and bedrock. A. bifida were present singly or in small clumps on the top edges of vertical/overhung faces. The boulder tops were very bare, with only a little encrusting coralline algae and P. trispinosa present. A. mentula and O. aculeata were present among the boulders, which also provided shelter for Cuckoo and Ballan Wrasse and small gadoids.

32b) A steep boulder slope extended from c. 14 to c. 21 m, the boulders decreasing in size downslope from 1+ m diameter. Below c. 22 m there was a slope of coarse sand, with P. maximus 'common'. Upper surfaces of boulders were well grazed. 'Pomatoceros crust' was 'common' on vertical/overhung faces, A. bifida was 'frequent', and crevices housed terebellids, ophiuroids and ascidians. Ling and small gadoids were reported.

Site 33. E Lunna Voe

Site 33b) is in E Lunna Voe, a small voe with a beach on the SE of Lunna Ness. 33a) is a little further to the NE, under the cliff.

33a) A rock slope extended to a coarse shell gravel/mud plain at c. 33 m. Above c. 14 m the slope was steep bedrock, there were then some boulders and then quite smooth bedrock until the sediment was reached. Kelp was present to c. 18 m, growing thickly above c. 14 m. O. nigra was 'common' between c. 18 and 24 m, Pomatoceros was 'frequent/common' and A. bifida 'common' on rock beneath the kelp zone. The area was well grazed by Echinus.

33b) The dive commenced in a small cave (entrance via a gulley c. 1 m wide, 3 m deep) at c. 1 m BCD. The walls were thinly covered with ascidians, sponges and bryozoans; boulder/cobble was present at the bottom. Outside of the cave there was a steep boulder slope with L. hyperborea, and then L. saccharina to a depth of c. 15 m. At c. 18 m the slope flattened to a region of coarse sand, well worked by Ensis sp.; P. maximus and large C. pagurus were seen here.

Site 34. Vidlin Voe

The area was in the middle of the Voe, immediately to the east of the northernmost of several drying rock pinnacles.

The site was surveyed between 16 and 27 m. It was a gently sloping region of muddy, shelly sand, well worked, with many D. exoleta and E. arcuatus shells on the surface. A few Echinus were present. Occasional L. saccharina (and one or two L. hyperborea) were attached to pebble and cobble down to 27 m - the deeper ones obviously rafted. Filamentous algae were 'occasional' on buried pebbles and shells. A few C. intestinalis and C. parallelograma were recorded. Patches of kelp debris were present.

Site 35. Giant's Leg

The arch formed by the 'Leg' is a dramatic piece of coastal scenery on the SW corner of Bressay. The area is dominated by high, nearly vertical cliffs and narrow geos.

A topographically quite complex site, dived by all team members. The habitats investigated can be put into two groups, those within and those outside the arch.

i) Inside the arch. On the inside of the 'leg' a shady, vertical/overhung rock wall, with angled faces, descended to c. 8 m. The rock was quite heavily creviced. From c. 8-10 or 11 m there was a sloping bedrock platform. To the NW and SE broad gullies, full of large boulders, descended out of the arch to a depth of c. 16 m. One of these gullies led into a scoured hole at c. 20 m, containing boulders. The landward side of the arch was a steep fairly uniform, bedrock cliff.

On the seaward (shaded) face, barnacles and small M. edulis covered the rock near CD, and A. esculenta was also present. By 3 m BCD thick clumps of Tubularia sp. were present, giving way to a turf of hydroids, bryozoans, Diplosoma sp., P. aurantium, A. proliferum etc. One well shaded, slightly overhung face was covered with small M. senile. S. elegans was 'common' and patches of C. viridis were found. A. digitatum, U. felina and D. sanguinea were scattered across the 8-11 m shelf. Echinus was 'rare'. The landward (and illuminated) cliff had c. 100% A. digitatum cover. A dark red algal crust was present, especially on boulder tops. The water column was thick with hydroids, medusae and salps. Visually, a spectacular site.

ii) Outside the arch. A vertical rock wall extended from c. 8-12 m, with encrusting red algae, A. digitatum and Pomatoceros on overhangs, Corynactis, S. elegans and small M. senile. U. felina was present in cracks and at the wall base. Below the wall L. saccharina formed a park to 17 m on a boulder slope, the deepest plant being found at c. 20 m. Some L. hyperborea were also present, as was an encrusting red alga. The boulders appeared to be well grazed by Echinus, but 'Pomatoceros crusts' were present on vertical faces. Below 20 m P. trispinosa and hydroids were more frequent.

Site 36. Ness of Sound S

This site was at the southern tip of Ness of Sound, a small headland immediately to the south of Lerwick.

It was surveyed between 4 and 22 m BCD. At 4 m a 2-3 m a wide vertical-sided gully was present. Bedrock continued down to c. 20 m, via ledges and approximately vertical cliffs. Large colonies of A. digitatum occurred on vertical faces and L. hyperborea continued to c. 16 m. C. viridis was present in shallower water. Echinus was 'common'. Large patches of encrusting coralline algae were seen. Very large numbers of Onchidoris bilamellata were

present on some gently sloping surfaces, feeding on barnacles. C. smithii was also present. Below the bedrock was a gentle boulder slope, with some very large boulders, surrounding some massive bedrock outcrops, with cliffs to c. 6 m high. Large pollack were seen; A. aurita were common in the water column.

Site 37. Munger Skerries

The SE side of Ness of Sound consists of low steep cliffs, geos and low ridges of rock running offshore. This site is c. 0.7 km north of Ness of Sound S.

A rugged area: the following description is compiled from two adjacent dive profiles.

Steep sided gullies were present near the shore, one dropping from c. 3 m to 10-12 m; A. digitatum and Pomatoceros were present on the side walls. Boulders (and some wreckage) were present in the gully bottoms. A short boulder slope was followed by an area of rather smooth, extremely well grazed, bedrock extending downwards from c. 14 m, with gullies and reefs to c. 2 m high. 'Pomatoceros crust' was present on some verticals and ophiuroid arms emerged from occasional cracks, otherwise macrofauna was scarce. An adjacent gully descended to c. 18 m at its mouth, and gave onto a gently sloping region of boulders, some very large, and occasional sand patches. The kelp forest had disappeared by c. 11 m; the well grazed rock, bright with encrusting coralline algae, between the holdfasts was conspicuous. Many Echinus were small, c. 1-3 cm in diameter.

Site 38. Flotta

The site was immediately to the south of a small island in Weisdale Voe, and extremely sheltered. Flotta is reportedly limestone, but boulders showed no heavy crevicing nor any unusual epifauna.

A boulder slope with dense L. saccharina extended to c. 5 m BCD. Between c. 5 m and 9 m the substrate was coarse sand, with C. filum, Asperococcus sp., Ulva sp., etc., well worked by M. truncata, E. arcuatus, etc. At c. 9 m there were a few boulders, and Modiolus clumps first appeared, becoming more frequent down an increasingly muddy sand slope to c. 20 m, where the inclination increased and the Modiolus became scarcer. A few large boulders were present at c. 20 m. L. saccharina was attached to Modiolus until c. 15 m, and K. pinnata and O. aculeata were found frequently in association with Modiolus. A. opercularis and B. undatum were 'common', and several C. frondosa were found below 10 m.

Site 39. Russa Ness

The site was immediately off a rather featureless strip of shore on the west side of Weisdale Voe.

The survey covered the range 10-25 m. A boulder/cobble slope with L. saccharina terminated at 10 m. Below this there was a shell gravel/mud slope, inclination 20°-30°, which become progressively muddier and softer with increasing depth. A low bedrock ridge was found at c. 17 m. L. saccharina occurred on occasional boulders to c. 16 m, and below this depth some Modiolus were found. C. opercularis was 'frequent', O. nigra 'occasional' on the sediment.

Site 40. Mavis Grind

This site was dived down from the shore, from the westmost point of Sullom Voe, very sheltered apart from a c. 3 km fetch to the NE.

The entry was down a muddy sand slope to the north of the main survey area. Here C. filum and foliaceous algae were found; A. irregularis, P. miliaris were 'common', Modiolus 'occasional'. To the right (i.e. south) was a vertical wall with 'abundant' 'Pomatoceros crust', 'frequent' A. aspersa and some A. scabra.

Continuing along the foot of the wall, the base of a slope of large boulders was encountered, the base descending from c. 10-14 m from north to south. A few tatty 'cape-like' L. saccharina were present at the base of the slope, and the boulders were very silty. A. aspersa was 'frequent/common' with 'occasional' large A. mentula. Some hydroids and sponges were present. H. araneus was 'frequent'. Beneath the main boulder slope there was a relatively barren, quite steep, soft mud slope, with some almost completely buried boulders. 'Occasional' Echinus were seen throughout.

Site 41. Vaila: Tower

This was at the mouth of a relatively narrow sound (Wester Sound), between Vaila Island and a headland. The following description (and the profile) is compiled from records for two dives whose depth ranges did not quite overlap.

A bedrock wall descended from c. 16 to 25 m towards the SW. Above the wall L. hyperborea was present. The wall itself was dominated by A. digitatum. Below was a region, gently sloping to the SW, of rather saw-toothed bedrock outcrops separated by cobble/boulder plains, with patches of coarse sand occurring in shallow gullies. Thick 'Pomatoceros crusts' occurred on some slightly overhung faces, ophiuroid arms were visible there, and A. digitatum was 'common' (c. 99% of polyps withdrawn), especially on the tops of the rock outcrops. O. nigra was the only obvious macrofauna on the cobble (with O. fragilis underneath), and also occurred on the outcrops. Large areas of encrusting coralline algae coloured these outcrops, and Echinus was plentiful. Hydroids were lacking even though a current was noted.

Site 42. Rusna Stacks

Exposed, just drying, rocks immediately to the south of the headland on the west side of Wester Sound.

Steep, current swept bedrock descended from a skerry to more than 30 m BCD. The site was only investigated below c. 17 m. Small L. hyperborea were present at this depth, but not below. There was massive A. digitatum cover on verticals, with groups of U. felina and small C. pagurus on ledges; S. elegans was also present. One wide, long gully was encountered at c. 22 m with small boulders and carpeted with O. nigra. A. abietina was present, typically at the mouths of crevices. Occasional small areas of coarse sand were present in the mouths of narrow gullies. Patches of P. trispinosa and coralline algae encrusted the rock; the site seemed well grazed by Echinus.

Site 43. Ronas Voe




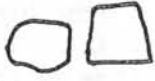























These dives were carried out in the sheltered waters of the upper part of Ronas Voe, primarily to search (unsuccessfully) for the anthozoan Aracnanthus sarsi, whose larvae had previously been reported from the Voe.

43a) This extended to c. 21 m BCD from the fish processing station on the south shore of the Voe. Full records are not available; the substrate was a soft mud slope with occasional boulders and (?) low, small bedrock outcrops.

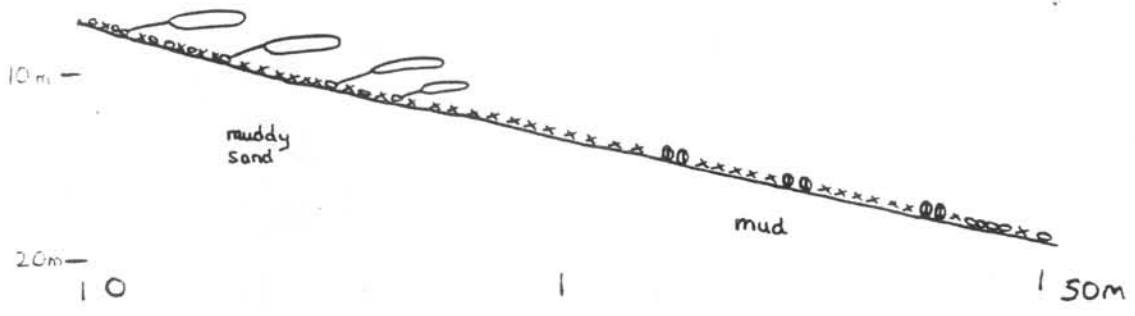
43b) The area surveyed was below and to the NW of a small beach on the N side of the Voe, opposite site 43a).

A moderate slope of mud and small boulders with dense L. saccharina extended to c. 3 m BCD beneath a narrow zone of mud with C. filum and foliose algae at c. CD. Boulders and L. saccharina then became scarcer, and a pebble/mud slope with decreasing proportion of pebble continued to deeper than 24 m. Kelp was not found below c. 10 m. In places the mud was well worked with, inter alia, C. pagurus holes. A. aspersa was 'common' in and below the laminarian zone. A thin brown algal mat was present on sediment below c. 10 m, giving c. 40% cover. Approximately 60 m N of the entry point boulders and bedrock outcrops were present down to c. 14 m; from c. 14-15 m there was a patch of small pebbles. The mean slope was somewhat steeper in this region.

Key to symbols:

	<u>Laminaria digitata</u>		Bedrock
	<u>Laminaria saccharina</u>		Boulders
	<u>Alaria esculenta</u>		Cobble/pebble
	<u>Laminaria hyperborea</u>		Sediment
	<u>Sacchoriza polyschides</u>		Ophiuroids
	<u>Halidrys siliquosa</u>		<u>Antedon bifida</u>
	Foliaceous algae		<u>Modiolus modiolus</u>
	<u>Chorda filum</u>		Hydroids
	Algal debris		Ophiuroid arms
	Algal mat or crust		<u>Arenicola</u> (casts)
	<u>Desmarestia aculeata</u>		<u>Alcyonium digitatum</u>
	Unspecified kelp		<u>Pomatoceros</u> crust
			Solitary ascidians
			Scallops
			Anemones

Site 1



'brown crust' + coralline

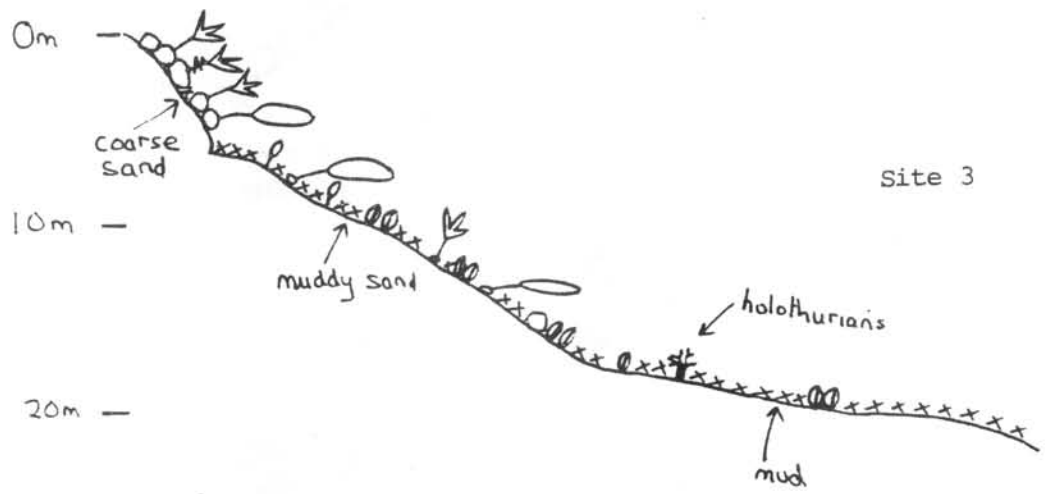
10m -

20m -

juv. *L. saccharina*
Ralfsia
O. nigra
V. felina
coarse sand

Site 2

c 60m



Site 3

10m -

Site 4

red algal crust

20m -

U. felina

30m -

shell gravel

80m

10m -

Site 5

20m -

O. fragilis

Coarse sand
c. 100m

30m -

0m -

Site 6

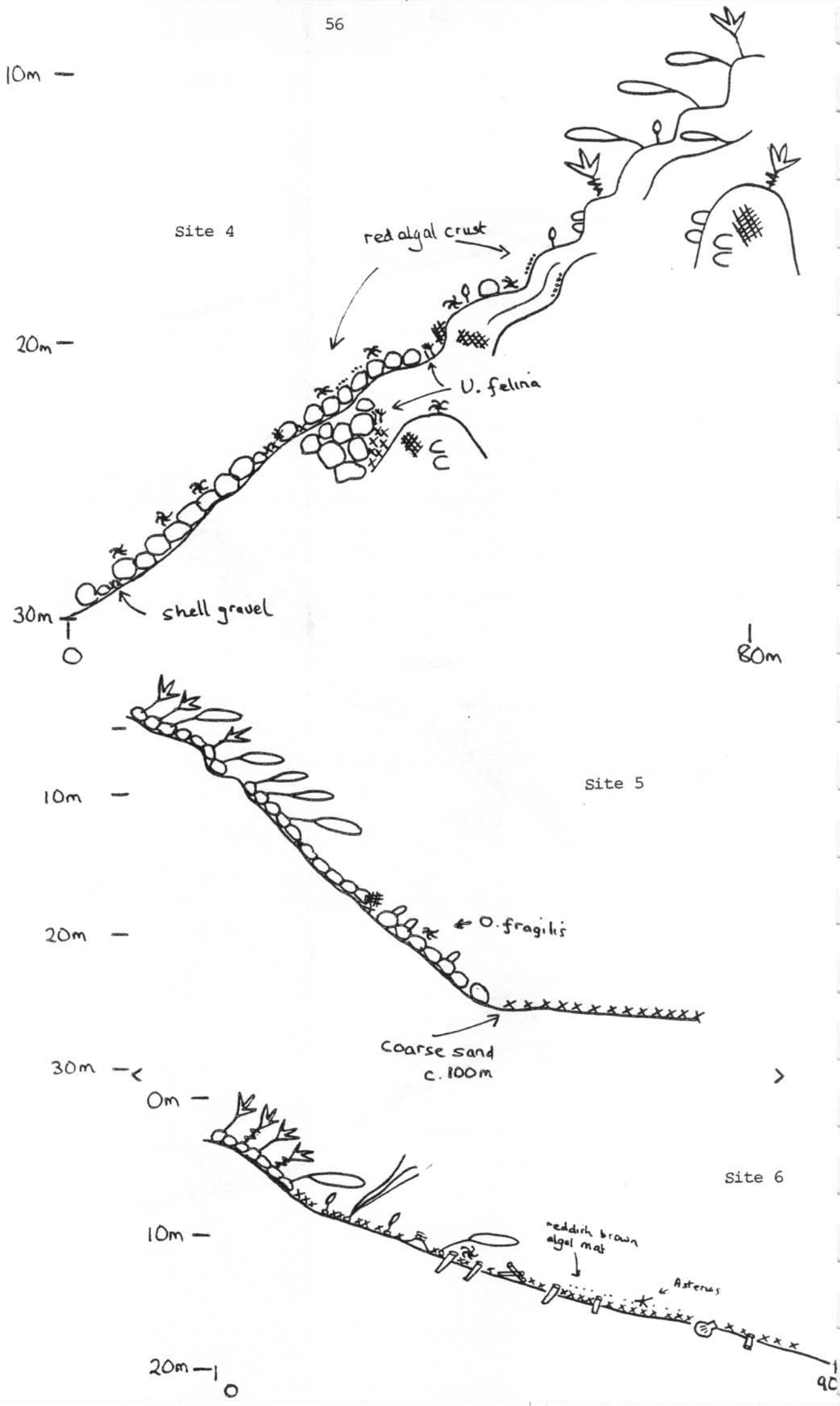
10m -

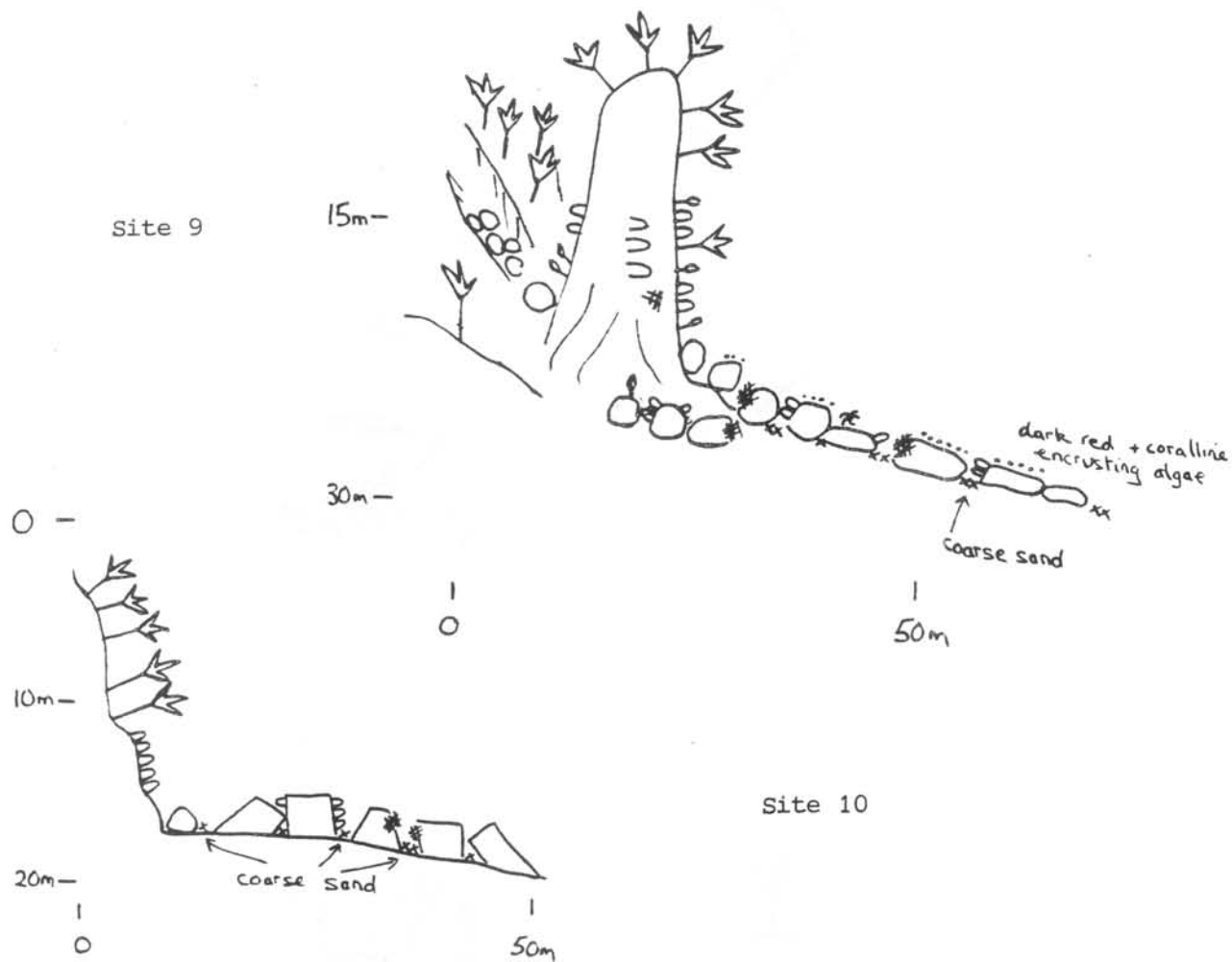
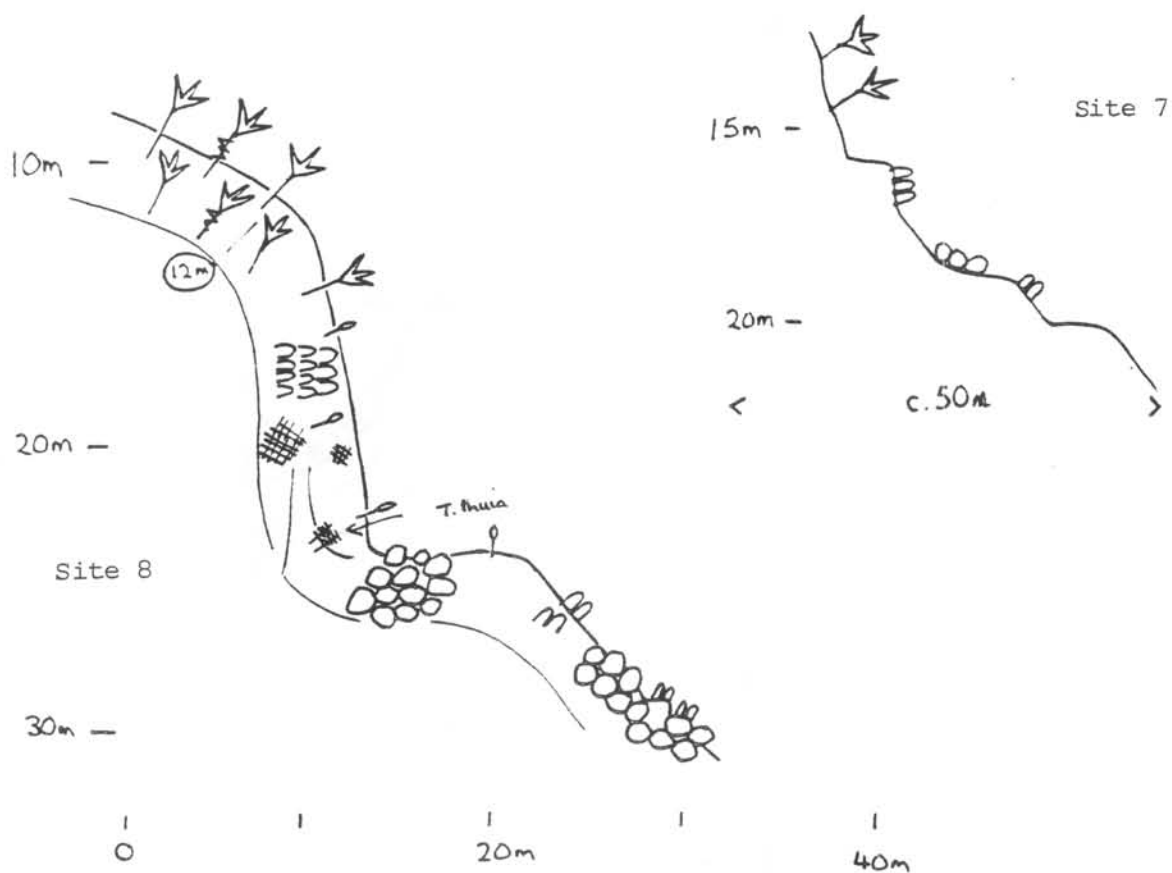
reddish brown
algal mat

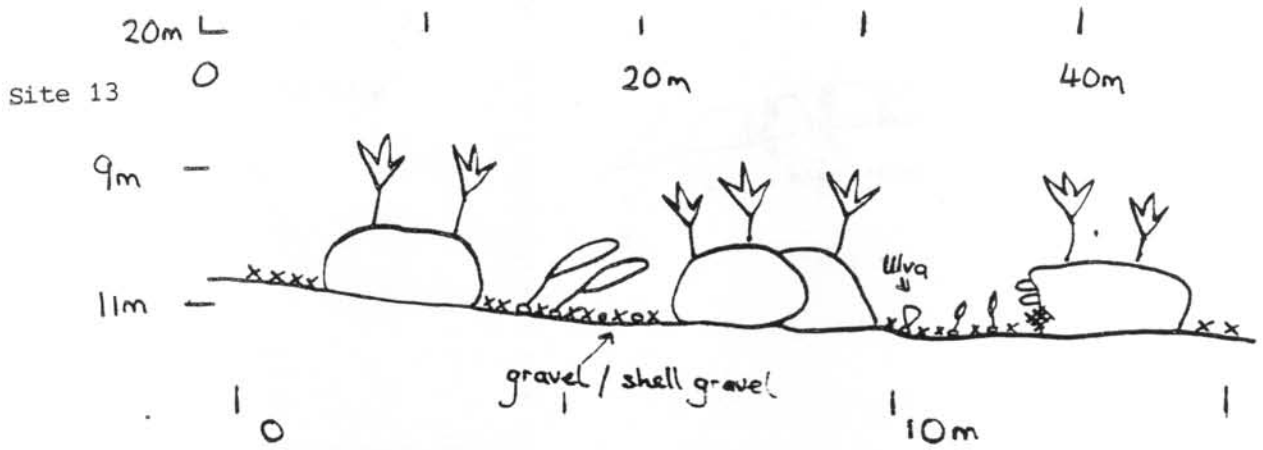
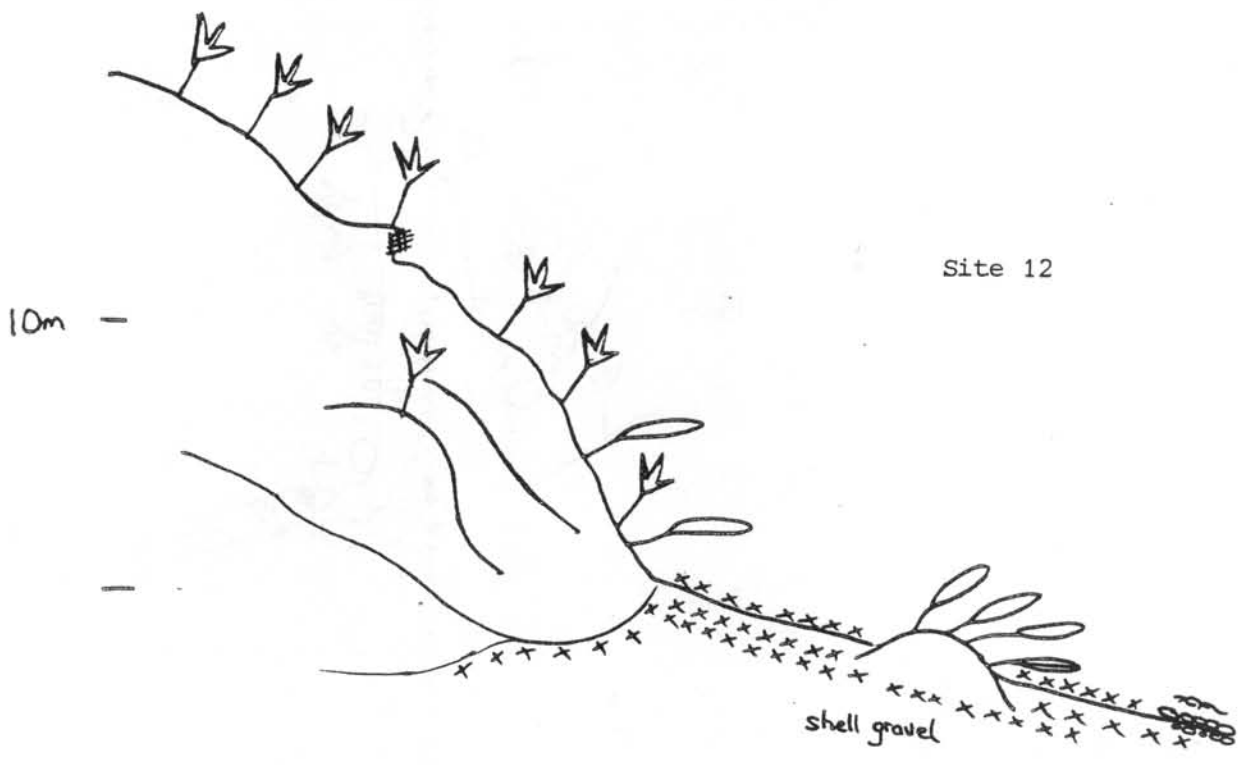
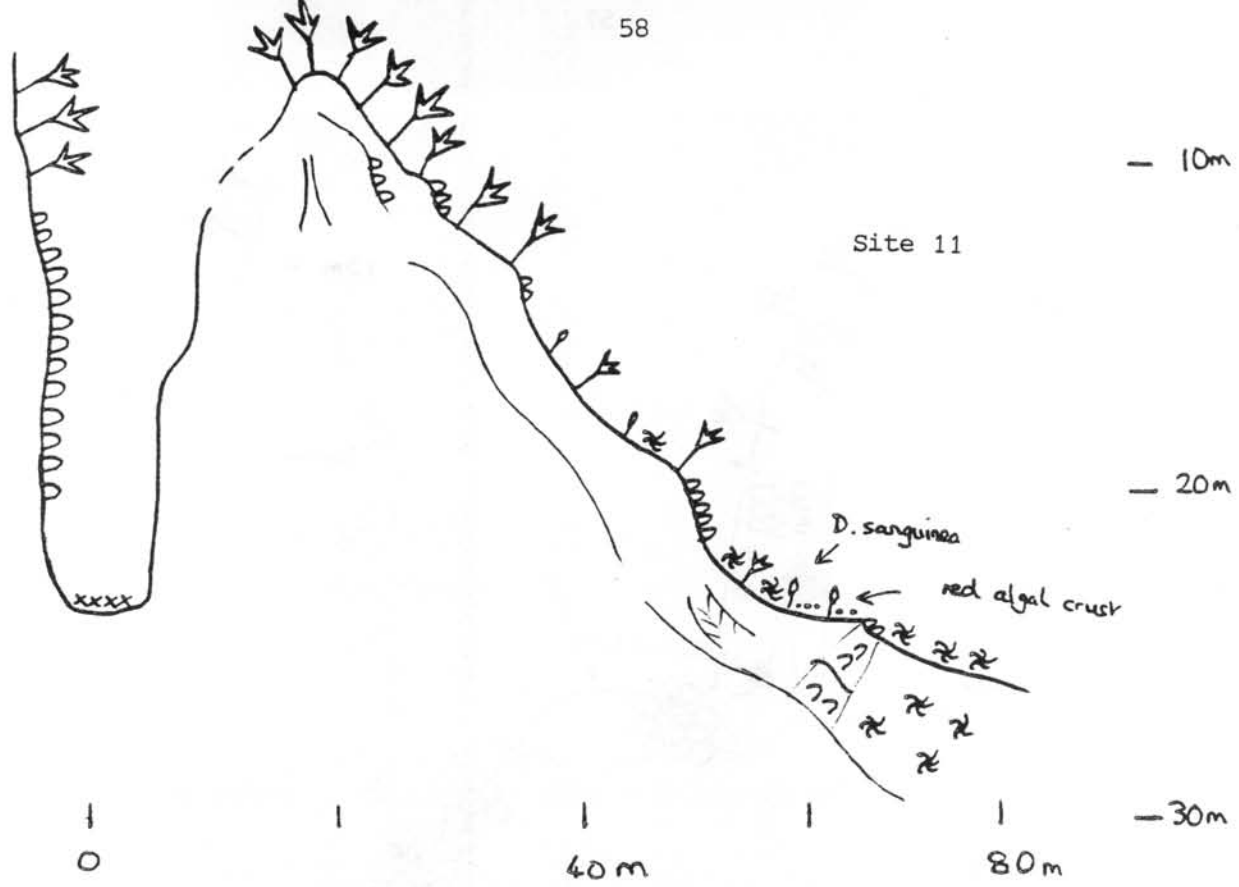
Asterias

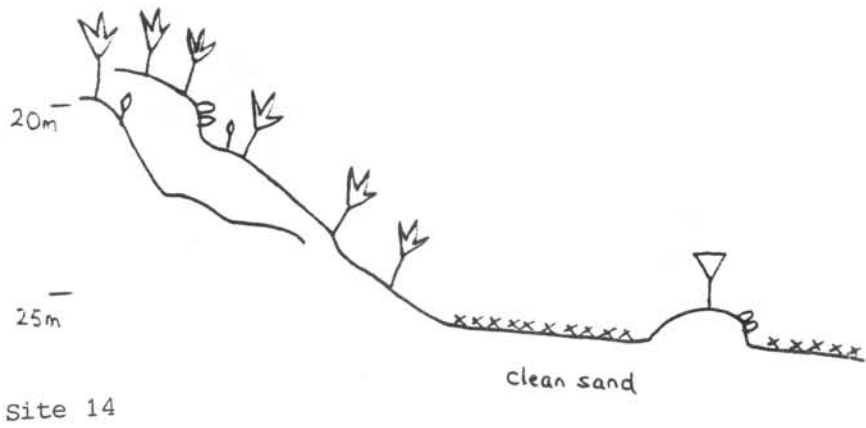
20m -

90

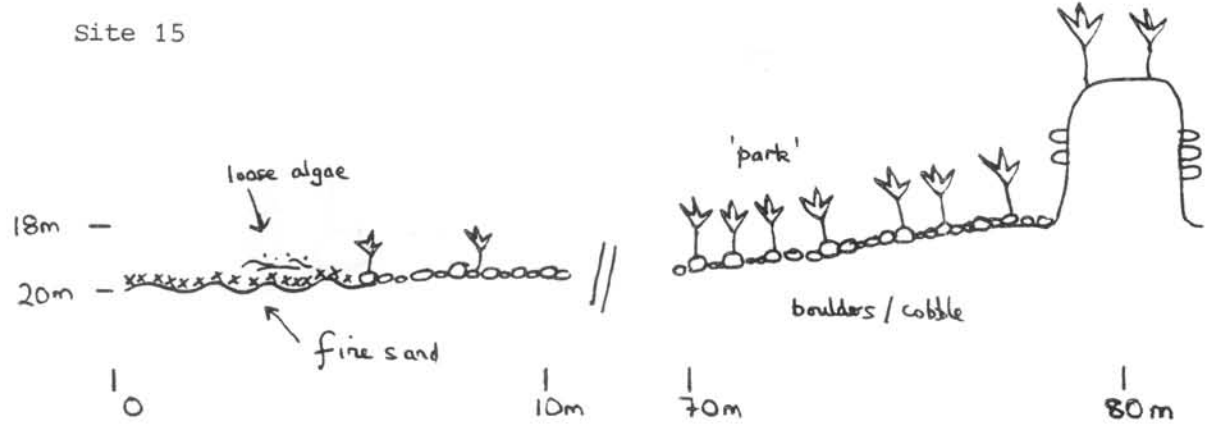




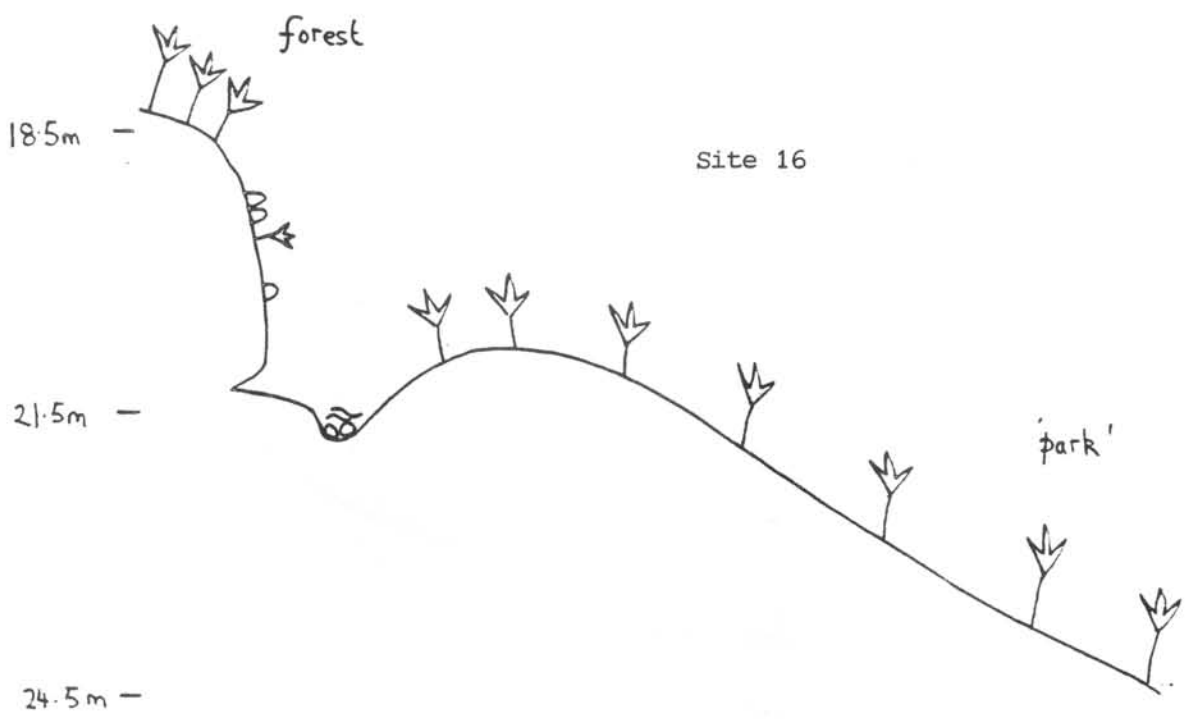




Site 15



Site 16



16m -

Site 17

24m -

pebble

70m

H. panicea

5m -

Site 18

10m -

sand, pebble + cobble

20m -

Site 19

20m -

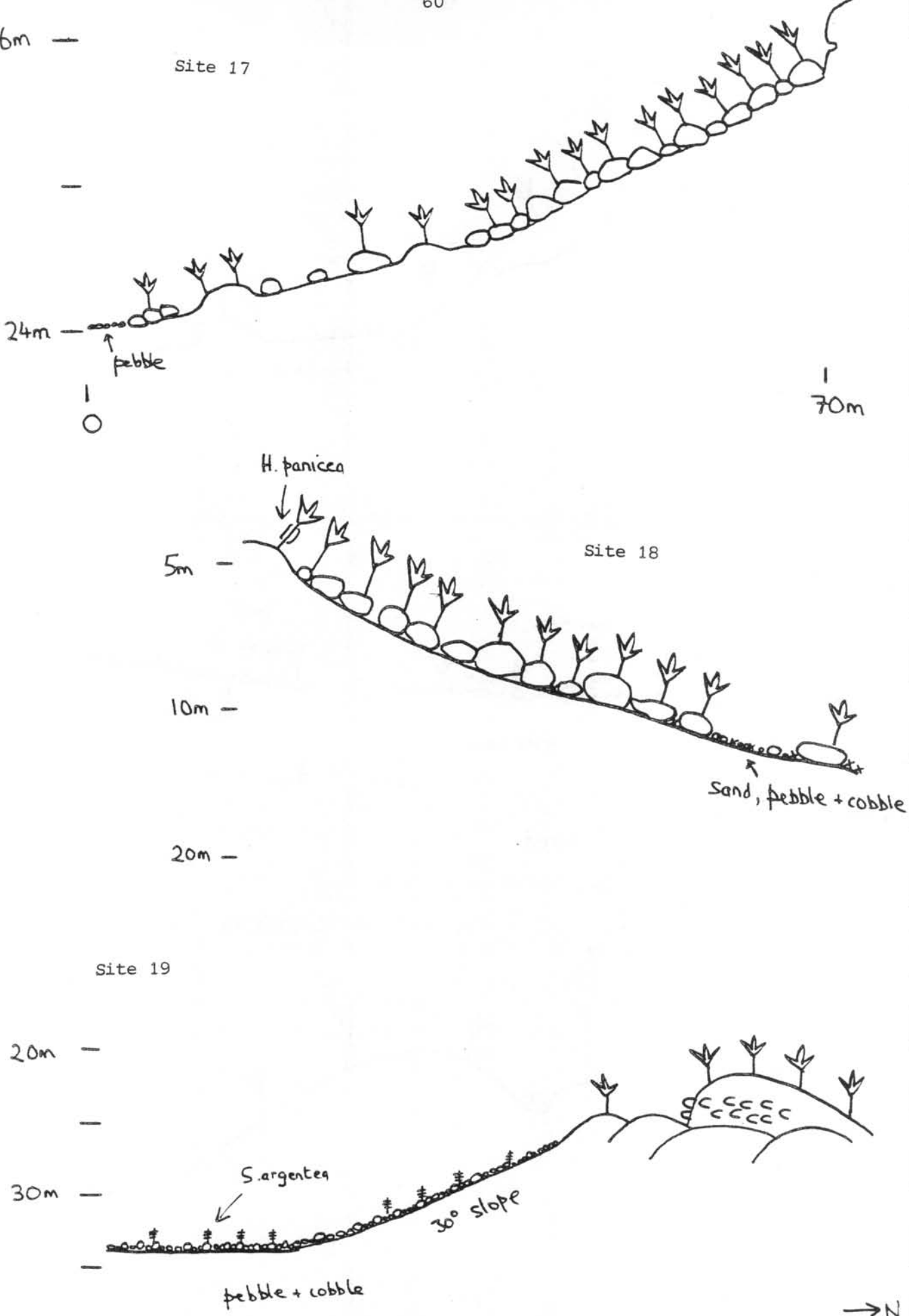
30m -

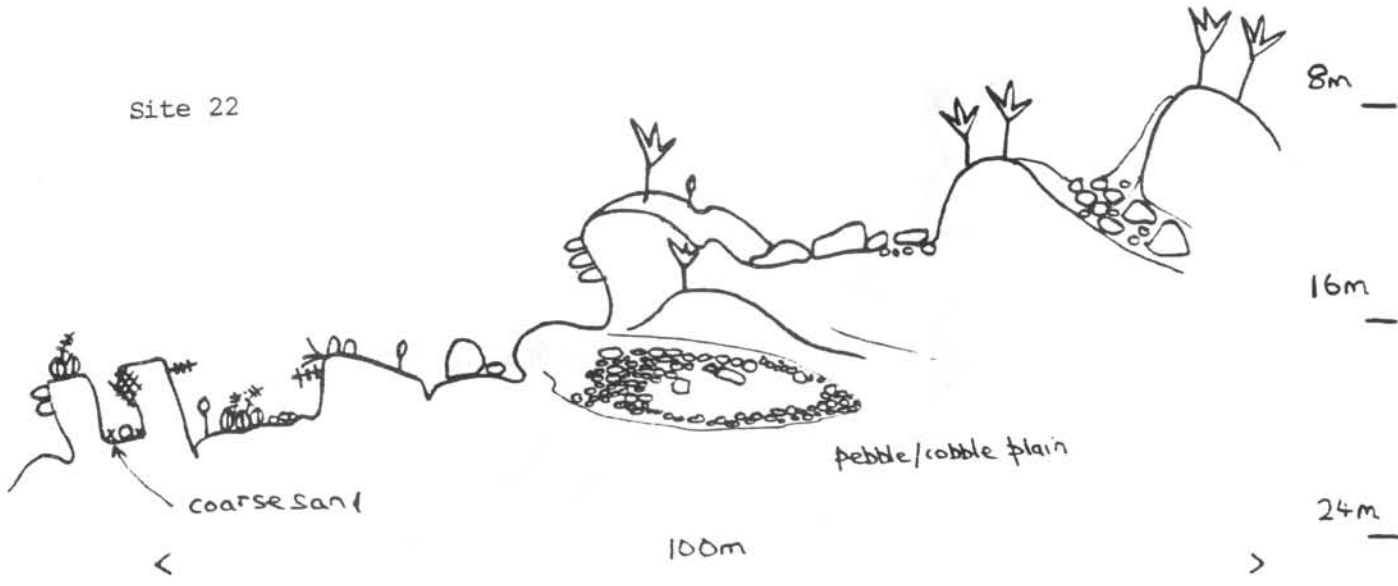
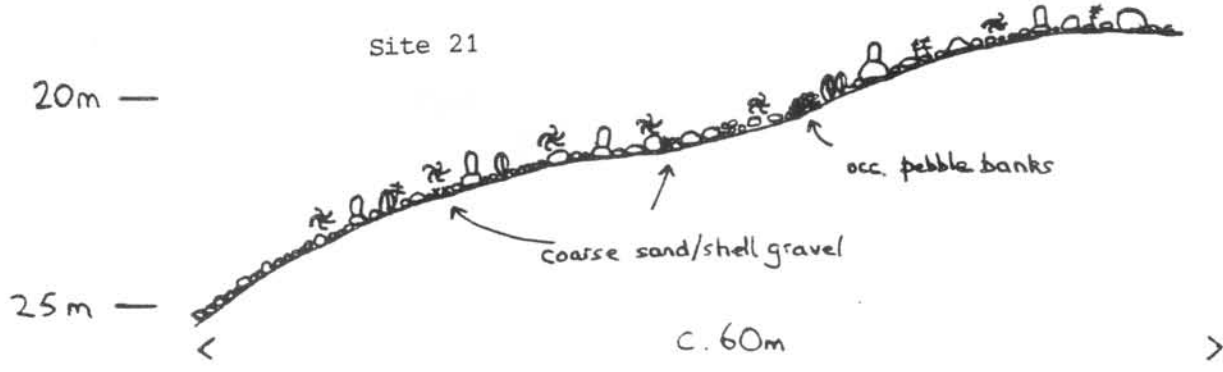
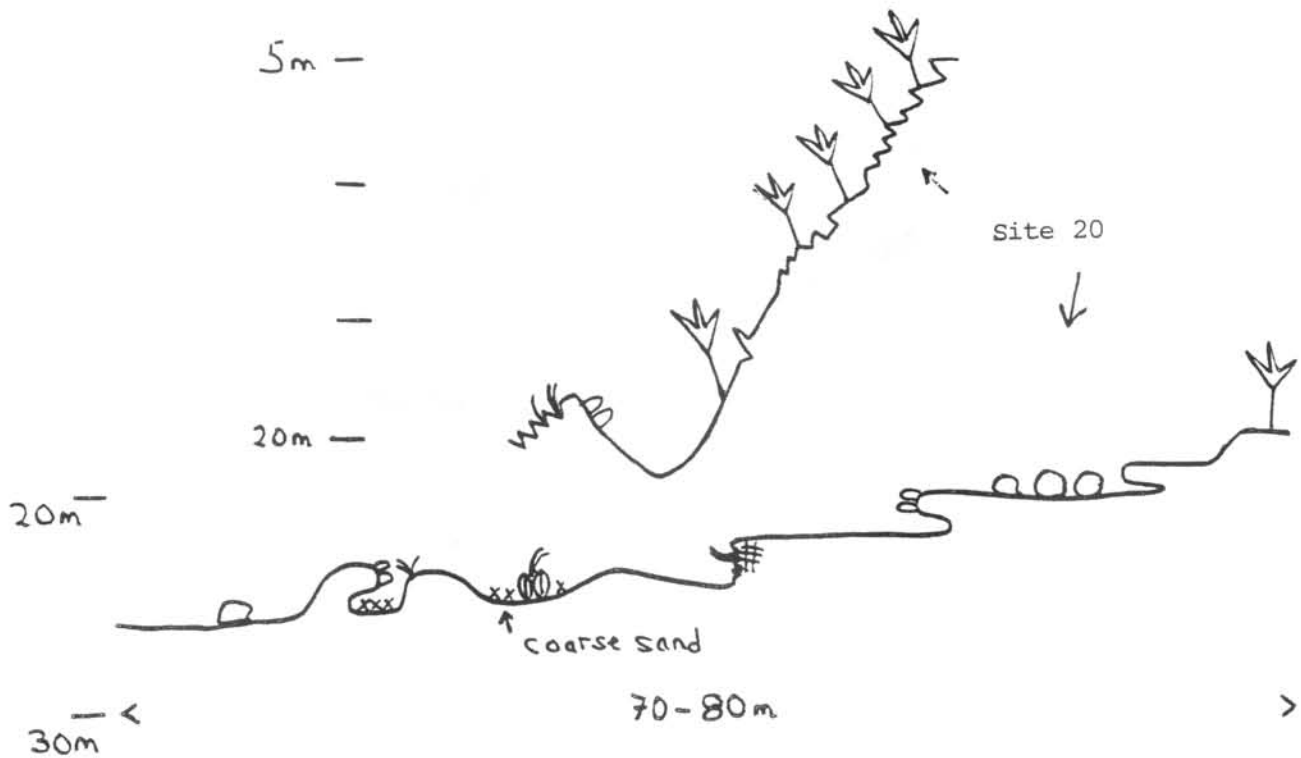
S. argentea

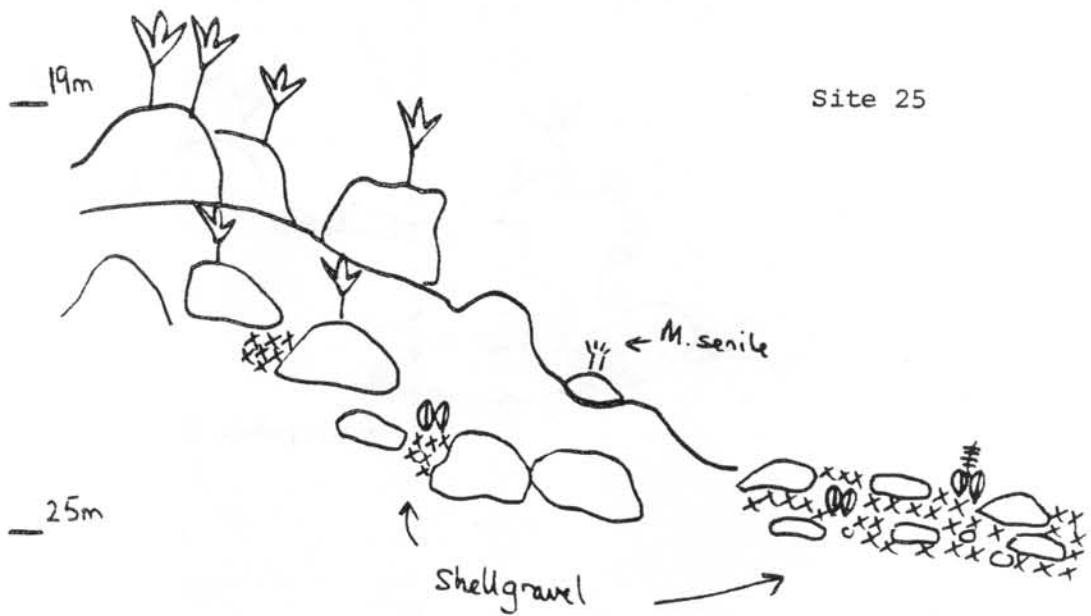
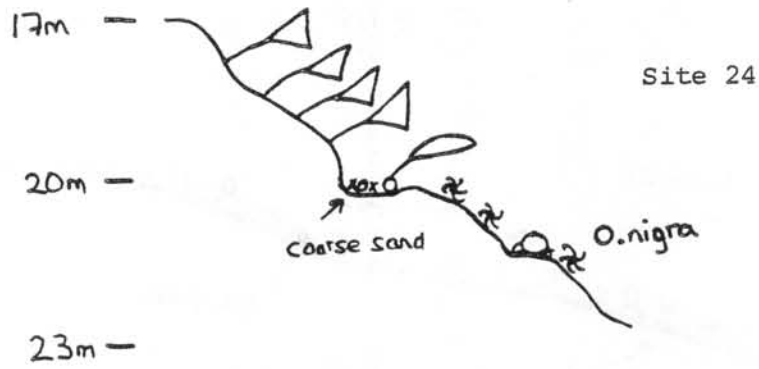
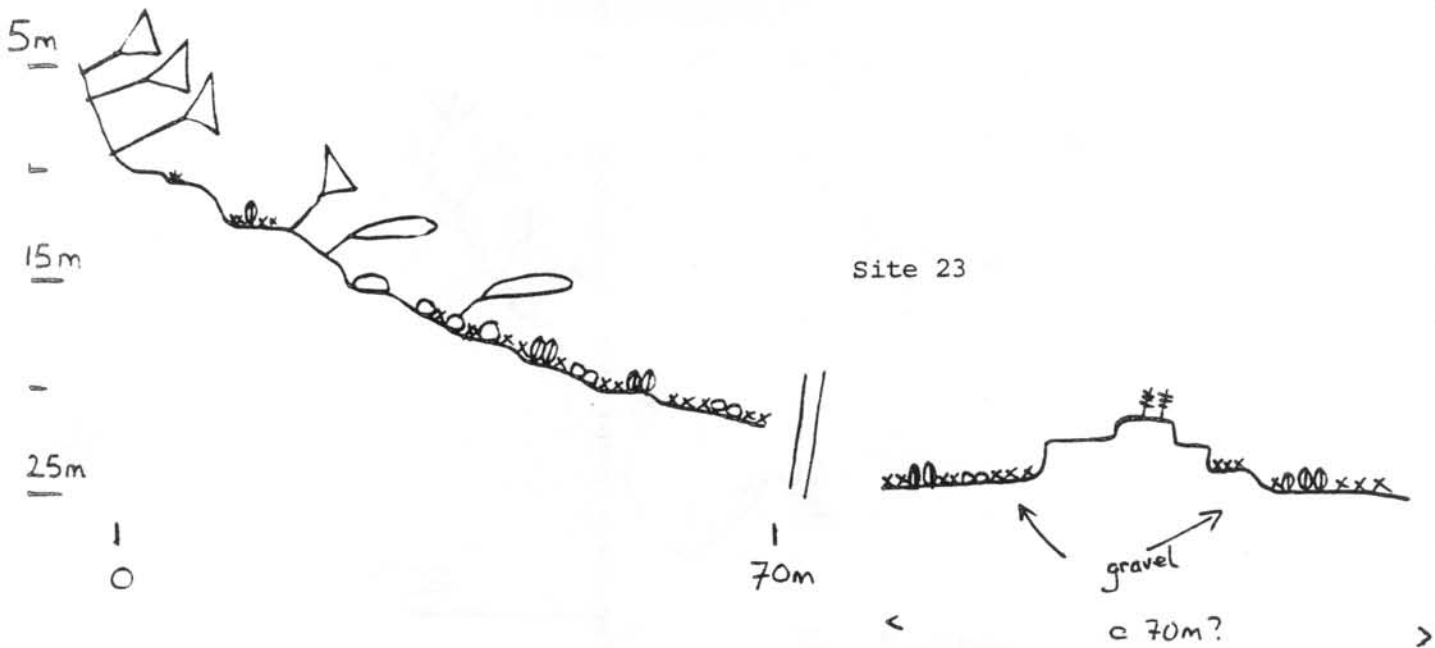
30° slope

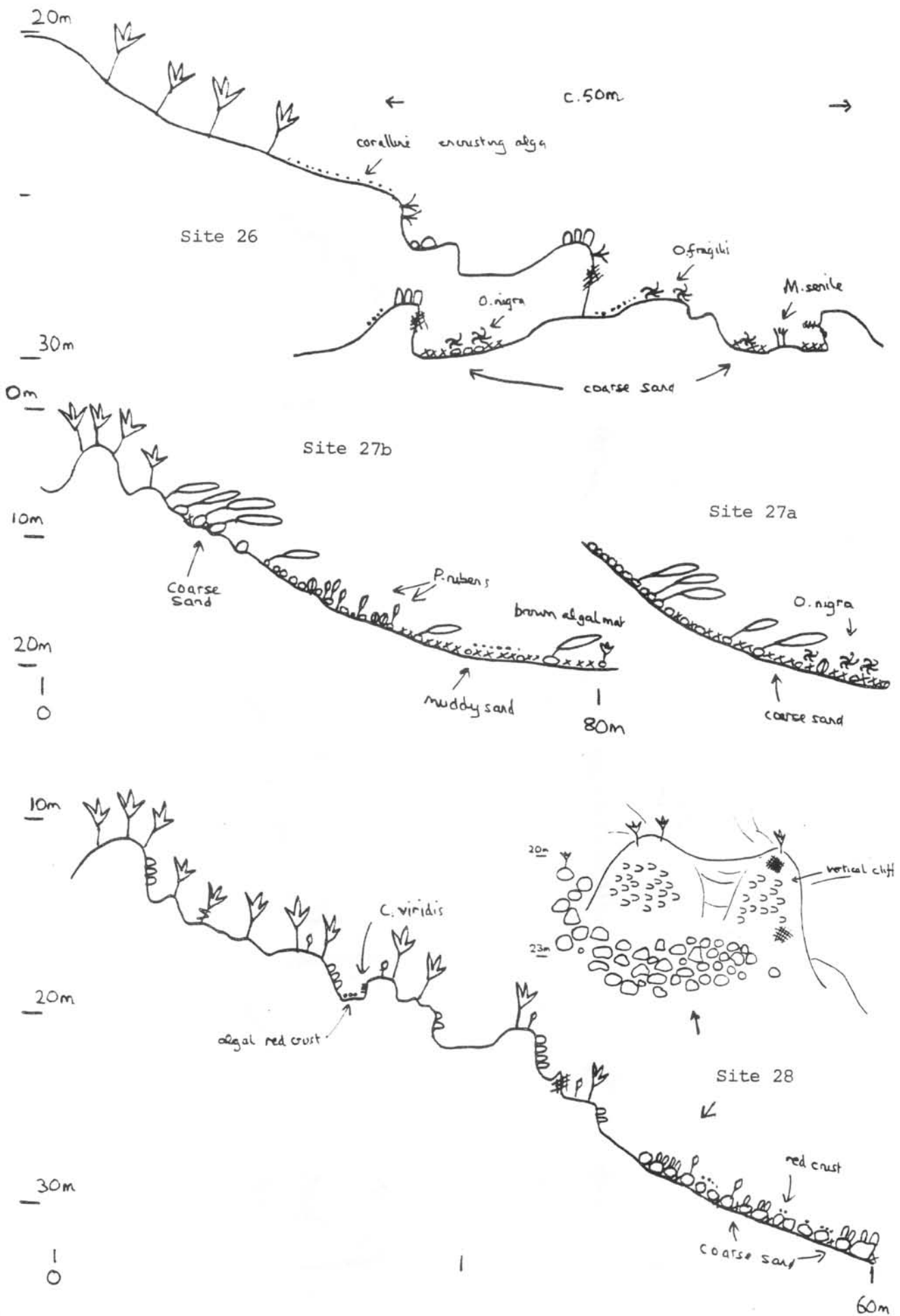
pebble + cobble

N

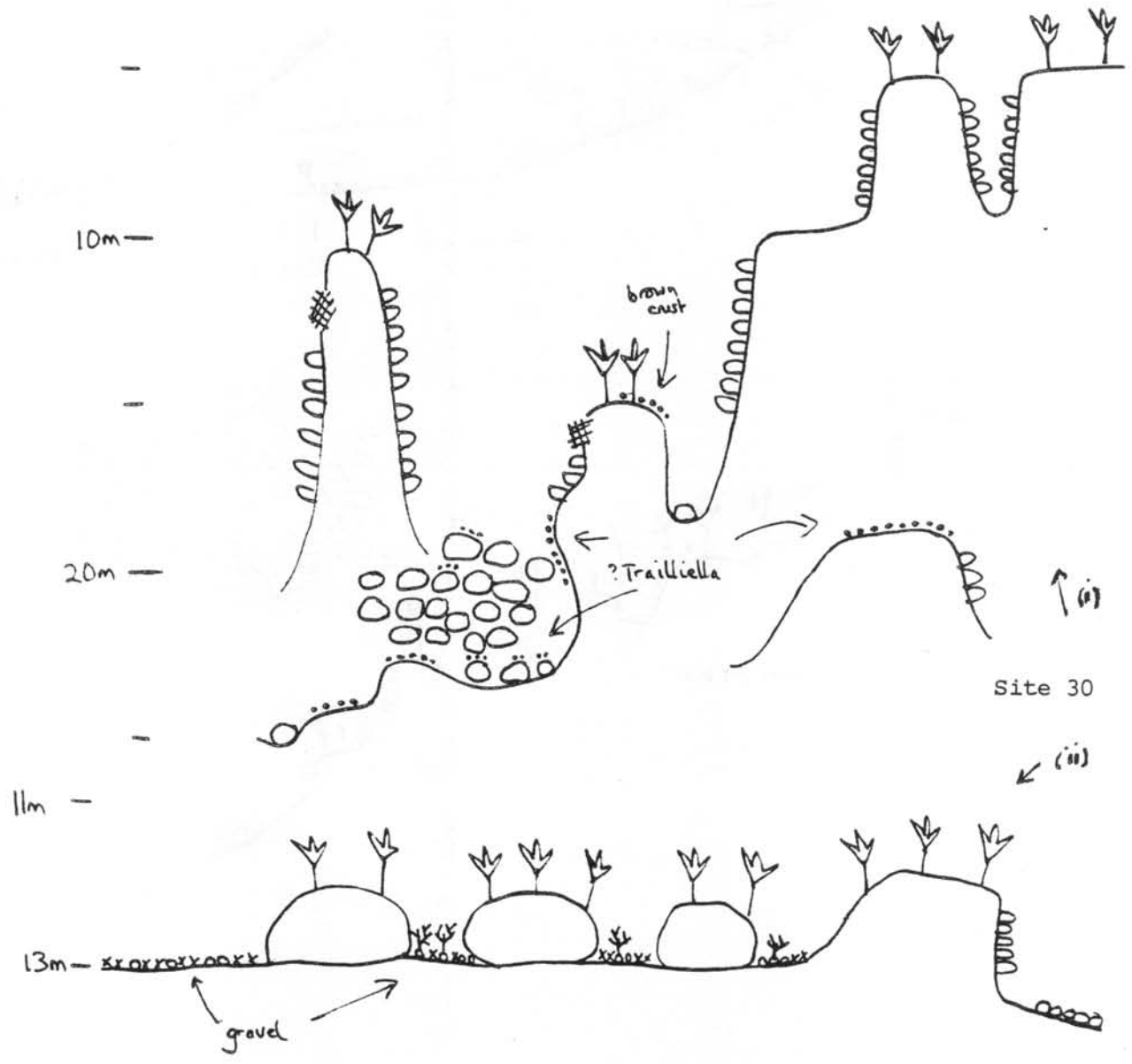
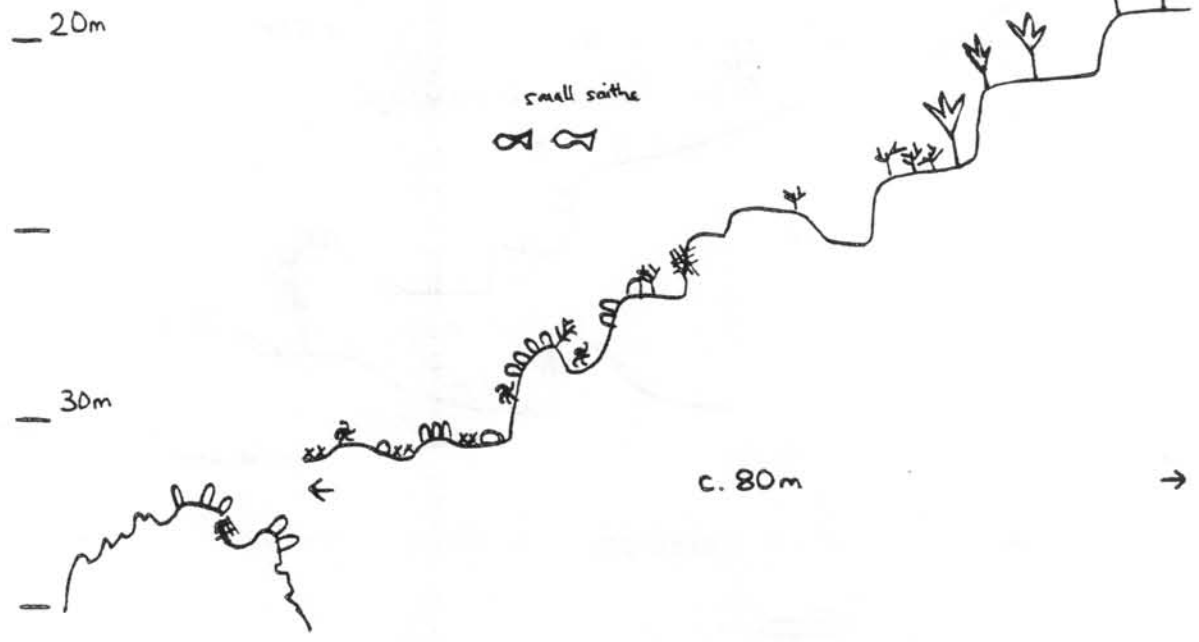




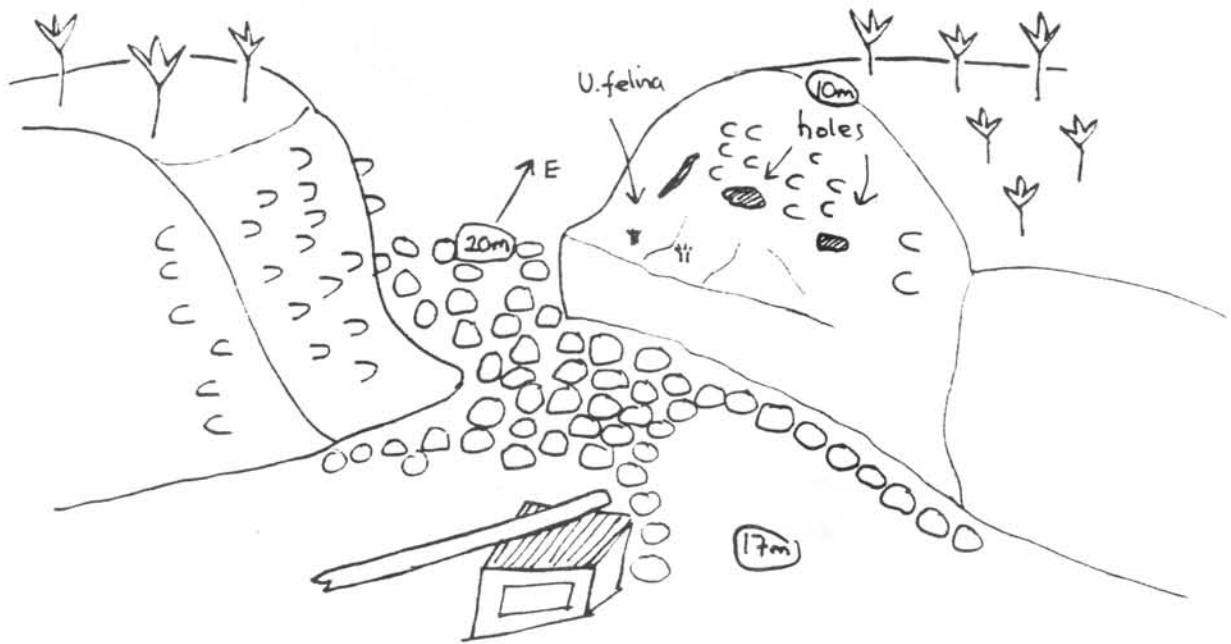




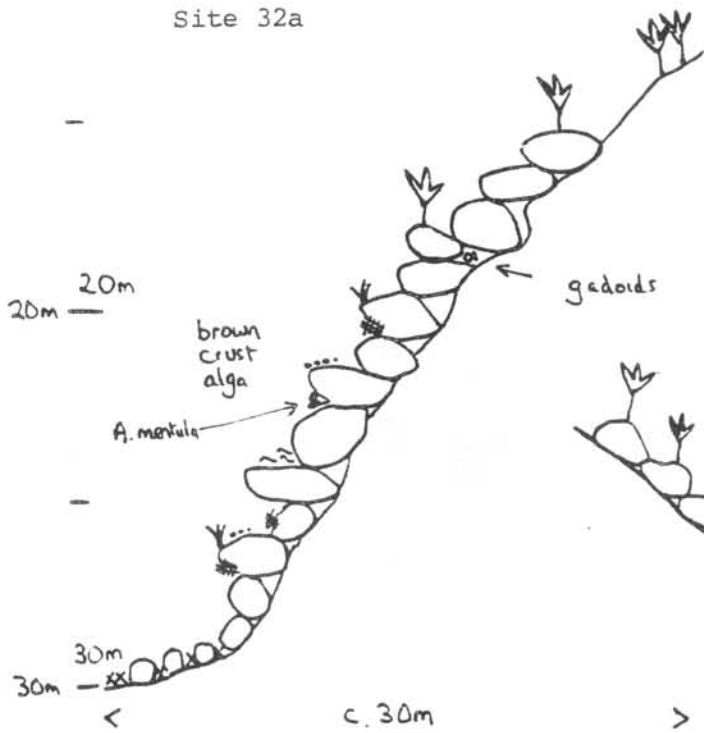
Site 29



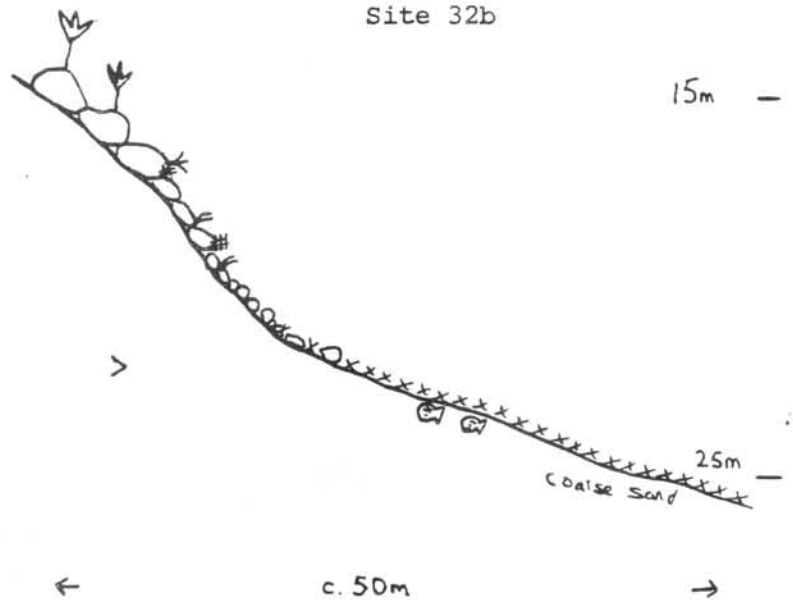
Site 31

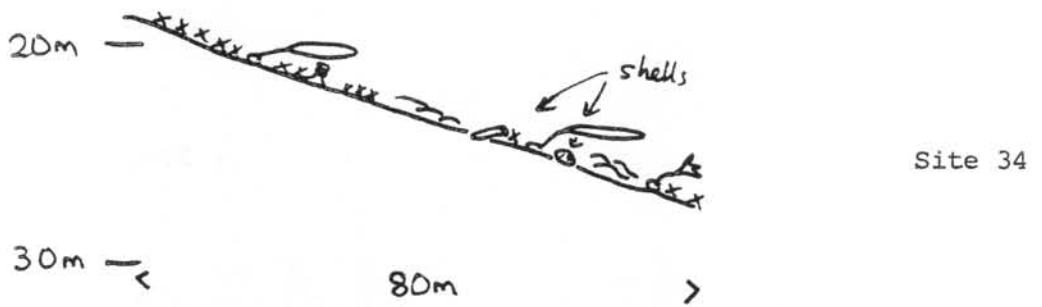
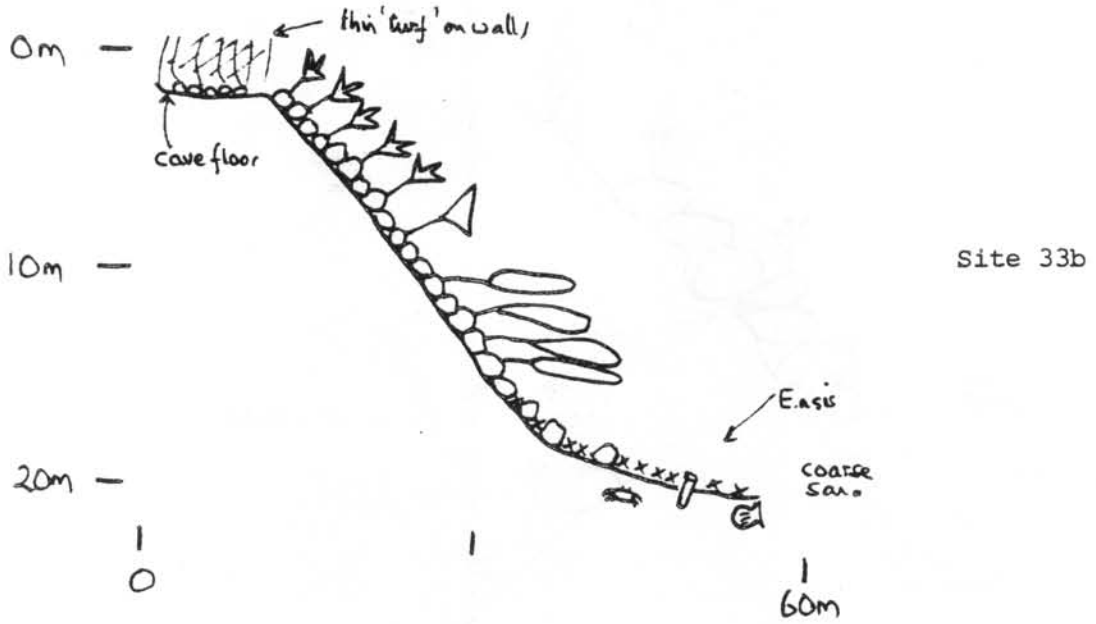
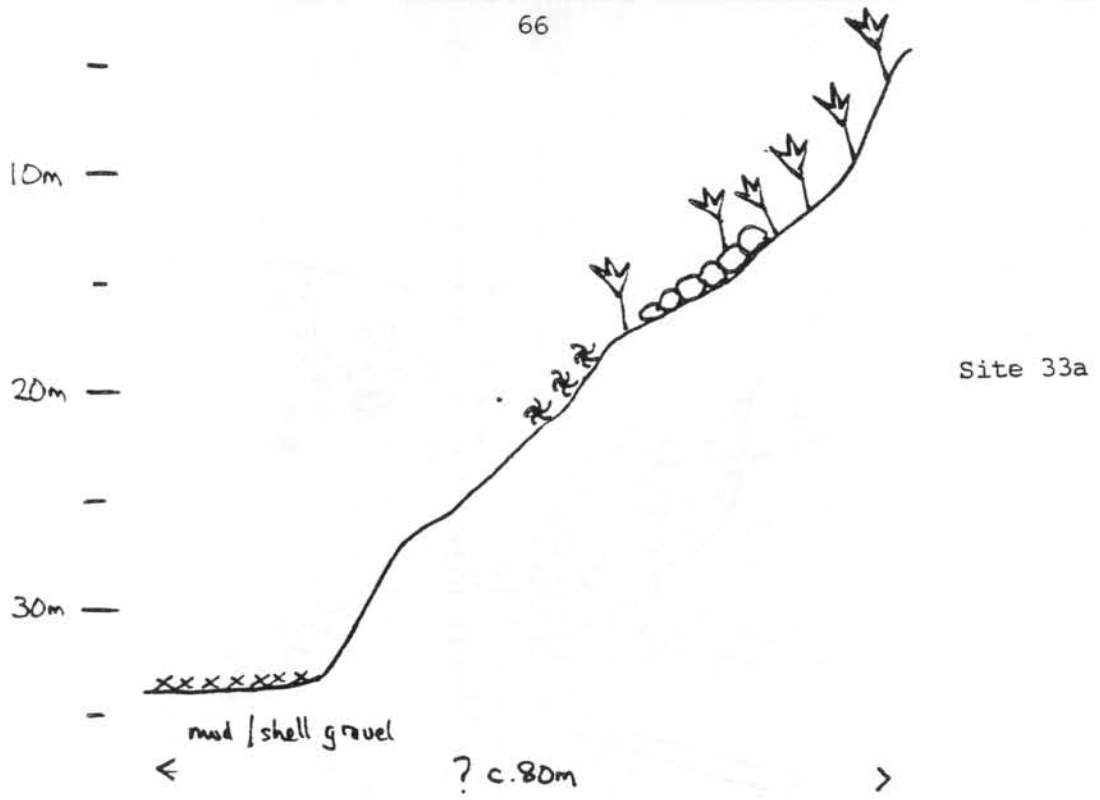


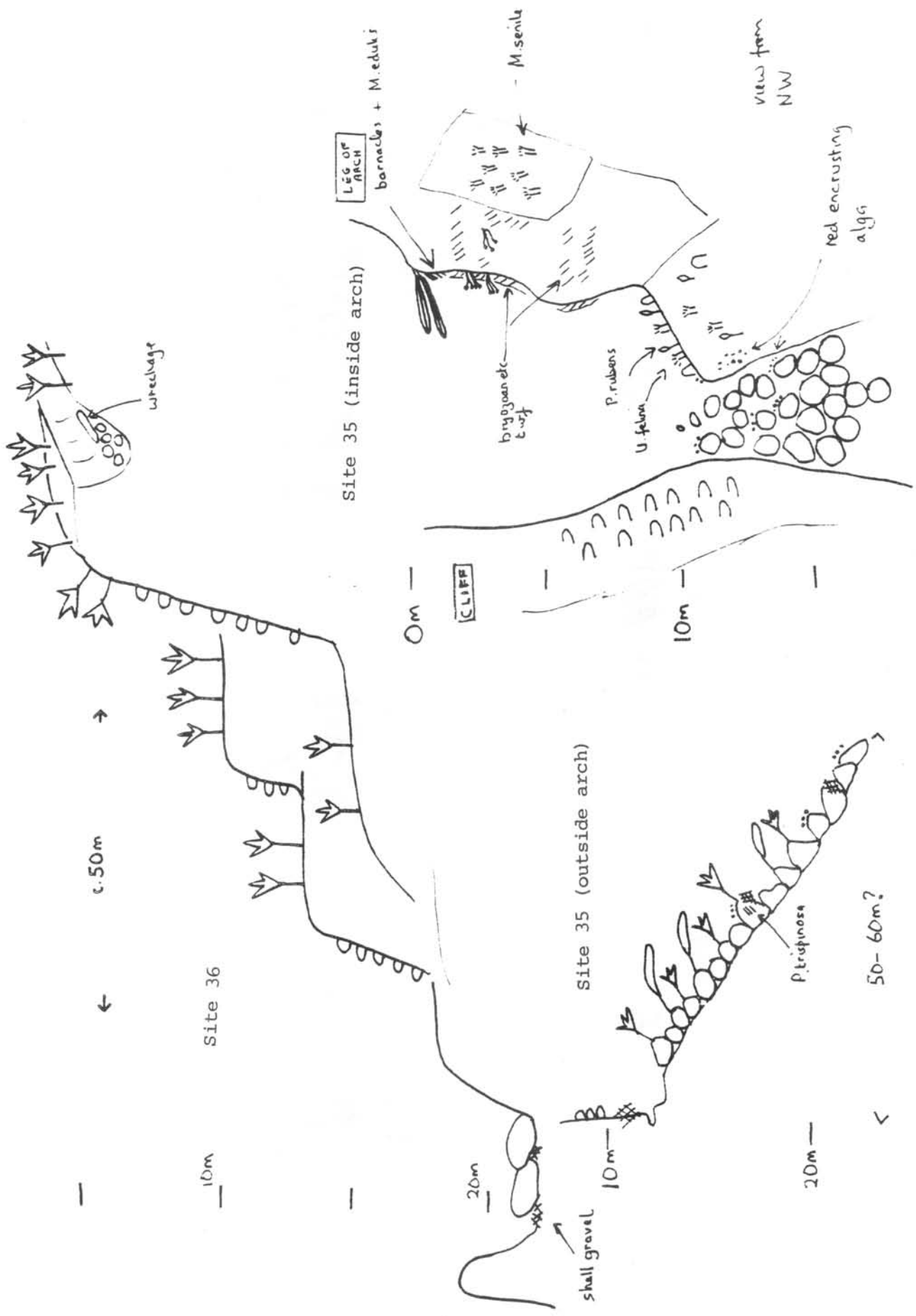
Site 32a



Site 32b





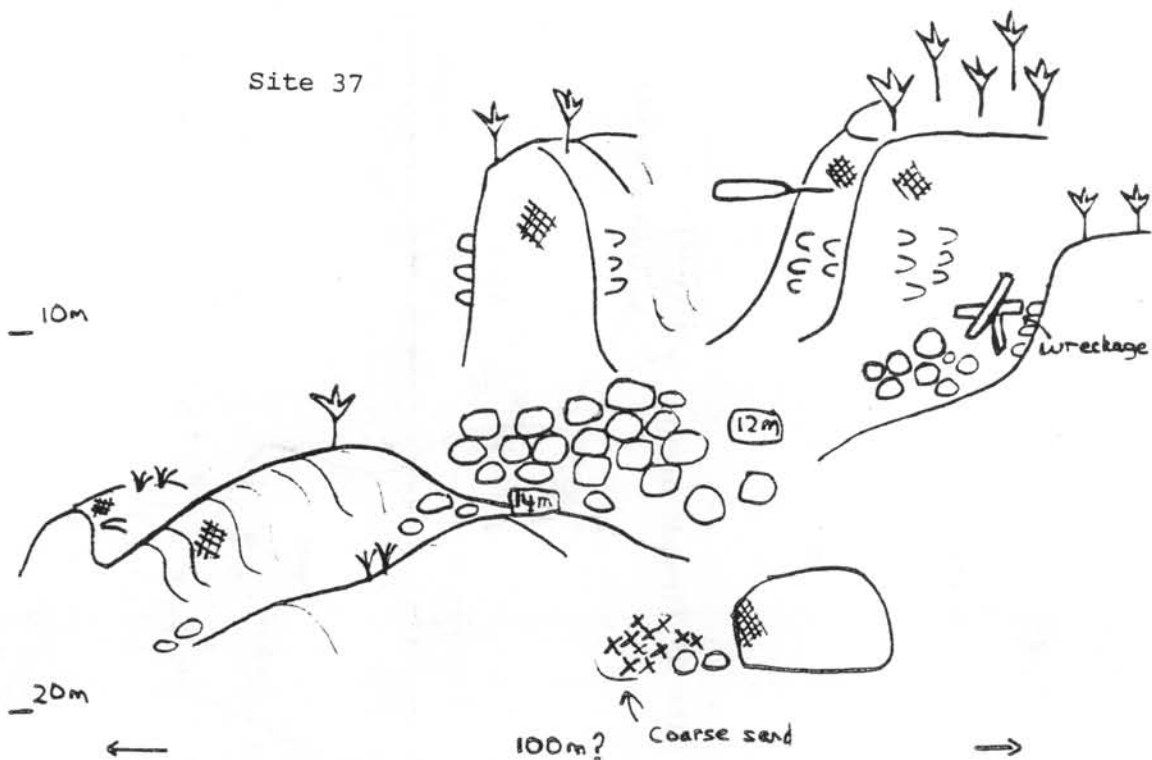


0m

Site 37

10m

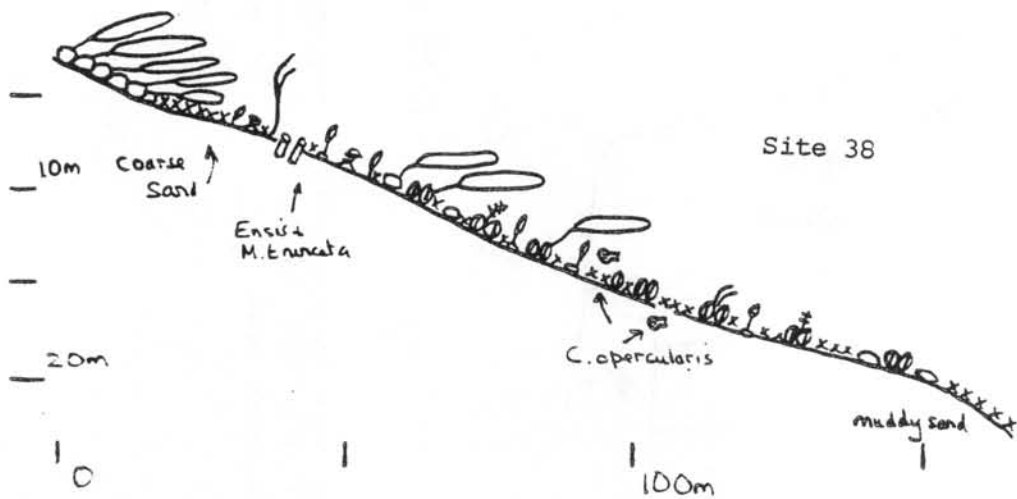
20m



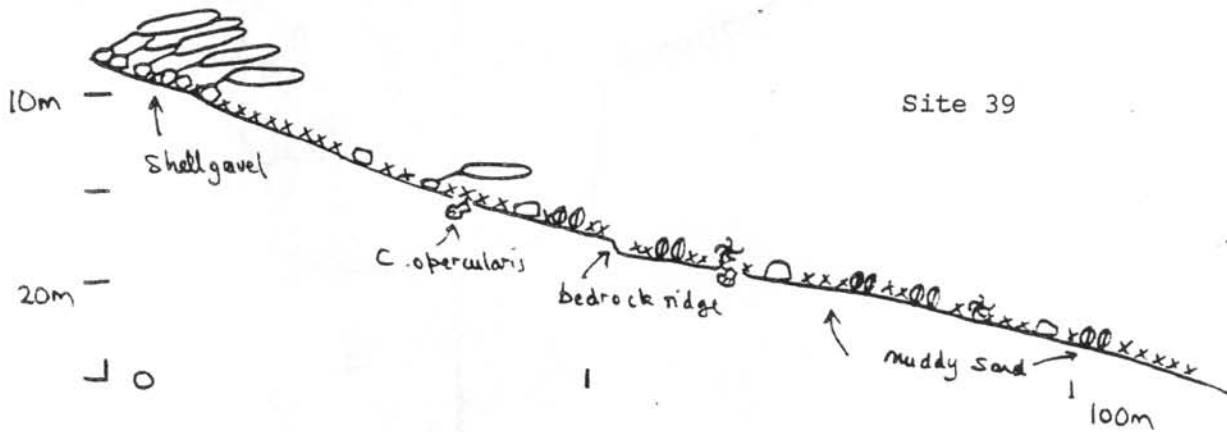
←

100m? Coarse sand

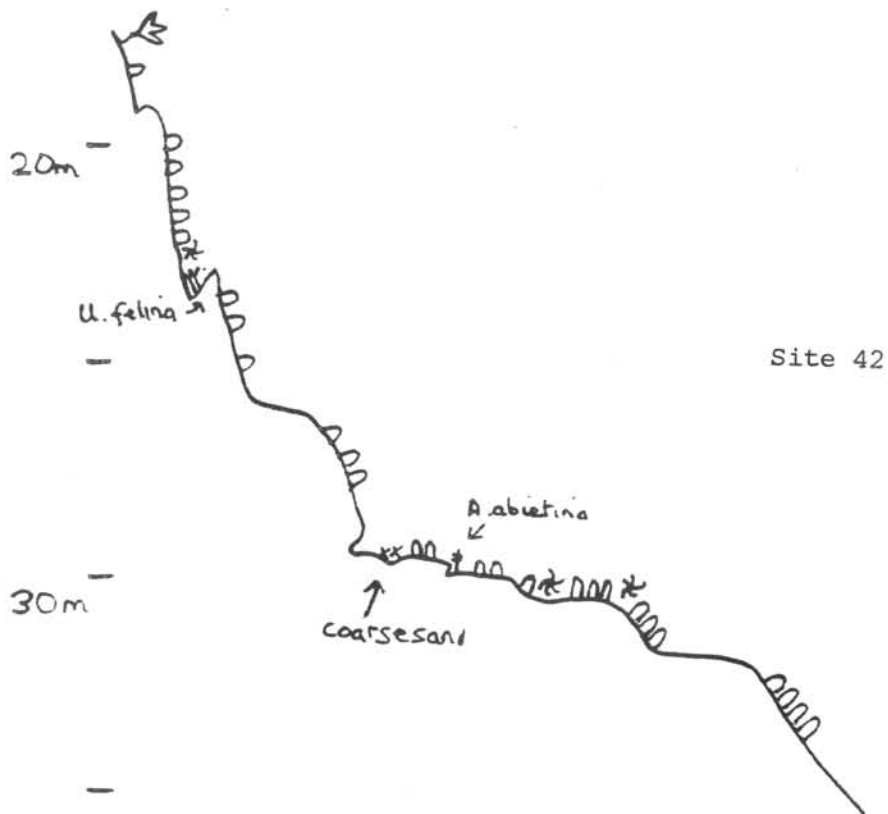
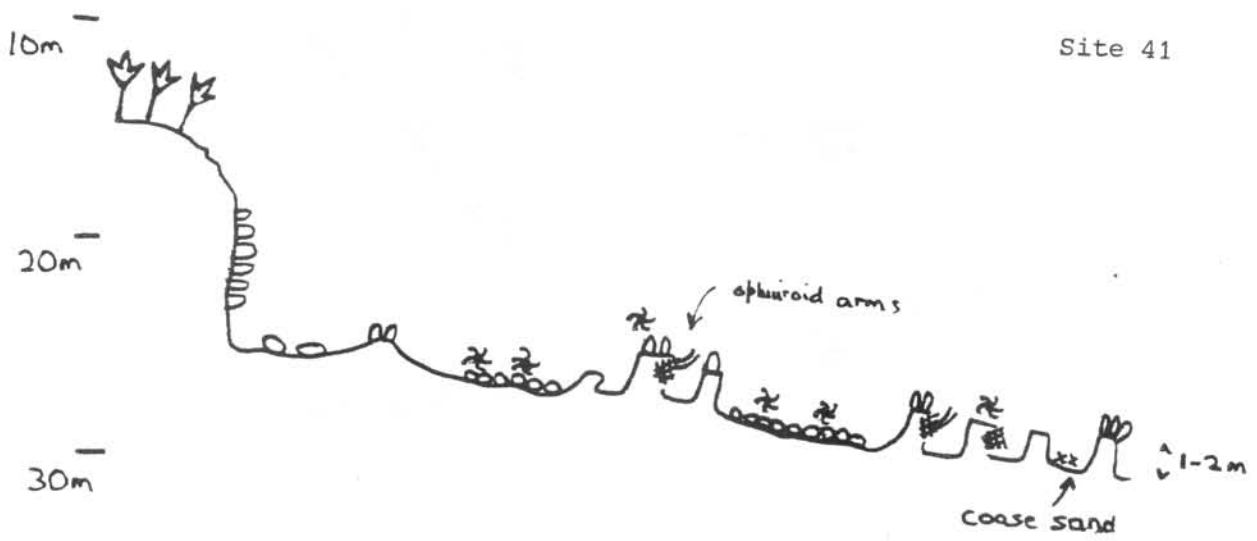
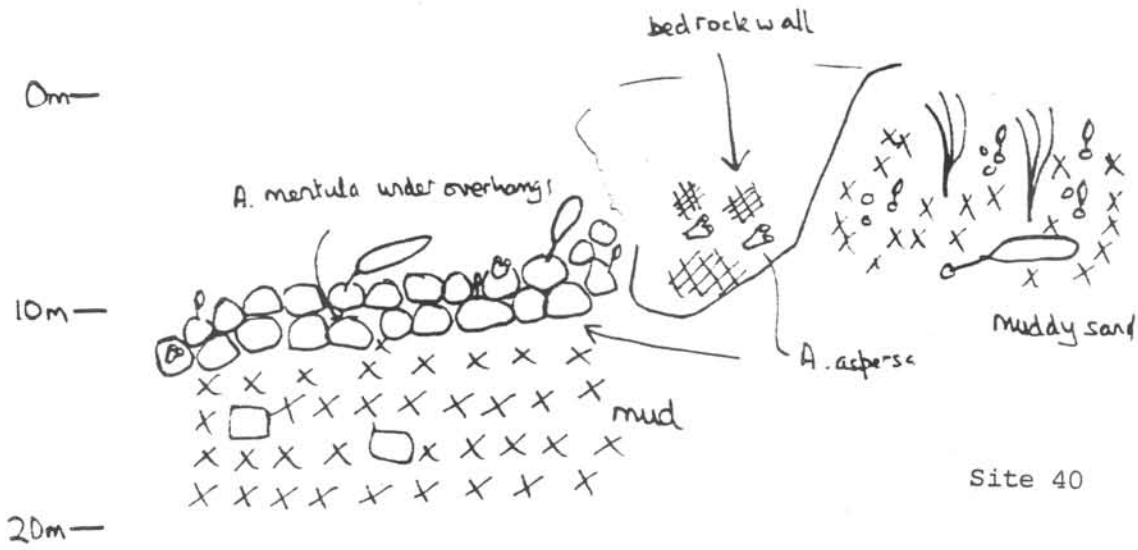
→

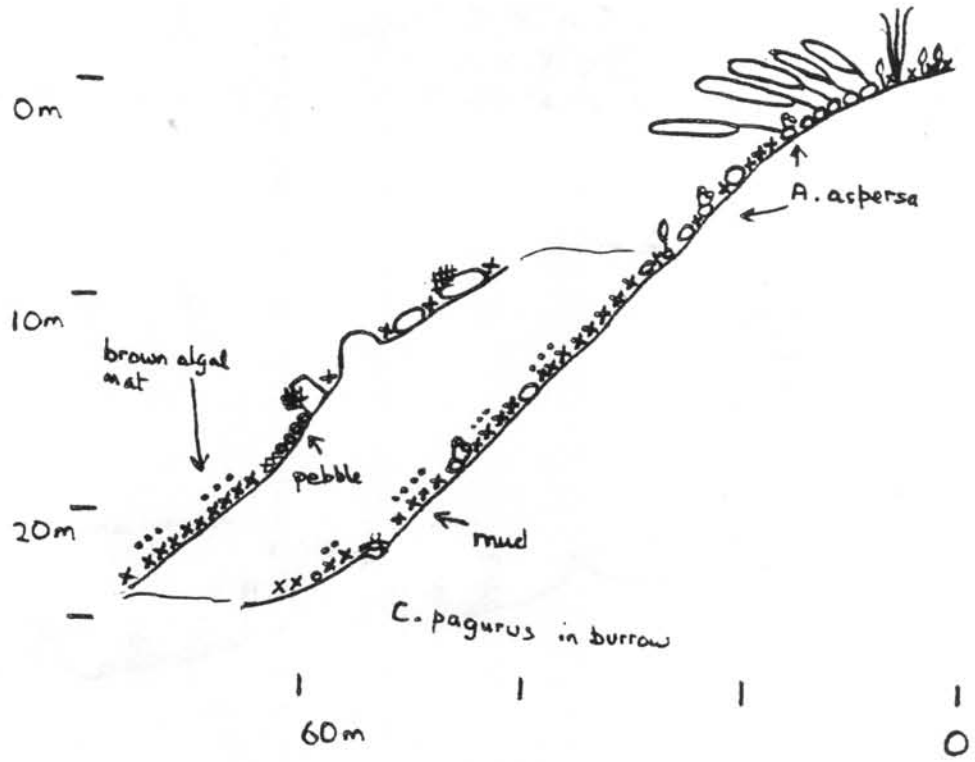


Site 38



Site 39





Site 43b

APPENDIX 5

Algal recordsPhaeophyta

<u>Alaria esculenta</u>	2, 5, 12, 13, 35
<u>Aglaozonia parvula</u>	11, 28, 29, 30, 32a, 37, 41
<u>Asperococcus turneri</u>	3, 38, 40
<u>Asperococcus</u> sp.	3, 38
<u>Chorda filum</u>	3, 6, 38, 40, 43b
<u>Desmarestia aculeata</u>	2, 3, 4, 6, 11, 12, 29
<u>Desmarestia viridis</u>	6, 38
<u>Dictyosiphon foeniculaceus</u>	28, 29
<u>Dictyosiphon</u> sp.	2, 11, 18, 26, 29, 30, 37, 38
<u>Dictyota dichotoma</u>	2, 12, 14, 16, 31
<u>Ectocarpoidea</u> indet	5, 27b, 38
<u>Elachista fucicola</u>	43b
<u>Laminaria hyperborea</u>	2, 3, 5, 6, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 20, 25, 27b, 28, 29, 30, 32a, 33b, 34 ⁺ , 35, 36, 37, 42
<u>Laminaria saccharina</u>	1, 2, 3, 4, 5, 6, 12, 13, 18, 23, 24, 27a,b, 32b, 33b, 34 ⁺ , 35', 36, 37, 38, 40, 43b
<u>Laminaria saccharina</u> (juv.)	2, 4, 30, 32a, 35, 37
<u>Laurencia</u> sp.	30 (attached to <u>L. difformis</u>)
<u>Leathesia difformis</u>	30, 38
<u>Phaeophyta</u> indet (encrusting)	2, 3, 4, 12, 16, 18, 27b, 30, 32a
<u>Phaeophyta</u> indet (filamentous)	16, 38
<u>Phaeophyta</u> indet (soft crust)	43b
<u>Saccorhiza polyschides</u>	2, 3, 4, 6, 8, 18
"Brownish red algal mat"	6

+ = ? rafted

Rhodophyta

<u>Audouinella infestans</u>	20 on/in <u>Sertularia argentea</u>
<u>Callophyllis laciniata</u>	2, 12, 14, 16, 17, 18
<u>Corallina officinalis</u>	43
<u>Corallinaceae indet.</u> (encrusting)	1P, 1A, 30, 4A, 5A, 60, 8F, 9F, 12F, 13A, 14C, 16A, 18C, 22C, 23A, 26C, 27aA, 28C, 29A, 300, 31F, 320, 350, 370, 380, 40F, 41F, 43b0.
<u>Cryptopleura ramosa</u>	12, 13, 14, 16, 18
<u>Delesseria sanguinea</u>	1, 2, 8, 11, 12, 14, 16, 18, 28, 29, 35, 40
<u>Dilsea carnosa</u>	14
<u>Gigartina stellata</u>	43b
<u>Griffithsia corallinoides</u>	3
<u>Kallymenia reniformis</u>	16, 28
<u>Lomentaria clavellosa</u>	2
<u>Membranoptera alata</u>	7, 8*, 9, 12*, 13, 18, 27b, 30*
<u>Myriogramme bonnemaisonii</u>	17
<u>Nitophyllum punctatum</u>	2, 11, 17
<u>Palmaria palmata</u>	34
<u>Phycodrys rubens</u>	2, 4, 7, 12*, 13, 18, 20, 24, 26, 27a,b, 28, 30*, 31, 34, 35, 38
<u>Plocamium cartilagineum</u>	8*, 14, 16, 28, 30
<u>Porphyra sp.</u>	11*, 17 (? <u>P. purpurea</u>)
<u>Pterosiphonia parasitica</u>	2
<u>Ptilota plumosa</u>	9
<u>Rhodophyta sp. (encrusting)</u>	2 (? <u>Ralfsia sp.</u>), 14, 16, 22, 41
<u>Rhodophyta sp. (dark red encrusting)</u>	4, 9, 11, 20, 26, 29, 31, 35
<u>Rhodophyta sp. (filamentous, encrusting)</u>	30
<u>Schmitzia hiscockiana</u>	30
<u>Trailliella imbricata</u>	30, 37

*specifically recorded as epiphytic on kelp

Chlorophyta

<u>Chlorophyta</u> <u>indet.</u> (fine, filamentous)	3
<u>Cladophora</u> <u>rupestris</u>	18
<u>Cladophora</u> sp.	43b
? <u>Codium</u> sp.	30 (basal filaments on/in specimen of <u>Myxilla</u> <u>incrustans</u>)
<u>Enteromorpha</u> sp.	38
<u>Ulva</u> sp.	3, 6, 13, 18, 38

Faunal records

Species	Site no		MCS SHEETLAND SURVEY 1987. Faunal record for Group: PORIFERA																																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43					
CLATHRINA CORINCEA																																																
GRANTIA COMPRESSA																																																
LEUCOSOLEMIA COMPLICATA																																																
LEUCOSOLEMIA SP																																																
SCYPHA CILIATA																																																
CLIONA CELATA																																																
CLIONA SP (GORING)	R																																															
HALICHONDRIA PANICEA	R																																															
HALICLONA VISCOSA																																																
ISODICTYA PALMATA																																																
MYCALE SP																																																
MYXILLA INCRUSTANS																																																
PACHYMATISMA																																																
SOHNSTONIA																																																
PLOCAMILLA CORIACEA																																																
PORIFERA INDET																																																
SUBERITES																																																
DSMUNCULA																																																

X ON KELP STIPE

Marine Conservation Society Shetland Survey 1987Index to slides (NCC set)

Slide no.	Site	Subject		Photographer
1	4	<u>Dyopedos</u> on 'whip'	1:2	GA
2	4	General habitat	w.a.	SH
3	4	Habitat with ophiuroids	w.a.,c.u.	DM
4	4	<u>Taurulus</u> , habitat	"	DM
5	4	<u>O.nigra</u> feeding on <u>Aurelia</u>	"	DM
6	4	Habitat	"	DM
7	4	Habitat	"	DM
8	4	Habitat, kelp	w.a.	DM
9	6	Sediment, <u>Asterias</u>	w.a.,c.u.	DM
10	9	Rock face, fauna	"	DM
11	11	Habitat	"	DM
12	11	Habitat, fauna	"	DM
13	20	<u>Modiolus</u>	"	DM
14	20	Habitat	"	DM
15	20	Habitat	"	DM
16	20	Habitat with <u>Modiolus</u>	"	DM
17	20	Habitat	"	DM
18	21	Habitat with <u>Strongylocentrotus</u>	28 mm	GA
19	21	<u>Strongylocentrotus</u> and <u>Echinus</u>	c.u.	GD
20	22	Habitat with Mysids	w.a.,c.u.	DM
21	22	Habitat	"	DM
22	23	Cobble and ophiuroids	"	DM
23	23	Habitat, <u>Crossaster</u>	28 mm ?	GA
24	26	Habitat	w.a.	DM
25	26	Habitat	"	DM
26	26	Habitat with <u>Lithodes</u>	"	DM
27	28	Faunal crust	c.u.	DM
28	28	<u>Haliclona viscosa</u>	1:2	RS
29	29	<u>Aglaozonia</u>	w.a.,c.u.	DM
30	29	Habitat	28 mm	GA
31	29	Habitat	"	GA
32	29	Habitat with ophiuroids	w.a.	DM
33	29	<u>Desmarestia aculeata</u> 'scrub'	w.a.	DM
34	30	<u>U.felina</u> and red crust algae	w.a.,c.u.	DM
35	35	Faunal turf, inside of arch	"	DM
36	35	Faunal turf, with <u>A.proliferum</u> , inside arch	"	DM
37	35	<u>M.senile</u> , inside arch	"	DM
38	36	<u>Hormathia coronata</u>	1:2	GA
39	40	Faunal turf	c.u.	GD
40	40	Clathrid	1:3 ?	RG
41	43b	Habitat	w.a.,c.u.	DM
42	43b	Tubes in mud	1:2	GA
43	43b	<u>Mycale</u> sp., on <u>Chlamys</u>	w.a.,c.u.	DM
44	11	Habitat with sponge, etc.	w.a. ?	SH
45	11	Habitat	w.a. ?	SH

Key to photographers: GA = Graham Ackers, GD = Graham Day, RG = Ronnie Gallagher, SH = Suzanne Hart, DM = David Moss, RS = Roger Sykes.

Photographs all with Nikonos.

w.a.,c.u. = Subawider at minimum focus, w.a. = wide angle lens, focus 1 m,
c.u. = close up lens, focus at 25 - 30 cm, 1:2 = extension tube, scale approx 7 cm,
28 mm = standard 28 mm lens.