A report to the
Nature Conservancy Council

from the
Field Studies Council Oil Pollution Research Unit.

SUBLITTORAL MONITORING AT LUNDY

JULY 28TH TO AUGUST 4TH, 1984.

Edited by
Keith Hiscock

December 1984

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SYNOPSIS

Lundy's marine habitats and communities are of very high scientific interest and many of the species present in abundance at Lundy are rarely encountered elsewhere in the British Isles. The objectives of the sublittoral work undertaken at Lundy in 1984 were to establish a monitoring programme to investigate changes in species and communities of high conservation interest including Mediterranean-Atlantic species and the red band fish Cepola rubescens, and to assess various methods of marking and photography of sites.

Photography was used to record Mediterranean-Atlantic species and sites were established at Quarry Bay, the Knoll Pins and at Gannet's Rock. Sites were marked with pitons and/or by ring bolts fixed into holes made with a compressed-air drill. A line marked at 50 cm intervals was tied to the pitons and ring bolts and photographs taken along the line. Close-up photographs were taken of some sections of rock for detailed recording. Various combinations of cameras, lenses, viewfinders and flashguns were tested to assess the photographic techniques used and photographs were processed and inspected each day, so that equipment and techniques could be improved. Sites were successfully marked, although drilling into granite was difficult and, for some sites, was abandoned in favour of pitons. Photography worked well and was considered to give satisfactory results for monitoring.

Areas previously occupied by the red band fish on the south part of the east coast were surveyed by towing a diver over the seabed following transit marks. The diver dictated observations through a telephone line and compass bearings on conspicuous features were noted. The survey locations were those used in a study undertaken by an Underwater Conservation Society Working Party in 1983, and in the same area as those surveyed during a detailed study in 1977. One further area was surveyed offshore. Gannet's Bay was surveyed by a a diver swimming over the seabed. Previously-surveyed areas were resurveyed and no red band fish were seen. The techniques used worked well.

In addition to sublittoral monitoring, the population of scarlet and gold star corals Balanophyllia regia which was measured in April 1984 was remeasured. Records from April, July and later ones from August 1984 show the population to have remained very much the same on all these occasions.

The studies were designed to be annual surveys aimed at monitoring natural fluctuations and establishing the longevity of species of high conservation importance. As such, they provide important information for management. However, the development monitoring studies to describe short-term natural changes and the effects of man's activities should be considered. Furthermore, although the techniques used during this work provided good results, development is required in both the equipment for photography and the methods to be used for analysis of photographs. The surveys of sediment off the east coast concentrated on searching for red band fish but could usefully be extended to other species of conservation interest. Other species of scientific interest are not being monitored under the present programme. For some species, such as the wrasse,

monitoring might be difficult but consideration should be given to other techniques of monitoring needed to expand the programme.

The following recommendations were made for future work:

It is recommended that the monitoring surveys commenced in 1984 are carried out at the same time of year for an initial period of two further years with more frequent and/or responsive survey if staff are available and where potential impacts need to be studied.

It is recommended that photographic methods are developed further, particularly with reference to the use of framers which define the area to be photographed.

It is recommended that methods to be used to analyse photographic survey results are developed before subsequent fieldwork is undertaken.

It is recommended that annual surveys searching for Cepola rubescens off the east coast of Lundy should be continued with additional systematic work on the sediment-living species of conservation importance

It is recommmended that consideration is given to methods for monitoring other species of scientific interest.

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1. GENERAL INTRODUCTION

The sublittoral habitats and communities present around Lundy have been intensively studied since about 1969. A summary of these investigations is given in the draft management plan for the proposed statutory marine nature reserve (Hiscock, 1983).

Lundy's marine habitats and communities are of very high scientific interest and many of the species present in abundance at Lundy are rarely encountered elsewhere in the British Isles. The very large amount of work undertaken in the past has enabled the range of habitats, communities and species present to be thoroughly documented. However, management requires an understanding of the dynamics of the communities present. Descriptions from particular areas allow some assessment of change by resurvey at the same location but, for many species, we know little of their longevity, of their potential for recruitment, or of their susceptibility to environmental change and perturbation. Gathering that information requires detailed survey and return to the same sites to record from the same areas and, in most cases, to be able to identify the same individual organisms. The most important species to study are those of high conservation interest and especially those about which we know very little. On Lundy, the colourful Mediterranean-Atlantic species are of great importance and but we know little of their dynamic ecology. Also, the very large population of the red band fish, Cepola rubescens, present off Lundy in the mid- and late 1970's, is of high scientific interest.

The objectives of the work reported here were 'to establish a monitoring programme to investigate changes in species and communities of high nature conservation interest. This will include studies on the red band fish Cepola rubescens and on the Mediterranean-Atlantic species found around Lundy and for which the area is important'. A further objective was to assess various methods of marking of sites and of photography of these sites. In addition to the work specified in the contract, measurement of the cup coral Balanophyllia regia undertaken at the Devil's Kitchen in April (Hiscock, 1984a) was repeated. Much of the work was written-up on Lundy by the field team and final drawings of sites prepared later by R. Irving.

Sites were established for photographic monitoring of communities on rock at Quarry Bay, the Knoll Pins and Gannet's Rock. Areas of sediment were surveyed for the red band fish off the south part of the east coast and in Gannet's Bay. The different activities undertaken each day are noted in the record of daily activities (Appendix 1). Photographs taken are described and their index numbers listed in Table 1 at the end of Section 2. Three sets of photographs were produced: an original set held by the NCC, a duplicate/replicate set held by the NCC, and a duplicate set held by K. Hiscock at OPRU.

2. PHOTOGRAPHIC MONITORING

2.1. Introduction

Many of the species of high scientific interest at Lundy are conspicuous and colourful. These include Mediterranean-Atlantic species such as the coral Leptopsammia pruvoti, the zoanthid anemone Parazoanthus axinellae, the sea finger Alcyonium glomeratum, the sea fan Eunicella verrucosa and the sponge Axinella polypoides. Because of their conspicuous nature, they can most easily be monitored by photography. Indeed, it has already been possible to describe the short-term stability of populations of several of these species in a cave at the Knoll Pins because photographs of the same area of rock were taken in 1981 and 1983 (Hiscock, 1984b). In designing a monitoring project based on photographic techniques, the following questions were asked:

- Where should the sites be located?
- What area of rock should be included in each picture?
- What photographic equiment will be required?
- Should the sites be marked?
- If marking is required, how should it be done?

It was decided to restrict site locations to the east coast of Lundy where the species of highest conservation interest are found in abundance and where the coast is sheltered from prevailing winds and therefore most often accessible. Two sites were selected where fairly unbroken vertical rock was colonised by a range of species of high conservation interest: the Knoll Pins and the submerged pinnacle east of Gannet's Rock. One site was selected where boulders met the mud plain and where species not often seen on vertical surfaces (sea fans and erect sponges) were present in large numbers: in Quarry Bay between Quarry Beach and Halfway Wall Bay. All of these sites were known from previous surveys and no searching for suitable locations was necessary.

The scale of photographs was partly determined by the equipment available and partly by experience in the use of photography for survey. Two scales were used, one with a picture area which included a 50 cm width of seabed within an area about 80 cm wide, and one which included an area 15 cm x 22 cm. The larger area, based on approximate distancing of the camera, was intended to show major features and enable counting of individual conspicuous species. The smaller area, with a fixed frame enclosing a known area, was intended to provide greater detail for smaller species and enable measurements to be made if required.

The photographic equipment required included lens systems to take good-definition photographs at the two scales, electronic flashguns able to illuminate the whole area included in a wide-angle photograph, and film of high definition and low grain. It was not considered necessary to attach large frames for the distance photographs to give a precise area of coverage.

Although a few areas could have been easily relocated by topographical features including the presence of rock spurs, caves or boulders of a particular shape, marking was considered important for the precise relocation of sites. In Sweden, Lundalv (1971) used a compressed-air drill to make holes in which to insert plastic plugs as markers. The system has also been used recently on Skomer by Dr. B. Bullimore. We decided to try this technique on the granite rock at Lundy but to have available pitons in case the very hard granite rock proved difficult to penetrate with the drill. Drilling holes should enable the location of markers at precise locations. However, it was considered unlikely that this could be fully achieved in the time available and that fastenings would most

likely be in crevices at opportunistic rather than systematically located places. It was therefore decided to use a transect method with a line between the fixed markers to act as a guide for photography.

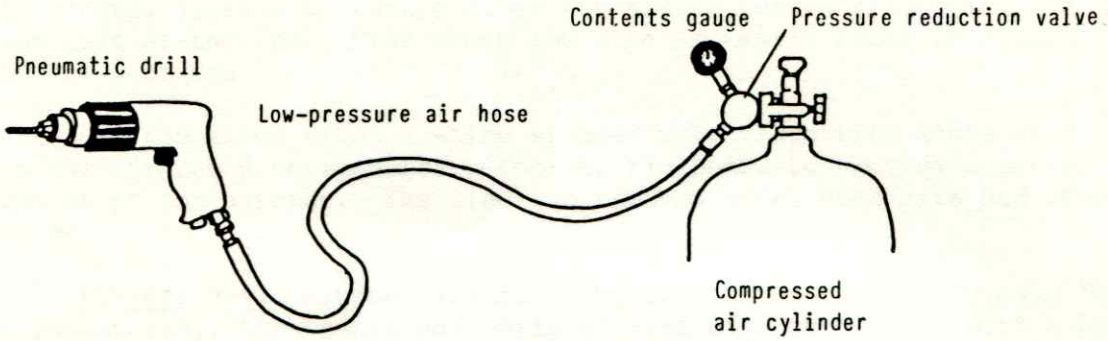


Fig. 1. Equipment used for drilling.

2.2. Methods

2.2.1. Rock drilling. Fig. 1 illustrates the equipment used to drill holes for the placement of fastenings in the rock. The pneumatic drill was a Consolidated Pneumatic Tool Company Ltd. CP7305.2200 3/8" capacity air drill Model 'C'and was powered from a diving compressed-air cylinder. Air pressure was reduced to about seven bars by the first stage of a diver's demand valve and was led through a 1 m long low-pressure hose attached to the drill. The compressed air drill was fitted with an 8 mm tungsten-tipped drilling bit. In order to successfully drill a hole underwater, it was necessary for the diver to obtain purchase on the surrounding rock either by gripping nearby rock to pull towards the drilling point or to brace against surrounding rock. On some occasions, the attendant diver pushed the elbow of the drilling diver to assist. Some drilling was necessary at the Knoll Pins cliff where little or no purchase was available and proved extremely difficult. Drilling into granite was very time- and air-consuming and, on average, one hole required about one-half or one-third of the air in a single tank, so that only two or three holes at most could be drilled. It was found useful to start drilling in a crevice. Having drilled a hole, a plastic masonry plug was inserted and the fitting screwed in. A variety of fitting were available including stainless steel screws, coated steel eyes and brass eyes. The coated steel eyes were used for underwater marking and provided a clipping point for small karibiners.

2.2.2. Use of pitons. Rock-climbing pitons (Cloggie No. 3 and No. 6, about 7.5 and 10 cm long respectively) were driven into apparent crevices using a 2 kg hammer at the starting and finishing points of the Gannet's Rock and Knoll Pins transects and at intervals along the Gannet's Rock transect. Several tries were often needed before a real crevice was found and some rocks split on using the pitons. Pitons driven into good crevices provided an extremely strong anchorage and this was essential where a marker buoy was being attached. In some cases, pitons were only held fairly strongly into crevices, sufficient to hold a taut line. Because of the danger of breaking rocks, pitons were not used along the part of the Knoll Pins transect adjacent to species of very high scientific interest.

2.2.3. Site marking. At the Quarry Bay and Gannet's Rock sites, the start of each transect line was marked by a plastic fishing net float tied via a c. 50 cm length of braided nylon line to a ringbolt or piton. The fishing float should be clearly visible on future dives and assist future relocation. No such marker was left at the Knoll Pins where the site is easily found in relation to topographical features.

At each of the three sites a white braided nylon rope with knots at 50 cm intervals was stretched between the pitons or ringbolts to provide a marker for the alignment of photographs. The line was removed after each site had been photographed.

2.2.4. Photography. Nikonos III and Nikonos IVA cameras were used. For distance photography, the camera was equipped with a 28 mm lens or with a Nikonos 15 mm lens and with an Oceanics 2001 or Sea and Sea YS150 flashgun. A Sea and Sea optical viewfinder (the angle of which is altered to the camera-to-subject distance) was used. For close-up photography, the camera was equipped with a 28 mm lens, Nikonos supplementary close-up lens and framer, and an Oceanics 2000 flashgun. Filmstock used was Ektachrome 200, Ektachrome 64, Ektachrome 100 and Kodachrome 64. The equipment used at each site is described in Table 1.

Ektachrome films were processed each evening using a Jobo rotary processor and Chrome-6 chemicals. This provided the opportunity for inspection and improvement which was extremely valuable in the development of techniques.

2.3. Quarry Bay

2.3.1. Introduction. Rock surfaces in Quarry Bay were the most sheltered holding circalittoral communities on Lundy. There was a slope of large boulders with some rock outcrops terminating in a mud plain at about 13 m below chart datum. Rock surfaces were colonised by foliose algae with high densities of some erect branching sponges, Caryophyllia smithii, and Eunicella verrucosa. All surfaces were highly silted. The area provided the opportunity to take record photographs to show sponges, C. smithii and E. verrucosa in particular. Also, in view of the suggestions that areas around Lundy might be becoming more silted, the level of the mud plain in relation to the boulder surfaces and the degree of silting on boulders could be observed.

2.3.2. Methods. A site was selected and buoyed at the edge of the boulder slope on 27th July 1984. A further rapid survey of the site was undertaken to determine a location for the photographs before marking on 28th July 1984. The rock drill was used to make holes for coated-steel ringbolts inserted into plastic plugs. Although obtaining purchase on the rounded boulders surfaces was difficult, three holes were drilled. The white nylon line was threaded through the ringbolts on each occasion that photographs were taken. A small buoy was attached to the southern ringbolt for future relocation. A description of the different activities undertaken at this site with full details of photographic equipment used are given in Table 1.

2.3.3. Results. The location of the site and transit marks for relocation are shown in Fig. 2. Topographical features in the region of the transect line are shown in Fig. 3. A summary of the results obtained and photographs filed is give in Table 1 (Figures and Table 1 are included at the end of this section).

2.4. The Knoll Pins

2.4.1. Introduction. The Knoll Pins are the richest site on Lundy for Mediterranean-Atlantic species. The underwater scenery at the Pins is also spectacular and the location therefore popular with sports divers. In one area, there is a small cave with large numbers of Leptopsammia pruvoti, some Caryophyllia inornatus, Hoplangia durotrix and Parerythropodium hibernicum and a patch of Thymosia guerni present. The area of the cave extends westwards as a large area of vertical rock. The vertical rock has colonies of Corynactis viridis and many areas of Parazoanthus axinellae and Alcyonium glomeratum. The area of the cave was photographed in 1981 and again in 1983 when areas to the west were also photographed as part of a viewpoint monitoring exercise. The site was selected as a location where large numbers of Mediterranean-Atlantic species could be photographed.

2.4.2. Methods. The monitoring site had been selected and photographed in 1983 (Hiscock, 1984b). On 2nd August 1984, the area was relocated and attempts made to drill holes to fix ringbolts along a length of vertical or near-vertical rock. Two locations were successfully drilled for plastic plugs and ringbolts but pitons had to be used at the western and eastern ends of the transect line. The two ringbolts were at locations where the line required holding against the rockface because of concavities. Special care was taken at this site to ensure that the rare species present were not damaged during marking. The pitons were placed remote from any of these species in case of splitting or dislodging rock. The different activities undertasken at this site, with full details of the photographic equipment used, are given in Table 1.

2.4.3. Results. The location of the site is shown in Fig. 4. Topographical features and the position of pitons and ringbolts are shown in Fig. 5. A summary of the results obtained and photographs filed is given in Table 1.

2.5. Gannet's Rock Pinnacle

2.5.1. Introduction. East and northeast of Gannet's Rock, there is a large submerged rock pinnacle which has a gravel bank piled against the south side and a vertical and overhanging very extensive cliff on the north side. Areas of the pinnacle are colonised by several species of high scientific interest including Leptopsammia pruvoti, Parazoanthus axinellae, Alcyonium glomeratum and Eunicella verrucosa amongst the most conspicuous species. The cliffs are dominated by dense colonies of Corynactis viridis with many different-coloured groups. A particularly rich and varied area was located in 1983 and further studied on July 23rd 1984. The site offered excellent opportunities for establishment of photographic survey sites on reasonably flat rock from depths of 13 to 25 m below chart datum.

2.5.2. Methods. The area was relocated on 29th July and a rapid survey undertaken by members of the team to determine a suitable location for the transect line. An area was selected along a line from a large group of L. pruvoti at the base of the cliff at 25 m below chart datum up the cliff past a colony of A. glomeratum and P. axinellae, though mainly over dense C. viridis, to an area of sloping rock from about 18 m below chart datum with sea fans and an increasing density of foliose algae, to an area of upward-facing rock colonised by patches of Pentapora foliacea amongst the folise algae at 14 m below chart datum. The top of the transect was marked by a piton hammered into a crevice. The other two members of the team then completed the laying of the transect line by running the braided nylon line and fixing it with a further two pitons, knotted at 50 cm intervals. The transect location was marked by a piton hammered

into a granite crevice 45 cm from the uppermost piton at the top of the transect line. A plastic trawl float was attached to the marker piton by 50 cm of line. The different activities undertaken at this site, with full details of photographic equipment used, are given in Table 1.

2.5.3. Results. The location of the survey site and a sketch of the shore features used for location are shown in Fig. 6. The location of the transect line in relation to topographical features on the pinnacle is shown in Fig. 7. A summary of the results obtained and photographs filed is given in Table 1.

2.6. Photographic tests at The Cove

2.6.1. Introduction. These tests were carried out after the immediate trials at Quarry Bay but before the monitoring photographs were taken at each site. The tests had three main purposes:

1. To test the use of ranging rods for accurate camera-to-subject distancing;
2. To compare the performance of Ektachrome 100 and 200 films;
3. To test the use of the Sea and Sea adjustable viewfinder.

2.6.2. Methods. A site was selected just off the jetty where rock surfaces fairly clear of cover by large algae were present. A braided nylon line knotted at 50 cm intervals and weighted at both ends was laid over the seabed. Photographs were taken as outlined in Table 1.

2.6.3. Results. A summary of the results obtained and photographs filed is given in Table 1.

2.7. Assessment of site marking techniques

The granite rock at Lundy caused considerable problems in the use of both the compressed-air drill and pitons. The drill had previously penetrated the igneous rocks of Skomer with ease and the drill bits were of high quality with no evidence of blunting following drilling. However, granite rock was difficult to penetrate, especially if the worker could not obtain purchase on nearby rock to push against the drill. Drilling holes into crevices was often found to be successful. However, it is clear that any requirement to drill a large number of evenly spaced holes would be difficult to fulfill. A crevice at about the desired location for the fixing of transect lines by pitons could usually be found, although some of the crevices were very shallow and substantial penetration impossible. In some other crevices, the use of pitons split off pieces of granite and great care was needed to avoid this. Further experiments with nailguns or a Cox gun (which fires a bolt into the rock to produce a hole) should be carried out if any regular spacing of markers or fixing is required.

The braided nylon line knotted at 50 cm intervals provided a good guide to photography, and re-laying a line in the same position in relation to topographical features should be possible. The knots could be seen in the viewfinder and good alignment was achieved. However, photography and the sorting of photographs would have been greatly aided if the 50 cm intervals had been numbered.

2.8. Assessment of photographic techniques

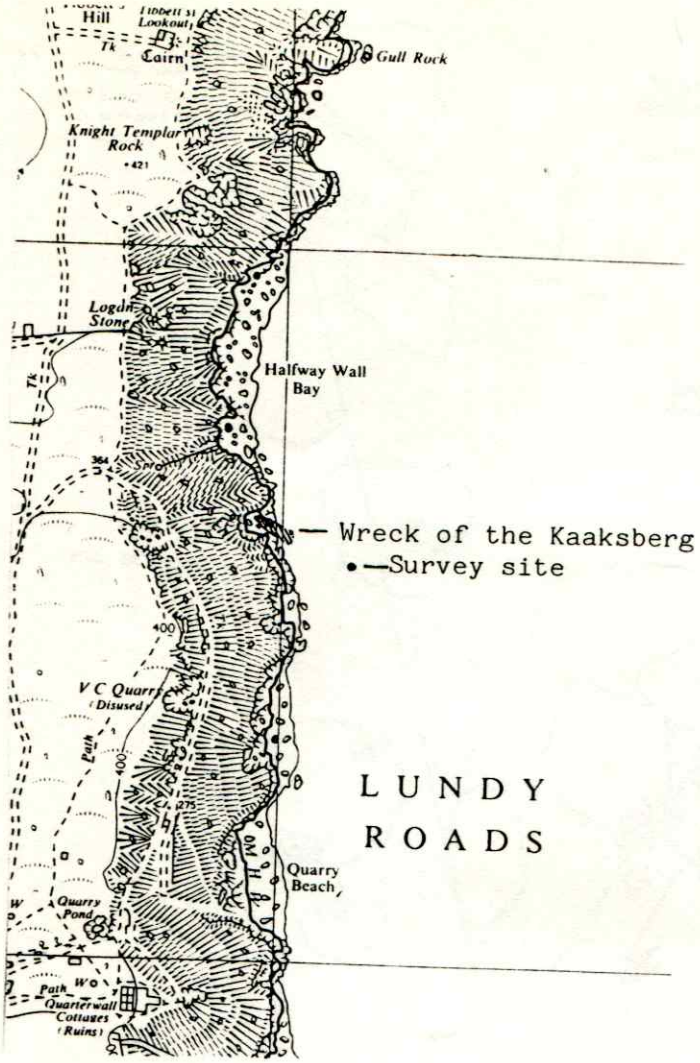
The photographic techniques were developed during the field trip by discussion and by inspection of results from tests, followed by improvements in techniques. The processing of each day's films in the evening was very important and greatly helped the work. The loan of a 15 mm Nikonos lens was very useful in assessing the potential of this expensive but optically very high-quality lens. Underwater horizontal visibility remained similar throughout the week (estimated as 3 to 5 m by R. Irving), although poor visibility (0.5 m) was noted at times on July 28th at Quarry Bay. The vertical Secchi disc reading on July 27th was 13.5 m. In general, this range of conditions was adequate to obtain good photographic results using a camera-to-subject distance of 0.9 m. However, poor results on some photographic sets suggest that an estimated 4 m visibility might be the minimum acceptable using a 28 mm lens, although a 15 mm lens would reduce the minimum acceptable visiblity. Tests undertaken during the week enabled optimum camera-to-subject distance and the viewfinder image required for positioning of the transect line within the picture area to be determined. The use of a transect line as a reference point in the photographs was an improvement on the original intention of taking viewpoint photographs of easily identified features. The angle of view and other features may be different in subsequent exercises and a frame attached to the camera for the Knoll Pins and Gannet's Rock photographs might provide an improvement in the replication of areas included. The use of such a frame requires testing, since rock surfaces are uneven and incomplete coverage of the transect may occur. Assessment of the use of the 15 mmm lens was difficult because of the uneven illumination of photographs. The Sea and Sea YS 150 flashgun has a specified 100° coverage providing that the flash angle is central to the subject. A different type of flashgun with a wider flash coverage should be used. The close-up photographs were generally of very high quality but the overlap of 2 cm between frames was inadequate. Further tests of the system should be undertaken to ensure that continuous or overlapping photographs are taken in future exercises. The single photographs of each area appeared to provide adequate data for analysis and the use of stereophotography is not proposed in the immediate future. The methods used to obtain photographs of sea fans and sponges at Quarry Bay provided good material for measurement of growth, although a larger backing board will be required in the future so that the whole sea-fan colony is included over the scale.

2.9. Recommendations for future photographic work

It is recommended that:

- Site marks and fixings established in 1984 are used in future years.
- Photography of the sites established in 1984 is undertaken at about the same time of year in 1985.
- 1985 studies include the comparison of 1984 and 1985 results.
- Equipment for photography is further tested at base before fieldwork at Lundy. In particular, this should include the modification of the close-up framer to ensure overlap of adjacent frames and the construction and testing of a frame for distance photography.
- The marker line is modified to include numbered tags at each 50 cm interval.
- The basic equipment used is upgraded to include a 15 mm Nikkor lens.
- Ektachrome 100 or Fujichrome 100 film is used.
- Films continue to be processed on-site to ensure a check on quality.

The information on camera settings outlined in Table 1 provides a good reference and should be followed in future work.



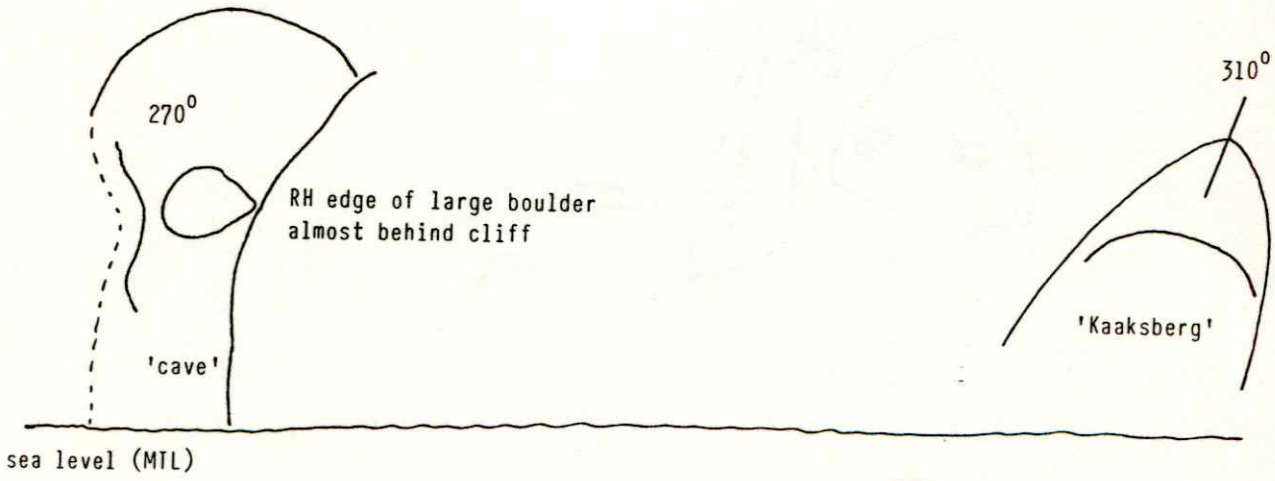


Fig. 2. Location of the Quarry Bay site and transit marks for relocation.

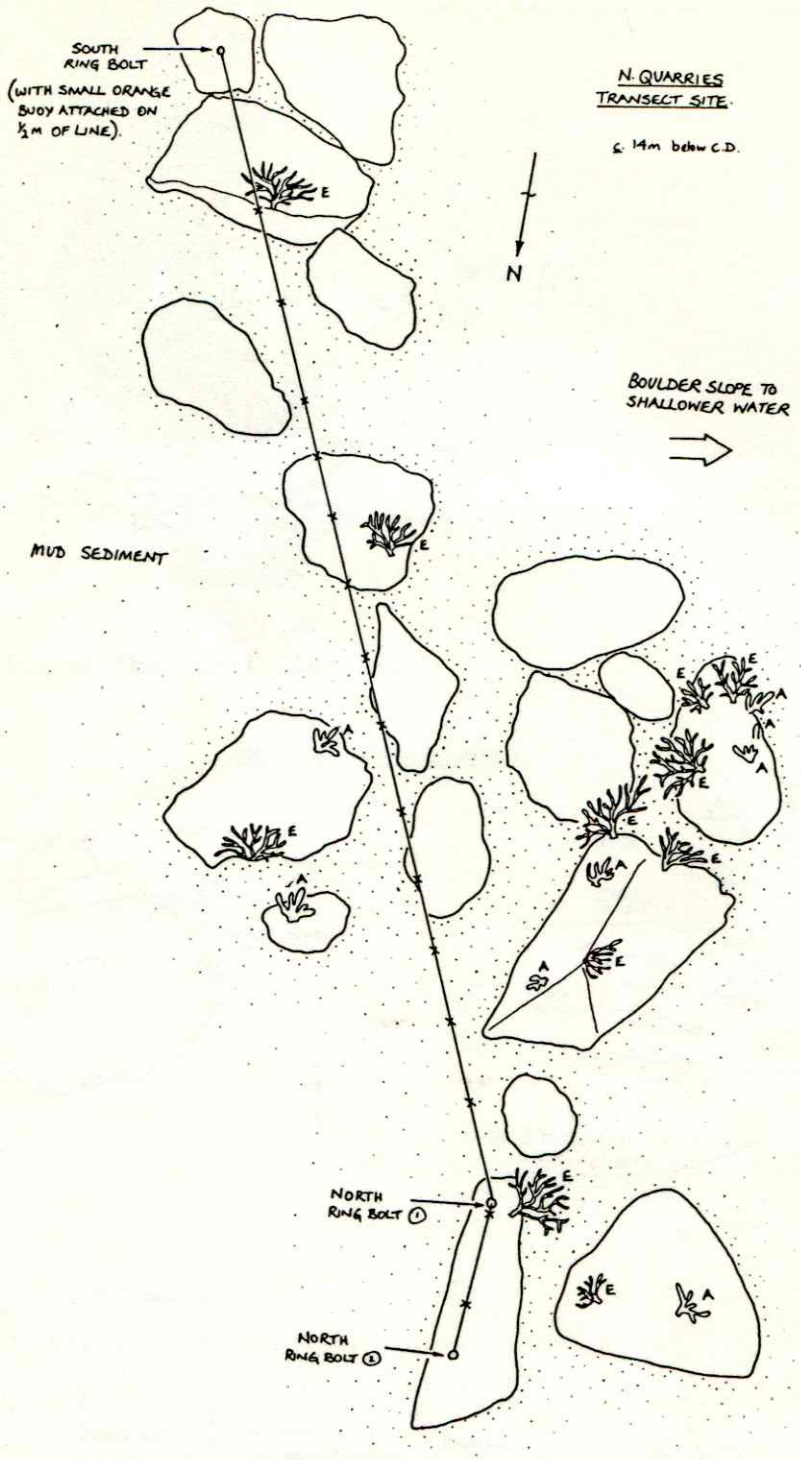


Fig. 3. Topographical features and the position of ring bolts along the Quarry Bay transect (plan view).

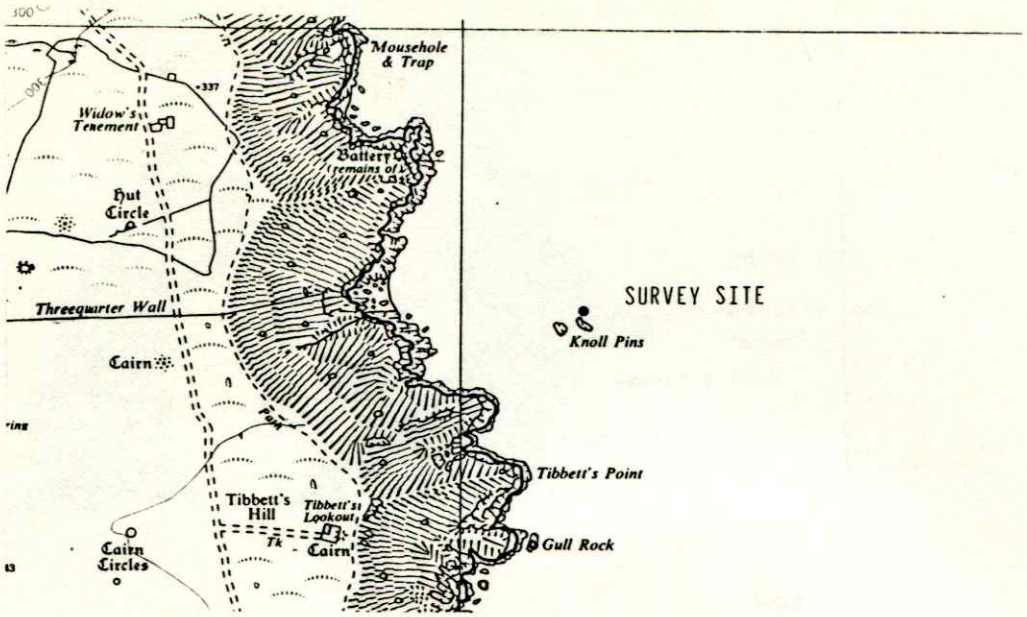


Fig. 4. Location of the Knoll Pins site.

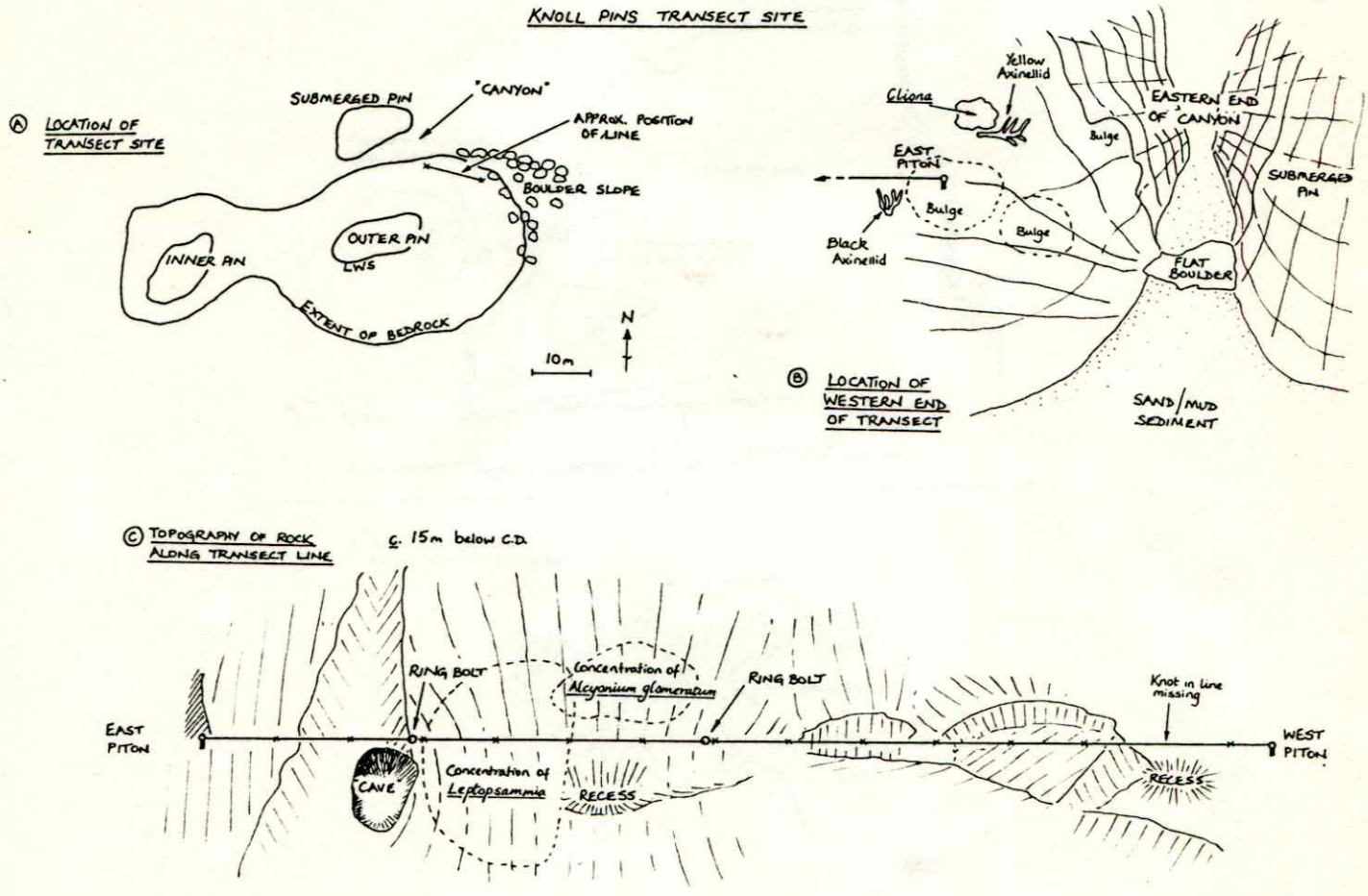
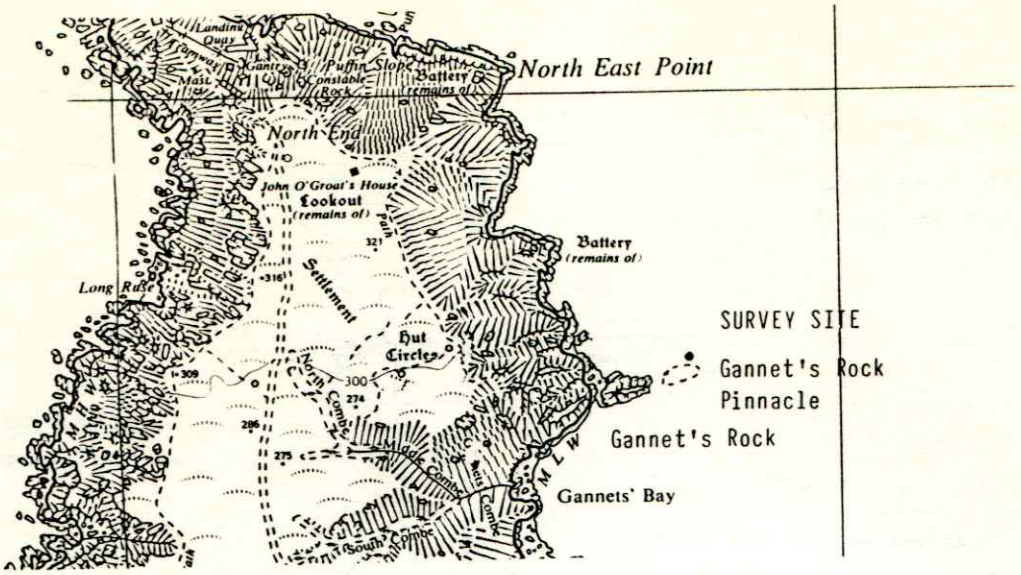
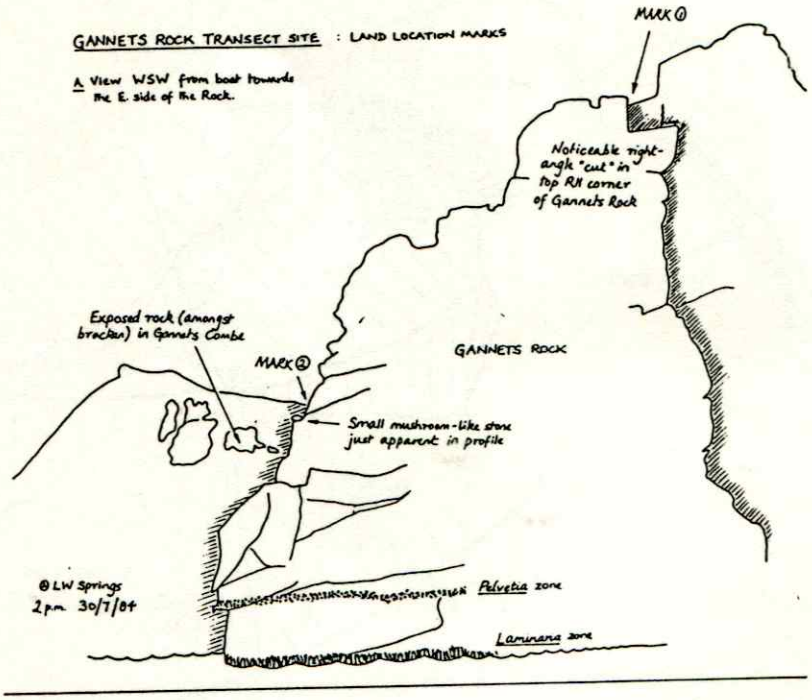


Fig. 5. Topographical features and the position of ringbolts and pitons along the Knoll Pins transect.





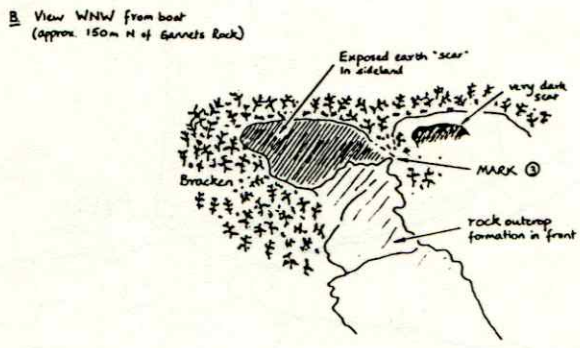


Fig. 6. Location of the Gannet's Rock Pinnacle site and transit marks for relocation.

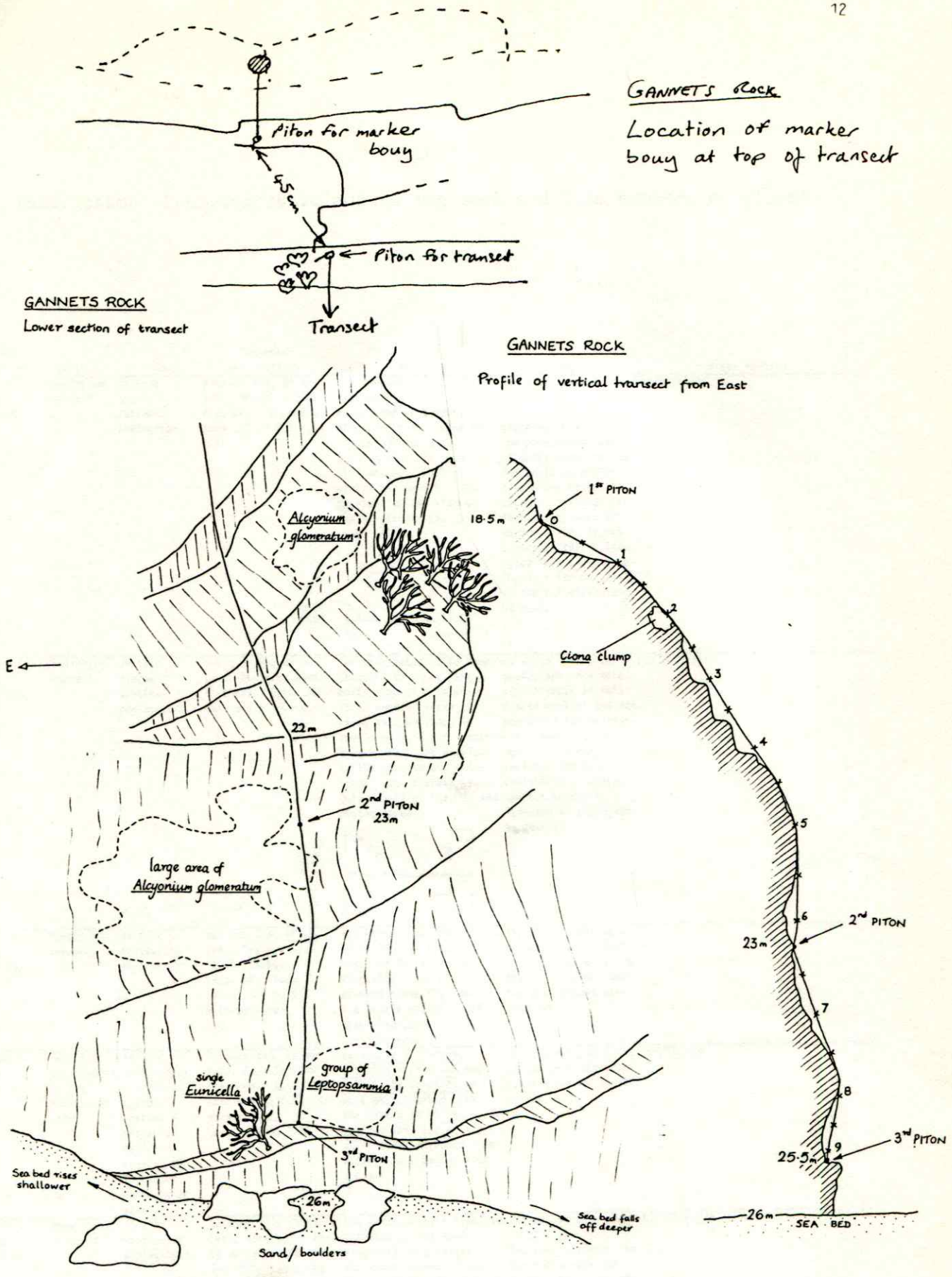


Fig. 7. Topographical features and the location of pitons along the Gannet's Rock Pinnacle site. Two further pitons were added after the sketches were made.

TABLE 1

Description of photographic monitoring work and file numbers of slides

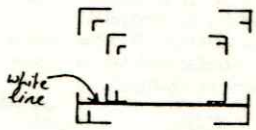
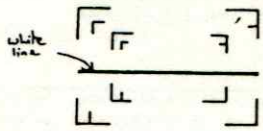
Site and date	Subject	Aim	Equipment and settings	Notes	Comments	Slide numbers
1. Quarry Bay 28.7.84	Monitoring transect	To test system - oblique photographs	Nikonos IVA, 28 mm lens, Oceanics 2001 flashgun. Ekta. 200. Lens set at 0.9 m, f16.	The un-knotted white line attached to three ringbolts used as a marker. Diver knelt on seabed to obtain oblique angle, looking west and at a distance of c. 0.9 m, camera-to-subject. The position of the line in the viewfinder was as shown below. 	The area covered and position of the marker line in each photograph was as desired. The photographs were slightly underexposed. The grain on photographs was rather coarse. Although the photographs were of good quality, it was suggested that a lower speed film and a ranging pole for camera-to-subject distance be used.	LSM/01-17/84
2. Quarry Bay 28.7.84	Monitoring transect	To test system - vertical photographs.	Nikonos IVA, 28 mm lens, Oceanics 2001 flashgun. Ekta. 200. Lens set at 0.9 m, f16.	The un-knotted white rope attached to three ringbolts used as a marker. Diver hovered above line using suit buoyancy to remain at c. 0.9 m, camera-to-subject. The position of the line in the viewfinder was as shown below. Only a part of the line was photographed. 	As above. Vertical photographs are more reproducible in this broken habitat and are preferred for monitoring. However, coverage of vertical rock surfaces and of individual branching species should be achieved by different approaches.	LSM/18-27/84
3. Quarry Bay 2.7.84	Monitoring transect	To take monitoring photographs.	Nikonos IVA, 28 mm lens, Sea and Sea YS150 flashgun. Ekta. 64. Lens set at 0.6 to 1.2 m (bracketed), f10.	The white rope, knotted at 50 cm intervals, was attached to the three ringbolts. The diver hovered above the line and took a set of photographs on each side of the transect.	The photographs were of poor quality due to suspended material in the water column and the photographs were destroyed.	-
4. Quarry Bay 2.7.84	Sea fans and sponges at the monitoring site	To take photographs of each species against a scale for future records of increase/ decrease in size.	Nikonos IVA, 28 mm lens, Oceanics 2000 flashgun. Ekta. 200. Lens set at 0.6, f8 aand f11. (bracketed), f10.	Eunicella verrucosa, Axinella polypoides and Polymastia boletiforme were photographed with the camera at 90° to their maximum area and with a white board ruled in 2 cm squares held behind each subject.	The photographs taken at f11 were correctly exposed and the system worked well.	LSM/57-69/84
5. Quarry Bay 3.8.84	Monitoring transect	To take monitoring photographs.	Nikonos III, 15 mm lens, viewfinder for 15 mm lens, Sea and Sea YS150 flashgun. Koda. 64. Lens set at 0.6 m, f13.	The knotted white line was attached to the three ringbolts as a marker. The diver hovered above the line and took vertical photographs with the line in the centre of the picture area.	The photographs provided a good monitoring set, although the flash coverage was incomplete at the top of the picture (due to either inadequate flash angle for the 15 mm lens or incorrect flash angle). The line was perfectly centred.	LSM/28-44/84

Table 1 (continued)

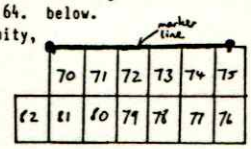
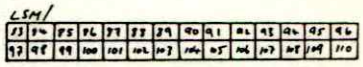
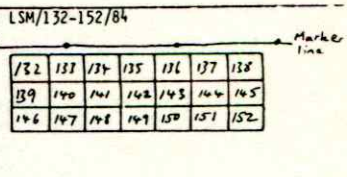
Site and date	Subject	Aim	Equipment and settings	Notes	Comments	Slide numbers
6. Quarry Bay 3.8.84	Boulders in the region of monitoring site	To take general views of boulders in the area of the monitoring site.	As above. Lens set at 0.9 m, f10 1.8 m, f4 and f8 0.9 m, f10	 Hand-held flash Pictures of buoy and white Eunicella	The photographs are useful general views of the site and can be used for viewpoint monitoring. Exposure was good. Flash coverage was inadequate.	LSM/45-47/84 LSM/48-52/84 LSM/53-55/84
7. Quarry Bay 4.8.84	Side of boulder at north end of transect	To take close-up monitoring photographs of the community on one boulder side.	Nikonos IVA, 28 mm lens, Nikonos supplementary close-up lens and framer, Oceanics 2000 flashgun. Koda. 64. Lens set at infinity, f8 and f11.	Overlapping (by c. 2 cm). Photographs were taken under the northern end of the line between the two ringbolts as shown below. 	The exposure was best at f11. The overlap was not adequate in most cases. The photographs were of excellent quality.	LSM/70-82/84 (photograph numbers are shown in the notes column)
8. Knoll Pins 2.8.84	Monitoring transect	To take monitoring photographs.	Nikonos III, 28 mm lens, Sea and Sea YS150 flashgun, Sea and Sea viewfinder, 0.9 m ranging rod. Ekta. 64. Lens set at 0.6-1.2 m (bracketed), f10.	The knotted white line was attached to the pitons and ringbolts. Photographs were taken along the top and bottom of the line to include each 50 cm length.	The photographs provided a good monitoring set, although the line was just out of the picture area for the below-line photographs. Colour and contrast were poor, although definition was good.	LSM/83-110/84 (set)  LSM/111-116/84 (additional sections)
9. Knoll Pins 3.8.84	Monitoring transect	To take monitoring photographs.	Nikonos III, 15 mm lens, viewfinder for 15 mm lens, Sea and Sea YS150 flashgun. Ekta. 64. Lens set at 0.6 m, f11 and f16.	The knotted white line was attached to the pitons and ringbolts. Photographs were taken along the line with the line central and to include each 50 cm length. Camera-to-subject distance was 0.6 m.	Flash illumination was uneven with inadequate coverage at the edges. The colours were bright and definition good. f11 provided the best photographs.	LSM/117-129/84
10. Knoll Pins 3.8.84	Cave	To take photographs of the same area of rock as photographed in 1981 and 1983.	As above. Lens set at 0.6 m and 0.9 m, f11, f16 and f22.	The cave was at the eastern end of the transect line and was photographed with a colony of Thymosia guernii as a marker to roughly correspond with the area covered by previous photographs. Photographs were taken at camera-to-subject distances of 0.6 and 0.9 m.	Colours were bright and definition good, with the photographs taken at f11 giving best results.	LSM/130-131/84
11. Knoll Pins 3.8.84	Anthozoan community	To take close-up monitoring photographs of the rare anthozoans present in the cave.	Nikonos IVA, 28 mm lens, Nikonos supplementary lens and framer, Oceanics 2000 flashgun. Koda. 64. Lens set at infinity, f11.	An overlapping series of photographs was taken on three lines of seven frames below the transect line, starting with the Thymosia colony in the lowest left photograph.	Photographs were of very high quality and included L. pruvoti, C. inornatus, H. durotrix and P. hibernicum, the main species of interest. There was no overlap in most of the photographs.	LSM/132-152/84 
12. Knoll Pins 3.8.84	Anthozoans	To take illustrative photographs of rare anthozoans.	As above.	These photographs were mostly taken in the cave.	High-quality photographs including the above species were taken. Small corals were difficult to differentiate, and macro photographs would be better for illustration.	LSM/153-156/84

Table 1 (continued)

Site and date	Subject	Aim	Equipment and settings	Notes	Comments	Slide numbers
13. Gannet's Rock Pinnacle 30.7.84	Monitoring transect	To take monitoring photographs.	Nikonos III, 28 mm lens, Sea and Sea viewfinder (set at 0.7 m), Sea and Sea YS150 flashgun, 0.9 m ranging rod. Ekta. 64. Lens set at 0.7 m, f8 and f11.	The knotted white line was attached to the pitons and photographs taken from the base of the line to the top with the line in the centre of the picture area and knots top and bottom of the viewfinder. Two sets were taken, one at f8, one at f11.	Photographs were evenly illuminated, sharp, and colours were good. Photographs using both apertures were correctly exposed, although the darker ones taken at f11 probably preserved more detail. f10 is probably about best to use. The framer did not correctly align the photographs with the knots and the top knot was not included in pictures, while the lower knot was well into the picture area. Overlap was good. Slides are labelled by the length along the line. (The f11 series is filed in the NCC set, the f8 series in the FSC set.)	LSM/157-173/84
14. Gannet's Rock Pinnacle 1.8.84	Monitoring transect	To take monitoring photographs on the left and right sides of the transect.	Nikonos III, 28 mm lens, Sea and Sea YS150 flashgun, 0.9 m ranging rod. Ekta. 64. Lens set at 0.7 m, f10.	The knotted white line was attached to the pitons and photographs taken from the base of the line to the top, with the line on the right of the pjcture area in the first series and on the left in the second series.	Photographs were evenly illuminated but poor in definition and contrast, due most likely to the higher turbidity of the water than on previous days, when good results had been obtained with the same equipment. Two sections were not photographed: at 2.5 m and 7.5 m on the left side of the line.	LSM/174-204/84
15. The Cove 29.7.84	Test transect on rock and sand at c. 0 m	To test equipment.	Nikonos III, 28 mm lens, Sea and Sea viewfinder, Sea and Sea YS150 flashgun, 0.9 and 0.7 m ranging rods. Ekta. 100. Lens set at 0.9 m and 1.2 m, f11.	A braided polypropylene line with knots at 50 cm intervals was stretched over the seabed between two lead weights. The diver hovered over the transect using the ranging rods and focus settings in three combinations: 1. ranging rod 0.9 m, focus 0.9 m. 2. ranging rod 0.9, focus 1.2 m. 3. ranging rod 0.7 m, focus 0.9 m. The Sea and Sea viewfinder with central spots marked on front and back lenses was set at 0.9 m.	The three sets of photographs were taken with no flash failures or sections missed. All photographs were in focus and correctly exposed. The knots, which had been lined up with the centre of the viewfinder, were slightly displaced towards the top of the picture. The definition was high and considered much superior to Ekta. 200. It was found that a measured camera-to-subject distance of 0.9 m produced a c. 67 cm length of line, giving good overlap. The use of a 0.7 m ranging rod did not give an overlap. There was difficulty with kelp fronds entering the picture area and some of the seabed was obscured in a few photographs. Results were very similar and the one series is included in each slide set.	LSM/205-216/84

3. SURVEYS OF AREAS COLONISED BY CEPOLA RUBESCENS

3.1. Introduction

In 1974, a large population of the red band fish Cepola rubescens was discovered in depths of 15-20 m off the east coast of Lundy (Atkinson, 1976). The species had not previously been observed in its natural habitat and subsequent investigations of this important population revealed details of the habitat, burrowing behaviour, activity patterns, social behaviour and age structure of the population. In 1977, the size of the population in the area of Halfway Wall Bay and Gannet's Bay was estimated to be c. 14,000 individuals (Pullin and Atkinson, 1978). However, studies of the age structure of the population revealed that a large recruitment had taken place in the early 1970's and that, with a lifespan of about seven years, further substantial recruitment was needed to sustain the population at its mid-1970's level. Brief investigations in 1981 revealed only a few groups of the fish and in 1982 a few burrows and one fish were seen during extensive searching. In 1983, survey work was undertaken by an Underwater Conservation Society (UCS) Working Party to establish regular monitoring of the area previously occupied by the large populations of Cepola and still by other species of high scientific interest including the anemone Mesacmaea mitchellii and the crab Goneplax rhomboides (Hiscock, 1984b). During that work, no C. rubescens were seen. The areas studied during the UCS Working Party were surveyed again during the current work and the Gannet's Bay area was also searched.

3.2. Methods

The searches of the south part of the east coast were undertaken by towing the diver over the seabed towards the transit marks used during the 1983 UCS work for the first four tows. The transit marks are shown in Appendix 2 and the areas surveyed by the 1983 UCS Working Party and by Pullin and Atkinson in 1977 are shown in Appendix 3. The fifth tow was in an area where sighting of C. rubescens had been reported by sports divers from Ilfracombe BS-AC inshore of the wreck of the M.V. 'Robert'. Divers were in communication with the boat crew via a DUCSET underwater telephone. The boat was manned by a coxswain, rope handler/standby diver, and scribe/standby diver. The boat proceeded at a speed of about one knot. During the tows, bearings on conspicuous features were taken and incorporated into the record of the diver's commentary, together with a note of the time, so that the course could be plotted and matched to the commentary. The notes taken by the scribe were later summmarised by the diver to provide an account of the observations made during the dive.

In Gannet's Bay, the area of seabed indicated by Pullin and Atkinson (1978) to be the main area populated by C. rubescens was surveyed by swimline transect, with the diver taking notes on the seabed while the cover boat crew noted the approximate line of the swim as indicated by the divers surface marker bouy in relation to coastal features.

3. Results

The line of each tow was plotted onto a copy of the 1:10,560 Ordnance Survey map (Fig. 8). The area surveyed in Gannet's Bay is shown in Fig. 9). Full records for each tow or dive area included in Appendix 4 and summarised below.

Tow 1 (KH). This tow extended from about 200 m south of Gull Rock to about 300 m north of Rat Island over a length of seabed of about 2 km, crossing the area surveyed by Pullin and Atkinson (1978). The tow started on muddy boulders dominated by foliose algae south of Gull Rock and extended southwards over a plain of sandy mud with some shell at 16-18 m below sea level, which was similar

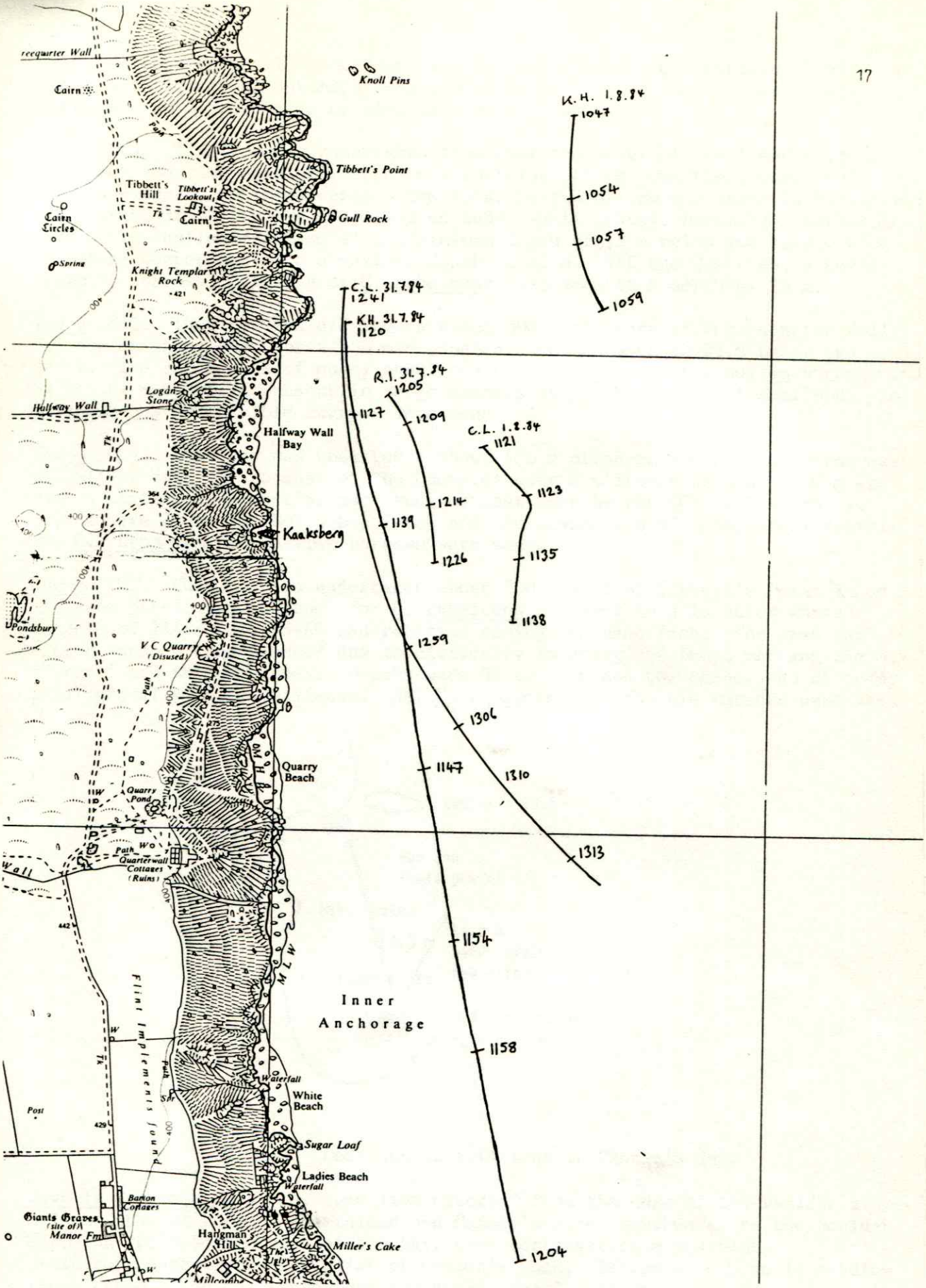


Fig. 8. The line of each survey tow plotted onto the 1:10560 Ordnance Survey map.

over a large area until the Landing Bay was approached when scattered shells and stones with some rock outcrops were observed. A c. 5 m width of seabed was surveyed. No C. rubescens or possible burrrows were seen.

Tow 2 (CL). This tow was undertaken from near the start of Tow 1 and extended over much the same area of seabed to a position off the Quarries, where the towline extended southeastwards. The total length of tow was about 1,200 m. The tow started at 19 m below sea level on muddy shell gravel, becoming smoother and sandier in shallower depths with a minimum depth of 15 m below sea level, then extending deeper again to a maximum depth of 22 m. Off the Quarries, a small group of burrows, possibly of C. rubescens, was seen at a depth of 15 m.

Tow 3 (RI). This tow was undertaken about 300 m offshore of Threequarter Wall Bay and extended over about 350 m of seabed. Depths were 26-28 m below sea level. The seabed was of muddy shell gravel with Goneplax rhomboides burrows and Mesacmaea mitchellii present in large numbers and with occasional scallops. No C. rubescens or possible burrows were seen.

Tow 4 (CL). This tow was undertaken about 450 m offshore and extended from east of Halfway Wall Bay to east of the Quarries over a distance of about 400 m and over a similar area ot that surveyed furthest east by the UCS Working Party. Depths were 27 to 20 below sea level and the seabed was of muddy shell gravel. No. C. rubescens or possible burrows were seen.

Tow 5 (KH). This tow was undertaken about 500 m east of Tibbett's Point in an area not previously searched for C. rubescens but near to a location where members of Ilfracombe BS-AC had reported seeing red band fish. The area was closer inshore than planned due to difficulty locating the buoys marking the M.V. 'Robert' and to rough seas. Depths were 33 to 35 m and the seabed was of muddy shell gravel with few epifauna. No. C. rubescens or possible burrows were seen.

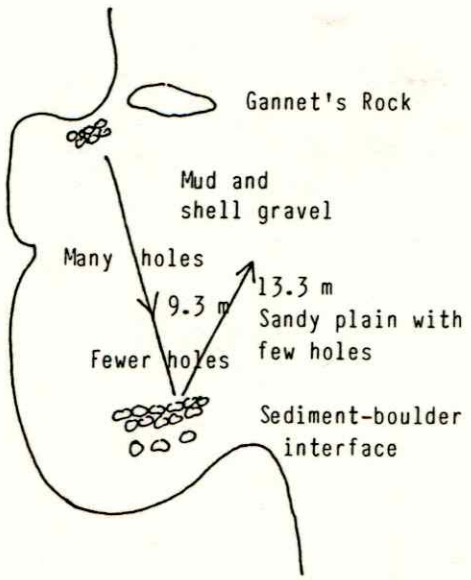


Fig. 9. Location of swim line in Gannet's Bay.

Dive in Gannet's Bay. The swim line extended from the edge of the boulder slope off the channel between the island and Gannet's Rock, southwards to the boulder slope on the opposite side of the bay, then northeast to a position south-southeast of the far point of Gannet's Rock. Depths were 9 to 13 m below chart datum. The mud in the bay had a high density of Goneplax rhomboides holes but no C. rubescens or likely holes were seen. Offshore, the sediment became increasingly coarser and burrows of G. rhomboides much sparser.

3.4. Discussion and conclusions

The tow lines off the south parts of the east coast and the swim in Gannet's Bay included the areas previously occupied by high densities of C. rubescens. The residual population present until 1982 had clearly disappeared.

3.5. Recommendations

It is recommended that the areas off Threequarter Wall Bay, Quarry Bay and in Gannet's Bay are resurveyed in the same way in future years.

4. STUDIES OF POPULATIONS OF BALANOPHYLLIA REGIA

4.1. Introduction

During the establishment of littoral monitoring sites at Lundy in April 1984, measurements were made of a popoulation of the cup coral Balanophyllia regia at the Devil's Kitchen south of Rat Island (Hiscock, 1984a). These measurements were repeated during the sublittoral survey week and later in the year (by R. Irving). The results of both studies are included here so that a record is maintained of work carried out in 1984.

4.2. Methods

Measurements were made on 31st July and 30th August. The methods used were similar to those described in Hiscock (1984a). The same number and letter code were used as in April.

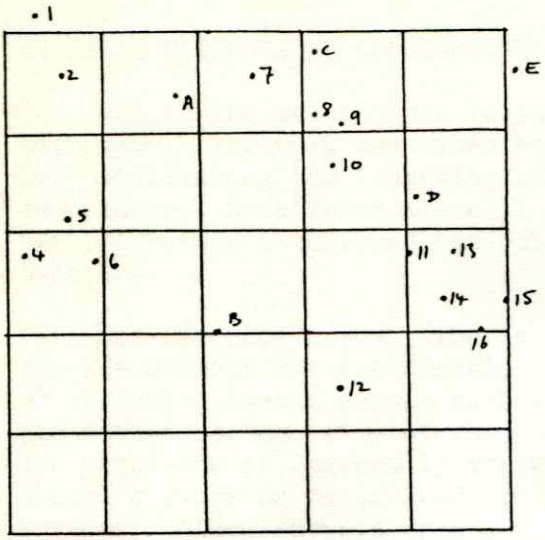
4.3. Results

Fig. 10 shows the distribution and size of corals within the survey grid. The same individual corals were present in April, July and August. In July, B.regia no. 3 was not found and in August B. regia no. 4 was not found, despite careful searching for it, although no. 3 was again located.

4.4. Discussion and conclusions

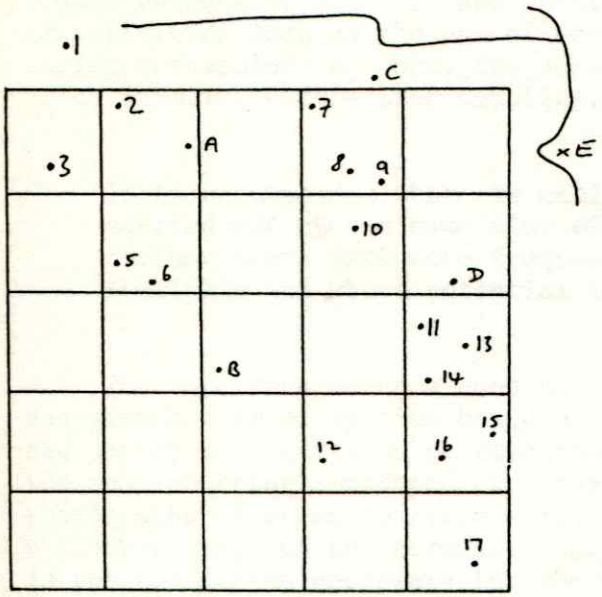
It is clear that very little change has occurred in the distribution or size of the corals between April and August, although the survey grid was located differently. There also appears to have been no observed recruitment, although B. regia produces planulae between May and August (P. Tranter, pers. comm.). However, we would not have expected to find very small corals under the silt layer at the site and new individuals may only be observed in the year subsequent to their recruitment. Measurements taken across the corallum were inconsistent from survey to survey and this seems most likely to be due to difficulty of measuring the irregular surface at a poorly defined top edge, rather than to any real increase or decrease in size. Relocation of the 50 cm x 50 cm marked area was also inconsistent from survey to survey, and the provision of marker screws on which to hang a divided quadrat is desirable.

July 31st, 1984. C. Lumb.



Balanophyllia regia	Caryophyllia smithii
1. 5.5 x 4.0	A. 6.0 x 5.5
2. 5.5 x 5.0	B. 11.5 x 10.0
3. Not found	C. 6.5 x 6.5
4. 6.0 x 5.5	D. Not measured
5. 8.0 x 7.0	E. 9.0 x 7.0
6. 7.0 x 5.5	
7. 7.0 x 6.5	
8. 6.0 x 5.5	
9. 8.0 x 8.0	
10. 8.5 x 8.0	
11. 6.5 x 5.5	
12. Not measured	
13. 6.5 x 5.5	
14. 6.0 x 6.0	
15. 6.5 x 5.0	
16. 4.0 x 3.5	

August 30th, 1984. R. Irving.



Balanophyllia regia	Caryophyllia smithii
1. 5.0 x 3.5	A. 6.0 x 6.0
2. 4.5 x 4.5	B. 11.0 x 8.0
3. 5.5 x 5.0	C. 5.5 x 6.5
4. Not recorded	D. 8.5 x 10.5
5. 5.0 x 5.5	E. 9.0 x 7.0
6. 5.0 x 6.0	
7. 6.0 x 6.5	
8. 4.5 x 4.5	
9. 7.5 x 7.0	
10. 7.0 x 8.0	
11. 5.5 x 4.5	
12. 5.5 x 7.0	
13. 6.5 x 6.5	
14. 4.5 x 4.5	
15. 6.5 x 7.0	
16. 4.0 x 3.5	
17. 6.5 x 6.5	

Fig. 10. Mapping and measurement of Balanophyllia regia and Caryophyllia smithii at the Devil's Kitchen in July and August 1984.

5. FINAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Monitoring studies are intended to follow changes in species and communities with time. The work described here was aimed at monitoring natural fluctuations and establishing the longevity of some of the species of high conservation importance. Such information is important for management of natural resources and provides a background against which the effects of man's activities can be assessed.

Surveys once a year, the interval for which these studies were designed, provide a basis for the description of change resulting from annual recruitment or unusual climatic events such as cold winters or hot summers which will affect populations at one time of the year. Other survey aims such as investigation of the abundance of seasonally variable species may help to interpret results of annual surveys or be of academic interest, but will not be detected by annual surveys. Also, surveys once a year will not provide a reliable basis for detecting long-term changes in the silt cover of rocks since this is likely to be very variable because of the importance of storms and spring tides in carrying suspensions of silt. Neither do surveys once a year provide information necessary to ascribe cause and effect in response to possible immediate impacts such as fishing at a certain time or intensive scientific work at a site. Studies of impacts from natural causes or from the activities of man will require a more responsive approach and should accompany events such as severe oil spills or activities such as the use of explosives for salvage, the use of airlifts during archaeological work, the deployment of fishing gear, and scientific work which involves destructive sampling.

It is recommended that the monitoring surveys commenced in 1984 are carried out at the same time of year for an initial period of two further years with more frequent and/or responsive survey if staff are available and where potential impacts need to be studied.

The recording methods used during photographic survey depend partly on size and growth form of species being monitored, partly on the sensitivity required, and partly on conditions of topography and turbidity at each site. At present, the species being monitored at Lundy are conspicuous and easily seen in single photographs of an appropriate size. The use of stereophotography, which provides a clearer image of the community and ability to measure the height of subjects, is not considered necessary for the species being surveyed at present.

An important requirement for monitoring is accurate relocation of sites and the site marks and methods used to re-lay the transect line on subsequent occasions are considered adequate at present, with the addition of numbered tags along the line. However, the ability to repeat the same camera angle and distance is questionable and a framer attached to the camera has already been suggested in Section 2.9. Another matter of concern is the analysis of photographs. Some aspects of analysis are theoretical at present and require testing before further surveys are undertaken.

It is recommended that photographic methods are developed further, particularly with reference to the use of framers which define the area being photographed.

It is recommended that methods to be used to analyse photographic survey results are developed before subsequent fieldwork is undertaken.

The search methods employed to study the abundance of Cepola rubescens are considered adequate in view of the very large size of previous populations. That population was of high scientific interest and the frequency of occurrence of such populations should be recorded. Other species of high scientific interest occur or have occurred in the same area as that being surveyed for Cepola, including the crab Goneplax rhomboides, the scallop Pecten maximus and the anemones Mesacmaea mitchellii and (previously) Calliactis parasitica. These species should be systematically included in the survey commentary.

It is recommended that annual surveys searching for Cepola rubescens off the east coast of Lundy should be continued with additional systematic work on the sediment-living species of conservation importance

Other species of scientific interst are not being monitored and further work may be carried out in the future. They include species which may prove more difficult to monitor, such as fish populations, and for which new methods may have to be developed.

It is recommmended that consideration is given to methods for monitoring other species of scientific interest.

6. REFERENCES

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Lundalv, T. (1971). Quantitative studies on rocky-bottom biocoenoses by underwater photogrammetry. A methodological study. Thalassia Jugoslavia 7, 201-208.

Pullin, R.S.V. and Atkinson, R.J.A. (1978). The Status of the Red Band Fish Cepola rubescens L. at Lundy. Nature Conservancy Council. 22 pp.

Appendix 1

Record of daily activities.

28th July

Weather: light southwesterly wind, clear skies, c. 6 m underwater visibility. Tides: 06.23, 7.2 m; 12.38, 1.1 m; 18.45, 7.7 m. CL and VL arrived at Lundy on the M.V. 'Polar Bear' at 09.30. KH and RI were already on Lundy to meet them. Equipment offloaded and assembled. Dives at Quarry Bay by KH, CL and RI to establish and photograph a transect at the edge of the boulder slope. Assembly of laboratory equipment and general occupation of Lower Old Light accommodation. The film taken at Quarry Bay was processed.

29th July

Weather: light southwesterly wind at first, strengthening after 14.00. Clear skies, c. 8 m underwater visibility. Tides: 01.06, 0.9 m; 07.10, 7.7 m, 13.25, 0.9 m, 19.30, 7.9 m. Much of the morning period was used to write notes, prepare and inspect photographic material, and discuss site establishment and survey techniques. Diving, photographic and survey equipment was prepared at the cove jetty and departure made for Gannet's Rock where a potential monitoring site had been identified during the previous week. The site was located by KH and a transect line established by CL and RI. On return to the jetty, tests of camera-to-subject distance and exposure were carried out by CL and KH along a transect laid off the jetty. Evening work included processing the film used in the photographic tests.

30th July

Weather: fairly strong westerly wind, decreasing during the middle of the day. Clear skies becoming cloudy after midday. Tides: 01.53, 0.7 m; 07.57, 7.7 m; 14.10, 0.7 m; 20.15, 8.1 m. Part of the morning period was used to write notes and inspect photographic material. Photographic and other equipment was prepared at the jetty and dives undertaken at Gannet's Rock to buoy the Gannet's Rock site and photograph the transect. Photographs were processed, inspected and mounted in the evening.

31st July

Weather: fairly strong westerly winds at first, decreasing during morning. Clear skies. Tides: 02.39, 0.6 m; 03.42, 7.09 m; 14.53, 0.7 m; 21.02, 8.1 m. KH and CL, assisted by VL, undertook two towed telephone dives off the east coast, surveying for Cepola in the morning. (RI gave a guided tour of the island to visitors.) At extreme low water, CL remeasured Balanophyllia at the Devil's Kitchen site and KH established stainless steel screw markers in the Rat Island cave transect. Dives were undertaken in the Surf Point gullies (CL) and north of Surf Point (KH and CL). Evening work included plotting towed dive course and transcribing notes. (KH gave illustrated talk to visiting diving group.)

1st August

Weather: strong westerly winds early, slackening during morning, rising midday, slackening early afternoon, and rising and turning south late afternoon. Mainly clear skies to midday, then cloudy with heavy rain in late afternoon. Tides: 03.24, 0.7 m; 09.27, 7.7 m; 15.38, 0.8 m; 21.47, 7.9 m. KH, CL and RI undertook further towed dives off the east coast, searching for Cepola in the morning. During the afternoon, CL and KH completed photography and marking of the Gannet's Rock transect. Photographs were processed in the evening. (RI gave a guided tour of the

shore to visitors in the afternoon and RI and KH gave an illustrated talk to visitors in the evening.)

2nd August

Weather: mostly cloudy, some light intervals in the morning, with heavy showers at times. Wind strong, south or southwest. Tides: 04.08, 0.9 m; 10.12, 7.5 m, 16.23, 1.1 m, 22.33, 7.6 m. KH, CL and RI completed work on the Quarry Bay site. KH established third ringbolt firmly. CL took photographs of transect. CL and RI photographed sea fans and sponges against grid on board, and RI mapped the area of the transect line. KH, RI and CL established and photographed Knoll Pins transect in afternoon. KH located site and commenced marking and laying of transect with RI. CL completed marking and took the set of distance photographs. Processed films in evening. (KH gave illustrated talk on marine life at Lundy and KH, CL and RI took part in discussion on marine nature reserve proposals with islanders in the evening.)

3rd August

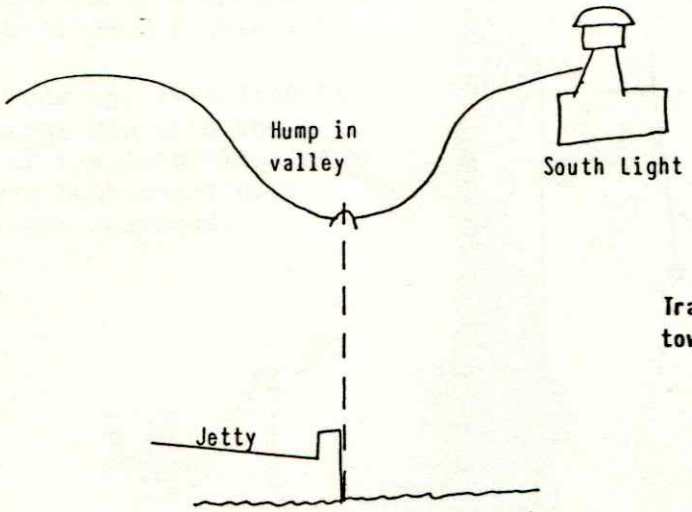
Weather: sunny periods with showers in between. Wind strong, southerly, turning easterly after midday. Tides: 14.54, 1.2 m; 10.58, 7.1 m; 17.10, 1.4 ; 23.22, 7.2 . Further work was undertaken at the Knoll Pins. CL photographed the transect and the cave using a Nikonos 15 mm lens. KH took 0.033 m^2 photographs in the cave. RI surveyed and drew position sketches of the transect line and removed it. Returned to Old Light in early aftertoon to catch up with paperwork. During late afternoon, the Quarry Bay transect was re-established by KH and the communities present on the furthest north boulder photographed in 0.033 m^2 areas. CL rephotographed the transect and sea fan-measuring boulders using the 15 mm lens.

4th August

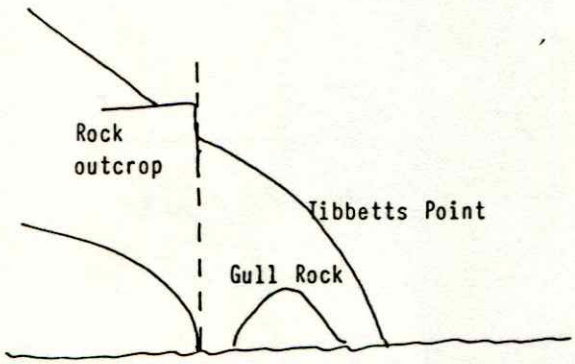
Weather: cloudy with sunny intervals. Wind strong, north-northwest. Tides: 05.32, 1.8 m; 1.49, 6.7 m; 18.03, 1.8 m. Packed equipment and personal gear at accommodation, ready for transport off the island in early morning. KH dived at Quarry Bay to rephotograph 0.033 m^2 areas. CL undertook swim lines across Gannet's Bay, searching for Cepola. Completed packing of diving and other equipment at the diving hut. KH departed on helicopter at 15.00. CL, RI and VL departed on 'Polar Bear' at 20.30.

Appendix 2

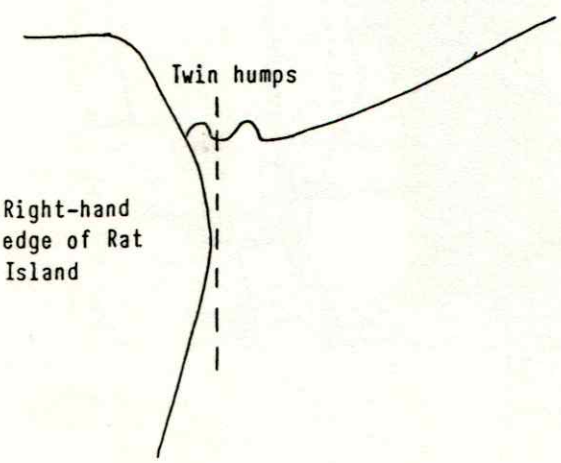
Transit marks for towed dives off the east coast. From the Underwater Conservation Society Working Party report (Hiscock, 1984). Tows 1 and 2 were along the transit marks for KV, Tow 3 along the transit marks for DR, and Tow 4 along the transit marks for BS.



Transit marks ahead of boat for tow by KV



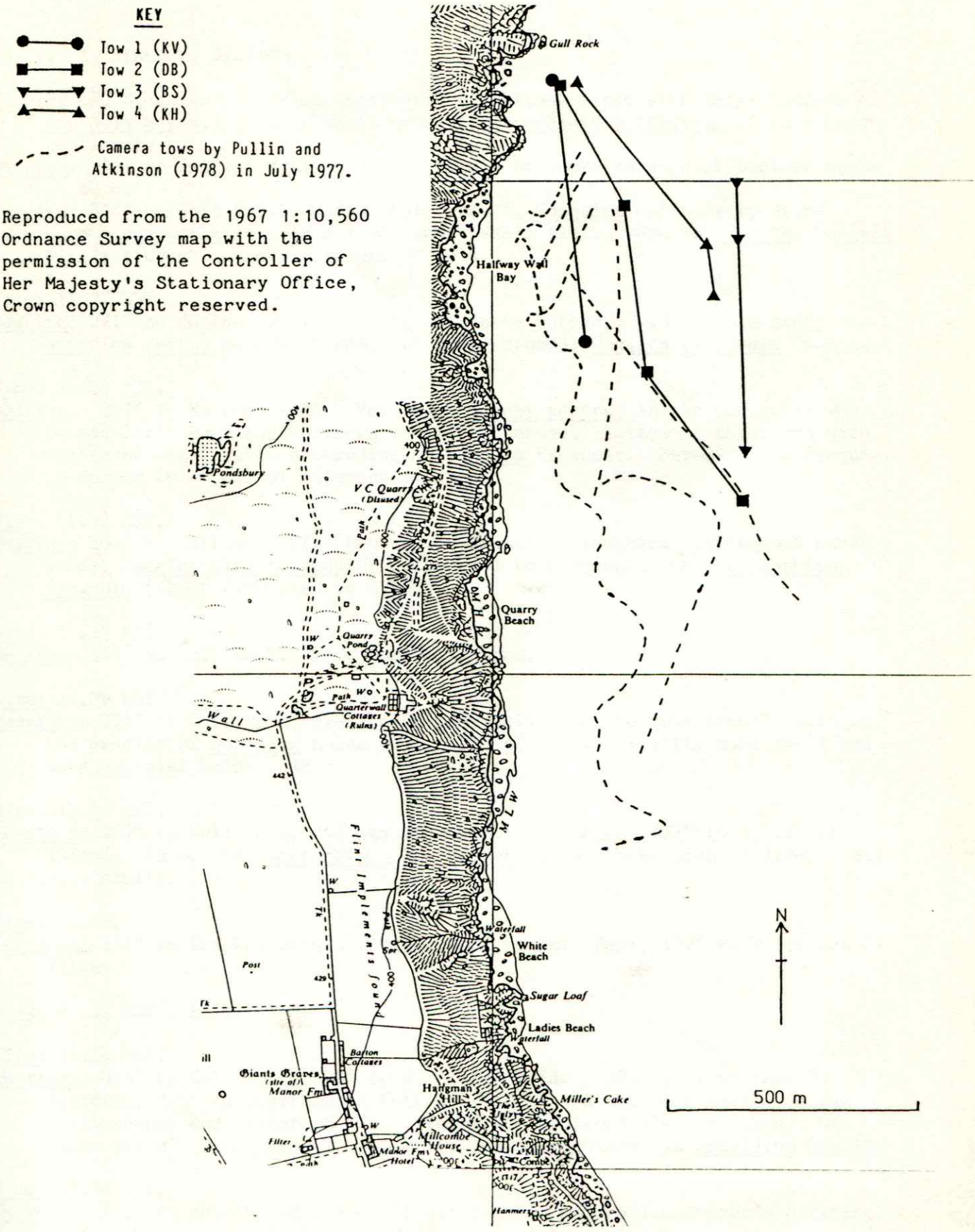
Transit marks ahead of boat for tow by DR



Transit marks ahead of boat for tow by BS

Appendix 3

Areas surveyed for Cepola rubescens by Pullin and Atkinson (1977) and the Underwater Conservation Society Working Party (Hiscock, 1984). Reproduced from Hiscock (1984).



Appendix 4

Field notes for each tow and dive, searching for Cepola rubescens. All depths are below sea level at the time of the dive.

Tow 1. K. Hiscock. 31.7.84

Time: 11.19 BST. Boulder slope dominated by foliose algae with large numbers of Aiptasia mutabilis and a small group of Zanardinia prototypus at 13 m below sea level.
Bearing: 245° to Halfway Wall. 13-15 m, small boulders to edge of boulder slope at 18 m.
Bearing: 356° to Gull Rock. Muddy shell gravel, Goneplax holes, very dense Cereus pedunculatus. 18 m level muddy shell plain, very few Cereus, Ophiura albida present. Rocky outcrops at 18 m.

Time: 11.27 BST.
Bearing: 271° to Halfway Wall. Coming off rocky outcrop. 18 m, more muddy. Asterias rubens Common (throughout muddy areas), Ophiura texturata Common.

Time: 11.29 BST.
Bearing: 287° to Halfway Wall. Very many Cancer pagurus in the mud (this was particularly over the northern end of the area). Bottom of thick mud with scattered small tubes protruding. Goneplax Frequent. Hermit crabs Frequent to Common (over all of sediment plain).

Time: 11.33 BST.
Bearing: 302° to Halfway Wall. Lanice Occasional in sediment (throughout muddy area). Atelecyclus rotundatus Occasional to Frequent. One Scyliorhinus canicula (about five seen in dive.)

Time: 11.35 BST.
Bearing: 354° to Gull Rock. Same sort of seabed.

Time: 11.39 BST.
Bearings: 355° to Gull Rock, 310° to Halfway Wall, 230° to Quarterwall Cottages. Low density of Goneplax holes (over much of run). Slightly more shell and more Goneplax holes. 18 m.

Time: 11.44 BST.
Bearings: 354° to Gull Rock, 252° to Quarterwall Cottages, 177° to W. of Rat Island. 18 m. One Liocarcinus ?depurator (total three seen in dive). Bit more shelly.

Time: 11.48.
Bearings: 276° to Timekeeper's building, 355° to Gull Rock, 177° to W. of Rat Island.

Time: 11.52 BST. 17 m.

Time: 11.54 BST.
Bearings: 355° to Gull Rock, 176° to W. of Rat Island, 304° to Timekeeper's building, 295° to Quarterwall Cottages. 17 m. A bit more muddy. A few small stones and oyster shells. Stones have foliose algae on them. One stone per m^2. One Cereus. Two large boulders covered in Metridium senile.

Time: 11.54 BST.
Bearings: 233° to church and flagstaff (in line), 304° to Timekeeper's building, 307° to Quarterwall Cottages. Muddy sand with widely scattered stones and

shells and some boulders. Number of stones and shells gradually increasing, 15 m. Ten percent cover of algae (Ceramium, Desmarestia, Brongniartella etc.).

Time: 12.00 BST.
Bearing: 354° to Gull Rock. Area of muddy gravel, slightly waved to large waves in places, with a patchy diatom film. Thirty to 60% algae. Rock outcrops, Anemonia viridis, foliose algae, beds of Cereus. [Opposite Millcombe Valley now.]

Time: 12.04 BST.
Bearings: 261° to church. End of dive.

Tow 2. C. Lumb. 31.7.84

Time: 12.41 BST (start dive). 13 m depth. Muddy shell gravel. Asterias rubens Occasional.
Bearings: Halfway Wall 278°, green-covered island E. of Rat Island 170°. 19 m depth. Cancer pagurus and Ophiura texturata Occasional.
Bearings: Halfway Wall 305°, Cottages 217°. 18 m depth. Large shell fragments present, mainly Abra with some live animals present. High mud content with covering of brown diatoms. O. texturata Occasional. No burrows seen. Some Lanice conchilega recorded, one or two large and several small.

Time: 12.55 BST. Same type of sediment. Goneplax burrows. Dragonets (?Callionymus lyra) Occasional. O. texturata Frequent to Common. Scyliorhinus canicula Occasional.

Time: 12.58 BST. Goneplax burrows. Large Cerianthus lloydi. Muddy sediments with small amount of shell (fragments). 16 m depth. Several juvenile flatfish.

Time: 12.59 BST. (Turned east).
Bearings: Gull Rock 355°, 'Kaaksberg' 312°, Quarterwall Cottages 233°, Green Island 171°. Lots of dragonets. Burrows possibly of red band fish seen - no fish in them. About four or five in total. 15 m.

Time: 13.03 BST. 15 m depth. Sediment very muddy still, with brown surface colour. Still dominated by O. texturata, Asterias rubens, with Goneplax burrows Occasional. 17 m depth, sediment becoming 'smoother', less in the way of surface features. Seabed scoured, with long-wavelength, small-amplitude ripples present. S. canicula and Eupagurus Frequent. Many covered with Hydractinia. No Adamsia or Calliactis. One octopus. No burrows at all in the substratum. Seabed becoming sandier and less mud present. One Ensis. Lanice juveniles more common. O. albida Common. Sandy sediment.

Time: 13.06 BST.
Bearings: Gull Rock 350°, 'Kaaksberg' 323°, Green Island 173°. 19-20 m depth. Occasional small stones. Marthasterias Frequent. 20 m depth, Eupagurus and Hydractinia Frequent. Lots of shell debris on sediment. O.texturata. Ascidians on small stones - ?Botrylloides leachii. S. canicula Occasional. 21 m depth, Atelecyclus rotundatus Rare to Occasional. Cerianthus lloydi, Alcyonidium gelatinosum. 22 m depth, sediment and muddy shell gravel. No Goneplax burrows but sediment full of small finger-size shrimp (?Callianassa) holes, 10-20 per 10 cm^2*. Sediment definitely a gravel, well-stabilised; holes stand out very clearly. One dragonet, three S. canicula.

Conclusions. No Cepola seen, although a few possible Cepola burrows were noted. Large numbers of Goneplax burrows and probable Callianassa holes noted. Seabed type initially shell gravel, becoming progressively sandier.

*As written but doubtless incorrect.

Tow 3. R. Irving. 31.7.84. (Detailed records are not available for this tow.)

Tow 4. C.Lumb. 1.8.84.

Time: 11.21 BST.
Bearings: Three-quarter Wall 282°, Halfway Wall 286°, Quarterwall Cottages 220°. 27 m below sea level. Sediment muddy shell gravel with occasional small pebbles. Occasional scallops. Several Mesacmaea mitchellii. Lots of small Atelecyclus rotundatus. Dogfish Frequent.

Time: 11.26 BST.
Bearings: Halfway Wall 291°, Quarterwall Cottages ?, Green Island 173°. Mesacmaea still present, 1/m^3. Liocarcinus depurator. Goneplax burrows, 1/10 m". Ophiura texturata ?Small crabs.

Time: 11.28 BST.
Bearings: Halfway Wall 289°, Quarterwall Cottages 228°, Green Island 178°. 29 m. Lot of dead scallop and oyster shells. [Now heading north.] Turritellids, dead or with Pagurus sp. Occasional to Frequent. Alcyonidium gelatinosum on Pecten valves. Cliona boring on rock fragments. [Now heading south.]

Time: 11.33 BST. Large surface area for attachment of encrusting organisms. One gurnard.

Time: 11.35 BST.
Bearings: Halfway Wall 301°, Quarterwall Cottages 233°, Green Island 175°. Several dogfish. Two Goneplax burrows. Cerianthus lloydi, Lanice, Asterias, Mesacmaea, Marthasterias all Occasional.

Time: 11.38 BST.
Bearings: Halfway Wall 307°, Halfway Wall Cottages 245°, Green Island 175°. 27 m.

Time: 11.41 BST. Left bottom, surfaced 11.43.
Bearings: Halfway Wall 310°, Quarterwall Cottages 248°, Green Island 175°.

Tow 5. K. Hiscock. 1.8.84

Dived: 11.45.
Time: 10.46. Bearings: Tibbett's Lookout 264°, 'Kaaksberg' 223°, Quarter Wall Cottages 213°. 33 m, muddy gravel with Ophiura texturata, Atelecyclus rotundatus, Asterias rubens (Occasional), Cliona on scallop shells. One Marthasterias glacialis. 33 m, mmore muddy. Muddy shell gravel. Goneplax rhomboides holes.

Time: 10.54. Bearings: Tibbett's Lookout 280°, 'Kaaksberg' 233°, Quarter Wall Cottages 217°. Paguridae Occasional, Scyliorhinus canalicula. Much of seabed fine mud with few shells. Quite large numbers of oyster shells and scallop shells here (in patches). Some Lanice.

Time: 10.59. Bearings: Tibbet's Lookout 287°, 'Kaaksberg' 2421°, Quarter Wall Cottages 222°.

Surfaced 11.02.

Time: 10.59. Bearings: Tibbet's Lookout 287°, 'Kaaksberg' 2421°, Quarter Wall Cottages 222°.

Surfaced 11.02.

Gannet's Bay swim. C. Lumb. 4.8.84

Dropped in just short of the north coast of Gannet's Bay and near the channel between Gannet's rock and the mainland, on boulder/sediment interface. Swam due south across the bay until encountered rock on the south side. Lots of Goneplax burrows, initially Frequent to Common, and Occasional Goneplax. Peachia Occasional. Cerianthus Frequent. Small shrimps (probably Crangon) Frequent. Mysidacea Common. Sagartiogeton undatus and Liocarcinus puber Occasional. Leopard-spotted goby Occasional on rocks on south side. Occasional flatfish, Callionymus sp. Fewer holes on south side of the bay and increased impoverishment of sediment. Run northeast was over increasingly sandy/coarser sediments with few holes and only Occasional Lanice present. No infaunal bivalves evident. Few anemones etc.

No sign of any Cepola, nor were any burrows seen and visibility was good, about 10 m.