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HOW TO COLLECT MARINE MOLLUSCA (INCLUDING SO-CALLED RARE SPECIES)

by

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I. INTRODUCTION

The finding, collecting and recording of marine Mollusca requires planning and practice in order to obtain best results. I have been asked to share the knowledge and experience I have acquired in this kind of research. It is hoped that this article will help those who are just beginning to take an interest in field work and provide some hints and new ideas for people who have been actively engaged in such work for years. The techniques described here are those which I have learnt from other people or have developed for myself. Some I have not yet tried. I am greatly indebted to David McKay with whom as a co-worker methods have been discussed and improved and augmented through field experience, and who has helped me to write this article.

My own reputation (much over-inflated!) for finding Mollusca is based upon records obtained not through good luck, good eyesight or specialist scientific training, of which in this context I have none, but by enthusiasm sufficient to make a pleasure out of an occupation which is both physically and mentally demanding; by planning, methodical working and attention to detail as described in this article; and that indefinable feel for an environment which is computed from rapid observation and assessment of many items of information and which can come to everybody through experience. Furthermore, homecoming, as will be seen below, is not the end of a successful expedition to the shore or upon the sea. Many hours have to be spent sorting the material collected and writing up records, not counting additional time curating and cataloguing specimens to a condition usdful for future reference.

This article is not a forum for discussion of the ethics of collecting live material. Clearly one should not leave behind a trail of destruction, but merely recording what one sees or thinks one sees, without collecting specimens for verification of identifications, or collecting samples of microhabitat in order to find the less obvious species, is bogus and to say the least scientifically inadequate. On the one hand, unverifiable and incomplete data is no basis upon which to rest a case for conservation or to provide records for any other purpose, on the other, the presenter of such 'records' is seriously hampering his or her growth as a naturalist by limiting identifying ability and awareness of what is to be found. But do not forget that equally one loses by merely collecting and not only observing, taking time to watch creatures in their environment and learning their relationship to one another. The dreadful habit of lazily allowing collected specimens to rot and then throwing them away is deplored. Either preserve specimens or look after them very carefully and subsequent to full examination return them to the spot from whence they came, in the hopes that they will live to fight another day.

A working knowledge of the whole fauna and flora is extremely useful. It enhances one's appreciation of the marine world and also leads one to the discovery of Mollusca which otherwise would be unnoticed. Barrett & Yonge (1958) and Campbell (1976) are helpful. Llewellyn-Jones (1972) provides basic information on the ecology of littoral Mollusca; and more advanced works on shore ecology include Eltringham (1971), Lewis (1964) and Yonge (1966).

Most surveys fall short over the identification of species listed. One cannot be expert in everything. In order to be useful one should be humble and in a report, however lowly and informal, say which reference books were used and/or if identifications were checked by an expert. Be honest, if in doubt identify only to genus or family, but give some information so that others can progress further, do not just ignore difficult species. If possible keep examples of all species found. Be aware of which groups are likely to cause most problems of identification and find out who is willing to help.

Nomenclature of Mollusca has been revised. Where names in this text differ from those used in the Concordance (Turk, 1973), the latter names are given in [ ] square brackets. Species mentioned here and not traceable in the Concordance are new segregates or new to the British list.

II. SHORE COLLECTING AND RECORDING - QUALITATIVE

This encompasses finding out the diversity, i.e. the number of species present and what species these are, as opposed to quantitative research (see below, III p.15) which assesses the numbers of animals and the population structure within individual species.

Work an area systematically, work a site systematically, onshore and if possible offshore also. Plan ahead, using whatever local knowledge, maps, charts, tide tables are available, to include all types of gross habitat there are, not excluding that muddy smelly harbour or long barren beach. It is important to record species conspicuous by their absence. Choose very exposed shores and totally sheltered corners, look for lagoons, rapids, wrecks, old piers, small sewerage outfalls, saltmarshes, all of which are likely to contain species not so often met with on more ordinary shores, which of course should be worked as well.

Forward planning should enable one to cover one very complex section of shore or two or more simpler ones up to half an hour's travelling time apart on the one tide. Places close together but with times of low water several hours apart, separated by a bottleneck or an isthmus, are ripe for attention on the one day. On a collecting trip covering several consecutive days and over unfamiliar ground use the time when the tide is too far in for shore work to look over the places planned for the morrow's visit. Sort out problems of accessibility such as difficult cliffs not obvious from the map. It should have been taken care of ahead, but if not check, and if it is necessary get permission to use private roads, cross private ground, park vehicles, etc. Get some ideas of which precise parts of the shore are likely to be the most rewarding and decide upon in which order they should be tackled. Visit harbours and talk to fishermen. Unless low water is very early in the morning (near dawn) or one must rely upon unco-operative public transport, plan to arrive on a shore at least two hours before low water. This gives one leeway should the tide be earlier than predicted, or if one has made a mistake. But all being well there is plenty of time to get a general impression of a shore and to collect dead shells from the strandline, and samples of shellsand to be sorted at home, not so much to bolster the list of species from a site, of dubious scientific value in the context of shore ecology (how far have they been transported?), but to obtain clues as to what may live in the area and to collect specimens for a dead shell reference collection. Note that this material should not be used for research where ecological data is important, but, correctly, identified, it is better than books for solving future problems of identification. It has limited use as voucher material. It supports a record of a dead shell only, not the record of the live animal seen nearby, even though clearly the same species.

a) Rocky Shores

1. General Ecology and Methods of Field Work.

The flora and fauna of rocky shores are ruled by the geology and degree of exposure to wave action which can change very suddenly and produce neighbouring but very different environments, adding to the infinite variety of the shore. Together they influence the quantity and quality of algal cover, which in turn affects everything else. Harder or softer rocks harbour different species. Granite shores, especially exposed ones, may at first glance be almost barren, and here small corners and differences in rock structure are all important in giving some shelter and providing a foothold. The boulders are generally worn smooth and are difficult to overturn uninhabited although the rock pools can be very interesting. Metamorphic rocks, gneiss and schist, can be very similar to granite, but the rock, having foliation (component minerals arranged in bands), is more irregular and lends itself to nooks and crannies and good turning-over stones. Conglomerates seldom support many species. Sandstone varies from very hard to quite soft, forms uninteresting shores where the rock is simply worn smooth and excellent ones where the rock is irregular. In the latter case there is often an admixture of rock types with shale and limestone also present. On its own shale, being so friable, is not very interesting, unless the fragments are large enough to shelter fauna, but mixed with harder rocks provides gullies etc. Limestone shores are usually very good because the lime itself provides calcium and attracts species requiring lime. The rock weathers into excellent crevices and produces large slabs which are good shelter and are easily overturned. Shores formed from lava and basic igneous rocks offer a variety of habitat depending on how hard and variable the rock is.

Algal cover is sparsest on exposed rocks, smooth rocks and very easily weathered rocks where it cannot take firm hold. On shores with uniform exposure and/or even slope, especially sheltered ones, the zonation of the algae with tide level is usually clearly marked. In others the zonation is poorly developed, species living on the shore in extraordinary juxtaposition or brought to different, usually higher, levels by unusual but obvious circumstances such as irregular rock conformation. Zoned shores are easier to work, but mixed shores are more rewarding and the tide height less important.

When recording rocky shore fauna the secret is not to overlook habitats, especially microhabitats. It is senseless just to turn over (and turn back!) boulders near the low water mark, as thereby one records a restricted range of microhabitat and gets a wrong impression of the shore. It is desirable to obtain the maximum amount of information in the minimum time and with minimum disturbance to the shore. The order in which one works the shore varies according to whether one follows the tide out or is chased in by it. Following the tide out is to be preferred. If one is working two shores on the one tide, of course on the second shore the reverse order applies. Time should not be wasted at the beginning of the day on particularly interesting habitats well up on the shore, such as rock pools, they can be earmarked for investigation after the tide has turned. Small pools are difficult to find again and should indeed be marked by leaving a piece of driftwood or an unusual stone on a nearby eminence. Do not waste time hunting for very small species, because they can be found very easily if small samples of the habitat are taken home for investigation at leisure, preferably each clearly marked and kept separately. All zones of the shore should be worked methodically. At the top, around and above the barnacle zone, crevices should be investigated with care for winkles (Littorina arcana, L. neritoides, L. saxatilis) and, if they contain silt, for species such as Cingula cingillus, Leucophytia bidentata and Otina ovata. Some silt should be taken home. Lichina (small, almost black densely-tufted alga) can be scraped off with a pocket knife. Very dry Lichina is usually empty but the dampier siltier roots contain an interesting fauna of juvenile winkles, Lasaea rubra and Turtonia minuta and perhaps Otina ovata. The barnacle zone contains large superficial Mollusca and smaller species and juveniles live in dead barnacle shells, particularly Littorina neglecta and L. neritoides. Portions of dead barnacle cover should be taken home for detailed investigation unless the weather is damp when the small species are out and about and can be obtained by stroking a hand over the barnacle surface.

At the bottom of the barnacle zone Littorina nigrolineata is likely to be one of the commonest species, except in sheltered areas. On exposed shores L. arcana or L. saxatilis is likely to dominate the barnacle zone and L. nigrolineata will be found below it in abundance.

The middle shore, from the commencement of the brown algae to the upper limit of Fucus serratus contains many microhabitats but the fauna may be restricted especially where the cover of Ascophyllum nodosum is dense. It is worth rummaging in and under it, both for the occasional nudibranch which, feeding on clumps of Clava multicornis has not gone out with the tide, and for species inhabiting the muddy underworld between boulders and in crevices. The greatest value of the middle shore is in the presence of rock pools (see below) and Mytilus edulis beds, which should be searched for species nestling amongst the byssus threads. It is easiest to take a sample of the mussel bed, especially the byssus and underneath parts, by cutting off the material with a large knife. Apart from nestling bivalves, the detritus-feeding Onoba semicostata and Odostomia rissoides (O. scalaris (predatory on small Mytilus) are likely to be present.

The lower shore, from the top of the F. serratus downwards, is generally regarded as being the most interesting and productive area, although this is not necessarily the case. There is a great variety in the algal cover. A shore densely blanketed with algae, especially Laminaria digitata will be very difficult to work because one is forever slipping, being tripped up or stepping unwittingly into holes. The weed is heavy to move away and the few species found seldom seem worth the effort. A lighter cover of algae, particularly F. serratus and the small species contain many more Mollusca. Some open rock and boulders suitable for overturning add to the variety of habitat and thus to the diversity of species. If the tide uncovers some F. serratus and there are rock pools, few species occurring above LWST will be inaccessible. A neap tide is, however, insufficient where there is dense cover of Ascophyllum nodosum and a spring tide exposing much Laminaria gives one longer on the shore.

2. Habitats.

Mollusc species occur on the lower shore in the following main habitats.

(i) Under boulders: those boulders with the largest surface area have the greatest number of inhabitants, but smooth rounded ones are seldom worth the effort of overturning them. Boulders embedded in fine sand or mud or silt are also frequently rather barren since conditions underneath are often anaerobic. The best boulders have a small gap underneath where water can circulate freely and there is room for epifauna to grow. The gap should also be under water or very damp, as boulders which dry out towards low tide time are less desirable roosts for mobile species although molluscs which can shut themselves tight to avoid desiccation (Acmaea spp, Pododesmus patelliformis, [Monia patelliformis), are quite common. One may indeed slightly re-arrange boulders so that they have wet gaps and hideyholes under and around them and thus encourage colonisation. Boulders with a good growth of small algae such as Corallina officinalis or Chondrus crispus on their upper surfaces or around their periphery often are richly colonised underneath. There may be 10 or more species of mollusc on one boulder. The sides should not be overlooked. All boulders should be turned to their original side up after use, but this is easier said than done and with the best of intentions sometimes the stone will not go back again. In suitable situations this can be avoided if in the first place it is not turned completely over, but propped up on end, supported if necessary by one's legs, from which position it can effortlessly be nudged back into place. The technique also causes less strain on the investigator but one has to be careful not to let the boulder lean over too far in case it topples and pins one down by the legs. Burrow among the loose stones under boulders.

(ii) Crevices and overhangs should be explored. Crevices do not present problems but overhangs may require some wet wriggling. Roof, walls and floor should all be looked at. Feel under ledges and around corners, but beware of dangerous animals such as lobsters, eels and urchins.

(iii) The tops of boulders and solid rock should not be overlooked. If encrusting Lithophyllum is present Acmaea virginea will be camouflaged upon it. In its absence Collisella tessulata (Acmaea testudinalis) is the more likely. Rock-borers should be expected in softer rocks, the siphons just protruding. Disturbance or vibration will cause them to retract. Hiatella arctica siphons are vermilion. Barnea and Zirfaea are white, well-mottled with brownish-grey. The presence of these may be betrayed both by partly weathered out holes, now deserted by their original occupants but inhabited by Venerupis senegalensis [V. pullastra] (one can obtain excellent growth series from smaller perfectly formed quite normal V. senegalensis to distorted V. saxatilis forms), Mya truncata and various species whose presence is more adventitious.

(iv) Algae are an enormously important habitat, both as food and shelter. Mollusca are to be found in five main categories of algal microhabitat. Many species are small and can be detected initially by gently running the fingers through algal fronds, some small specimens will stick to the hand - the more specimens the richer the algae. Fucus serratus fronds should be cut off at the holdfasts and put into a polythene bag with as little disturbance as possible and taken home for investigation. Fronds with Spirorbis usually contain pyramidellids feeding upon it. Fronds and clumps of small algae should also be removed as close to the rock substrate as possible and investigated later. Species which always should be selected include, as available, Cladophora, Corallina, Chondrus and Gigartina and others can be added if they seem interesting. Filamentous algae sometimes contains swarms of molluscs, chiefly rissoids and young bivalves. Fronds of large algae (Laminaria and Alaria) should be inspected visually and portions taken if promising. They are particularly rich if they support hydroids (see below). Codium and Himanthalia deserve special consideration. Rissoids and small bivalves do thrive on them, but they are also home to Sacoglossa particularly Elysia viridis and Placida dendritica [Hermaea dendritica]. These delicate species should be looked for carefully in the field, but they may also appear later on algae, left to settle in sea water at home. Laminaria holdfasts are a very popular subject of investigation but make a better basis for quantitative studies (see below). If other habitats are looked at properly no additional species will be found here, and for present purposes their use is much over-rated. Large old holdfasts which apparently do not contain too many juvenile Mytilus or a swarm of other single species can be removed at rock level with a large knife or chisel or kicked off and taken for examination at home, the frond trimmed away.

(v) Animal substrates to be investigated include: Clumps of Modiolus modiolus for interstitial species such as Kellia suborbicularis, Venerupis senegalensis and Hiatella arctica and superficial species such as Capulus ungaricus. A heavy growth of Pomatoceras attracts Odostomia unidentata and Onchidoris bilamellata fusca. Alcyonium digitatum is food for Tritonia spp and provides crevice shelter in its base. Sponges have superficial predators such as Lamellaria spp and dorids. Dead Halichondria panicea frequently contains colonies of Kellia suborbicularis and Putilla semistriata (Cingula semistriata), (both of which also inhabit dead shells stuck to the undersides of boulders). Hydroids are well known as host foods for nudibranchs, which may be most easily seen under water on hydroids on algal fronds and rock surfaces, also the undersides of upturned boulders if kept beneath the water. Hydroids may be gently scraped off, or portions of algal frond bearing hydroids removed, transported in a collecting pot containing sea water, and examined at home in a dish. Sipunculids alert one to the possible presence of Epilepton clarkiae, a commensal. Echinoderms especially holothurians should be examined for pyramidellids and eulimids.

(vi) Rock Pools: These, although found at all levels on the shore, are, technically, part of the sublittoral environment even though species living in the higher pools have to be able to withstand more extreme conditions than obtain in the true sublittoral. Pools are of two main types, the deep rather vertical-sided ones containing a strictly lower shore and sublittoral fauna and flora which are difficult to work unless one is prepared to swim (intentionally or otherwise) and if possible can be ignored in favour of the second type. These are shallow, rather flat-bottomed, in which much of the area is accessible by wading. The base is gravel or rock, and dotted with boulders which are easily overturned. These pools are to be worked for all the microhabitats they display, algae, boulders and crevices, not forgetting the sediment if it is thick enough. Pools on exposed coasts have a considerable flora of encrusting Lithophyllum which, particularly when old, can be broken away to reveal a crevice fauna and species requiring a more lime-rich environment than otherwise available on that shore.

(vii) More specialised habitats included in this section on rocky shores are Harbours: Old harbour walls have crumbling crevices. Old wooden piles contain an infauna and an epifauna. Teredinids can occur, and one can obtain a sizeable list of species from piles which have grown large barnacles to provide crevices. Piles recently removed during reconstruction work are an excellent source of material. It is a moot point whether species found only on removed piles after all the piles have been removed, should be recorded as alive (which is usually assumed to mean still living) in that locality, since their habitat is no more.
Very exposed cliffs: The little sheltered corners found here can contain a considerable number of species, some not found elsewhere. It goes without saying that such cliffs should only be investigated on days when there is little or no swell.

Tide-rips and rapids: These have an enhanced fauna due to the flow of water and are generally rich in hydroids and therefore nudibranchs. They can be difficult and dangerous to work, slack water may be the only possible time.
Waterfalls: These occur where a high level tidal inlet or lagoon empties over a sill as the tide goes out. Those in which the flow of water relaxes to a trickle at least in some channels are the more easily worked. Such sites contain a very rich fauna as the lower shore zones extend much higher up the shore than usual and are very accessible. The low water period is lengthened by several hours. The rapids conditions encourage diversity due to the flow of water, especially in those parts remaining wet. Hydroids and other encrusting organisms are usually abundant. Sublittoral species are to be expected.
Lagoons: These often occur above waterfalls and can very conveniently be worked in conjunction with them because the water in the lagoon falls to its lowest level very much later than in the sea outside. It continues to fall until the incoming tide has risen to sill level. Lagoons are effectively cut off from the sea for varying periods and they benefit from the calm conditions so caused, but suffer less than very sheltered but non-lagoon waters from lack of good water circulation and therefore enjoy a high level of diversity of species. The level of the sill combined with the amount of fresh water entering determines how brackish the lagoon will be. Salinity is not uniform, but exhibits interesting variation from one part of the lagoon to another, thus producing a variation in the fauna. Some lagoons have fresh water at the surface and salty water below. A lagoon is like a rock pool on a giant scale and, like it, is sublittoral.

b) Sediment Shores

1. General Ecology and Methods of Field Work.

The techniques for working sediment shores are different from those for rocky shores because the species found are often buried and have to be dug out. A beach is not homogeneous along its length or from hign to low water. All parts should be at least cursorily examined and with experience those places which are likely to be most prolific will be detected quickly. Most species live in wet places and from low water neaps downwards and are best detected at the surface just as the tide starts to rise. Usually a good spring tide is required for a sediment shore to be worked effectively, and if the sea is calm one's range can be extended considerably by wading.

Coarse gravel and pebble shores can be dug with a garden fork for bivalves such as Mya and Venerupis. Fine gravel and sand and mud can also be dug with a spade or trowel. In wet conditions the sediment may be turned over and left to drain back into the hole, revealing Mollusca left behind on the surface. Sieving is sometimes useful, for the qualitative purposes described here a 1 - 2 mm mesh is adequate. Dig where there is plenty of water to hand or the sediment is wet enough for a large puddle to be formed by digging. Not only will more species be found, it is less laborious. One can dig in shallow water to reach species not uncovered by the tide. Non-molluscan species such as Leptosynapta should be examined for commensals (Devonia perrieri), Echinocardium for species living adjacent (Tellimya, Montacuta and Gari). Meiofaunal species require special methods for extraction and samples of gravel can be taken home for this purpose.

Many species can be found alive without digging. Upper shore flats, especially if muddy and slightly brackish have Hydrobia ulvae and Retusa obtusa on the surface, which can be easily seen if one crawls on hands and knees should the sediment be firm enough to do so. Burrowing gastropods such as Lunatia [Natica] leave winding trails which are easily spotted and can be followed to the bump at the end, the animal. Bivalves such as Donax leave short straight trails. Mactra and Cerastoderma [Cardium] may jump out. Care should be taken to approach a sediment shore very gently without heavy footfalls so as not to scare the Mollusca into burrowing down, then they can be snatched by hand, which is less damaging to the Mollusca than digging, especially if the sediment is soft and loose. It is very hard on the fingernails but gloves make one fumble. Holes should be looked for, keyhole-shaped for Ensis, star-shaped for Echinocardium, round holes for many species. Mya and Lutraria syphons can be seen. Ensis and Dosinia spout into the air if disturbed and are then uncatchable without digging. The Ensis spout is nearly vertical, while that of Dosinia is at about 60°. Many species live only half burrowed into the sediment, Modiolus modiolus and Circomphalus casina [Venus casina] to name but two. Many species will be found just lying about on the surface. This may be their natural existence, or they may have been washed out.

2. Special Sediment Environments.

Saltmarsh: This is very specialised and contains few species but since some of them do not live elsewhere such an environment is always worthy of investigation. There is always time to do so as it is at the upper part of the shore. Limapontia depressa and Alderia modesta live partly burrowed into the substrate and are also to be found under damp mats of Vaucheria. Ovatella myosotis [Phytia myosotis] occurs with them and also amongst stones. Stiff mud, clay and peat: These may contain boring species such as Barnea which can be dug out with a large knife.
Harbours: The sediment in tidal harbours may not look inviting but it ranges in consistency from gravel to mud and may be somewhat brackish. One can obtain a variety of species from Cerastoderma edule [Cardium edule], Macoma balthica and Scrobicularia plana through to totally marine species and of shore species (brought in accidently by fishing boats) which can become established as viable colonies.
Lagoons: These have already been mentioned. Their sediment fauna is as interesting as their rocky shore fauna. Akera bullata lives at the surface of the sand and also swims daintily above it. Cerastoderma glaucum [Cardium glaucum] can be found.
Lithothamnion gravel: This is found intertidally only in West Scotland and Ireland. Live Lithothamnion is loose-packed and dark reddish-purple in colour and supports Acmaea spp and larger gastropods and bivalves. The dead gravel is yellow-white and more compacted and contains an enormous molluscan fauna of both small interstitial species and large burrowing bivalves which live in layers. Samples should be taken home for investigation.

III. SHORE COLLECTING AND RECORDING - QUANTITATIVE

This requires a more selective approach than that needed for qualitative work and general recording. At the planning stage one needs to make sure of the aims of the research, whether to take samples from different habitats within one area or to take samples from similar habitats from many sites. The number of samples should be decided upon, bearing in mind that meticulous sorting and counting is necessary and may well take a long time. If one site is worked in depth, it should be if possible investigated in advance qualitatively for flora and macrofauna, a transect line decided upon, spacing of sampling point chosen. Unless there are other considerations, the whole shore should be equally exposed to wave action from top to bottom, and reasonably well endowed with specimens at all points.

a) Rocky Shores

These are very difficult to work effectively. It is virtually impossible to make statistically valid quantitative surveys on rocky shores unless they are done in great number. A review of the literature shows that most of the good work done consists of population studies of particular species or groups of species. The most usual method used is that of the transect. A line is laid out from high water to low water and samples are either taken right along it or at, say, five places along its length, spaced out as evenly as possible with regard to tide level. (Source of statistical error, the points will not be evenly spaced). Plants and animals as required occupying 10 x 10cm or larger are collected, identified and counted. Most of them will be very small and hidden in crevices, overlooked or impossible to collect (error). The area chosen does not present x number of animals per unit area but per unit volume, as they are usually to be found roosting on top of each other. The space occupied is almost impossible to ascertain accurately because of bumps and crevices (error). Sampling of Mollusca supported on algae is easier and less prone to error. Algae should be collected in standard-sized polythene bags and filled to approximately the same capacity (error). The algae is investigated at home. The shore is far more varied than we can appreciate, and the samples so obtained should all be regarded as random samples. The differences due to sampling error will be modified by the unavoidable ones caused by variation in season, weather, etc.

b) Sediment Shores.

These shores, by being virtually planar and far less variable than rocky shores, are much easier to work and good results can be obtained (see Eltringham (1971), Holme & McIntyre (1971). The usual method is to work selected sites along a transect, several transects to a beach. Samples of sand or fine gravel are usually 10 x 10cm and 5 or 10cm deep, but if the animal population is rather sparse larger samples should be taken. The samples are sieved in situ through a 1mm or 0.5mm mesh. Coarser material can be worked, digging deeper.

c) Population Studies.

These are undertaken on chosen, generally common, animals. On rock shores one can take a quadrant samples, useful for attached species such as Mytilus edulis, but one has to take into account the so variable three-dimensional effect of an uneven underlying surface and the animals heaped on top of one another. A photograph can be taken of a standard marked area and the number of animals counted. On sediment shores standard samples are easy to obtain specimens. As an alternative, a standard number of specimens, 25 to 250 can be taken and analysed. Analysis takes the form of counting, measuring, weighing (wet and/or dry weight) or dissection to determine sex and breeding condition.

IV. DIVING

Diving for material or records is a specialised form of shore collecting rather than of offshore work, although the aim is to obtain species not normally found upon the shore. Many of the techniques already described can be adapted to under-water work. At present most divers fail to bring to the surface sufficient material to make a satisfactory scientific study of the dive site. Too many divers rely on being able to see the specimens which they intend to record or collect. This is most inadequate. They will miss many species. Diving reduces the time spent on site as well as one's vision, therefore samples of the substrate must be brought to the surface for examination. Boulders are much easier to overturn under-water. Samples of rocky habitats, algae, hydroids, encrusted stones and dead shells, particularly large still-articulated bivalves, are extremely interesting. If possible sediment samples should also be obtained, either with a scoop and bag or on the grand scale with a suction pump.

All diving groups know the best sort of conditions in which to dive, but less prolific sites (concomitant with criteria of safety and visibility) should also be investigated, on the same principle as on the shore.

V. OFFSHORE COLLECTING

Offshore collecting is often ignored by the casual mollusc recorder who regards it as expensive or difficult. It is not necessarily either. One can see catches brought in by fishermen, or cadge trips to sea on inshore fishing boats, so long as one does not get in the way, is happy to go where they are going, and if able, help them. The 'rubbish' brought up with scallop dredges contains many mollusc species. Take plenty of buckets or refuse bags to put things in and sort it out later. Some fishermen will collect this material for one if given suitable containers and no complicated instructions. One has to be opportunistic and not over fussy about where the material comes from. It may be difficult to find out precisely.

Assuming a suitable boat offshore work is not difficult. The most important detail frequently overlooked is the recording of the method by which the material was collected. Different methods collect different animals from the same ground. A grab bites into a small portion of sediment and will take animals burrowing to the depth of its bite, but covers a very small area and while extensively used for quantitative work is very hit or miss for recording purposes and it will not work on well-compacted sediments or rock. Scallop dredges and Agassiz trawls cover a large area of the sea floor and are good for gathering the large superficial species and retaining a considerable amount of finer debris. Fish trawls catch boulders which may be homes of many species and also retain interesting material in their foot-ropes. Pieces of weed, Flustra and star-fish are not all removed between hauls and so the specimens may not have come from where one thinks they have. The net is usually shaken out between hauls and an examination of the deck beneath is fruitful. Dredges scrape or dig into the bottom with varying degrees of efficiency according to their design. For qualitative work a Naturalist's dredge is an excellent all-round tool. Whatever the gear used, if it is possible try to sample the variety of substrate and depth the chart offers. Samples having been obtained, much data can be lost through careless initial sorting. Beware of help from seamen! No stones, dead shells, weed, etc. should be thrown back overboard in haste without examination inside and out. It should be remembered that some species of Mollusca pretend that they are uninteresting pieces of mud. Animals other than Mollusca should be checked for commensals and parasites. Echinoderms should be examined outside and inside for eulimids and pyramidellids. Gut contents of demersal fish (haddock, flatfish, etc.) should be examined. The fish will not have travelled far since they ingested any specimens which are still recognisable. Sampling for plankton is extremely easy, the difficulty lies in identifying the catch. Specimens can be trapped, using weighted baited pots or nets anchored at or near the bottom of the sea and left for about 24 hours. Lobster pots and similar devices catch a variety of gastropods. The crustaceans themselves should be examined for superficial Mollusca especially Pododesmus squamula (Heteranomia squamula). I have found Dendronotus frondosus well camouflaged on a crab.

VI. COLLECTING EQUIPMENT

a) Shore Collecting.

1. Clothing

One should ideally be equipped for all shores and all weathers, allowing for individual choice. Since collecting should not be restricted to a nice sunny Summer day, one should be adequately prepared for bad weather and to work in Winter. Footwear should be suitable for wading, therefore the choice is between thick-soled plimsolls and thigh waders. Wellingtons, for the serious shore researcher, are inadequate and false economy. Waders, except for those people with small feet, are not much more expensive than Wellingtons if purchased from industrial suppliers or ship chandlers. Trousers, apart from protecting the legs from cold, are useful as covering against injuries incurred in slithering over rocks and when resting boulders against the legs. In very hot weather shorts with big pockets are better than swimwear. Upper garments should be chosen to allow the arms to get wet above the elbow, not necessarily short-sleeved or rolled-up, but plunged into the sea, and a dry jersey to wear later is comforting on a cold day. Completely wind and waterproof trousers and outer jackets should be as heavy duty as possible commensurate with comfort, lightweight nylon will soon get torn. Jackets should be long enough to protect one when bending, but short enough not to get in the way. A waterproof outer layer, apart from protecting one from the elements, is very useful when sliding about on very weedy shores, crawling under overhangs and for sieving. Heavy duty clothing can be obtained from ship chandlers (rather than sports or boating shops) and the seams should be welded or sewn with rot-proof thread. Some people wear wet suits on the shore. Gloves are a matter of personal choice. Heavy duty ones protect the hands from cuts by barnacles or Pomatoceras and from abrasion by Spirorbis, but make one fumble. Try loose gloves which are easily slipped off when wet inside, or one gloved hand for the boulder and one bare hand for the specimens.

2. Tools

As will have been understood from the frequent exhortations to take material home for sorting, the first necessity is for something to carry it in. Brightly-coloured plastic buckets (easily visible if one inadvertently leaves them behind, or deliberately wishes to mark a place of interest) are very good, and cheap in supermarkets and DIY shops. Ideally two or three per person per shore are needed, therefore if more than one shore is to be covered on one tide at least 6 buckets are required. Samples of crevice material, algae, sediment etc. can be put into polythene bags, the stronger the better. Second-hand ones usually leak. More delicate material such as nudibranchs and hydroids and small shelled Mollusca need collecting pots (large Mollusca go into buckets). A plentiful supply of pots, in various sizes, should be taken on the shore. Use anything from mini jam pots to yoghurt jars to special containers. Plastic is better than glass and a firm lid is necessary. A large knife such as a diver's knife is useful for prising off limpets and holdfasts, portions of Mytilus or Modiolus beds, for opening shale, cutting algae, digging in sediment. One can use a chisel or jemmy. A pocket knife is invaluable, not only for cutting jobs but also for lifting delicate specimens. A knife slid gently underneath will lift the animal without damage, which is not always the case when forceps are used. A knife will extract material from crevices, remove limpets and chitons from rock. Some people use forceps or probes, but their use is restricted. A hand-lens is a matter of personal preference, a useful adjunct to poor eyesight but only really necessary on the shore if one desperately needs to identify something there and then. Because of the amount of equipment needed, it is not easy to mix rocky shore work and that on sediment shores, unless there are plenty of people to carry gear. For a sediment shore one ought to have a good spade and/or a garden fork, or a trowel, and a fine-mesh sieve. A large one is expensive but can be made for oneself if wire mesh is available, or purchased from builders' merchants (rather large and awkward but much cheaper than proper scientific ones). Also of course one needs buckets, polythene bags and collecting pots.

The amount of equipment carried depends on individual circumstances basically determined by how far one intends to walk, and a rucksack is useful. Large digging tools and sieves are the most difficult but fortunately can often be discarded in favour of a trowel or large knife. In some places one can leave the work to other people digging for bait or food and merely investigate their efforts. Cockles are obtained by a variety of gadgets from rakes to table-spoons, but this sort of equipment is not necessary. Similarly the variety of tools used for digging Ensis can often with advantage be discarded in favour of cunning and stealth. (I haven't tried salt!) For rock-boring species one may require a hammer and chisel or jemmy or even a pick-axe. If one has a vehicle, a large sorting tray (see below) or polythene refuse bags are needed as protection against spills of salt water. Fish boxes are better than cardboard boxes for keeping one's gear in.

b) Diving Equipment

This is a specialised subject rather separate from the topic of this article and therefore not discussed.

c) Offshore Collecting Equipment

Details of specialist gear and its use are in Holme & McIntyre (1971). The Naturalist's dredge is usually small enough not to produce an overwhelming amount of material to sort and it does least damage to the bottom of any gear dragged along. It is not very good at digging into certain compacted bottoms, but will act as a grab in soft mud and is robust enough to emerge successfully after a noisy encounter with rock. Suitably rigged it can be worked in very shallow water to over 50m from a dinghy and from a large boat to almost any depth. Jeffreys added hempen tangles to enmesh species on the outside of his dredge when working in very deep water during the 'Lightning' and 'Porcupine' expeditions. A dredge is easier to empty if it is not permanently closed at the back end but has a cod-end fastening. Plankton nets can be home made out of fine net, reinforcing fabric, stiff wire, rope and a jam jar or tin can. Traps, set from the shore or from small boats, can be made from a polythene container either with a funnel aperture or a hole in the lid large enough to let animals in but small enough not to encourage them to leave immediately. Bait it with rotten fish. Edward (Smiles, 1879) stuffed old pots and pails with long grass and old clothes and suspended it over a cliff below low water mark to catch small organisms. I have not tried this but hope to do so, using a net and substituting algae, hydroids etc. for the grass, weighting it with a stone, attaching a running line and anchoring it on the shore. It could also be buoyed offshore.

As for onshore work, offshore one requires a plentiful supply of buckets and bags to put material into for later sorting and examination. Large sweetie jars are useful. One also needs smaller pots for delicate species and special treasures seen while on board. Mending materials such as string and fresh netting to mend or replace dredge bags should be to hand.

d) Paperwork

Labels are the first essential. Good quality paper or card which will not disintegrate in water or when abraded is best. Data should be written in pencil in the field, for permanent labelling of stored specimens permanent ink should be used. Many inks, including Printers Inks, tend to dissolve in alcohol or formalin solutions, test first! In the field a hard-backed waterproof-covered notebook is needed to record station data, ecology and draft species lists. Precise locality can be noted by latitude and longitude UTM grid reference, Decca co-ordinates or National Grid. The foremost is the most useful especially if offshore work is envisaged.

VII. EXAMINATION OF MATERIAL AT HOME

The first criterion is for a place where wet and messy processes can take place. One also needs to be able to examine specimens in a good light, certainly with a hand-lens and if possible with a microscope. Live material appreciates being kept in a refrigerator or aquarium tank.

a) Weed washing

This is best done out of doors. Samples of algae should be left overnight in buckets of fresh water. Then the algal fronds should be shaken over a large sorting tray before being discarded. The residue in the bucket should be washed in its entirety into the sorting tray, pieces of weed and other debris removed by hand, and then the water and floating debris decanted off. Care should be taken not also to decant off floating Mollusca. The remaining material, a mixture of sand, algal fragments and animals should be removed and carefully examined. It may be preserved in 70% industrial methylated spirits for investigation at leisure. If it is sieved to remove the sand, the finer fraction should not be discarded before it is examined for very small species and juveniles. For quantitative analyses the specimens will have to be counted, their numbers estimated, or weighed as appropriate. Other samples can be left in dishes of sea water to see what crawls out. Nudibranchs can be found this way. They bloat horribly in fresh water.

b) Laminaria holdfasts

Laminaria holdfasts should be cut up into small pieces so as to remove all crevices and either soaked in fresh water as above or left in a sorting tray in sea water until the animals emerge. Specimens in fresh water can be extracted by the decanting method after most of the little bits of holdfasts have been removed by hand, those in sea water can be removed individually with forceps. They may be preserved and analysed as above. Holdfast sorting is a very laborious and time-consuming process.

c) Sediment Samples

1. Dry material

Shell sand is sorted more easily if it is sieved at approximately 5mm (through a kitchen colander) 2mm (household sieve) and 1mm (coffee sieve) and the fractions examined separately a little at a time. Unless the shells are in very fresh condition or from a special location difficult of access it is not worth spending much time on this.

2. Wet material

Offshore and shore examples are worked in the same way. First larger Mollusca, pebbles, dead shells, rubbish are removed by hand and the bulk of the sample sieved if this has not been done in the field, and the different fractions examined. Small samples and fine material are best looked at in shallow dishes under low power microscope if available. If the material is to be stored before examination addition of rose bengal is helpful to stain protein and show up what was live tissue (caution, it also stains periostracum, which may be on dead shells). Short-term storage is often 5% buffered formaldehyde but this is not suitable for Mollusca for more than a few weeks, 70% industrial methylated spirits is better.

3. Meiofauna

Special techniques are used to extract this. Mollusca are usually few and far between. Meiofauna clings tenaciously to sand grains and must be relaxed to be released. There are several methods, of which, for qualitative purposes a short soak in a very weak solution of industrial methylated spirits or in 7% solution of magnesium chloride, both in sea water, is easiest. The process should not be continued until the animals are dead - the tissues rapidly collapse - but the sample should be washed through a fine sieve (the animals are smaller than the sand grains) and revived in sea water.

d) Nudibranchs

These are easy to keep alive if not damaged and kept cool. In the long term the water should be changed every day or an aerator used, and food (hydroids, sponges etc.) offered. Spawn can be hatched successfully. When alive nudibranchs are not difficult to identify, but in case of difficulty make very detailed notes about all parts of the animal and its behaviour. Sketches and colour photographs are useful. Sending live specimens through the post for expert identification is no longer feasible.

VIII. HOME EQUIPMENT

a) Sorting and Analysing Specimens

One or more large sorting trays are useful. These are quite expensive but can be obtained from a variety of sources. Photographic dealers have a range of sizes of developing trays which are ideal. Small sorting trays (plastic cat-litter trays, plant pot drip trays and saucers) are also useful but these have alternatives in the form of normal household bowls, dishes and plates. Saucers, preferably plain, can be used as petrie dishes. Forceps of various grades can be easily if expensively obtained from medical suppliers. Tweezers are cheaper but not as easy to handle. A good hand-lens or a microscope is essential. A microscope opens up a whole new world and should be at the top of the list of desiderata.

b) Preserving Specimens

Chemicals for the relaxing and preservation of specimens are only necessary for keeping material prior to identification and for the preservation of voucher specimens. For the former, deep freezing will suffice. The importance of retaining specimens cannot be overstressed. If difficulties are encountered in the obtaining of chemicals it is usually possible to cadge some from the institution with which you intend to lodge the specimens. If possible the specimens should be relaxed prior to fixation and preservation. Many methods are described in Smaldon & Lee (1979), but one easy method which is very good for Prosobranchs especially Neogastropoda has not been mentioned. They can be chilled to torpor, overnight, in the coldest part of the refrigerator (not frozen stiff) and then deep-frozen, after a week thawed out, fixed and preserved. Methods of fixation and preservation depend upon what the future of the specimen is to be, and most are regarded as beyond the scope of this article. It is advisable to fix specimens in formalin * (usually about 10% i.e. 9:1 dilution) and after several days wash them and transfer them to 70% industrial methylated spirits. Large specimens require longer. Bivalves can be opened or some gastropods persuaded to emerge if they are boiled.

If one wishes to keep dry shells, fresh dead material found on the shore rather than material taken alive are very acceptable alternatives in reference collections of dry shells (but see p). Small shells cannot easily be emptied but should be fixed and dried intact. Live specimens can first be boiled and the soft parts removed. Forceps or an implement to spear the foot of gastropods is necessary. Shells should be thoroughly washed. They can then be dried. Some examples of bivalves can be closed with thread or elastic bands to hold them shut (the traditional method) but it is helpful to leave others open so that the insides of the shells are visible for future comparison. Gastropod opercula should be kept. Algae and most incrustations can be removed if desired by soaking the shells in a strong solution of household bleach for an hour or so, and any superfluous material picked away. The shells should then be very thoroughly rinsed in fresh water, dried and lightly rubbed with baby oil to bring out the colour. Shells with periostracum should not be bleached as the bleach destroys this. Shell lots should be kept separately and must be labelled with precise data on locality, date, ecology if they were taken alive, otherwise they are not worth keeping. Optional additional data includes name of collector,

* Formaldehyde and related chemicals are health hazards!

name of identifier, and least important of all, name of specimen. Unfortunately in many collections this is the only piece of information with the specimen, and it is on its own useless. The specimen can always be identified, other data cannot be obtained. The original identification may have been wrong and therefore is misleading.

c) Paperwork

Last, but not least, home paperwork, which takes two forms. The one, labelling of specimens, has already been covered. The other, preparation of data, is more complicated. As with specimen labelling, data should, so far as is practicable, at all times be kept in a form readily understandable by other people should one suddenly not be there to explain. Whatever the endpoint of the data, whether merely for one's personal enjoyment, as part of a recording scheme, or as the basis for publications, the bare bones should be reasonably organised. As soon as possible on return from the field detailed lists should be written up together with notes on other phyla, ecology and indeed the state of the weather. Lists of the results of sievings and weed washings, countings and weighings should be made out in a clear form and not left on grubby scraps of paper. A notebook, looseleaf or personal card index system is to be preferred to the B R C field cards which are totally inadequate and encourage one to be far too skimpy over recording of data. There is not space to enter all the basic essentials. Unless one uses many cards per station one cannot describe the habitat, tide level, degree of exposure, relationship to other plants and animals in a satisfactory manner. There is not room to enter numbers of animals seen (1000+) is a very common figure, even when reduced to per m^2) and so many common species are omitted that it is more sensible to write out the whole of one's list and have species in order. Order is important for quick comparison of one list with another. Whether one uses an alphabetical order (and gets in a muddle when names change) or an order of classification (not entirely static either) is personal choice.

IX. CONCLUSIONS

Collecting methods on such a variable terrain as the shore are difficult to quantify. The methods and ideas set out here are a counsel of perfection and may not all be apposite, but whatever one does, the main criteria of using some planned approach, paying attention to detail and being thorough from beginning to end, are very important. There is one "Technique" which has not so far been mentioned. It applies to all shores, and to all samples worked upon at home, and indeed to any natural history field work of a qualitative kind. This is the "Shopping List". There are two sorts of list which should be kept to the forefront of one's mind or even written down as a guide. Firstly, an idea of what species/groups one would expect to find and of those rarities one would hope to find. At the end of the time on the shore check against this "Shopping List" and make another effort to fill the gaps. Perhaps one won't find the listed species, but usually one does, and also is rewarded by finding something else as well. Secondly, have a list of the habitats and microhabitats to be investigated, again check them off in case some have been overlooked. This "Shopping List" is just as useful when diving, but is not applicable to offshore work since the bottom is normally invisible. It does apply to the investigation of the samples brought up.

All these methods have been described with British waters in mind, but they work for anywhere in the world, all one has to do is keep an eye open for the local variations in environment and to remember that similar shapes of Mollusca, not necessarily of the same genus or even the same family, by and large inhabit similar shapes of habitat.

X. ACKNOWLEDGEMENTS

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XII. BOOKS FOR IDENTIFICATION OF MOLLUSCA

Although there are many books available, not all of them are useful. A review of books is a separate subject out of place here, and so, allowing that some people will have favourite books and papers not on the list given below, I list here those books which in my experience are most often used and appear to lead to fewest mistakes in identification.

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XIII. APPENDIX

Examples of species lists. NB not necessarily all the species found at a station are given here. Lists are, unless stated, of material collected by the author.

Sullom Voe $60^{o}27.3'$N $01^{o}17.8'$W 24 April 1975

In 22m, van veen grab half full of muddy sand.

Lepidopleurus asellus	11	Astarte sulcata	2
Gibbula tumida	1	Abra nitida	4
Turritella communis	4	Chamelea gallina [Venus striatula]	1
Nucula nucleus	3	Clausinella fasciata [Venus]	1
Modiolus modiolus	2	Timoclea ovata [Venus]	8
Lucinoma borealis	3	Mya arenaria	1
Thyasira flexuosa	50+	Corbula gibba	1
Mysella bidentata	2	Thracia sp. (juv.)	1

Wyville-Thompson Ridge $59^{o}58'$N $07^{o}22'$W 6 November 1977

In 641 m, boulder clay, taken by rock dredge.

Lepidopleurus alveolus	20+	Limopsis aurita	6
Puncturella noachina	1	Limopsis minuta	50+
Laeocochlis granosa	1	Cyclopecten hoskynsi	2
Amphissa costulata	2	Chlamys sulcata	4
Troschelia berniciensis	1	Pododesmus squamula [Heteranomia]	3
Oenopota cf. violacea	1	Thyasira sp.	4
Antalis entalis [Dentalium]	2	Astarte sulcata	9
Portlandia cf. arctica	1	Timoclea ovata [Venus]	3
Bathyarca frielei	10+	Cuspidaria sp.	1
Bentharca nodulosa [Acar]	20+		

Lemreway, Loch Shell 58°01.0'N 06°26.0'W 5 May 1977

Sheltered shore, rocks and boulders (Lewisian Gneiss), muddy gravel. Much algae. Ascophyllum nodosum and Littorina littorea extensively harvested. Algae and boulders have fine film of muddy detritus.

a) On Fucus serratus

Acmaea testudinalis	1	Barleeia unifasciata	1
Margarites helicinus	1	Rissoella opalina	6
Gibbula cineraria	4	Skeneopsis planorbis	500+
Lacuna pallidula	1	Omalogyra atomus	20+
Littorina littorea	1	Buccinum undatum (juv.)	1
Littorina obtusata [L. littoralis]	100+	Hinia incrassata [Nassarius]	10+
Littorina mariae	20+	Odostomia rissoides [O. scalaris]	20+
Rissoa rufilabrum	5	Odostomia turrita	100+
Rissoa albella	3	Odostomia unidentata	2
Rissoa inconspicua	200+	Mytilus edulis (juv.)	20+
Rissoa interrupta	500+	Pododesmus squamula [Heteranomia]	1
Rissoa parva	100+	Turtonia minuta	10+
Alvinia punctura [Alvania]	2	Parvicardium sp. (juv.)	1
Onoba aculeus	50+		

b) On red algae at LWN

Rissoa albella	4	Skeneopsis planorbis	1
Rissoa inconspicua	100+	Omalogyra atomus	6
Rissoa interrupta	100+	Chrysallida indistincta	2
Rissoa parva	50+	Odostomia unidentata	2
Alvinia punctura [Alvania]	2	Musculus discors	1
Onoba aculeus	20+	Pododesmus squamula [Heteranomia]	1
Rissoella diaphana	8	Parvicardium sp. (juv.) [Cardium]	3
Rissoella globularis	10	Hiatella arctica	1
Rissoella opalina	13		

c) On Laminaria digitata holdfasts

Gibbula cineraria	1	Hinia incrassata [Nassarius]	5
Rissoa inconspicua	10+	Chrysallida indistincta	2
Rissoa parva	10+	Odostomia unidentata	2
Alvinia punctura [Alvania]	20+	Musculus discors	1
Onoba semicostata	50+	Pododesmus squamula [Heteranomia]	1
Skeneopsis planorbis	1	Parvicardium sp. (juv.)	3
Omalogyra atomus	2	Hiatella arctica	1

Ceann a Chlachain Bridge, Benbecula 57°24.0'N 07°16.0'W 2 May 1978

Shore sheltered from wave action but strong current.

a) Under boulders resting on shelly gravel, LWST

Lepidopleurus asellus	few	Goniodoris nodosa	c
Lepidochitona cinereus	common	Onchidoris bilamellata [O. fusca]	c
Tonicella rubra	2	Acanthodoris pilosa	3
Acanthochitona crinitus	1	Cadlina laevis	c
Margarites helicinus	c	Aeolidia papillosa	1
Gibbula cineraria	c	Arca tetragona	1
Calliostoma zizyphinum	c	Mytilus edulis	f
Lamellaria perspicua	1	Musculus discors	c
Trivia arctica	c	Modiolus modiolus	c
Trivia monacha	1	Pododesmus patelliformis [Monia]	c
Nucella lapillus	c	Pododesmus squamula [Heteranomia]	c
Ocenebra erinacea	c	Kellia suborbicularis	4
Buccinum undatum	c	Clausinella fasciata [Venus]	1
Hinia incrassata [Nassarius]	c	Hiatella arctica	c

b) Under one boulder in small waterfall (completely covered with sponges, hydroids and tunicates)

Lepidopleurus asellus	2	Mytilus edulis	c
Lepidochitona cinereus	c	Musculus discors	c
Margarites helicinus	c	Modiolus modiolus	c
Gibbula cineraria	c	Chlamys distorta	3
Calliostoma zizyphinum	3	Pododesmus patelliformis [Monia]	c
Trivia arctica	1	Pododesmus squamula [Heteranomia]	c
Nucella lapillus	c	Kellia suborbicularis	2
Hinia incrassata [Nassarius]	c	Hiatella arctica	c
Aeolidia papillosa	1		

Traigh Torr Mor, Arisaig   56°54.4'N 05°43.7'W   14 May 1979

Fairly sheltered beach with area of strong current just offshore.

a) Hard sand, LWST

Gibbula magus	few	Tellina squalida	f
Lunatia alderi [Natica]	f	Gari depressa	f
Buccinum undatum	f	Tapes decussata [Venerupis]	c
Hinia reticulata [Nassarius]	c	Paphia aurea [Venerupis]	c
Aequipecten opercularis [Chlamys]	1	Paphia rhomboides [Venerupis]	f
Lucinoma borealis	common	Venerupis senegalensis [V. pullastra]	c
Cerastoderma edule [Cardium]	c	Chamelea gallina [Venus striatula]	c
Spisula subtruncata	f		

b) Maerl gravel, LWST

Lepidopleurus asellus	common	Parvicardium scabrum	f
Callochiton achatinus	1	Ensis arcuatus	c
Lepidochitona cinereus	c	Lutraria angustior	f
Collisella tessulata [Acmaea testudinalis]	c	Circomphalus casina [Venus]	c
		Dosinia exoleta	c
Acmaea virginea	c	Dosinia lupinus	f
Gibbula cineraria	c	Tapes decussata [Venerupis decussatus]	c
Gibbula magus	c	Paphia aurea [Venerupis]	f
Littorina littorea	c	Paphia rhomboides [Venerupis]	c
Bittium reticulatum	c	Chamelea gallina [Venus striatula]	c
Hinia reticulata [Nassarius]	c	Clausinella fasciata [Venus]	f
Modiolus modiolus	c	Timoclea ovata [Venus]	1
Ostrea edulis	few	Mya truncata	c
Lasaea rubra	f	Hiatella arctica	c

Firth of Lorne   56°22.1'N 05°37.6'W   24 May 1979

In 50 m, rock with some shell gravel, no mud, taken by small dredge.

Emarginula fissura [E. reticulata]	2	Modiolarca tumida [Musculus marmoratus] (in ascidians)	2
Calliostoma zizyphinum	4		
Jujubinus clelandi [Clelandella]	1	Pseudamussium septemradiatum	1
Velutina plicatilis	1	Aequipecten opercularis [Chlamys]	2
Velutina velutina	1	Pododesmus patelliformis [Monia]	3
Buccinum undatum (juv.)	1	Myrtea spinifera	4
Hinia incrassata [Nassarius]	7	Astarte sulcata	50+
Teretia anceps [Philbertia teres]	1	Parvicardium ovale [Cardium]	1
Dendronotus frondosus	1	Gouldia minima [Gafrarium]	1
Antalis entalis [Dentalium]	1	Timoclea ovata [Venus]	10+
Nucula nucleus	1	Pandora pinna	1

Broad Sands, Dirleton $56^{o}03.8'N$ $02^{o}46.5'W$ 22 September 1976

Fairly gently sloping hard sand facing north-east but partly sheltered by offshore islands.

Lunatia alderi [Natica]	common
Cerastoderma edule [Cardium]	c
Mactra stultorum [M. corallina]	c
Spisula elliptica	1
Spisula solida	c
Spisula subtruncata	c
Lutraria lutraria (juv.)	c
Tellina fabula	c
Tellina tenuis	c
Donax vittatus	c
Gari fervensis	few
Venerupis senegalensis [V. pullastra]	c
Chamelea gallina [Venus striatula]	c
Thracia phaseolina	c
Thracia villosiuscula	f

Holy Island (Lindisfarne) $55^{o}41.5'N$ $01^{o}47.9'W$ 8 April 1978

General collection over whole of exposed rocky shore (limestone). Data from weed washings not included.

Lepidochitona cinereus	common
Tonicella rubra	2
Acanthochitona crinitus	few
Collisella tessulata [Acmaea testudinalis]	c
Acmaea virginea	c
Patella aspera	c
Patella vulgata	c
Helcion pellucidum [Patina]	c
Margarites helicinus	c
Gibbula cineraria	c
Lacuna pallidula	c
Lacuna vincta	c
Littorina littorea	c
Littorina obtusata [L. littoralis]	c
Littorina mariae	c
Littorina neglecta	c
Littorina saxatilis	c
Littorina neritoides	c
Rissoa parva agg.	c
Lamellaria latens	c
Lamellaria perspicua	f
Trivia arctica	f
Nucella lapillus	c
Buccinum undatum	f
Hinia incrassata [Nassarius]	c
Limapontia capitata	c
Goniodoris nodosa	c
Ancula cristata	c
Aegires punctilucens	c
Onchidoris bilamellata [O. fusca]	c
Onchidoris muricata	c
Acanthodoris pilosa	f
Cadlina laevis	c
Archidoris pseudoargus	f
Jorunna tomentosa	f
Dendronotus frondosus	f
Cuthona viridis	f
Coryphella gracilis	f
Coryphella verrucosa	f
Mytilus edulis	c
Musculus discors	c
Modiolus modiolus	c
Pododesmus patelliformis [Monia]	c
Pododesmus squamula [Heteranomia]	c
Kellia suborbicularis	c
Hiatella arctica	c
Zirfaea crispata	c

Belle Greve Bay, Guernsey $49^{o}28.4'N$ $02^{o}31.5'W$ 25 September 1980

Open but sheltered bay. On red algae.

Helcion pellucidum [Patina]	3juv
Gibbula cineraria	3
Gibbula pennanti	20+
Calliostoma zizyphinum	2juv
Jujubinus striatus [Cantharidus]	3juv
Tricolia pullus	3
Lacuna pallidula	30+
Lacuna parva	30+
Lacuna vincta	1
Littorina mariae	20+juv
Rissoa parva	100+
Onoba semicostata [Cingula]	5
Putilla pulcherimma [Cingula]	20+
Skeneopsis planorbis	10+
Omalogyra atomus	20+
Rissoella diaphana	5
Rissoella opalina	20+
Barleeia unifasciata	50+
Cingulopsis fulgida	50+
Bittium reticulatum	1juv
Odostomia rissoides [O. scalaris]	4juv
Goniodoris castanea	1
Aequipecten opercularis [Chlamys]	1juv

Herm   49°28.2'N 03°27.4'W   24 September 1980

Wide sheltered shore, sand, shell gravel and sandy pools, rocks.
List contributed by all members of Porcupine Expedition.

Lepidochitona cinereus	c	Mytilus edulis	f
Patella aspera	f	Aequipecten opercularis {Chlamys}	f
Patella vulgata	c	Pododesmus squamula {Heteranomia}	c
Helcion pellucidum {Patina}	c	Kellia suborbicularis	f
Monodonta lineata	c	Laevicardium crassum	c
Gibbula cineraria	c	Cerastoderma edule {Cardium}	c
Gibbula magus	f	Spisula solida	f
Gibbula pennanti	c	Spisula subtruncata	f
Gibbula umbilicalis	c	Lutraria angustior	c
Calliostoma zizyphinum	c	Ensis arcuatus	c
Littorina obtusata {L. littoralis}	c	Tellina donacina	f
Littorina mariae	c	Arcopagia crassa {Tellina}	f
Littorina nigrolineata	c	Gari depressa	f
Littorina saxatilis	c	Abra nitida	f
Rissoa parva	c	Venus verrucosa	f
Trivia arctica	f	Circomphalus casina {Venus}	f
Lunatia alderi {Natica}	f	Dosinia lupinus	f
Nucella lapillus	c	Clausinella fasciata {Venus}	f
Ocenebrina aciculata	f	Timoclea ovata {Venus}	f
Hinia incrassata {Nassarius}	c	Thracia villosiuscula	f
Hinia reticulata {Nassarius}	f	Hemisepiola aurantiaca	f
Glycymeris glycymeris	f		

Lihou, Guernsey   49°27.5'N 02°39.8'W   23 September 1980

Rock and gravel shore with pools, semi-exposed.
List contributed by all members of Porcupine Expedition.

Lepidochitona cinereus	c	Onoba semicostata {Cingula}	c
Acanthochitona crinitus agg.	f	Putilla pulcherrima {Cingula}	f
Haliotis tuberculata	f	Barleeia unifasciata	c
Diodora graeca {D. apertura}	f	Skeneopsis planorbis	c
Acmaea virginea	f	Omalogyra atomus	c
Patella aspera	c	Cingulopsis fulgida	c
Patella vulgata	c	Bittium reticulatum	f
Helcion pellucidum {Patina}	c	Cerithiopsis tubercularis	f
Monodonta lineata	c	Lamellaria perspicua	c
Gibbula cineraria	c	Trivia arctica	f
Gibbula pennanti	c	Nucella lapillus	c
Gibbula umbilicalis	c	Ocenebrina aciculata	c
Calliostoma zizyphinum	c	Odostomia unidentata	f
Tricolia pullus	c	Elysia viridis	f
Lacuna pallidula	c	Limapontia capitata	f
Lacuna parva	f	Limapontia senestra {Acteonia}	f
Lacuna vincta	f	Berthella plumula	f
Littorina neritoides	c	Nucula nucleus	f
Littorina mariae	c	Striarca lactea {Arca}	f
Littorina arcana	c	Mytilus edulis	f
Littorina neglecta	c	Aequipecten opercularis {Chlamys}	f
Littorina nigrolineata	f	Pododesmus squamula {Heteranomia}	c
Littorina saxatilis	f	Lasaea rubra	c
Manzonia crassa {Alvania}	f	Kellia suborbicularis	f
Rissoa parva	c		

<u>Havelet Bay, Guernsey</u> $49^{\circ}27.0'N$ $02^{\circ}31.4'W$ 22 September 1980

In 10-15 m, coarse shell gravel, taken by Naturalists' dredge (small).

Lepidopleurus asellus	c	Hinia incrassata [Nassarius]	c
Lepidopleurus cancellatus	f	Philbertia linearis	f
Emarginula conica	f	Goniodoris nodosa	f
Emarginula fissura [E. reticulata]	f	Nucula nucleus	c
Diodora graeca [D. apertura]	f	Palliolum tigerinum	c
Acmaea virginea	c	Aequipecten opercularis [Chlamys]	c
Jujubinus montagui [Cantharidus]	f	Pecten maximus (juv.)	f
Gibbula cineraria	c	Pododesmus squamula [Heteranomia]	c
Gibbula tumida	c	Lucinoma borealis	c
Gibbula magus	f	Parvicardium ovale [Cardium]	f
Calliostoma zizyphinum	f	Parvicardium scabrum [Cardium]	f
Tricolia pullus	c	Laevicardium crassum	c
Littorina saxatilis	f	Gari tellinella	f
Rissoa parva	c	Gouldia minima [Gafrarium]	f
Onoba semicostata [Cingula]	c	Paphia rhomboides [Venerupis]	f
Putilla semistriata [Cingula]	f	Clausinella fasciata [Venus]	c
Calyptraea chinensis	c	Timoclea ovata [Venus]	c

<u>Les Barbees, Jethou</u> $49^{\circ}26.8'N$ $02^{\circ}28.5'W$ 22 September 1980

On frond and stipe of <u>Laminaria hyperborea</u> brought up entangled in a crab pot.

Helcion pellucidum [Patina]	10+	Musculus discors	20+
Tricolia pullus	3	Modiolarca tumida [Musculus marmoratus]	9
Rissoa parva	3	Modiolus modiolus	3 juv.
Putilla semistriata [Cingula]	2	Aequipecten opercularis [Chlamys]	1 juv.
Laminaria latens	2	Pecten maximus	1 juv.
Chauvetia brunnea	1	Pododesmus squamula [Heteranomia]	1
Crenella prideauxi	2	Hiatella arctica	3

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