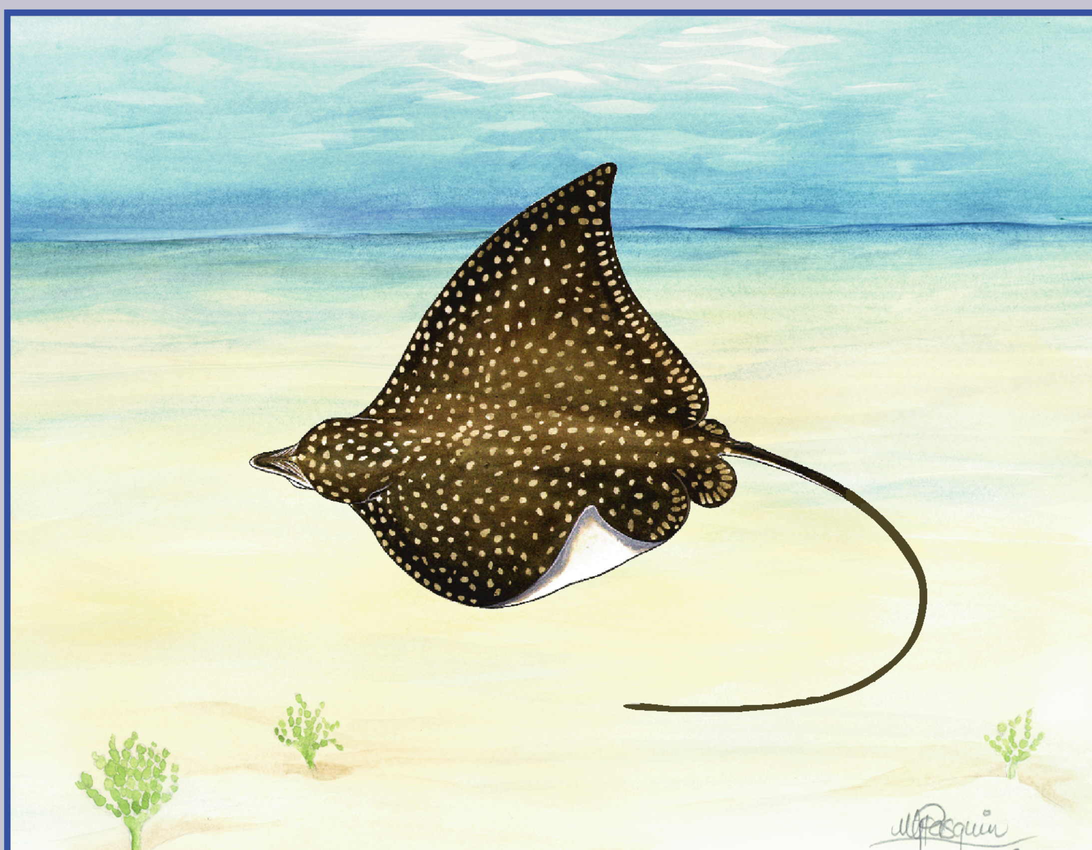
BERMUDA ZOOLOGICAL SOCIETY

presents

The Ecology of Harrington Sound, Bermuda

written by

Dr. Martin L. H. Thomas



Project Nature

Field Study Guides for Bermuda Habitats

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The Ecology of Harrington Sound, Bermuda

(Second Edition)

Project Nature

Field Study Guide

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The Ecology of Harrington Sound, Bermuda
Eighth in the series of Project Nature Guides
published by the Bermuda Zoological Society
in collaboration with the
Bermuda Aquarium, Museum & Zoo

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Foreword

Although Harrington Sound looks ordinary enough it may be one of the most fascinating and mysterious places in Bermuda and is thought by some to be unique in the world. Appearing on satellite photographs of Bermuda as an unprepossessing patch of dark blue, it is one of the deepest points on the surface of Bermuda's volcanic pedestal. Fondly but erroneously thought by many residents to be the possibly bottomless remains of the crater of Bermuda's volcano, its murky depths are instead the result of its surprising past as a fresh water marsh. In addition to its unusual origins, Harrington Sound contains many other mysteries, such as unexplored caves, an intriguing variety of flora and fauna and unusual marine habitats and features. For these reasons it was decided to devote a Project Nature field guide to elaborating on and exploring the wonders of this unusual marine environment in Bermuda, Harrington Sound.

All guides in the Project Nature series are designed to promote the exploration of Bermuda's marvelous variety of habitats, both on land and in the sea. The guides contain background information and diagrams, identification guides for common species and ideas for activities to do at different field trip sites. These guides are tremendous resources for teachers, parents, older students, and anyone else who simply enjoys learning about the natural world around them. Armed with "The Ecology of Harrington Sound, Bermuda" you will be prepared to begin your exploration of Harrington Sound, one of the most beautiful and interesting places in Bermuda. Enjoy!

Holly Holder
Education Officer
Bermuda Zoological Society
May 2003

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The help of the following people is gratefully acknowledged; without their encouragement and assistance this guide could not have been produced.

Jack Ward, Principal Curator of the Bermuda Aquarium, Museum and Zoo paved the way for its production and enthusiastically supported the work. Mary Winchell, the former Education Coordinator is largely responsible for all the previous publications in the Project Nature series, now comprising eight field guides. Holly Holder, the present Education Coordinator has taken over Mary Winchell's supportive role and this is the first field guide published under her leadership. Liz Nash took on the task of preparing this manuscript, including setting up the text, assembling all the illustrations of species, inserting them in the text and printing the end product. Her dedication to this task for the entire series of field guides has ensured that the final products would be easy to use, most attractive and as error free as possible.

Many people have assisted in the background field, library, proof-reading and museum work essential to a task such as this. Without their help and encouragement the guide would be much less complete and practical than it is. Grateful thanks are extended to: Anne Glasspool, Lisa Greene, Bobbi Cartwright, Judie Clee, Mary Lou Harley, Tiana Harley-Thomas, Sarah Manuel, Jo-Anne Stevens, Alan Logan, Bill Mitchell, Richard Winchell, Wolfgang Sterrer, Margaret Emmott, and Penny Hill. Much of the background material for this field guide was taken from "Marine Ecology of Harrington Sound, Bermuda" by Martin L. H. Thomas, a report prepared for the Bermuda Aquarium, Natural History Museum and Zoo in 1993 and published in 2003 as a Scientific Report.

The series of illustrations depicting the development of Harrington Sound over the past 15,000 years was drawn by the author.

The sea bed and Spotted Eagle Ray on the cover were illustrated by Michelle Pasquin. The illustrations of the species of plants and animals important in the ecology of Harrington Sound, Bermuda, were adapted, with permission, from a variety of sources including, "Marine Fauna and Flora of Bermuda" edited by W. Sterrer, "Bermuda's Marine Life" by W. Sterrer, and "Bermuda's Seashore Plants and Seaweeds" by W. Sterrer and A. R. Cavaliere; others were prepared especially for this publication by the author.

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Introduction

The Project Nature field guide series has been produced to provide essential background material for school teachers to describe the characteristics of the major natural ecosystems of Bermuda, and to conduct field trips which give hands-on experience of these unique systems to their students. Because, in Bermuda, the historical geological background and the present geological conditions are of great importance in setting the biological scene, most of the field guides have presented considerable detail on geological topics. The biological material has been presented in two major categories. The first of these is the ecological characteristics of the **ecosystem** under discussion and the second consists of descriptions of all the common species of animals and plants that are present together with a picture of each. The ecology is vital to an understanding of the structure and functioning of an ecosystem. The descriptions and illustrations are equally necessary because they enable teachers and students to identify the animals and plants they are likely to find, and then link them to the ecological information. Each field guide is essentially a self-contained document but others in the series may be useful in giving additional information on surrounding areas. Up to now all but one of the field guides has concentrated on the major ecosystems of the land, shore and sea. For instance sandy shores, rocky shores, forests, wetlands, coral reefs, bays and seagrass beds have been featured. These are the main systems found in Bermuda that are readily accessible and which have good, safe field study sites within them. The one departure from this plan was devoted to the more general topic of oceanic island ecology. This field guide is another departure for the series in that it covers one geographical feature rather than an ecosystem.

Why have we taken this new approach? **Harrington Sound**, the subject of this guide, is a marine feature that has no comparable counterpart anywhere in the world. Its geological background, oceanography and biological structure and functioning are totally unique and very interesting. Additionally, it is a very large structure familiar to all Bermudians and seen by the majority of tourists. The Bermuda Aquarium, Natural History Museum and Zoo, Bermuda's foremost tourist attractions, are situated at Flatts Inlet on its shores. It provides important aesthetic and recreational opportunities and can teach us many scientific lessons. Additionally, although Harrington Sound is large it has a very delicate natural balance which can be easily upset by both natural events and human activity. This results in great variability from season to season and year to year, superimposed on a system of great **biodiversity**. As an example of this, there are at least 100 different species of marine sponges in the sound and yet the deep flat bottom areas support very little life! In the past Harrington Sound has supported a commercial fishery for mussels (Zebra Mussels, *Arca zebra*) and a recreational fishery for Calico Clams (*Macrocallista maculata*); however, both of these failed although sport fishing for various fin-fish continues. Additionally, Harrington Sound supports the main Bermudian populations of scallops which have great potential in aquaculture. As scientific knowledge of the Harrington Sound continues to build and its unique characteristics are more appreciated, more effort is being applied to its **conservation**. Many of its important species are protected and harmful fisheries have ceased; however, the shores of the sound are densely populated and pollution is inevitable. A very close watch and thorough understanding of the sound is essential to its well-being.

Sounds are quite large bodies of seawater that are surrounded by land to a varying degree. The term '**landlocked**' is usually applied to such situations although many have quite large connections to the sea. Bermuda has several sounds that are readily apparent if you look at a map or fly over the islands on a clear day.

The largest of the sounds is Great Sound in the Western half of Bermuda, within which lies Hamilton Harbour. Great Sound connects to North Lagoon and thence to the Atlantic Ocean by a large opening between the Dockyard to the West and Spanish Point to the east. Large ships can enter North Sound although the ship channels have to be maintained by dredging. Within the southern portion of Great Sound lies Little Sound, a smaller sound somewhat separated from the main sound by Morgan's

Point to the West and Burgess Point to the east. However, in the past this separation was less complete as the strip of land now connecting Morgan's point to the main island was a group of islands with channels between them. These were amalgamated to produce the U.S. Naval Air Station Annex during the second World War. The Annex ceased to be a U.S. base in 1992 and is currently being developed as a residential and recreational area.

The other three sounds found in Bermuda all lie in the eastern part of the island mass. The most easterly of these is St. George's Harbour which like Great Sound is accessible to large ships bound for the town of St. George; however, this situation too has changed under man's influence. The ship channel into St. George's Harbour through Town Cut was created by dredging and blasting and opened to traffic in 1917. Before that only comparatively shallow-draft vessels could enter the harbour. This channel too is maintained by dredging. This sound also connects to the sea off the eastern end of Bermuda by Stoke's Cut and St. George's Channel. In the southern part of St. George's Harbour lies Smith's Sound cut off from the sound proper by Smith's Island. Smith's Sound is quite small and is really a bay.

To the west of St. George's Harbour lies Castle Harbour another sound which connects to St. George's Harbour; through Ferry Reach in the north, to the south shore by Castle Roads and other inter-island passages and to North Lagoon by the passage between Ferry Point and Coney Island. Castle Harbour is not accessible to large vessels although a channel for small cruise ships bound for the Castle Harbour Hotel was opened in 1929. Although at the present time Castle Harbour is mainly cut off from Ferry Reach and St. George's Harbour by the land mass housing the airport, this was not always so. As in the case of the U.S. Naval Air Station Annex described above, a series of islands were joined together during World War II to create the airport. The material needed for this construction was largely dredged from Castle Harbour. Before that time numerous channels between islands allowed water exchange between Ferry Reach, St. George's Harbour and Castle Harbour. The Longbird Causeway opened in 1871 as a road connection between the main island and St. George's Island had previously served to partially isolate Castle Harbour from Ferry Reach and the northern passage to North Lagoon.

Man's activities have therefore served to materially change the situation in three of the four large Bermudian sounds. These activities have certainly changed the amount of water exchange between the sounds and the adjacent sea. In the case of Great Sound, the ships channel from North Lagoon has allowed freer exchange there but the U.S. Naval Air Station Annex structure has reduced exchange between Great and Little Sounds. However, this situation is slight compared to the changes in the Castle Harbour-St. George's Harbour complex. There, water exchange has been greatly reduced. In Castle Harbour, previous clear waters supporting significant coral reef growth, including the only fringing coral reef in Bermuda have been altered to murky conditions in which sediment stays suspended in the water to the detriment of the growth of larger corals (See Project Nature, Coral Reefs of Bermuda). These changes that reduce water exchange, lower what is termed the '**flushing rate**' of these water bodies. This is important in that any pollutants introduced into the water take longer to disperse. In general, reduced flushing is harmful to the general ecology and reduces biodiversity.

The fourth large sound, Harrington Sound is separated from Castle Harbour to its east by a rocky ridge of ancient limestone which includes the Walsingham Tract and other hilly areas which are important ecological areas supporting many rare and endangered terrestrial animals and plants. (See Field Guides to Forests and Wetlands.) Harrington Sound is by far the most landlocked of the large sounds, but unlike the other situations described above, this is a purely natural situation. Harrington Sound has only a small, shallow surface connection to North Lagoon through Flatts Inlet. At the narrowest point, under Flatts Bridge, this passage is very narrow and very fast currents are created as water enters and leaves the sound with the tides. In common with the other sounds, there is also sea water exchange between the sound and close-by marine waters through underground caves and fissures. This will be described in more detail below but even with this added water exchange, Harrington Sound is the least flushed of all the Bermuda sounds.

In terms of depth, none of the Bermudian sounds are deep bodies of water. Only Great Sound (Including Little Sound) and Harrington Sound have depths that exceed 20 m or 65 ft. In Great Sound these deeper areas are very limited in extent, whereas in Harrington Sound they make up a significant area of the bottom.

All of the sounds have a wide diversity of **habitats** within them. Habitats are ecological areas with specific physical and biological characteristics. All the sounds have both rocky and sedimentary shores although the former type is certainly predominant. Harrington Sound has only very small areas of sandy shore. Seagrass beds also can be found in all of the sounds on sandy and muddy bottoms. Shallower waters in all sounds tend to be sandy with occasional rocky outcrops and in deeper areas mud predominates. Reference to other field guides that cover these topics would provide wider general background material about their characteristics.

Harrington Sound is also interesting in that features within the sound have been given very interesting and colourful names. Where else could you find places like Devils Hole, My Lords Bay, Red Bay, Green Bay, Gill Licker Shoal, The Dumplings, Cockroach Island, Tern Rock, Shark Hole, Abbot's Cliff and Patton's Point all in one relatively small body of water.

One of the problems with Harrington Sound is that it is heavily populated around the shore and access is very limited. Even where parks exist the shoreline is precipitous and unsuitable for getting into the water. Fortunately the Bermuda Aquarium, Natural History Museum and Zoo are situated on the sound at Flatts and can be consulted on the availability of boats to take students into the sound. From a boat access to the areas where one can wade or snorkel is easy and the sound is rarely rough enough to stop boat travel. Additionally, travelling around the sound by boat shows up many of its unique features such as the shoreline cliffs, the islands and its general character.

The sandy shallow waters and seagrass beds of Harrington Sound are all sedimentary environments. The presence of sediment means that a community of burrowing organisms is likely to be present. Naturally these species can not be readily observed and one has to infer their presence by signs on the surface of the sediment. These may be hollows or mounds, a variety of burrow mouths, meandering lines of disturbed sediment, **casts** of faecal material or masses of eggs in a variety of shapes. To see well in sandy shoreline waters and over seagrass beds, it is a distinct advantage for field trip participants to be prepared to wade and wear a face mask for better visibility in the water. In most locations there is a further advantage to swimming face down, with a mask and snorkel, in the shallow water. This not only aids observations but prevents sediment getting stirred up into the water and reducing visibility. What you can see just wading around in shallow water is multiplied many times over by the use of a face mask and additionally, getting into the water and swimming, places the student in the aquatic environment of these habitats.

There is less readily available information on Harrington Sound than on more generally occurring natural systems found in Bermuda such as coral reefs or rocky shores, covered in previous Field Guides. Nevertheless, there are several books that give some information and can be used as general background resources for studies. One of the main ones of these is "Marine Fauna and Flora of Bermuda" edited by Dr. Wolfgang Sterrer, formerly director of BBSR and now Curator of the Natural History Museum at BAMZ. This large book describes and illustrates all but the very uncommon animals and plants found in Bermuda's marine waters. Dr. Sterrer has also produced two books which present the commoner marine animals and plants at a level suitable to the non-scientist. The first of these "Bermuda's Marine Life" describes common animals and plants of the sea and gives a wealth of interesting information about them. The second book in this series is "Bermuda's Seashore Plants and Seaweeds" co-written by Dr. Sterrer and Dr. R. Cavaliere, which covers the seaweeds and seashore plants in the same lighthearted, but informative manner. In the future, this series of highly useful books will turn to animals and plants of the land. The most recent book on Bermuda's fishes is by Smith-Vaniz, Collette & Luckhurst (1999). The basic ecology of marine communities was covered in the book "A Guide to the Ecology of Shoreline and Shallow Water Marine Communities of

Bermuda" by Drs. M. Thomas and A. Logan. Another more general book called "The Natural History of Bermuda" by Dr. M. Thomas has been written and is in the process of publication, it should appear fairly soon. Useful sources of information are detailed in the Bibliography at the end of this field guide.

In the general text, words in **bold** are defined in the glossary at the end. In the subsequent sections bolding is used for emphasis.

Scientific names, written in italics, are given for the first mention of any species in the text or section but not for subsequent mentions in the same section. Scientific names are included because they provide a reference to that exact species in other writings. Common names can change from place to place; indeed quite a few apply only in Bermuda. Additionally, scientific names, once you get used to them also give clues to family relationships of organisms and are often are quite descriptive of some feature. For example the scientific names *'arenaria'* or '*arenicola*' mean 'sand dwelling'; a burrowing sea cucumber *Holothuria arenicola*, is very common in sheltered bays. Another common inhabitant of the sheltered sandy habitat is the Cockworm, whose scientific name is *Arenicola cristata*. An example of a scientific name linked directly to Harrington Sound is that of one of the small fishes generally referred to as 'fry'. The Rush Fry whose scientific name is *Hypoatherina harringtonensis* (formerly *Allanetta h.*) is very common in the sound. It was originally found in Harrington Sound although it also occurs elsewhere.

Geological Background

The Origin of the Bermuda Islands

Ancient History

According to the most widely accepted theory, Bermuda had its origins on the Mid Atlantic Ridge of the Atlantic Ocean about 110 million years ago. This puts Bermuda in the sub-group of oceanic islands called **ridge islands**. The Mid Atlantic Ridge is a largely underwater geological feature running down the centre of the Atlantic Ocean. The Mid Atlantic Ridge is a site of intense geological activity because it lies at the junction between the European and American **tectonic plates**. There are two types of these junctions; at some the surface of the earth is enlarging as molten **magma** from within rises to the surface and solidifies. Such junctions are called spreading junctions. At the other type, one plate slides beneath the another, causing earthquakes and building mountain ranges. The West Coast of North America is an example of the second type. Sometimes islands are produced in this situation too; these are called **island arcs** because they often occur in arc shaped groups. Along the Mid Atlantic Ridge, molten magma from within the earth rises to the surface and hardens to form the plates. This is a continuous process and as a result the two plates move slowly apart at about 4 cm/yr. Because of this process, the Atlantic Ocean is steadily enlarging. Together with the spreading, come frequent small tremors, some earthquakes and the creation of a variety of volcanoes. One of these erupting 110 million years ago, later became the Bermuda islands. The volcano appeared just to the West of the ridge and produced a large sea mount which rose close-to or above the surface. This volcano, which has been called Mount Bermuda, then moved slowly away from the ridge, covering 1,200 km or 750 miles during 60-80 million years without further volcanic activity; it then went through a second phase of eruption. At this time Mount Bermuda was enlarged to form the Bermuda **Seamount**, consisting of three volcanic peaks, the Bermuda Pedestal, the Challenger Bank and the Plantagenet or Argus Bank. If Bermuda had arisen solely as a result of a volcanic eruption away from the Mid Atlantic Ridge, it would be a **hot spot island** rather than a ridge island. Some recent theories suggest that Bermuda is indeed a hot spot island and therefore not as old as originally thought. More research may sort out these conflicting ideas.

The group of peaks rises sharply about 4,000 m or 13,000 ft from the seabed but the Bermuda Pedestal is the only one currently above sea level. The Bermuda Seamount has moved a further 800 km or 500 miles away from the Mid Atlantic Ridge in the last 30 million years or so to lie where it is today. Luckily, volcanic activity is a thing of the past for the Bermuda Seamount as it now lies in a stable area of the earth's crust. However, occasional earthquakes still occur as weaknesses in the underlying rock give way under the stress of the spreading process. The last significant earthquake, centered 370 km southwest of Bermuda occurred on March 24, 1978 and measured 5.8 on the Richter scale!

At first the island which became Bermuda would have been a volcanic island and the rock would have been hard, black basalt resulting from the volcanic eruptions. A good model of very early Bermuda can be seen in the island of Surtsey lying off the south coast of Iceland. Iceland itself is on the Mid Atlantic Ridge and volcanic activity there is virtually constant. One large eruption in the recent past produced Surtsey, a new island consisting of dark volcanic rock. At first, as in the case of Bermuda, Surtsey had no life but as soon as the rock cooled, animals and plants started to colonise this new habitat. However, Surtsey is far to the north of Bermuda in cool waters and coral reefs will never develop there. In the case of Bermuda, the remains of the original volcanic island are now well below the island surface which consists of light coloured, alkaline limestone rocks and soils, very different from the original dark coloured and acidic basalt.

The Making of Modern Bermuda

The limestones of Bermuda have all been formed by biological activity in warm, well lighted, shallow sea water. The two main groups of organisms that have laid down this huge cap of limestone are **crustose calcareous algae** (often called **crustose coralline algae**) and **corals** which together form reefs. Crustose calcareous algae are sheet-like seaweeds, resembling pink rock, that deposit calcium carbonate (limestone) within their tissues so becoming rock hard. Just when limestones started to form in ancient Bermuda is unclear and depends on the temperature of the surrounding seawater. As explained later, Bermuda lies somewhat further north than where seawater warm enough to support **corals** generally can be found. Its warmer than usual waters, for its latitude, are the result of water from further south, transported here by the **Gulf Stream** a huge ocean current. However, it is likely that warm ocean currents have bathed the shores of Bermuda for millions of years and therefore the reefs would have been among the first ecosystems developed around Bermuda. They in turn have been important in the creation of many other terrestrial and shallow-water habitats. More details of this are given in the field guide "Oceanic Island Ecology of Bermuda."

One very important process in the creation of a modern Bermuda was the formation of large areas of **sand dunes** on top of the limestone cap covering the volcanic seamount. Three features are very important in this regard; the first is the laying down of a mass of limestone by organisms as explained above. Secondly large quantities of sand arose partly from erosion of the limestone and also from particles of calcium carbonate arising from fragments of limy seaweeds, and shell and skeletal material from a wide variety of animals. The third, and most important factor was the lowering of sea level that occurred during the most recent glacial period, when vast quantities of sea water were converted to the ice caps. The lower sea levels exposed both rock and sand to the air. The rock surface eroded to sand which added to that already present. Once dried the sand was blown about by the winds producing sand dunes. Over long periods of time, under the influence of slightly acidic rain, the dunes were re-converted to rock, a process known as **lithification**. This rock was called **aeolianite**, and the vast majority of the rock now found in Bermuda is of this type. Aeolian is a word that means wind-created.

The Formation of Harrington Sound

To look at the origin of Harrington sound we must go back about 15,000 years. At this time the Bermuda land mass was much larger than at present because sea level was greatly reduced as a result of the water tied up in the ice caps to the north and south. The islands at this time extended from North Rock or beyond to the north, and to just beyond the present south shore as well as to the east and west of the present land mass. The land was not a level plain but rather a large tract of sand dunes that were higher around the edge of the land mass particularly along the south shore. Within the land area the dunes were lower and among them were several large **depressions** as well as many small ones. These large depressions would over time form the sounds. Rainfall bringing somewhat acidic rain tended to run into all these depressions where it further deepened them due to erosion. However, water did not collect at first as the underlying aeolianite limestone was very porous. Fissures through which water percolated enlarged with time to produce caves which ran out to lower areas, some to the coast. The rain water also helped to reconvert the dunes to limestone as freshwater saturated with lime evaporated from between the grains leaving a limestone cement. At about 15,000 years ago it was probable that the location of Harrington Sound was a large depression among the dunes with a ridge of smaller dunes running in an east-west axis down the center of this depression. These dunes divided the depression into two areas which eventually became the north and south **basins** of Harrington Sound. The deeper areas to the north and south of the ridge had within them wet areas as well as caves and passages beneath the surface. Collapse of these structures further deepened the depressions. The probable nature of Harrington Sound 15,000 years ago is shown diagrammatically in **Figure 1.1** which shows a cross section along a north-south axis.

Although the details are not known, it can be assumed that the deeper depressions including those within the future Harrington Sound would have damp areas at the bottom which, even in the absence of standing water, would support a range of freshwater marsh species. As these plants grew and then died they started to leave behind dead remains which became **peat**. Peat was essential to the further development of the depressions as it slowly formed a layer relatively impermeable to fresh water. In other words, peat sealed the surface of the sand and aeolianite and allowed freshwater **ponds** and **marshes** to develop. Another important characteristic of peat is that it decays only very slowly and preserves within its structure recognisable remains of plants and animals of the ponds and marshes. By 11,000 years ago ponds and marshes were well developed in the Harrington Sound depression as shown by remains preserved in the peat still present below the mud in the two deep basins of the sound. At this time sea level had risen to about the same level as the bottom of the depressions and served to block any remaining freshwater drainage to the ocean. This situation is shown in **Figure 1.2.** Peaty soil above water level supported extensive swamp-forest dominated by Bermuda Palmetto (*Sabal bermudana*). At water level, the forests gave way to marshes characterised by grasses such as the Saw Grass (*Cladium jamaicense*) and various rushes and reeds (Details of freshwater marsh vegetation are given in Project Nature, Wetlands of Bermuda). These marshes in turn gave way to extensive ponds. Freshwater snail shells from the ponds are well preserved as fossils in the mud from the pond bottoms. With time the ponds filled with peat and mud and the whole basin bottom became very flat. This is reflected today in the very flat muddy bottoms of the two deep basins lying at about 20 m (65 ft) below present sea level.

About 8,000 years ago the climatic warming trend that was resulting in rising sea levels was temporarily reversed and sea levels fell again. This resulted in a return of the drainage from the depressions to the sea. But this time, the peat layer was well developed and the freshwater drained over its edges at the pond margins. Peat water is quite acid and it dissolved the limestone at the edges of the basins resulting in the formation of a **moat**-like depression there. This depression persists to this day as a discontinuous slightly deeper trough (24 m, 70 ft) around the very flat mud bottoms of the two basins. This situation is shown in **Figure 1.3**.

This lowering of sea level lasted only a thousand years or so and then the level rose steadily again as the climate warmed and the polar ice caps melted. As sea level rose higher than the bottoms of the basins, it flooded into the sound through the caves, cracks and fissures created earlier. At this point, there was a mixture of salt and fresh-water in the ponds and fresh-water organisms were replaced by those of **brackish** conditions. Brackish is a term that describes diluted sea water. This period is reflected in the sediments by the presence of the shells of brackish water snails and is shown diagrammatically in **Figure 1.4,** which depicts conditions at about 6,000 years ago. No doubt there were also brackish water plants such as Widgeon Grass (*Ruppia maritima*), but **biodiversity** would have been quite low in this changeover period from a fresh to a salt environment.

Sea level rose quite steadily for the next several thousand years and Harrington Sound and other sounds became sea water environments. By 3,000 years ago, this process was well underway and the situation was as shown in **Figure 1.5.** The sound was shallower than at present but fully saline and supported a diverse marine community which would have entered through caves and fissures. There is no reason to suppose that the fauna and flora would have been much different than it is today. However, large fish such as the Spotted Eagle Ray (*Aetobatis narinari*) which frequent shallow waters, would probably not have been present. At this time the other sounds were probably completely landlocked and ecologically very similar to Harrington Sound.

As sea level approached present conditions and stabilised, surface connections between the sounds and the sea were established in lower spots around the rims. In all but Harrington Sound, these formed large connections and tidal regimes similar to those of the coastal sea were established increasing flushing rates and allowing the free access of marine creatures. In the case of Harrington Sound the land around the rim was high enough that this did not happen and only one or two small connections developed. The present one through Flatts Inlet may once have been augmented by one through the present Major's Bay to Shelly Bay on the north shore. As a result Harrington Sound has only a very small tide and a low flushing rate. The present situation is summarised in **Figure 1.6**.

The Sediments of Harrington Sound

The **sediment** can tell us a great deal about the ecological conditions in Harrington Sound. Sediments are named according to their particle size. Gravels are coarse with large particles,

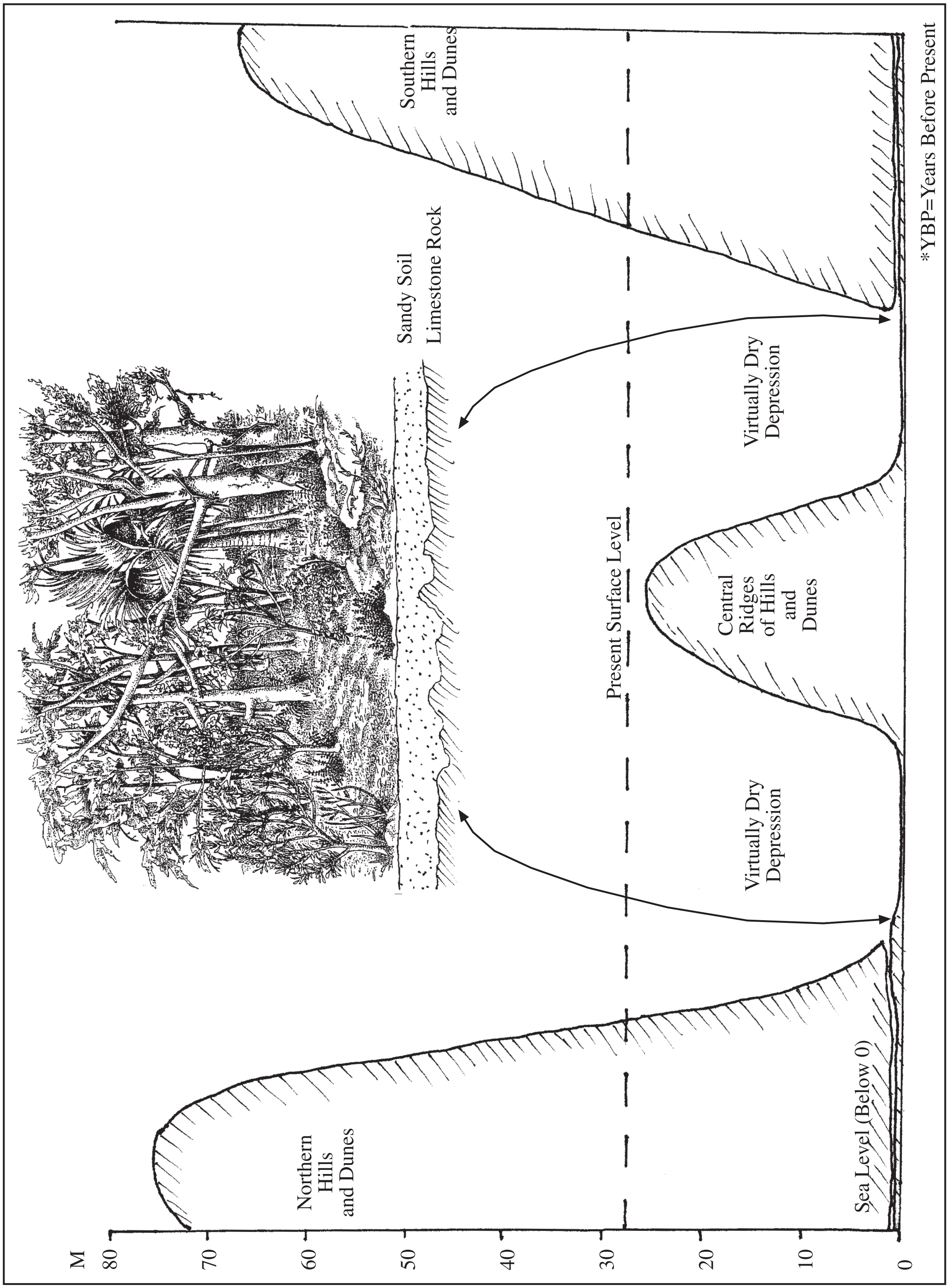


Figure 1-1 Harrington Sound Depression 15,000 YBP*

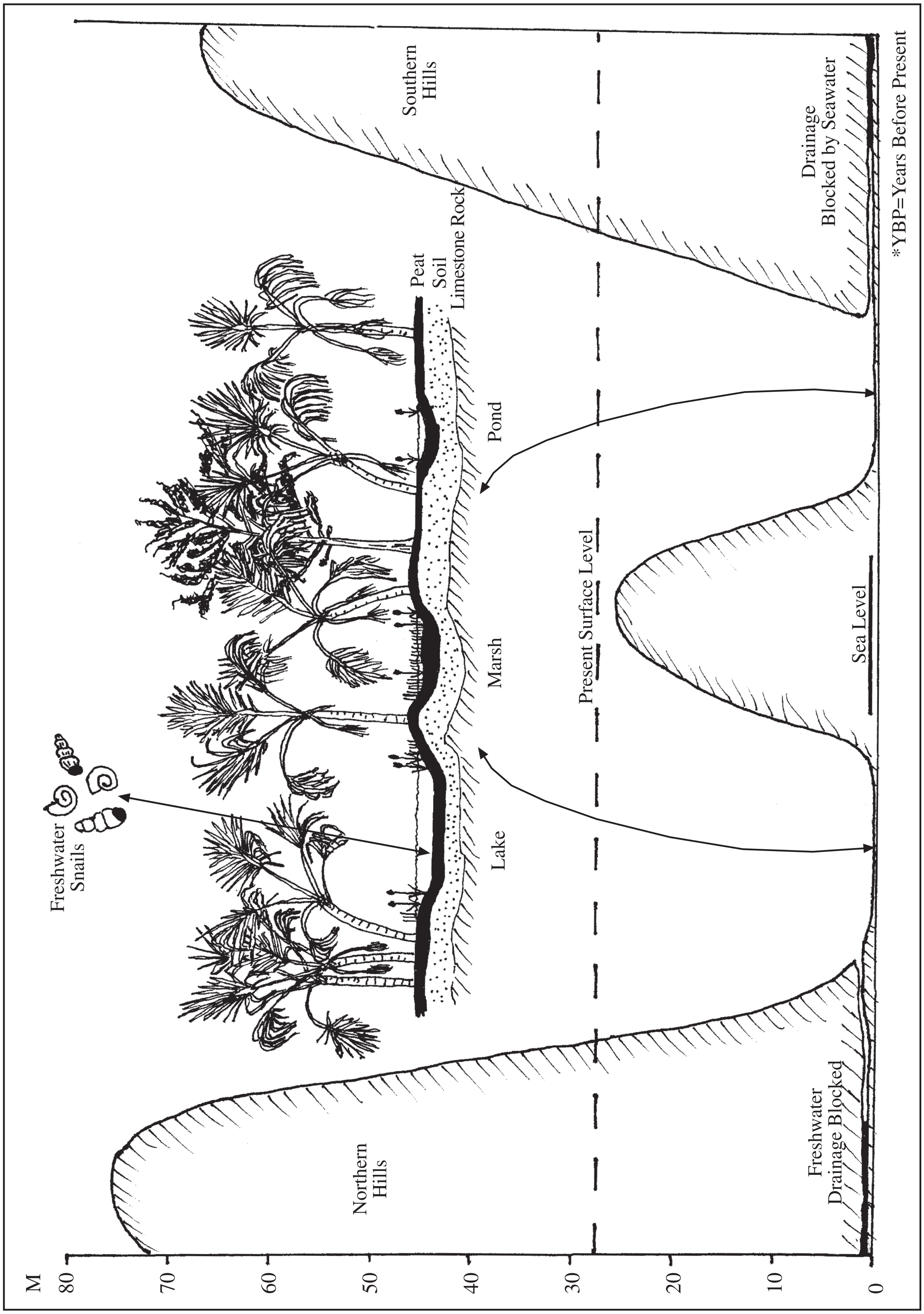


Figure 1-2 Harrington Sound Depression 11,000 YBP

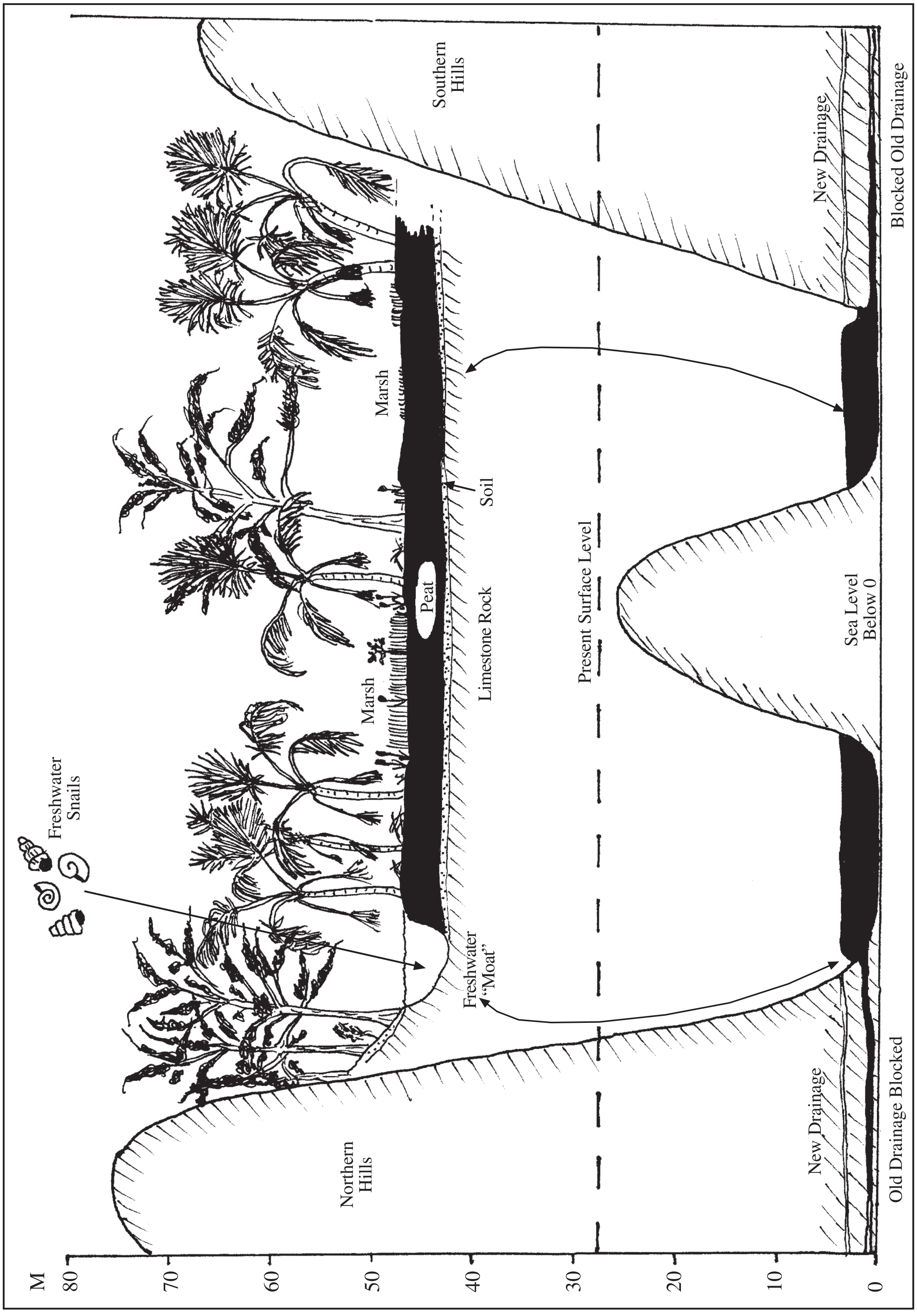


Figure 1-3 Harrington Sound Depression 8,000 YBP

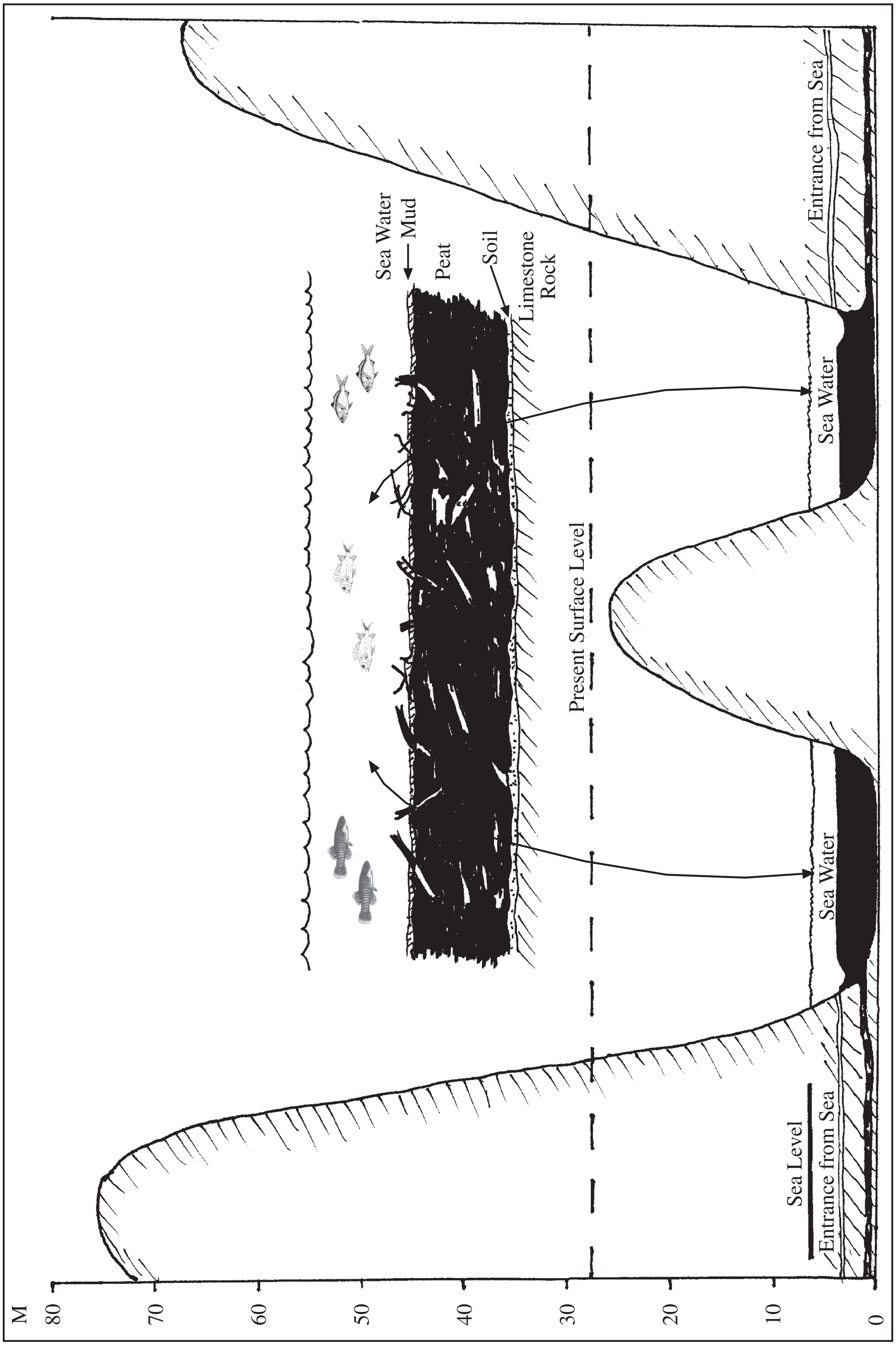


Figure 1-4 Harrington Sound Depression 6,000 YBP

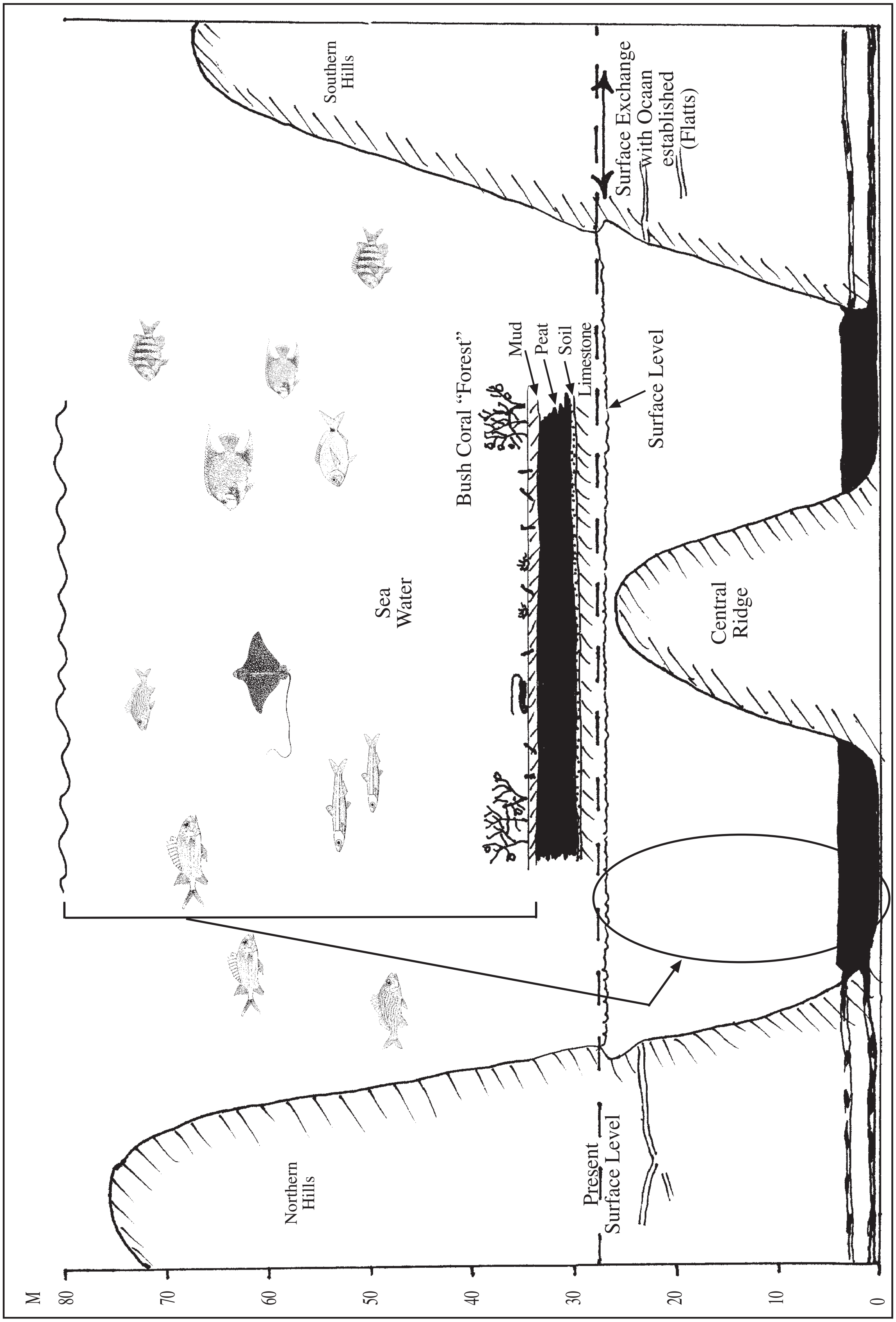


Figure 1-5 Harrington Sound Depression 3,000 YBP

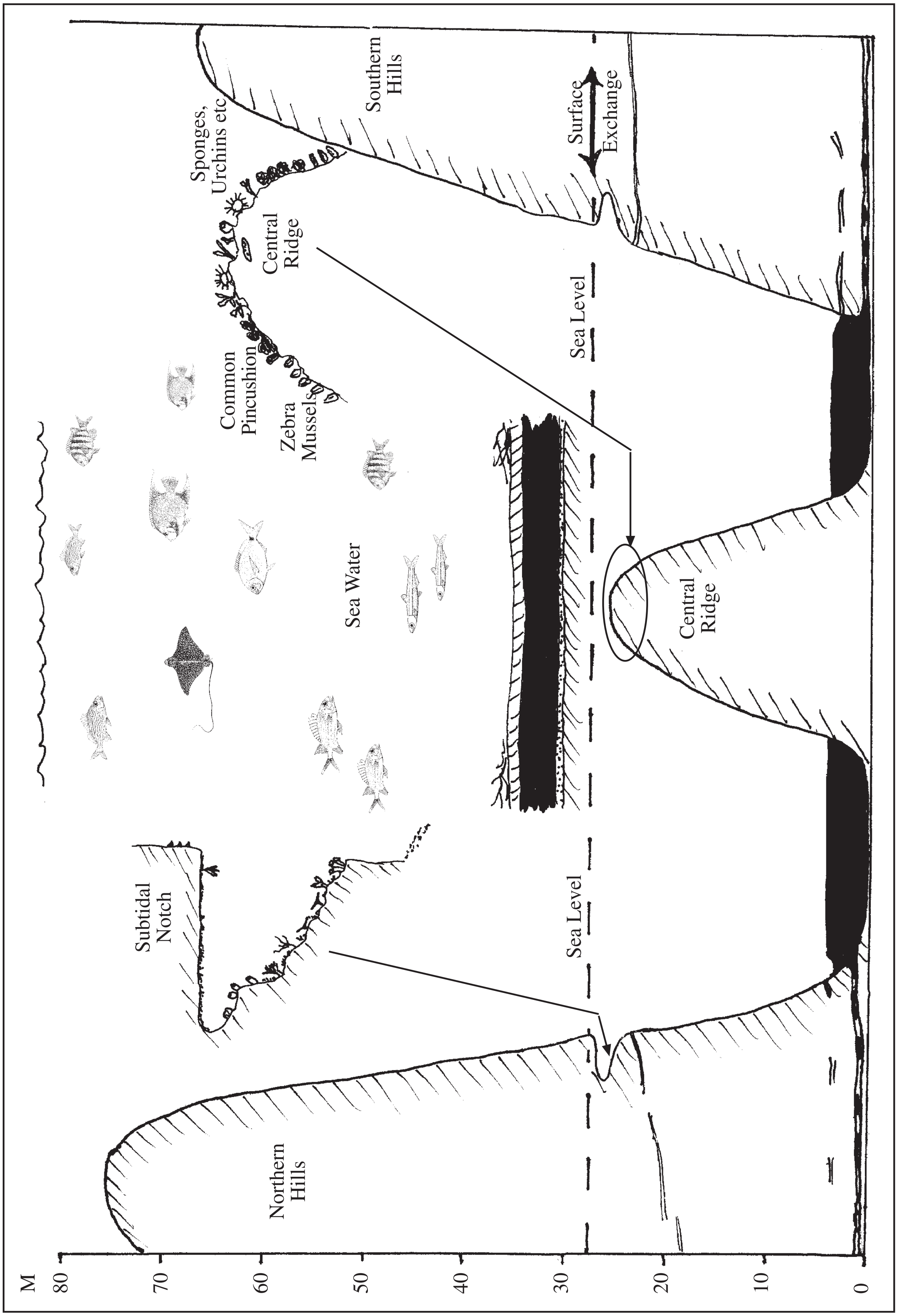


Figure 1-6 Harrington Sound Today

sands have medium sized particles or grains and silts or muds have fine particles. The particles themselves may have either a physical or biological origin. Sediment particles of physical origin are mostly the result of erosion of rock while those of biological origin are mostly parts of skeletal or protective structures of animals or plants. To return to the physical origin, the erosion may be the result of either physical forces or biological processes. The latter is termed **bio-erosion**. Bio-erosion is particularly important in Harrington Sound and it will be discussed below in relation to the ecology.

Once sediments are formed they can be transported by water currents. The coarser the sediment, the faster the current required to transport it. Consider the rocky coast. Waves breaking on the rocks can loosen large chunks or boulders which then grind together to give finer sediments. Boulders are too large and heavy to be transported by the water and just fall to the bottom close to their point of origin. Gravels on the other hand, may move a short distance in heavy waves but are suspended in the water for very short periods and quickly drop to the bottom. Sands in turn stay in suspension longer and move further. Muds and silts on the other hand stay in suspension in the water for long periods and can be transported to distant locations. Muds only settle to the bottom under quite still conditions.

An examination of sediments under a hand lens or microscope will reveal both the particle size and origin type of the sediment. Sediments derived from plant or animal parts are initially easy to identify and a chart for doing so is available in Project Nature, Sheltered Bays and Seagrass Beds. Examples of such particles are sea urchin spines and Plateweed (*Halimeda* species) segments. However, as time progresses these particles grind together, become smaller in size and eventually cannot be identified except by chemical tests. Sediments from erosion or bio-erosion are more difficult to trace back to their source. Mud particles all look the same regardless of where they come from.

In Harrington Sound the only locations where water currents are fast enough to remove all but the gravels are where the very vigourous currents sweep under Flatts Bridge. As soon as the current lessens, sands predominate and a large plume of sandy bottom extends from the bridge well out into the sound. This **tidal current** is important only relatively close to the bridge and for the rest of the sound the main water movements are the result of wind and the waves produced by winds. However, today the wash from power boats is also significant. These currents are all produced at the surface and do not affect water over a few metres (feet) deep. It is not surprising then that the particle size of sediments in the sound decreases as depth increases. There is a broad band of sandy sediment around the edge of the sound extending to a depth of roughly 10 m (33 ft), beyond that the bottom is basically muddy, being totally fine mud beyond a depth of 18 m (58 ft). Between the 10 m (33 ft) and 18 m (58 ft) points there is an interesting zone of bumpy mud. Here the mud is lying on top of a layer of coarser sediment of biological origin. This will be discussed later in relation to ecology, but we know that this underlying coarse sediment consists principally of the broken remains of the Ivory Bush Coral (*Oculina diffusa*) along with a considerable volume of Zebra Mussel (*Arca zebra*) shells. These remains are too coarse to be moved there by the weak water currents at that depth and indicate that previously there was a different biological community there.

The Hydrography of Harrington Sound

Hydrography is concerned with the characteristics and movement of water. When applied to the open sea it is called **oceanography.** In Harrington Sound the hydrography is critical in both determining the characteristics of various habitats and in a consideration of the stability of the sound.

Water Exchange and Tides

The topics of water exchange and flushing have been introduced already in relation to the development of Harrington Sound. Harrington Sound is unique among the Bermudian sounds in having only a very narrow surface entrance into the sound. This entrance through Flatts Inlet and under Flatts Bridge develops fast currents as the tides rise and fall in North Lagoon causing water to enter and leave the sound. In the other sounds, there is enough water exchange during each tidal cycle that the **tidal range** (rise and fall) and time of the tide is the same as on the coast. In Harrington Sound this is not so. The range of the tide is reduced and the timing of high and low water are delayed. This is because insufficient water can flow in or out on a tide to raise or lower the level of the sound to those tidal levels on the coast. The tidal range outside Harrington Sound is about 75 cm (2.5 ft) whereas inside the sound it averages only 19 cm (7.5 in), additionally the times of high and low tides in the sound are about three hours later than those on the adjacent coast.

Despite the very small tidal range in the sound, the huge volume of water entering and leaving creates extremely fast currents under Flatts Bridge; these reach velocities of 4.6 knots (2.4 m/sec) (7.5 ft/sec). However, as the current enters the sound it slows rapidly and characteristic surface currents in the sound are very slow.

The volume of water entering and leaving the sound on each tide can be calculated from its area and the tidal range. If this volume is compared to that passing under Flatts Bridge the two figures do not match. This calculation has shown that only about half the water that enters the sound does so through the bridge! The other half enters through submerged caves and fissures or seeps out of the porous limestone surrounding the sound. When swimming around the edge of the sound one frequently encounters cold currents originating from water that has passed through underground passages. A large volume of water exchanges through Green Bay cave which is assumed to communicate to North Lagoon.

The Water Body

The whole water body in an area is usually referred to as the **water mass**. Each water mass has a characteristic **temperature range** and **salinity** and may show various types of layering or **stratification**. The surface waters of Harrington Sound range from about 30^{O}C (86^{O}F) in summer to 16^{O}C (61^{O}F) in winter and the salinity is the same as coastal waters around the island at 36 parts per thousand (3.6% of sea salts by weight). While these characteristics are not remarkable, the water stratification within the sound is. To understand this situation we must look at physical changes in sea water as it heats and cools with the seasons. In winter the cool water formed at the surface is denser than that under it and therefore sinks to the bottom. This combined with winter storms ensures that the whole water body mixes at this season so that it is virtually the same from top to bottom. In early summer as warmer weather arrives and the days get longer, the surface water heats up quite rapidly and the density of the surface water falls as it expands. Consequently, the warmer, lighter, surface water does not sink but remains on the surface and lighter summer winds do not mix it to any great depth. This results in a very pronounced layering of the water in the sound in late summer. Although details vary from year to year the normal situation sees a warm layer of water about 18 m deep (60 ft) overlying cold water in the deeper parts of the sound. The junction between these two layers is called the **thermocline**. There is a big density difference between the water above and below the thermocline and this prevents mixing between the deep and shallow waters. This would not be a serious situation in ecological terms were it not that the oxygen produced only close to the surface is needed for respiration by animals at all depths. Animal populations isolated below the thermocline continue to use the oxygen dissolved in the water but it is not replenished. As a result the deep waters of the sound see a decreasing oxygen supply as soon as the thermocline is established each year. As time wears on the oxygen levels may fall to zero and a condition known as **anoxia** sets in. Most animals cannot stand anoxic conditions for more than a very short time and they die. While anoxia does not occur in the deep water every year, it is a fairly regular occurrence that results in mass mortalities of deep water animals that cannot move to shallower depths. This is the reason for the low bio-diversity on the bottoms of the deep basins in the sound.

The isolated water below the thermocline may also develop unusual chemical conditions harmful to life. This usually presents no problems since the oxygen lack has limited life down there; however, very severe storms in early winter may result in some of this water being brought to the surface resulting in fish kills. This is certainly one of the main aspects of unstable conditions in the sound.

The Ecology of Harrington Sound

Introduction and Ecological History

Harrington Sound is an enigma in that it is one of the most studied areas of Bermuda and yet the least known. It has attracted a lot of attention because it is unique in the world, has had obvious ecological problems and is important in Bermuda, but poorly known because up until recent times most of the published accounts have been in German or in unpublished reports or obscure scientific journals. Recently this material has been brought together and is available as a scientific report of the Bermuda Aquarium, Natural History Museum and Zoo.

There are several ecological events that have pushed Harrington Sound into the limelight. Probably the most important of these was the **population explosion** of a green seaweed the Common Pincushion (*Cladophora prolifera*) in the 1970s. This is an example where the scientific name has true meaning because this seaweed can certainly proliferate under the right conditions. The Common Pincushion is not attached as most seaweeds are but occurs as fuzzy ball-shaped plants, about 10 cm (4 in) in diameter, lying freely on the bottom in shallow water. Prior to the 1970s this alga was present but not common; in the 1970s it mysteriously started to reproduce rapidly in many bays and sounds of Bermuda forming what were called **algal mats**. At its peak, layers of this marine plant over 1 m (3.3 ft) thick were found. This produced profound ecological changes. The Common Pincushion, like other plants needs quite bright light to grow. Once a mat of this species reached 30 cm (1 ft) or so thick it had taken up all the light. Deeper layers of the mat in darkness died, and decayed. This decay used up all the available oxygen and the deeper parts of the mat became black and foul-smelling and anoxic. Everything in and below them suffocated and died. Thus this population explosion caused **mass mortalities** of the animals and plants of shallow bays. A few organisms such as the snail the Lettered Horn Shell (*Cerithium litteratum*), Violet Finger Sponge (*Haliclona molitba*) and the Fire Sponge (*Tedania ignis*) lived on the surface of the mat but the net effect of this occurrence was devastating. During the 1980s this species almost disappeared from shallow bays around the sound but underwater surveys have shown that it is still abundant on the central ridge of old dunes in the sound. Why did this species proliferate and then recede? Scientists have theorised that the cause was increased pollution; however, there was no real evidence for this and pollution has not declined in recent years while the Common Pincushion has.

Another example of a somewhat similar occurrence concerns the Calico Clam (*Macrocallista maculata*). This is a clam that lives buried in the sandy bottom that is prized as human food. It lives in shallow sandy locations. Somewhat prior to the explosion of the Common Pincushion, the Calico Clam had become very common and was gathered in large quantities by a sports fishery. As the algal mat increased in size and depth, huge numbers of these clams died. When the alga receded the clams showed no immediate signs of recovery and they were declared an endangered species. The fishery stopped. However, by 1993 large numbers of tiny Calico Clams were present and they are now common in sandy bottoms in the sound.

A final example of a population explosion is that of the Purple Sea Urchin (*Lytechinus variegatus*) which had a population explosion in the early 1900s and has now settled as a common inhabitant.

At the other extreme from population explosions are incidences of mass mortality. That of the animals smothered under algal mat has already been described. Another type of mass mortality is shown by occasional large fish kills. One of these took place during the last few years. The cause of these fish kills is often a mystery, but the possibility of the surfacing of deep toxic water has already been mentioned. Another possibility is that toxic **phytoplankton** bloom caused the mortalities.

To finish these historic events of ecological importance, the massive rock-falls from the cliffs into the sound must be included. Although these are widely regarded as merely physical events, they have a biological cause which will be discussed below.

Planktonic life in Harrington Sound

Plankton are small animals and plants that live up in the water. Some just drift but others can swim weakly; however, they can never swim strongly enough to go against any sort of current. In many cases their swimming abilities are to prevent sinking to the bottom. Plant plankton are called **phytoplankton** and animal plankton are termed **zooplankton**.

Many species of plankton have been identified from the waters of Harrington Sound but most are too small to be seen with the naked eye and all are difficult to capture. Only the most common will be mentioned. The commonest group among the phytoplankton in the sound are the **dinoflagellates**. Literally their name means "armoured flagellates" and a **flagellum** is a hair-like organ that beats in the water to drive the plant upward. Each organism consists of but a single cell which is usually sheathed in a coating of thin plates. At least 25 species of phytoplankton occur in Harrington Sound and they form the food for zooplankton, benthos and some small fish. In comparison to the open sea, the zooplankton of the sound are mostly very small species of protozoa and larval stages of other creatures.

Plankton are essential food for animals close to the bottom of the food chain. They are especially important to animals such as clams, scallops, sea squirts, sponges and some worms which filter plankton and other particles from sea water as their food. These filter feeders are especially abundant in Harrington Sound.

Life on and in the Sound Sediment

Harrington Sound is mainly a sedimentary environment and a huge number of seaweeds and animals live either on the sediment surface or burrowed into it. Only the common and important examples will be mentioned here but other examples are shown below in "The Variety of Life in Harrington Sound".

Burrowing Animals

The most accessible part of the bottom of the sound is the shallow sandy zone close to the shore. It has several different habitats all of which can be readily seen. The first of these is the sandy areas in which the most common animals are burrowers. There is a wide variety of burrowing animals and they fall into two general groups. First there are those that make a reasonably permanent burrow in which the burrow lining is strengthened or cemented in some way to prevent it collapsing. These animals tend to stay in one location for long periods, many for life. The second group consists of a group of creatures that wander through the sand leaving no burrows. An important group of semi-permanent burrowers are the clams, for example the Calico Clam (*Macrocallista maculata*). Those like the Calico Clam are quite active in that they can retreat down a deep vertical shaft when threatened or come up close to the surface to feed. They feed by drawing in water with plankton and other food particles and filtering this material out of their gills. Another group of clams typified by the Tellins such as the Sunrise Tellin (*Tellina radiata*), live fairly deeply buried all the time and have long tubular siphons which extend up to the surface of the sand where they get their food. One siphon sucks water and food in; the other gets rid of the water. Some of these burrowing clams, such as the Calico Clam, have siphon holes at the surface that can be seen by a snorkeller; others leave no visible marks. Other permanent burrowers such as some of the worms, for example the Cockworm (*Arenicola cristata*) have readily recognisable burrow structures at the surface. The Cockworm makes a U-shaped burrow with a low mound at the tail end and a depression at the head end. These result from the feeding behaviour which moves sand through the burrow to extract food from it. Even more striking are the burrows of the Burrowing Shrimp (*Callianassa branneri*). This rarely seen shrimp makes deep, branched, complex burrows with side chambers for food fermentation and storage. Waste sand is ejected at the far end of the burrow to form a large mound. Sand is often seen streaming from the peak of the mound, making it resemble a volcano. **Figure 2** is a sketch of an area of bottom in Harrington Sound dominated by semi-permanent burrowers.

The wandering burrowers are virtually impossible to detect as there is usually nothing at the surface to betray their presence. These animals are usually, but not always, **predators**, seeking

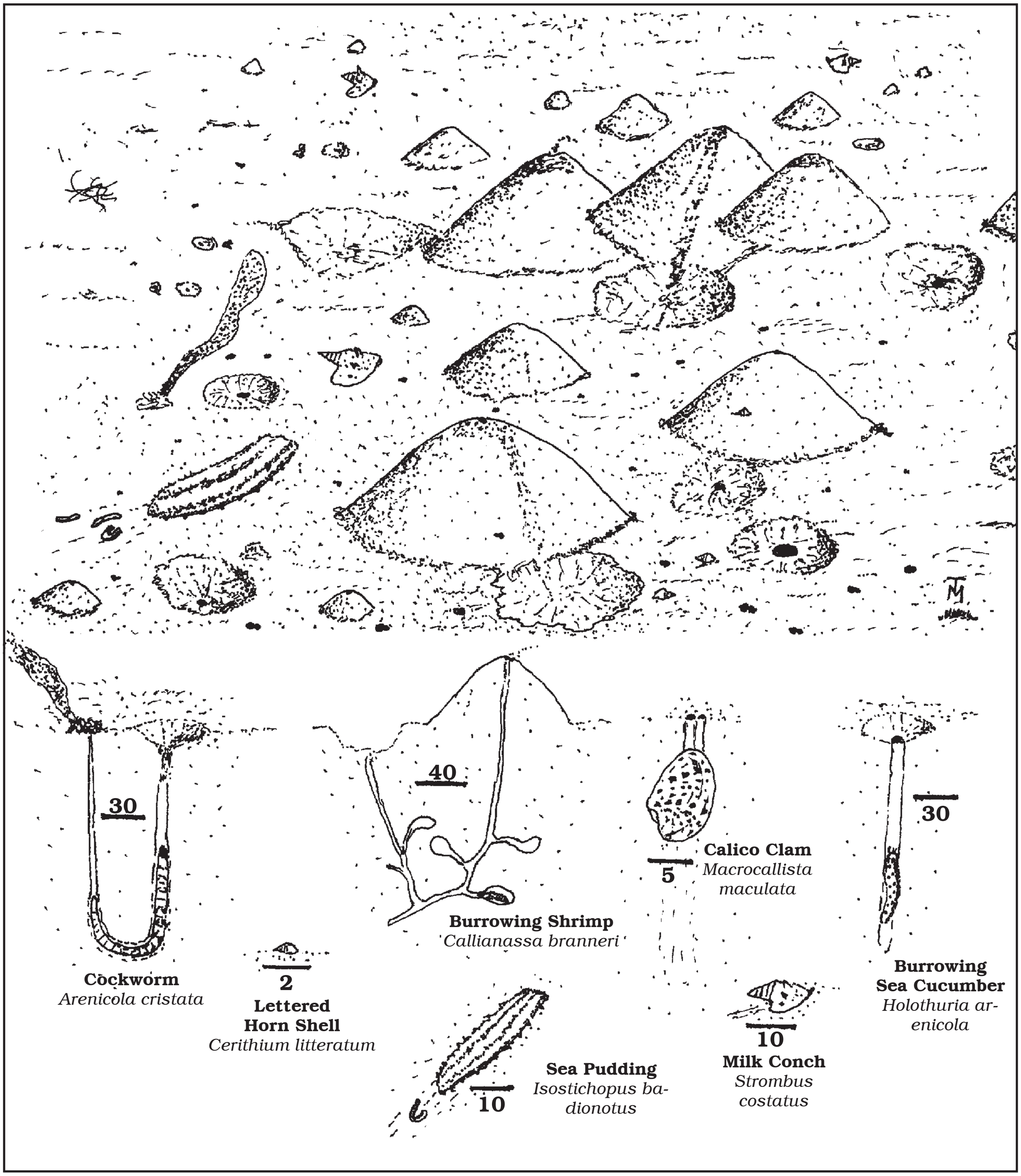


Figure 2. Top Sketch of the appearance of the sediment surface at a location dominated by semi-permanent burrow dwellers. Below Burrow structures and key to the organisms illustrated. Note: Scale differs between species. Bar and number 30 show scale in centimetres (10 cm = 4 in).

the permanent burrowers as their prey. The commonest of these in Harrington Sound is the Milky Moon Snail (*Polinices lacteus*) which preys on clams through which it can bore a hole to extract the body. Shells of this snail may be found on the surface as may its egg mass. This egg mass is called an egg collar and is brown in colour, collar shaped with overlapping ends. Several worms also have this mode of life but are not normally seen at all. Another interesting burrowing animal that you are most unlikely to see but which is common is the Heart Urchin *Moira atropos.* Only reaching 5 cm (2 in) in diameter, this light-brown urchin moves through the sand 10 cm (6 in) or so below the surface. It sorts food particles from the sand and leaves no trace of its presence at the surface.

Other shallow sandy areas show no mounds or other structures and house chiefly Calico Clams.

Sand Surface Crawlers

On the surface of the sand at both types of location there are usually both **sea cucumbers** and **sea urchins** both being quite common. The sea cucumber locally known as the Sea Pudding (*Isostichopus badionotus*) moves slowly along the surface eating huge quantities of sand from which it digests a meagre food supply. The Purple Sea Urchin (*Lytechinus variegatus*) also feeds as it moves slowly over the sand but it is more selective. It collects particles of dead organic material (detritus) and some small plants from the sand surface. Both the cucumber and the urchin can survive and grow where food is in very short supply. Another large creature that is quite common in some areas and that feeds similarly to the urchin is the Milk or Harbour Conch (*Strombus costatus*). The adult snail is large and heavy being up to at least 20 cm (8 in) long with a huge lip on the aperture. Like the Calico Clam this species is protected.

Anchored Green Seaweeds

Another common community of the shallow sand surface is characterised by the presence of stiff green seaweeds that appear to be rooted in the bottom. Algae or seaweeds have no true roots and these structures (**rhizoids**) are just anchors. Unlike flowering plant roots these organs cannot take up nutrients such as nitrates from the sediment. The commonest group of these plants are the Plateweeds with three species the most frequently seen being the Common Plateweed (*Halimeda incrassata*). Plateweeds form little bushes up to about 15 cm (6 in) high made up of dividing branches of small plates of distinctive shape. Each plate is firm and light green, flexibly connected at the top and bottom. The hard nature of these plates comes from the calcium carbonate (limestone) laid down in the tissues as a defense against grazing animals. As the plants age, the plates are freed and fall to the bottom where they make very characteristically-shaped particles. These plants are very important contributors to the sediment a process termed **biodeposition**. Other chalky seaweeds such as the Merman's Shaving Brush (*Penicillus capitatus*), the Hard Funnelweed (*Udotea cyathiformis*) and the Hard Fanweed (*Udotea flabellum*) share this habitat.

Seagrass Beds

The most sheltered shallow sandy areas in Harrington Sound, such as the bay on Trunk Island, show the development of seagrass beds. Seagrasses are flowering plants, with true roots. They have elongated leaves that grow in tufts from a stem just within the sediment. Unlike the seaweeds the seagrasses can extract needed nutrients from the sediment and have fast growth rates. The leaves are constantly renewed and the older ones break off and decay to form **detritus** an extremely important food for marine creatures, which is carried in currents far beyond the grass beds themselves. Another important ecological role of the seagrass beds is that they form a protective environment heavily used as a nursery ground by a variety of fishes and **invertebrates**. Additionally Green Turtles (*Chelonia mydas*) graze in seagrass beds. In Bermuda at least 30 species of fish use the grass beds as nursery grounds. These fish include the Bermuda Bream (*Diplodus bermudensis*), the Shad or Silver Jenny (*Eucinostomus gula*), the Bigeye Mojarra (*Eucinostomus havana*), the Mottled Mojarra (*Eucinostomus lefroyi*), three grunts, the Blue-striped, White and French (*Haemulon sciurus, aurolineatum* and *flavolineatum*), the Pinfish (*Lagodon rhomboides*), the Sand Diver (*Synodus intermedius*), the Spotted Goatfish (*Pseudupeneus maculatus*), the Slippery Dick (*Halochoeres bivittatus*), the Slender Filefish (*Monacanthus tuckeri*), as well as the Bucktooth

Parrotfish (*Sparisoma radians*) and the Bandtail Puffer (*Sphaeroides sprengleri*). The larvae of the Spiny Lobster (*Panulirus argus*) settle in seagrass beds to begin their crawling life. Another aspect of ecological importance is that the seagrass plants act as a substratum for the settlement of algae and sedentary invertebrates. These systems are very productive, quite stable and have high **biodiversity**.

There are three species of seagrass in Bermuda. The commonest one, that forms the largest beds is Turtle Grass (*Thallasia testudinum*), which has strap-like leaves up to 1 cm (3/8 in) wide and up to 65 cm (2 ft) long. However most beds have plants with leaves about 25 cm (10 in) in length. The leaves usually have a whitish tinge which results from a tiny, calcified green seaweed known as Scaleweed (*Fosliella farinosa*) which grows abundantly on the surface of the leaf. There are two other seagrasses, Manatee Grass (*Syringodium filiforme*) which has slender cylindrical leaves and Shoal Grass (*Halodule wrightii*), with elongated flat leaves only 2 mm (1/16 in) wide and 15 cm (6 in) long. These other species may form beds on their own or occur around or scattered within Turtle Grass beds.

Figure 3 is a drawing of a seagrass bed showing some of the characteristic species that may be seen there.

Deeper Waters

With increasing depth, the sediments increase in muddiness and the quantity of life on and in the bottom decreases. However there is an area stretching from about 10-18 m (33-60 ft) deep that is of particular interest. We know that at one time these depth ranges were typified by bushes of the Ivory Bush Coral (*Oculina diffusa*), forming a sort of underwater forest. Although the bottom was muddy, there was a wealth of dead coral remains sticking up through the mud on which new coral could settle. Growing on the coral branches were many Zebra Mussels (*Arca zebra*) as well as many slender sponges. Zebra Mussels were always considered a delicacy and were the key ingredient of “Mussel Pie”. When it was realised that these mussels abounded in Harrington Sound at a depth too great to be collected by hand, a dredge fishery sprang up. Metal-framed dredges were towed through the Ivory Bush Coral beds to collect the mussels. In their wake, there was nothing but broken coral, much of which sank into the mud. This fishery destroyed an entire, unique and very productive habitat in the sound before it was stopped in 1993. Since the broken coral became covered in mud stirred up in the dredging, it was unsuitable for new coral to settle on. Now most of it forms an irregular mud bottom supporting very little life. In a few areas, coral pieces rise high enough to provide a growing place for a few sponges. This is an example of how a poorly regulated fishery destroyed a productive habitat turning it into an unproductive mud-plain.

Below the old Bush Coral beds the mud is fine and deep. As mentioned under hydrography, these depths may also become deprived of oxygen in late summer to early winter. Here the biodiversity is very low and all that is commonly found are a few small clams called Gould’s Cerina (*Gouldia cerina*) and a worm called the Ringed Tube Worm (*Spiochaetopterus costarum oculatus*).

The Rocky Littoral Zone

The **littoral zone** is the area that is typically marine around the edge of tidal water bodies. The lower part of this is the **intertidal zone** which is covered with seawater on each high tide, or twice per day. The upper littoral zone is that wetted regularly by waves, splash or spray so that it is regularly soaked in salt water. The intertidal zone in Harrington Sound is narrow for two reasons. The main one of these is the small tidal range with a mean of 19 cm (7.5 in), the second is the almost universal vertical rock wall at that level. Similarly the upper littoral zone is very narrow because of the sheltered nature of the sound. The typical littoral zone is a band of vertical rock no more than 45 cm (18 in) high. Nevertheless, it is a distinctively different habitat with characteristic inhabitants.

At low tide, the littoral zone shows a black band at the top and a greeny-yellow one in the intertidal. The black zone as in all rocky shores in Bermuda is characterised by a blue-green cyanobacterium called Hofmann’s Scytonema (*Scytonema hofmanni*). This plant is made up of tiny filaments partly embedded in the rock. To the naked eye it just appears as black limestone. It is an important food supply for crabs and periwinkles. Embedded completely in the rock

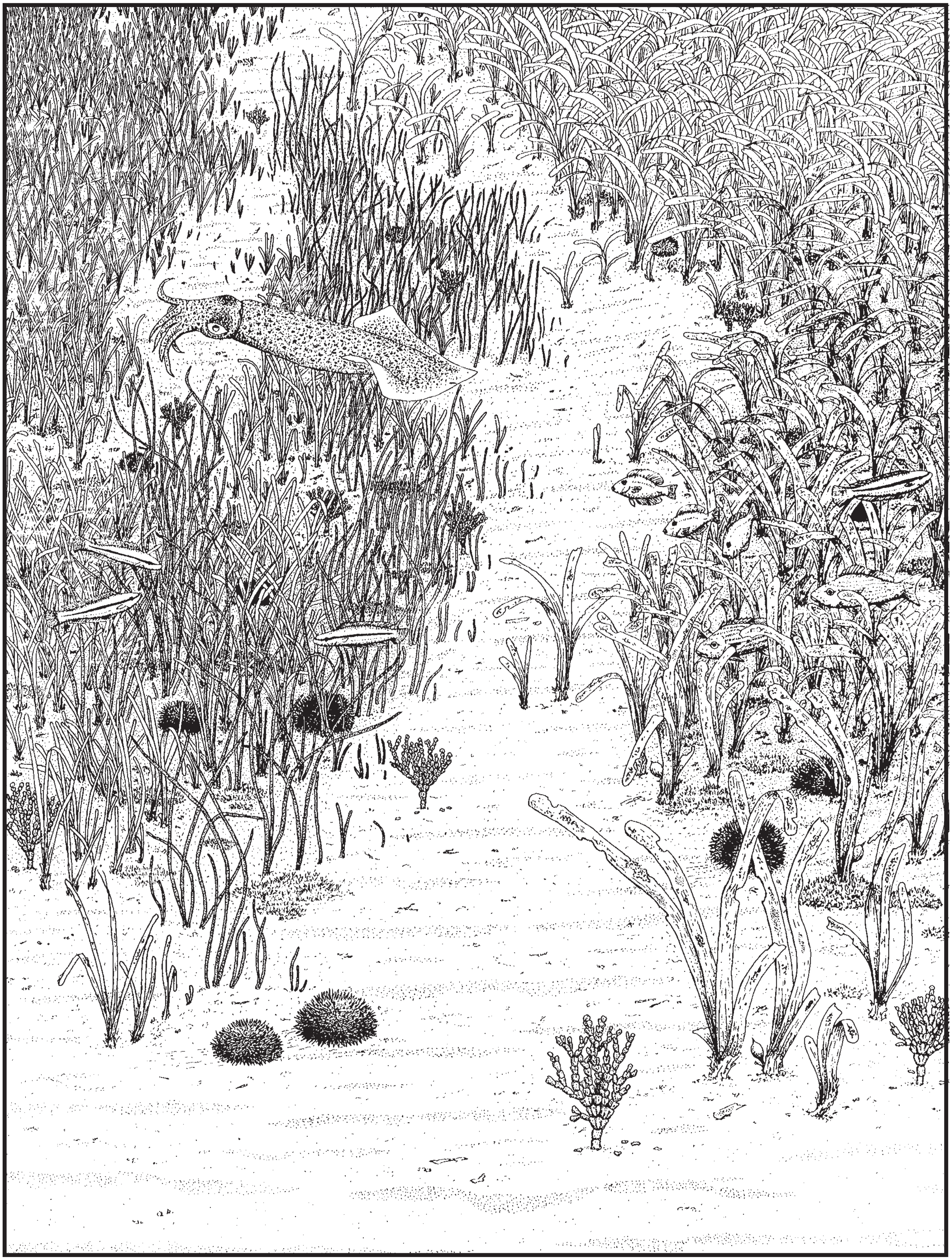


Figure 3. A typical seagrass bed in Bermuda showing communities dominated by the two commonest species Turtle Grass and Manatee Grass.

Key to Figure 3

Turtle Grass
Thalassia testudinum

Shoal Grass
Halodule wrightii

Manatee Grass
Syringodium filiforme

Thicketweed
Spyridia hypnoides

Scaleweed
Fosliella farinosa

Common Plateweed
Halimeda incrassata

Purple Urchin
Lytechinus variegatus

White Urchin
Tripneustes ventricosus

Slippery Dick
Halichoeres bivittatus

Yellow Grunt
Haemulon sciurus

Doctorfish
Acanthurus chirurgus

Arrow Squid
Loligo plei

under the Hofmann's Scytonema is a second blue-green cyanobacterium the Pink Blue-green (*Entophysalis deusta*). Where the black colour is absent or faint, the presence of this plant is indicated by a distinct pink colour of the rock. Animals or plants, like this, that live embedded in rock are termed **endolithic**. In the lower part of the black or pink zone and extending into the upper intertidal are scattered plants of two tufted red seaweeds and one green. The reds are the Stiff Sea Moss (*Bostrychia binderi*) and the small Siphonweed (*Polysiphonia* spp.). Both are tufted and quite stiff but the former has a distinct curly appearance; both may bleach to a yellowish tint in summer. The green tufts are the Green Cushionweed (*Cladophoropsis membranacea)*. Just above high tide level is a sparse population of the Zebra Periwinkle (*Littorina ziczac*), a small Zebra-striped snail. Species of periwinkle are used world-wide to show the top of a narrow zone just above the intertidal termed the **supra-littoral fringe**. In a sheltered place like Harrington Sound the intertidal zone and a zone termed the **midlittoral zone** are one and the same. In exposed places the midlittoral rises above the intertidal (See Project Nature, The Rocky Coast). Barnacles are universally used to mark the top of the midlittoral zone and in Harrington Sound it is the Striped Barnacle (*Balanus amphitrite*) that does this, extending down a few centimetres (ins) into the zone among a mat of low mixed-species red and green algae termed an **algal mat**. At the bottom of this zone coinciding with low tide level biodiversity increases. The commonest animals there are the Large Tube Snail (*Serpulorbis decussatus*), which is really a snail that has become attached to the rock. It feeds by filtering particles from the water; a **filter feeder**. Also common there are moss animals such as the Pink Sea Moss (*Schizoporella errata*), which are **colonial animals,** the colony appearing as rough sheets of pinkish-brown colour; they too are filter feeders. Immediately below low tide level the intertidal merges with the unique Harrington Sound Notch.

The Unique Harrington Sound Notch

There seems to be no other example of a structure like the Harrington Sound Notch anywhere in the world. When it was first noticed it was assumed to be a wave-cut notch similar to those in the intertidal zone of exposed rocky shores. However, two facts argued against this. First, Harrington Sound is sheltered with low waves and secondly, the notch is just below low tide mark rather than being intertidal. Obviously the notch was cut into the rock face by some other means and boring sponges such as the Orange Boring Sponge (*Cliona lampa*) were assumed to be responsible. The Orange Boring sponge is common under Flatts Bridge where it appears as orange patches in the rock. It can indeed burrow into limestone but likes a habitat with vigorous currents rather than a quiet habitat such as the notch. In a recent detailed analysis of the notch it was shown that the notch is cut out by thousands of **endolithic** clams called Black Date Mussels (*Lithophaga nigra*). This is another good example of a scientific name with real meaning. Lithophaga means 'rock-eater' and nigra means 'black'. The common name too is descriptive since the clam is about the same size, shape and colour as a dried date. Date clams settle on the rock from a planktonic larval stage and burrow in by both mechanically scraping the rock away with the serrated shell and softening and dissolving it with an acid secretion. A classic example of **bioerosion**! They are **filter feeders** and as they grow they enlarge the burrow. In the notch there are about 4,000 burrows in each square meter (just over a square yard) of rock, but they are invisible due to the **algal mat** which covers the tiny entrance holes in the rock surface.

The shape of the notch is quite constant around the sound, with a flat top and sloping bottom. On the average the notch is cut back about 1 metre (3.3 ft) and the cleft is about 90 cm (3 ft) deep. However in places it goes back at least twice this far. It is not a good place to dive into as the rock surface has sharp points and there are several stinging organisms living there. A drawing of the notch with characteristic inhabitants is shown in **Figure 4**. In ecological terms the importance of the notch is that it creates a unique, very sheltered environment rich in food supplies for filter-feeding organisms. Some of these are species that only occur there.

One of the most diverse groups of organisms to be seen in the notch are the sponges. These may appear as sheets, lumps, fingers or strands and be almost any colour. Over 100 apparently different sponges have been observed in the notch. A common example is the Fire Sponge (*Tedania ignis*), which is usually lumpy or fingerlike and some shade of red. It will inflict a mild sting if touched. There are other red sponges but they are hard to tell apart, therefore do not touch any sponges with reddish colour in the notch. Another common sponge there is the Chicken Liver Sponge (*Chondrilla nucula*) composed of smooth brownish lumps. If you see a beautiful sky-blue small sponge it will be the Etherial Sponge (*Dysidea etheria*), while green chimney-like ones may be the Green Chimney Sponge (*Amphimedon viridis*). One with a very graphic name is Dead Man's Fingers (*Leucetta microraphis*), which consists of whitish fingers; purple fingers may be the Violet Finger Sponge (*Haliclona molitba*). With so many sponges there, only a few can be mentioned. The notch is the best place to observe one of the corals that lives in dim, quiet places; this is the Chinese Hat Coral (*Agaricia fragilis*). This delicate coral shaped like a conical hat is brown with white flecks and very common. Another interesting coral living there is the Ivory Bush Coral (*Oculina diffusa*). The ivory bush coral grows as a delicate bush of branching fingers; it was mentioned above as once having been common in deeper water! The so-called Fire Coral (*Millepora alcicornis*) is also present, but not abundant; it may form greyish finger like clumps or be other shapes. Like the Fire Sponge it can inflict a mild, not dangerous, sting; technically speaking it is not a coral but a **colonial hydrozoan**; however, it has a coral-like appearance.

The notch also supports a variety of sea anemones. The most obvious of these is the Purple-tipped Sea Anemone (*Condylactis gigantea*), which has pale tentacles tipped in violet. Another colourful group of inhabitants are the sea squirts. These, mostly colonial, animals have a body consisting of a sac-like structure attached to the rock at the base. They vary in colour between species. A common very beautiful one, the Purple Sea Squirt (*Clavelina picta*) has a transparent body with a brilliant purple ring around the outer end. It grows in large clumps, as does the Orange Sea Squirt (*Ecteinascidia turbinata*), of a pastel orange colour. Large jet-black, solitary sea squirts will be the Black Sea Squirt (*Phallusia nigra*). A clump of transparent tubes, hanging down from the top of the notch will probably be the Greybeard Sea Moss (*Zoobotryon verticillatum*), another colonial animal, this one a member of the bryozoa or moss animals. Swimming around in the notch you may be lucky enough to see small Reef Squid (*Sepioteuthis sepioidea*) or Arrow Squid (*Loligo plei*) among the common Sergeant Majors (*Abudefduf saxatilis*), the commonest fish seen there.

The notch is also a good place to observe some of the delicate pink seaweeds. One of the commonest is the Pointed Needleweed (*Amphiroa fragilissima*), which consists of small thin rods which branch evenly. It is hard to the touch due to calcium carbonate in the tissues and grows as thick clumps. Another of these **calcareous seaweeds** but growing as a sheet rather than a bush will be seen there too. This type of seaweed is an important reef builder (See Project Nature, Coral Reefs of Bermuda). It consists of flat, very hard, pink sheets on the rock surface. These algae, hard to identify are called the **crustose coralline algae**; they are worth looking for.

Submerged Caves and Underwater Cliffs

There are many underwater cliffs in the sound and several submerged caves. These are generally inaccessible to anybody but specialised divers, but will be mentioned because they are an important habitat. The caves too show an important link to the past history of the sound as explained above. The attached fauna and flora of cave mouths and submerged cliffs is a very rich assemblage, the main species being the same as those found in the notch. The flora and fauna of the caves change with the distance into the cave; plants disappear quickly as light decreases but attached, filter feeding, animals such as sponges go well into these structures. However, food quickly becomes scarce since it is not formed there and only very specialised cave creatures are found deep within caves. On no account should anyone ever snorkel down into a cave mouth because quite strong tidal currents may be entering.

The Ecology of the Fish Population

A very great variety of fish occur in Harrington Sound but studies have shown that by far the most common species are a group consisting of the White Grunt (Tomtate) (*Haemulon aurolineatum*), the French or Yellow Grunt (*Haemulon flavolineatum*), the Bermuda Bream (*Diplodus bermudensis*) and the Blue Striped Grunt (*Haemulon sciurus*). The interesting thing about this group of fish is that they are all

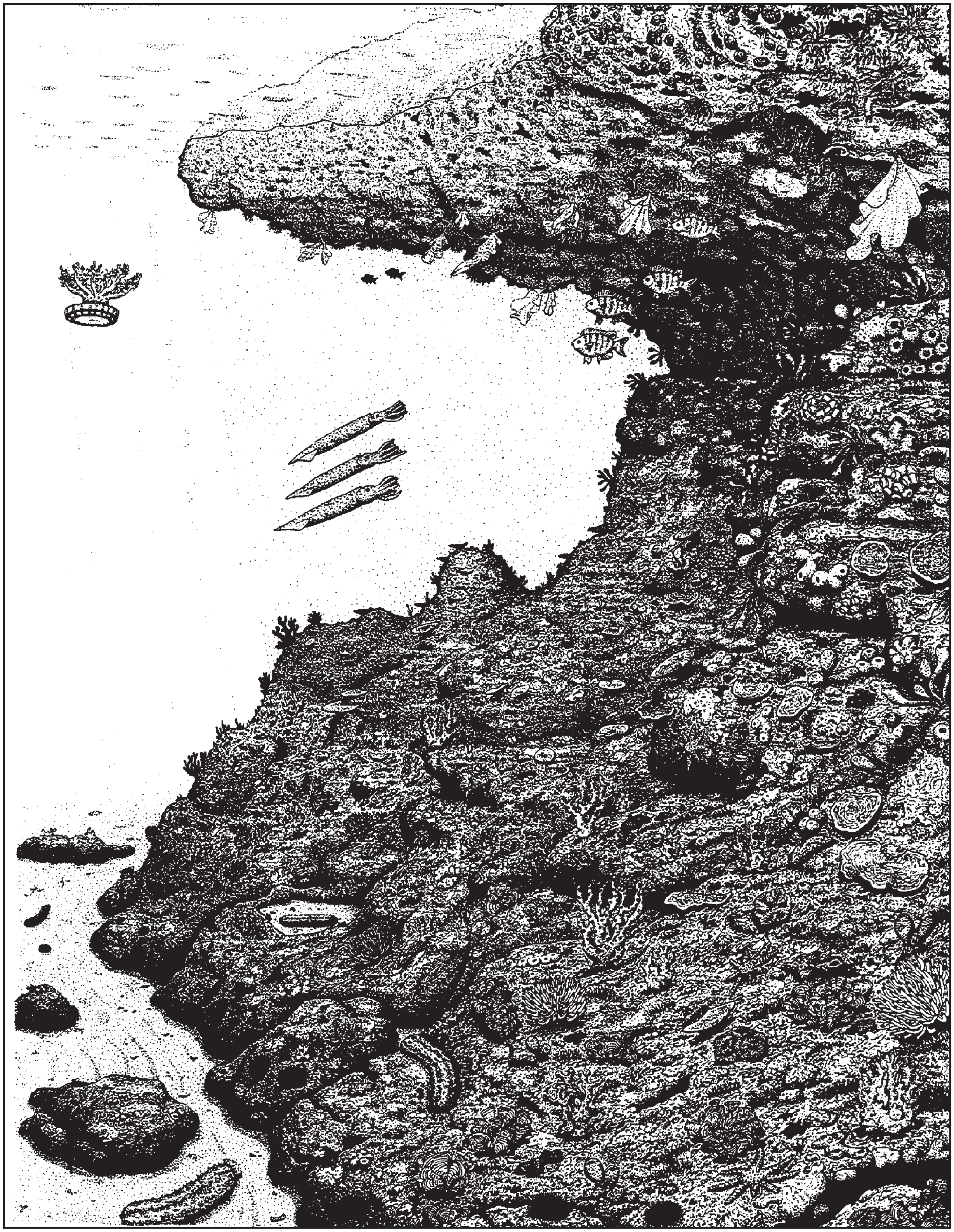


Figure 4. A well developed sublittoral rock wall community in the notch in Harrington Sound.

Key to Figure 4

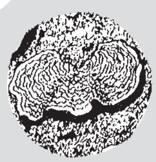
Strap Sea Lettuce


Green Chimney Sponge


Jamaican Petticoat

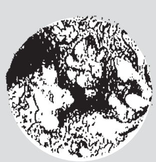

Purple Tipped Anemone

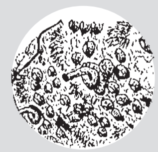

Upside-down Jellyfish

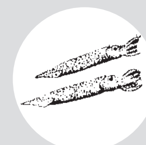

Chinese Hat Coral


Ivory Bush Coral

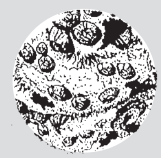

Fire Coral


Chicken-liver Sponge


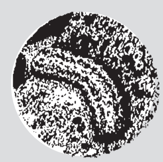
Large Tube Worm


Arrow Squid


Pink Sea Moss


Common Barnacle


Purple Sea Urchin


Sea Pudding


Purple Sea Squirt


Sergeant Major


essentially bottom feeders, eating the benthic animals and plants living there. While the grunts eat principally an animal diet of worms and small crustaceans, they also eat some snails, small clams and a few small fish. The Bermuda Bream on the other hand eats mainly seaweeds and other plant material supplemented by some snails and worms. The total populations of these fish are so large that together they consume almost all the available bottom-living food during the summer. At the peak of their feeding they consume 3% of the food supply per day. By the time winter sets in, their food is greatly depleted and they change their diet to other available foods thus allowing the benthic organisms to recover.

Many other fishes populate Harrington Sound in smaller numbers than those mentioned above some are worth special mention. The Barred Hamlet (*Hypoplectrus puella*), a beautiful little fish that is the smallest local member of the grouper family, is especially common wherever there is cover on the bottom. This fish has an interesting daily spawning behaviour. Barred Hamlets are both male and female at the same time, spawning as a male one evening and a female the next.

One of the really fantastic fishes of the sound is the Spotted Eagle Ray (*Aetobatus narinari*). This is a beautiful member of the ray group, and the only one commonly seen around Bermuda. If you gaze into the water from Flatts Bridge, Spotted Eagle Rays are often seen moving in or out of the sound. They swim against the extremely fast current, at that location, in an apparently effortless manner. They may be up to 2 m (6 ft) long. The back is a dark grey with many white spots. Eagle Rays feed by digging up shellfish living in the sand. In doing so they leave a large saucer shaped depression. In Harrington Sound, not infrequently they jump clear of the water and land with a loud splash.

Another very characteristic sight in these relatively sheltered waters, are large shoals of tiny silvery fish, locally called fry. Five different, related species school in this way; they are the Bermuda Anchovy or Hogmouth Fry (*Anchoa choerostoma*), the Blue Fry (*Jenkinsia lamprotaenia*), the Rush Fry (*Hypoatherina harringtonensis*), the Pilchard (*Harengula humeralis*) and the Anchovy (*Sardinella anchovia*). If the fish you see are really small and numerous, averaging 3-4 cm (1-1 1/2 in) in length, they will be from the first three species. These three are much the commonest of the group. These small fry are highly prized as bait and are caught in large numbers, using seine nets close to the shore. The Pilchard and Anchovy are larger fish up to 10 cm (4 in) in length. All are in the herring family and all feed on tiny animals in the water. It is an awe-inspiring sight to swim slowly through a shoal of these fish and see them divide neatly around your body.

Juvenile Great Barracuda (*Sphyraena barracuda*), up to about 45 cm (18 in) in length, are very frequent in the bays of the sound, where they patiently wait, singly or in small groups, for small fish to swim by. Then a short burst of speed will net them a meal. Two other elongated, very streamlined fish found commonly in the sound, are the Needlefish or Houndfish (*Tylosurus acus*) and the Bermuda Halfbeak or Garfish (*Hemiramphus bermudensis*), the second being an endemic species. The Needle Fish has both jaws extending forward, while in the Halfbeak, only the lower jaw does so. These fishes are commonly seen in Flatts Inlet.

Another common fish of shallow bay environments is the Slippery Dick (*Halichoeres bivittatus*), another member of the wrasse group. This elongate, slim, little fish, which stays close to the bottom, reaches about 15 cm (6 in) long. It is green and white with two purple-black stripes running the length of the body. Like most of the wrasse family, it goes through a series of colour and sex changes as it grows. The Slippery Dick can dive into the sand to escape capture, and as its name suggests, is extremely slimy if handled.

Although parrotfish occupy a very wide range of habitats, they are not common in Harrington Sound; those that do occur are described in the variety of life section below.

Another very interesting bottom dweller of sandy parts of the sound is the Peacock Flounder (*Bothus lunatus*). The Peacock Flounder is a master of camouflage, and can change colour to blend in with the bottom. It also fans sand over its upper surface so that only the two periscope-like eyes show. It feeds on small fish and invertebrates.

The Longsnout Seahorse (*Hippocampus reidi*) is perhaps the most charming of the little sound fishes but, unfortunately, it is becoming quite rare. If you are lucky enough to see one, it will be clinging by its tail to seaweeds or seagrasses or among creatures in the notch. Seahorses are masters of camouflage and can change colour rapidly. The male broods the young in a pouch on his abdomen.

Birds in Harrington Sound

Harrington Sound is not one of the great birding locations of Bermuda but it does have several interesting characteristics, There are several Longtail (*Phaeton lepturus*) nesting sites in cliff holes in the sound, notably in the sanctuary on Rabbit Island. The Common Tern (*Sterna hirundo*) which in the past was very common in Bermuda and its eggs used for food, has declined to about 25 pairs. Several of its small breeding sites are on islands in Harrington Sound. Additionally, the young-of-the-year terns congregate in small flocks in Harrington Sound and linger there until November when they migrate away for the winter. Ospreys (*Pandion haliaetus*) are fish hawks which occasionally visit Bermuda, when here they can often be seen in Harrington Sound.

Blooms and Population Cycles

The fact that Harrington Sound is noted both for population explosions and mass mortalities has been mentioned already, this is one of the main factors leading to its unstable history. The well-known cases of the Common Pincushion population explosion and the more recent return to abundance of the Calico Clam have already been described as has the obvious variations in the Purple Sea Urchin populations. Less obvious have been large variations in scallop populations now at a low level. Harrington Sound has supported the best Bermudian populations of both the Calico Scallop (*Argopecten gibbus*) and the Bermuda scallop (*Pecten ziczac*) and at times the Bermuda Scallop has been numerous enough to support a small sport fishery. These scallops are now being investigated from the point of view of aquaculture but the experiments have been plagued by heavy mortalities as a result of both predation and toxic phytoplankton in the water. The return of large scallop populations is still very much in doubt. More assured seems to be the return of the Harbour or Milk Conch to its former abundance.

Conservation Problems

Many examples above have shown that many of the marine inhabitants of Harrington Sound live a fairly precarious existence. If sport or commercial harvesting is added to the natural variability, then the pressure on the species can lead to a catastrophic decline. In many cases Harrington Sound species have been afforded protection from harvesting and have subsequently greatly increased in abundance. This is true of the Harbour Conch, the Calico Clam and the Spiny Lobster (*Panulirus argus*); however, despite protection, the scallops show little signs of recovery and the Ivory Bush Coral community at medium depths seems to be gone forever. In some cases such as that of the Calico Clam there is evidence that in the past the population also fluctuated wildly. Calico Clams are present as fossils but were apparently quite rare until the mid 1900s when they became abundant. One wonders therefore whether they might decline again despite the ban on exploitation. One of the formerly common bivalve inhabitants of the sandy bottom of the sound and other coastal bays, the Tiger Lucina (*Codakia orbicularis*) appears to have died out completely in recent years with no hint of a reason. This is a case of apparently natural **extirpation** or the complete loss of a species from part of its natural range while it continues to live elsewhere. Obviously the sound is a delicate environment that needs continuous monitoring to preserve its unique character.

One thing that is difficult to control is pollution. The area around Harrington Sound is densely populated and sewage treatment in all these properties is by the use of cesspits. While these cesspits control the passage of harmful bacteria into the surrounding rock, this is not true of potential plant nutrients such as nitrates and phosphates. These pass into the porous rock in the cesspit drainage and can make their way by gravity into the sound. Even tiny changes in the quantities of these substances in the water can trigger changes and these commonly take the form of blooms or population explosions of plants. Although this was never proven as the cause of the Common Pincushion explosion of the 1870s, the consensus of expert opinion was that it was the most likely cause. Harrington Sound is a low-lying area and in rainfall there is a lot of surface drainage into the sound from roads and the surrounding land. This adds a variety of pollutants including oil. Another aspect of pollution in the sound is the vast quantity of trash that has been dumped into this water body. Underwater photography records show that trash is everywhere on the bottom and in places almost a solid layer. While efforts have been made to remove some of that in shallow water, huge quantities remain. A great public education effort is needed to convince people not to throw things from boats or shoreline property and to try to help clean up what is already there.

The Variety of Life in Harrington Sound

List of Species Mentioned and/or Illustrated in this Guide

Key to Habitat Codes

B = Lagoons, Bays and Coastal Waters	R = Rocky Shores
C = Coral Reefs	SG = Seagrass Beds
M = Mangrove Swamps and Salt Marshes	SP = Saltwater Ponds
O = Open Ocean	

Note: Common names are listed in the first column except where there is no accepted common name, in these cases the scientific name is used. For each group of organisms, the common names are in alphabetical order. The habitat codes defined in the key show where the organisms are commonly found. The illustrations following the list are in the same order as the list and are also accompanied by habitat codes.

Common Name	Scientific Name	Taxonomy	Habitat Code
Hofmann's Scytonema	Scytonema hofmanni	Blue-green Cyanobacteria	R
Oil-spot Blue-green	Calothrix crustacea	Blue-green Cyanobacteria	R
Pink Blue-Green	Entophysalis deusta	Blue-green Cyanobacteria	R
Gonyaulax polygramma	Gonyaulax polygramma	Plant Plankton - Dinoflagellates	B, O
Gyrodinium spirale	Gyrodinium spirale	Plant Plankton - Dinoflagellates	B, O
Prorocentrum gracile	Prorocentrum gracile	Plant Plankton - Dinoflagellates	B, O
Common Pincushion	Cladophora prolifera	Seaweeds - Green Algae	B
Common Plateweed	Halimeda incrassata	Seaweeds - Green Algae	B
Disc Plateweed	Halimeda tuna	Seaweeds - Green Algae	B
Flathead Shaving Brush	Penicillus pyriformis	Seaweeds - Green Algae	B
Green Cushionweed	Cladophoropsis membranacea	Seaweeds - Green Algae	B
Hard Fanweed	Udotea flabellum	Seaweeds - Green Algae	B, SP
Hard Funnelweed	Udotea cyathiformis	Seaweeds - Green Algae	B
Mermaid's Wine Glass	Acetabularia crenulata	Seaweeds - Green Algae	B, SP
Merman's Shaving Brush	Penicillus capitatus	Seaweeds - Green Algae	B, SP
Slender Plateweed	Halimeda monile	Seaweeds - Green Algae	B
Soft Fanweed	Avrainvillea nigricans	Seaweeds - Green Algae	B, SP
Strap Sea Lettuce	Ulva fasciata	Seaweeds - Green Algae	R
Tapered Shaving Brush	Penicillus dumetosus	Seaweeds - Green Algae	B
Tufted Jointweed	Cymopolia barbata	Seaweeds - Green Algae	B
Jamaican Petticoat	Padina jamaicensis	Seaweeds - Brown Algae	B
Banded Threadweed	Ceramium byssoideum	Seaweeds - Red Algae	B, C
Crustose Coralline Algae	Lithothamnion spp., Lithophyllum spp.	Seaweeds - Red Algae	B, C
Laurence's Clubweed	Laurencia obtusa	Seaweeds - Red Algae	B, SG, R
Laurence's Tufted Weed	Laurencia papillosa	Seaweeds - Red Algae	B
Pointed Needleweed	Amphiroa fragilissima	Seaweeds - Red Algae	B, C
Red Boneweed	Galaxaura obtusa	Seaweeds - Red Algae	B, C
Scaleweed	Fosliella farinosa	Seaweeds - Red Algae	SG
Siphonweeds	Polysiphonia spp.	Seaweeds - Red Algae	B, C, R
Soft Spineweed	Acanthophora spicifera	Seaweeds - Red Algae	B
Stiff Sea Moss	Bostrychia binderi	Seaweeds - Red Algae	R
Thicketweed	Spyridia hypnoides	Seaweeds - Red Algae	B
Dwarf Seagrass	Halophila decipiens	Herbaceous Flowering Plants	B, SG
Manatee Grass	Syringodium filiforme	Herbaceous Flowering Plants	B, SG
Shoal Grass	Halodule wrightii	Herbaceous Flowering Plants	B, SG
Turtle Grass	Thalassia testudinum	Herbaceous Flowering Plants	B, SG
Acartia bermudensis	Acartia bermudensis	Animal Plankton - Crustacea	B

Calanopia americana	Calanopia americana	Animal Plankton - Crustacea	B
Corycaeus flaccus	Corycaeus flaccus	Animal Plankton - Crustacea	B
Evadne tergestina	Evadne tergestina	Animal Plankton - Crustacea	B
Oithona nana	Oithona nana	Animal Plankton - Crustacea	B
Penilia avirostris	Penilia avirostris	Animal Plankton - Crustacea	B
Podon polyphemoides	Podon polyphemoides	Animal Plankton - Crustacea	B
Chicken Liver Sponge	Chondrilla nucula	Sponges	B, SP
Dead Man's Finger (Sponge)	Leucetta microraphis	Sponges	B, SP
Etherial Sponge	Dysidea etheria	Sponges	B, SP
Fire Sponge	Tedania ignis	Sponges	B, SG, SP
Green Chimney Sponge	Amphimedon viridis	Sponges	B
Lavender Anemone Sponge	Niphates erecta	Sponges	B, SG
Orange Boring Sponge	Cliona dioryssa	Sponges	B, C
Violet Finger Sponge	Haliclona molitba	Sponges	B, SG
Fire Coral	Millepora alcicornis	Hydroids and Coral-like Hydroids - Coral-like Hydroids	B, C
Chinese Hat Coral	Agaricia fragilis	Corals	B, C
Finger Coral	Porites porites	Corals	B, C
Ivory Bush Coral	Oculina diffusa	Corals	B, C
Rose or Cactus Coral	Isophyllia sinuosa	Corals	B, C
Ten-ray Star Coral	Madracis decactis	Corals	C
Purple-tipped Sea Anemone	Condylactis gigantea	Anemones	B, C
Ringed Anemone	Bartholomea annulata	Anemones	B, C, SP
Cockworm	Arenicola cristata	Polychaete Worms	B
Ringed Tube Worm	Spiochaetopterus costarum oculatus	Polychaete Worms	B
Striped Barnacle	Balanus amphitrite	Crustacea - Barnacles	R
Burrowing Shrimp	Callianassa branneri	Crustacea - Shrimps	B
Spiny Lobster	Panulirus argus	Crustacea - Lobsters	B, C
Ocellated Box Crab	Calappa ocellata	Crustacea - Crabs	B
False Cerith	Batillaria minima	Gastropoda - Snails	B, M
Large Tube Shell	Serpulorbis decussatus	Gastropoda - Snails	R
Lettered Horn Shell	Cerithium litteratum	Gastropoda - Snails	B, SG
Milk or Harbour Conch	Strombus costatus	Gastropoda - Snails	B
Milky Moon Snail	Polinices lacteus	Gastropoda - Snails	B
Varicose Alaba	Alaba incerta	Gastropoda - Snails	B
Zebra Periwinkle	Littorina ziczac	Gastropoda - Snails	R
Atlantic Grooved Macoma	Psammotreta intastriata	Clams and Mussels	B
Bermuda Scallop	Pecten ziczac	Clams and Mussels	B
Black Date Mussel	Lithophaga nigra	Clams and Mussels	B, C
Calico Clam	Macrocallista maculata	Clams and Mussels	B
Calico Scallop	Argopecten gibbus	Clams and Mussels	B
Dwarf Tiger Lucina	Codakia orbiculata	Clams and Mussels	B
Gould's Cerina	Gouldia cerina	Clams and Mussels	B
Leafy Jewel Box	Chama macerophylla	Clams and Mussels	B, C, R
Rock Scallop	Spondylus ictericus	Clams and Mussels	C, R
Sunrise Tellin	Tellina radiata	Clams and Mussels	B
Sunset Clam	Tellina laevigata	Clams and Mussels	B
Tiger Lucina	Codakia orbicularis	Clams and Mussels	B
Zebra Mussel	Arca zebra	Clams and Mussels	B
Arrow Squid	Loligo plei	Octopus and Squid - Squid	B, C
Reef Squid	Sepioteuthis sepioidea	Octopus and Squid - Squid	B, C
Greybeard Sea Moss	Zoobotryon verticillatum	Moss Animals	B, SP
Pink Sea Moss	Schizoporella errata	Moss Animals	B
Heart Urchin	Moira atropos	Echinoderms - Sea Urchins	B
Purple Urchin	Lytechinus variegatus	Echinoderms - Sea Urchins	B, SG
White Urchin	Tripneustes ventricosus	Echinoderms - Sea Urchins	SG
Sand Dollar	Leodia sexiesperforata	Echinoderms - Sand Dollars	B
Burrowing Sea Cucumber	Holothuria arenicola	Echinoderms - Sea Cucumbers	B

Sea Pudding	Isostichopus badionotus	Echinoderms - Sea Cucumbers	B
Black Sea Squirt	Phallusia nigra	Sea Squirts	B
Orange Sea Squirt	Ecteinascidia turbinata	Sea Squirts	B, SP
Purple Sea Squirt	Clavelina picta	Sea Squirts	B, SP
Spotted Eagle Ray	Aetobatus narinari	Fish - Rays	B, O
Blue Fry	Jenkinsia lamprotaenia	Fish - Anchovies	B
Anchovy	Sardinella anchovia	Fish - Herrings	B
Bermuda Anchovy or Hogmouth Fry	Anchoa choerostoma	Fish - Herrings	B
Pilchard	Harengula humeralis	Fish - Herrings	B
Sand Diver or Snakefish	Synodus intermedius	Fish - Lizardfishes	B
Bermuda Halfbeak or Garfish	Hemiramphus bermudensis	Fish - Needlefish and Halfbeaks	B
Needlefish or Houndfish	Tylosurus acus	Fish - Needlefish and Halfbeaks	B
Rush Fry	Allanetta harringtonensis	Fish - Silversides	B
Longsnout Seahorse	Hippocampus reidi	Fish - Seahorses	B, SG
Barred Hamlet	Hypoplectrus puella	Fish – Groupers	B
Bigeye Mojarra	Eucinostomus havana	Fish - Mojarras	B
Mottled Mojarra	Eucinostomus lefroyi	Fish - Mojarras	B
Shad or Silver Jenny	Eucinostomus gula	Fish - Mojarras	B, SP
Sharksucker or Remora	Echeneis naucrates	Fish - Remoras	B, O
Horse-eye Jack	Caranx latus	Fish - Jacks and Pompanos	B, O
Yellowtail Snapper	Ocyurus chrysurus	Fish - Snappers	B, SP
Bermuda Bream	Diplodus bermudensis	Fish - Chubs and Breams	B
Bermuda Chub	Kyphosus sectatrix	Fish - Chubs and Breams	B
Blue-striped Grunt	Haemulon sciurus	Fish - Grunts	B
French or Yellow Grunt	Haemulon flavolineatum	Fish - Grunts	B
White Grunt or Tomtate	Haemulon aurolineatum	Fish - Grunts	B
Pinfish	Lagodon rhomboides	Fish - Porgies	B, SP
Spotted Goatfish	Pseudupeneus maculatus	Fish - Goatfishes	B
Beaugregory	Stegastes leucostictus	Fish - Damselfishes	B, C
Sergeant Major or Cow Polly	Abudefduf saxatilis	Fish - Damselfishes	B, C
Slippery Dick	Halichoeres bivittatus	Fish - Wrasses	B
Great Barracuda	Sphyraena barracuda	Fish - Barracudas	B, C, O
Peacock Flounder	Bothus lunatus	Fish – Flatfishes	B
Grey Triggerfish	Balistes capriscus	Fish - Triggerfishes	B, C
Queen Triggerfish	Balistes vetula	Fish - Triggerfishes	B, C
Slender Filefish	Monacanthus tuckeri	Fish - Leatherjackets	B
Honeycomb Cowfish	Acanthostracion polygonius	Fish - Trunkfishes	B
Smooth Trunkfish	Lactophrys triqueter	Fish - Trunkfishes	B
Bandtail Puffer	Sphaeroides spengleri	Fish - Puffers and Porcupine Fishes	B
Bucktooth Parrotfish	Sparisoma radians	Fish - Parrotfishes	B, SG
Redtail Parrotfish	Sparisoma crysopterum	Fish - Parrotfishes	B, C
Striped Parrotfish	Scarus croicensis	Fish - Parrotfishes	B, C
Green Turtle	Chelonia mydas	Turtles and Terrapins - Turtles	B, O, SG
Osprey	Pandion haliaetus	Birds - Hawks	B
Common Tern	Sterna hirundo	Birds - Terns	B
White-tailed Tropic Bird or Longtail	Phaethon lepturus	Birds - Tropic Birds	B, CL, O

Blue-green Cyanobacteria

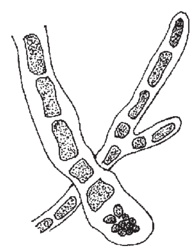
Hofmann's Scytonema
Scytonema hofmanni
This species is very important in sediment formation but is not seen on sandy bottoms. It forms the black zone at the top of rocky shores and is characterised by a spiky surface to the rock. Spikes up to 12 cm (5 in) high. **Native**.

R

Oilspot Blue-green
Calothrix crustacea
This blue-green cyanobacterium of just above high tide mark and the upper intertidal may appear in at least two forms. The first is just like a jet-black heavy oil spot, the second a fuzzy, very small black mound up to about 4 mm (3/16 in) high. **Native**.

R

Pink Blue-green
Entophysalis deusta
Microscopic cells and filaments often embedded in limestone rock (endolithic). Usually gives the rock a pinkish colour at just above high tide level although other colours are possible. Common. 1/10-1 mm (1/32-1/16 in) long. **Native**.



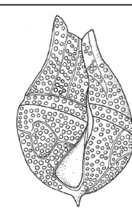
R

Plant Plankton

Note: Plant Plankton are very small and can only be collected with special equipment and they are very delicate. A high-powered microscope is needed for identification. There are no common names. Sizes in metric units only. A μm is one thousandth of a mm.

Dinoflagellates (Plant protozoa with flagellae)

Gonyaulax polygramma
Armoured by plates on the outside and having two distinct grooves one longitudinal and one transverse, housing the flagellae. About 60 μm in diameter. Greenish-brown. Common. **Native.**



B, O

Gyrodinium spirale
Has an elongated cell shape with longitudinal marks. One of the two flagellae is in a spiral groove, the other in a longitudinal one. About 80 μm long. Greenish-brown. **Native**.

B, O

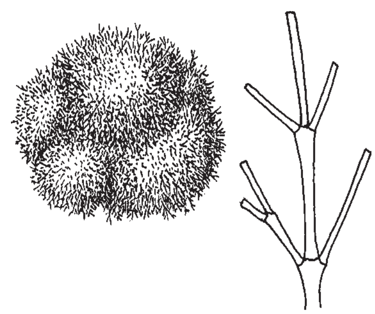
Prorocentrum gracile
Flattened from side to side and armoured with two plates. Has one flagellum at one end. About 50 μm long. Greenish. **Native.**

B, O

Seaweeds

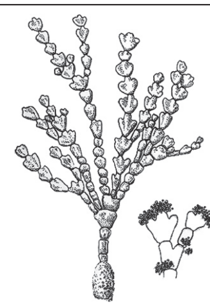
Green Algae

Common Pincushion
Cladophora prolifera
This often uncommon seaweed may 'bloom' under suitable conditions to form a layer on the bottom of quiet bays. The plants are unattached and just lie on the bottom as a roughly ball shaped cluster of branching filaments about 8 cm (3 in) across. The colour in life is a deep green. **Native**.



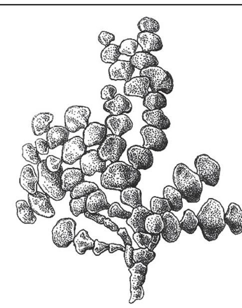
B

Common Plateweed
Halimeda incrassata
This green alga commonly about 10 cm (4 in) high consists of a series of small, three ridged plates, jointed together. It is a green seaweed but it incorporates calcium carbonate into its tissues, giving it a hard texture and whitish-green colour. **Native**.



B

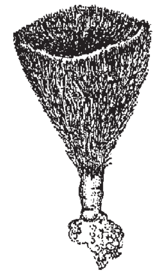
Disc Plateweed
Halimeda tuna
Less common that the other plateweeds, the Disc Plateweed is still frequently found in clumps up to about 6 cm (2 1/4 in) high. The unique feature of this plateweed are the broad, fan-shaped or kidney-shaped segments. Quite easily identified when seen in sediments. **Native**.



B

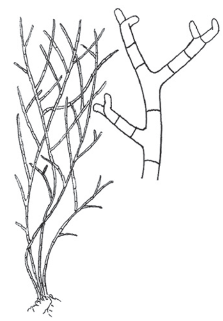
B

Flathead Shaving Brush
Penicillus pyriformis
This species is about 10 cm (4 in) high and has a short stalk capped by a brush that is flattened or even dish-shaped at the top. Not as common as the other two species of shaving brush, but found regularly on quiet sandy bottoms. **Native**.



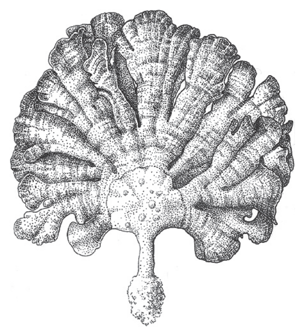
B

Green Cushionweed
Cladophoropsis membranacea
This is a very tiny, usually only 1 cm (1/3 in) high filamentous green seaweed that grows as a mat on the bottom among seagrasses, or out in the open. All that can be seen are the bright green tips of the filaments protruding from a soft layer of sediment. The bottom is usually slightly raised where it occurs. **Native**.



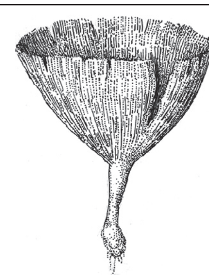
B, SP

Hard Fanweed.
Udotea flabellum
The Hard Fanweed is one of Bermuda's prettiest green seaweeds. Anchored in the sediment, it has a short, robust stalk which bears a fan shaped structure with distinct growth lines. About 10 cm (4 in) in height this seaweed is quite heavily calcified and consequently very firm to the touch. **Native**.



B

Hard Funnelweed
Udotea cyathiformis
The Hard Funnelweed is about 15 cm (6 in) in height and like its relative above is well calcified giving it a whitish cast. It is surmounted by a funnel shaped structure which is usually divided by several splits. **Native**.



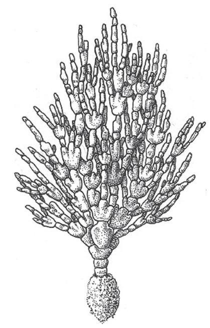
B, SP

Mermaid's Wine Glass
Acetabularia crenulata
A charming little green seaweed only 5 cm (2 in) high, consisting of a slender stalk on which are one or more curved green discs with radial bands. In quiet waters. **Native.**

Merman's Shaving Brush
Penicillus capitatus
A robust greenish white alga, anchored in soft bottoms by root-like organs, The plant is 10-15 cm (4-6 in) high and consists of a stout stalk surmounted by a brush-like array of greenish filaments. Widely distributed. **Native.**

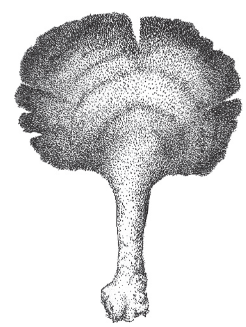
B, SP

Slender Plateweed
Halimeda monile
The Slender Plateweed is similar in size to the Common Plateweed and forms similar clumps. They can be distinguished by the narrower, non-ridged plates that this species has close to the branch tips. An important contributor to shallow water sediments. Up to 15 cm (6 in) high. **Native**.



B

Soft Fanweed
Avrainvillea nigricans
The Soft Fanweed has a luxuriant velvety texture, a result of its being made up of very numerous filaments closely pressed together. Above the sediment anchor the broad stalk rises up to 10 cm (4 in) before it expands into a 10 cm (4 in) high, quite thick green fan. It is only very lightly calcified. **Native**.



B, SP

Strap Sea Lettuce
Ulva fasciata
A soft, flat green seaweed often found on the roof of the notch. The elongated blades may divide and reach about 15 cm (6 in). **Native.**

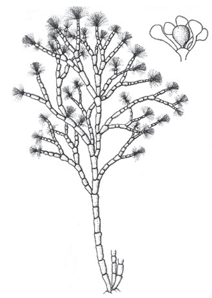
R

Tapered Shaving Brush
Penicillus dumetosus
Only 10 cm (4 in) in height, this species differs from the one above in that the stalk is shorter than the brush portion and the brush tapers more slowly from the base. **Native**.

B

B

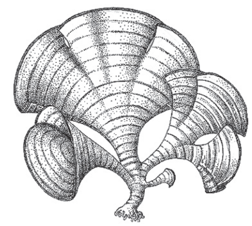
Tufted Jointweed
Cymopolia barbata
This 5-15 cm (2-6 in) high, calcified, green alga is very common where a sheltered rocky shoreline gives way to sediment just below low tide. It can be recognised by its jointed branched structure, with each branch ending in a tuft of green filaments. **Native**.



Brown Algae

B

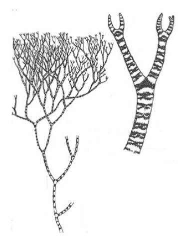
Jamaican Petticoat
Padina jamaicensis
This is a brown, fan shaped seaweed about 10-15 cm (4-6 in) high. The fan is generally banded with lighter zones reflecting the light calcification present. Widely common. **Native**.



Red Algae

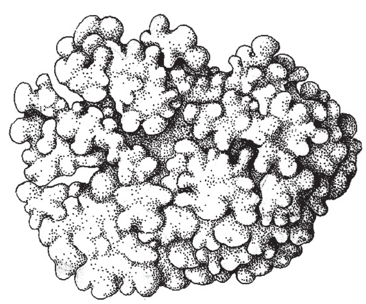
B, C

Banded Threadweed
Ceramium byssoideum
A small red, threadlike seaweed, generally looking like pink turf or small clumps. Microscopically, the characteristic red-banded appearance shows up. Grows to 10 cm (4 in) high. **Native**.

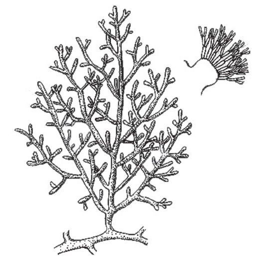


B, C

Crustose Coralline Algae
Lithothamnion spp., *Lithophyllum* spp.
These algae are the main rock-builders of the coral and algal-vermetid reefs. They form smooth to knobby sheets of pale pink, rock hard algae. However, they may be hidden by a thin overgrowth of turf-like red seaweeds. These species can create very large expanses of growth and all are highly resistant to both wave action and heavy grazing. Very variable in size, commonly to 30 cm (1 ft) across. **Native.**



Laurence's Clubweed
Laurencia obtusa
Commonly found in seagrass beds this red alga grows in clumps about 15 cm (6 in) high. The plant is copiously branched and tends to a yellowish colour except for the tips of the branches which are a vivid pink. **Native**.

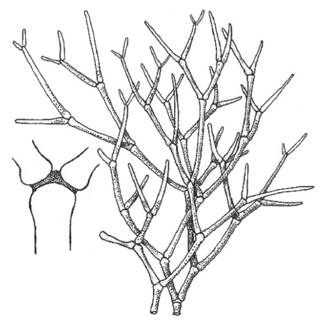


B, SG, R

Laurence's Tufted Weed
Laurencia papillosa
This is one of a group of Laurence's Weeds that grow as small tufts about 10 cm (4 in) tall. The greenish stems divide repeatedly but have characteristic knobby ends with a red tip. These plants are quite common on reefs protected from violent wave action. **Native.**

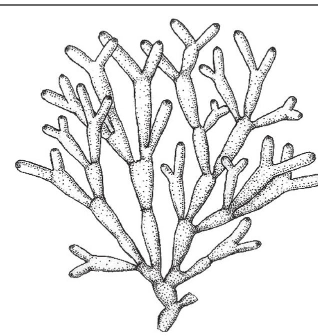
B

Pointed Needleweed
Amphiroa fragilissima
This common alga is heavily calcified with calcium carbonate and a light pink in colour. The hard, thread-like branches divide repeatedly and evenly. In quiet areas it may form bush-like growths 15 cm (9 in) high, but on reefs it is usually part of the low turf dominated by Siphonweeds. **Native.**



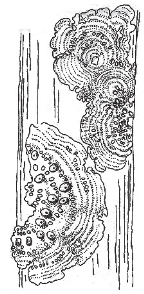
B, C

Red Boneweed
Galaxaura obtusa
This seaweed and other close relatives are hard to the touch due to the presence of calcium carbonate in the tissues. They have chunky, cylindrical branches that form small bushes up to about 12 cm (4 1/2 in) high. Quite common on inshore reefs where the dense growth form makes a good habitat for small creatures.



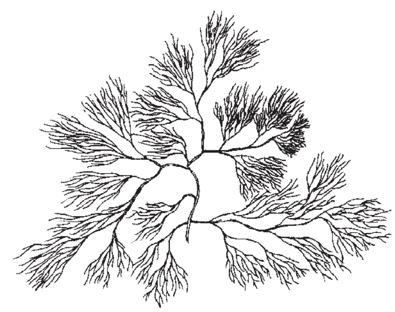
B, C

Scaleweed
Fosliella farinosa
A red seaweed but showing up as white circular, tiny patches about 2 mm (1/16 in) in diameter on seagrass leaves, where it can be very abundant. This is one of the crustose coralline algae and it incorporates large amounts of calcium carbonate in the tissues. **Native**.



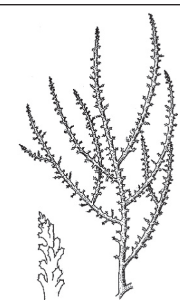
SG

Siphonweeds
Polysiphonia spp.
The Siphonweeds are probably the most common seaweed of the reefs. They can grow in heavily grazed areas where they form an almost invisible low turf with other red algae such as Pointed Needleweed. Ungrazed they could be several cm (in) high but the commonly found turf is but a mm (1/20 in) thick. It can grow in very wave-washed habitats including the lips of Boiler Reefs. **Native.**



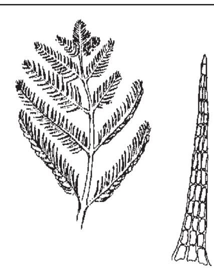
B, C, R

Soft Spineweed
Acanthophora spicifera
This sparsely branched pale yellow to reddish, red alga, gets its common name from the spiny final branches. It is a plant of sheltered rock bottoms such as inshore reefs. Commonly 10-15 cm (6-9 in) high, it may reach twice this size. **Native.**



B

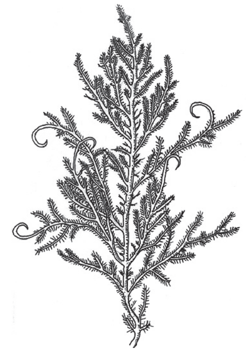
Stiff Sea Moss
Bostrychia binderi
A generally purple to black red alga that may bleach to yellowish in intense sunlight. Generally only about 2 cm (3/4 in) high this seaweed is commonly found in small depressions in the upper intertidal zone. **Native**.



R

B

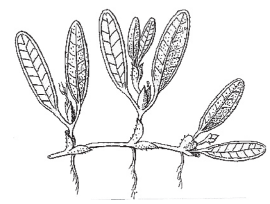
Thicketweed
Spyridia hypnoides
This red seaweed found in tangled masses on sandy bottoms and among seagrasses, often appears more yellowy-brown than red, as it entraps a lot of sediment which anchors it to the bottom. Often found in a mat 5-8 cm (1 3/4-3 in) deep and of variable extent, it has a branching, spiny appearance with many hook-shaped branches near to the tips. **Native**.



Herbaceous Flowering Plants

B, SG

Dwarf Seagrass
Halophila decipiens
This rare species of harbours and sounds has broad, oval leaves up to about 2 m (3/4 in) long arising from a buried rhizome. **Native**.

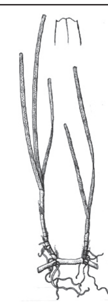


B, SG

Manatee Grass
Syringodium filiforme
Leaves round in cross section, narrow and up to 30 cm (6 in) long. Quite common in small stands and mixed with the other two species of seagrass. **Native.**

B, SG

Shoal Grass
Halodule wrightii
The smallest of the common Bermudian seagrasses. The leaf blades are flat and narrow, up to15 cm (6 in) long and 2 mm (1/16 in) wide. Commonly found around the edges of Turtle Grass beds or mixed in with the other two species. **Native.**



Turtle Grass
Thalassia testudinum
The largest and most common of the common seagrasses. Leaves flat and up to 1 m (3 ft) long and 5 mm (1/4 in) wide and commonly encrusted with epiphytes. Grows in clumps of leaves arising from a buried rhizome. Forms extensive beds. Important in sediment stabilisation and as food for turtles. **Native.**

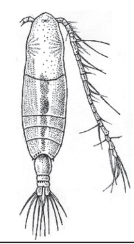
B, SG

Animal Plankton

Note: Zooplankton, although larger than phytoplankton are generally quite small**.** A compound or stereo microscope is needed for identification, depending on the size of the specimens. Sizes are given in metric units only.

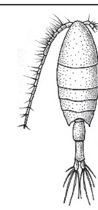
Crustacea (Copepods, shrimps, crabs etc)

Acartia bermudensis
This is a member of the permanent plankton and is a calanoid crustacean. Shaped rather like a grain of rice with two long antennae almost as long as the body. The length is about 1.2 mm and the body is almost colourless. **Native**.



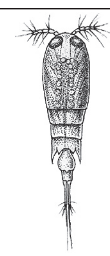
B

Calanopia americana
This calanoid crustacean is a member of the permanent plankton. The body is an elongated oval with antennae about 2/3 of the body length. About 1.4 mm long. Basically colourless. **Native**.



B

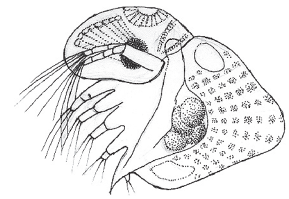
Corycaeus flaccus
A cyclopoid crustacean and a member of the permanent plankton. The colourless body has two prominent eyes and is broadest at the front, tapering steadily back. The antennae are short. Colourless. About 1.6 mm in length. **Native**.



B

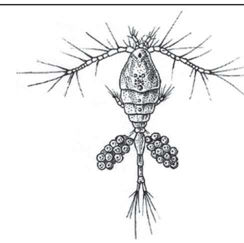
B

Evadne tergestina
Very similar to the species above except that the hind end of the shell is rounded and the head is more clearly set off from the body. About 0.7 mm in length. **Native**.



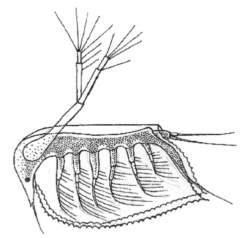
B

Oithona nana
A small cyclopoid crustacean of the permanent plankton. This species has a single eye at the front and females often have two egg sacs. The antennae are about half the length of the body. Colourless. About 0.6 mm long. **Native**.



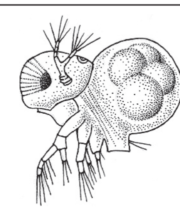
B

Penilia avirostris
This cladoceran crustacean has a small but obvious eye and antennae almost as long as the body. It has a beak-like point on the head and a rather rectangular body. About 1.1 mm long this creature is colourless. **Native**.



B

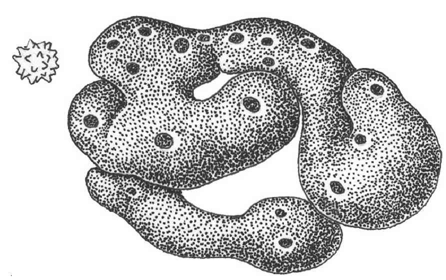
Podon polyphemoides
A cladooceran crustacean with large prominent eyes and a hump-backed body. The body is colourless and the antennae very short. Length about 0.7 mm. **Native**.



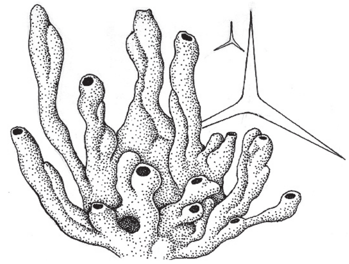
Sponges

B, SP

Chicken Liver Sponge
Chondrilla nucula
This sponge varies greatly in size but is commonly up to 15 cm (6 in) in size. It consists of groups of rounded oblong extensions, which are closely attached to the rock. The colour is greenish to brownish and the texture very smooth, hence its common name. This sponge also has plants within its body in a symbiotic relationship but in this case they are Blue-green cyanobacteria (formerly called Blue-green Algae). Common in many environments including all

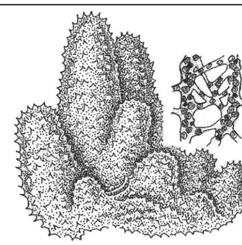


Dead Man's Fingers (Sponge)
Leucetta microraphis
A well named sponge as the upright finger-like lobes with a hole at the top are a deathly white colour. Common in the notch as well as in caves. A medium sized sponge up to 50 cm (20 in) high. **Native**.



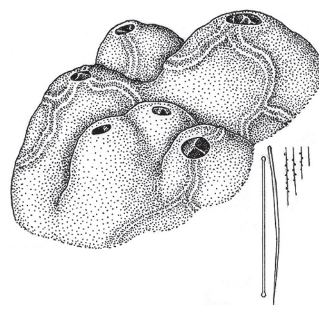
B, SP

Etherial Sponge
Dysidea etheria
This sponge is hard to mistake for any other as it is a clear sky blue. It is a small sponge, consisting of rounded lobes rarely over 5 cm (2 in) high in sheltered places. **Native**.



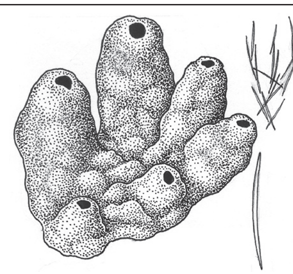
B, SP

Fire Sponge
Tedania ignis
This sponge up to about 10 cm (4 in) high may be found attached to both seagrasses and Thicket Weed. It is generally shaped like a thumb but may have several lobes. The main distinguishing feature is its red colour. This sponge can inflict a sting, so do not touch any red sponges. **Native.**



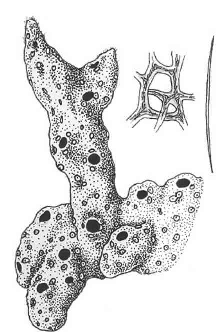
B, SG, SP

Green Chimney Sponge
Amphimedon viridis
This dull green sponge consists of thick chimneys in a group. Each chimney has a hole at the tip. A smallish sponge up to about 18 cm high (7 in) high. Very common in the notch and in caves. **Native**.



B

Lavender Anemone Sponge
Niphates erecta
This species which reaches about 15 cm (6 in) high is common on lagoonal and inshore reefs. Of an attractive lavender colour it consists of groups of irregular protrusions growing up into the water. Careful examination will usually reveal that the surface of the sponge includes many tiny anemones called Parazoanthus parasiticus. **Native**.



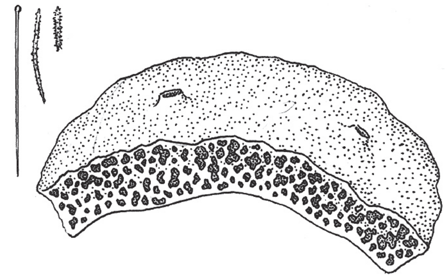
B, SG

Orange Boring Sponge

Cliona lampa

B, C

Visible as small patches and low bumps on the rock, this species is orange or yellow-orange in colour. The boring sponges erode limestone by a combination of chemical and mechanical methods, and eject very characteristic cubic particles which become incorporated into the sediments. A very common species on shallow inshore reefs and under Flatts bridge. Colonies to 30 cm (12 in) across. **Native**.



Violet Finger Sponge

Haliclona molitba

B, SG

This sponge is a beautiful clear violet colour. It is typically finger like in shape and about 5-10 cm (2-4 in) long. Its general habitat is as an epiphyte on seagrasses or seaweeds in coastal bays. **Native**.

Hydroids and Coral-like Hydroids

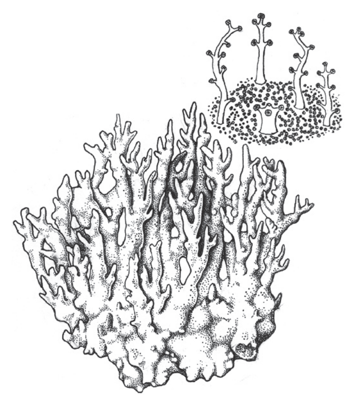
Coral-like Hydroids

Fire Coral

Millepora alcicornis

B, C

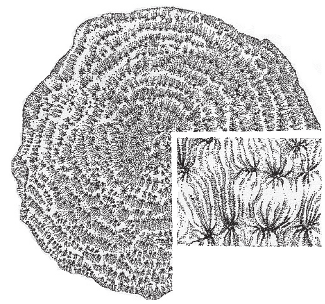
This is a hydrozoan that looks just like a coral. Of a pale dusky ochre colour, it can take almost any form, from a flat plate to a highly branched colony. It is smooth in texture and can inflict a mild sting, persisting for a few hours. Persons very sensitive to it can be in quite severe pain, so touching it is not recommended. It is a very important reef builder where wave action is severe, but common even in very sheltered, inshore situations. It is extremely variable in size. Up to 1 m (3 ft) high. **Native**.



Corals

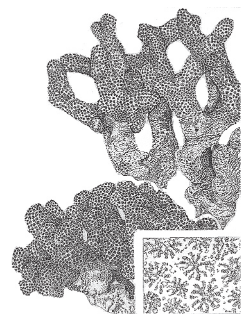
B, C

Chinese Hat Coral
Agaricia fragilis
The Chinese Hat Coral is a delicate coral of shady locations. It is typically found on the near-vertical sides of the reefs. Attached to the rock by a short stalk it grows into a thin, brownish conical structure up to 30 cm (1 ft) across, resembling a Chinese hat. It is not a reef builder. **Native**.



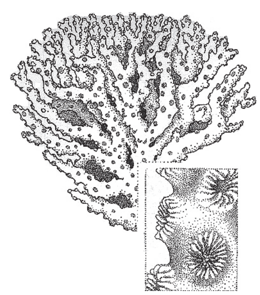
B, C

Finger Coral
Porites porites
This is a very variable coral, which can form quite large colonies up to 1.3 m (4 ft) across. It consists of finger or thumb like protrusions, which branch one to several times. Generally grey in colour, it can on rare occasions be a beautiful lavender shade. This species is becoming rare in Bermuda. **Native**.



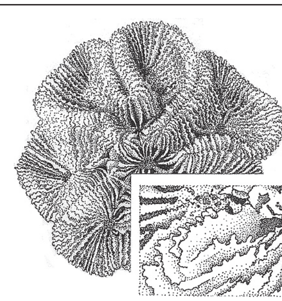
B, C

Ivory Bush Coral
Oculina diffusa
Ivory Bush Coral can form multi-branched, bush-like structures up to 75 cm (2 1/2 ft) high on quiet reefs such as those in Castle Harbour. In places it may form dense ‘forest-like’ communities. It is a delicate and beautiful coral. **Native**.

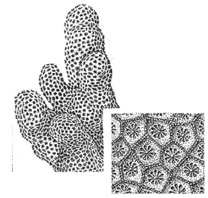


B, C

Rose or **Cactus Coral**
Isophyllia sinuosa
The most impressive feature of this small coral is the colour, which may be white, grey, green, yellow or brown, sometimes with iridescent highlights of orange or blue. It forms small domed, ridged colonies up to about 20 cm (8 in) across and lives on near-shore reefs. **Native**.

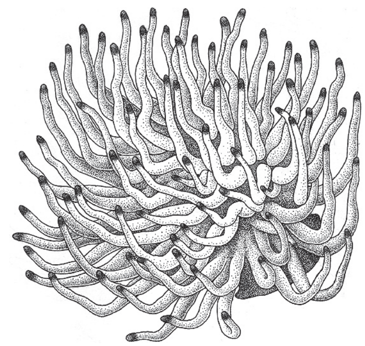


Ten-ray Star Coral C
Madracis decactis
The colonies are generally less than 30 cm (1 ft) across and consist of a collection of brownish knobs, closely grouped together. **Native.**

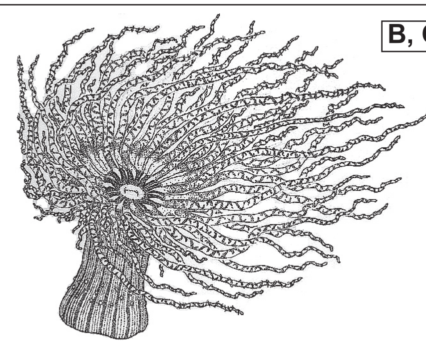


Anemones

Purple-tipped Sea Anemone B, C
Condylactis gigantea
This pale green, very distinctive large anemone has purple-tipped, robust tentacles and is up to 30 cm (1 ft) in diameter. The body of the anemone is usually hidden in a crevice, but the crown of tentacles is very obvious. Careful examination of this anemone will usually reveal the presence of one or more cleaner shrimps among the tentacles. Present on all types of reef. **Native**.

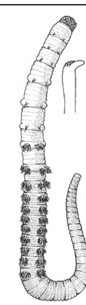


Ringed Anemone B, C, SP
Bartholomea annulata
This medium sized, common, pale brown anemone has numerous tentacles which have distinctive lighter rings around them. Normally about 6 cm (2 1/4 in) in diameter including the tentacles it is found in an amazing variety of habitats from mangrove swamps to the outer reefs. **Native**.

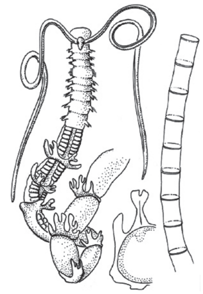


Polychaete Worms

Cockworm B
Arenicola cristata
A large worm that constructs U-shaped burrows that develop a pit at the head end and a mound of castings at the tail end. The worm is up to 25 cm (10 in) long and 1 cm (1/2 in) wide. The soft body has a series of bright red gills. Used widely as bait. **Native.**



Ringed Tube Worm
Spiochaetopterus costarum oculatus
This worm is much more likely to be found in a fishes stomach than elsewhere. The body is slender and up to 60 mm (2 1/4 in) long, with two very long antennae. The tube the worm inhabits is parchment-like with regular rings. **Native**.

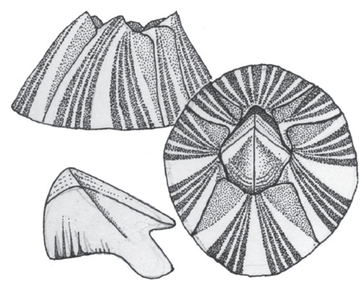


B

Crustacea

Barnacles

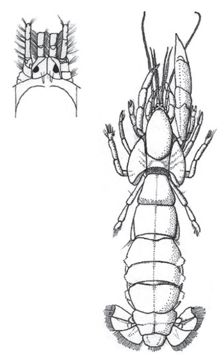
Striped Barnacle
Balanus amphitrite
This barnacle, common on rocky shores occurs at near to high tide level. It is conical with stripes running up the sides of the cone. The opening at the top can be closed with four plates. Up to about 1 cm (3/8 in) in diameter but usually much smaller. **Native.**



R

Shrimps

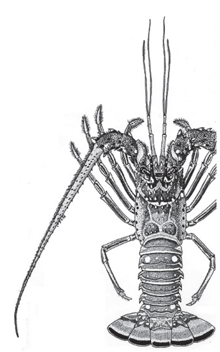
Burrowing Shrimp
Callianassa branneri
A quite large, somewhat lobster-like shrimp common in sandy, shallow bays. The burrow locations are easily recognised by a large, volcano-like mound of sand with a hole at the top through which sand is ejected. The rarely seen shrimp is about 10 cm (4 in) long, cream in colour, with a large abdomen and one large claw. **Native.**



B

Lobsters

Spiny Lobster
Panulirus argus
The Spiny Lobster is the main lobster fished for food in Bermuda and the Caribbean. Living in crevices and caves within the reefs, it emerges at night to feed on a wide variety of food. These lobsters can measure up to 50 cm (1.5 ft) or more in length. They have no large claws but do have long, robust antennae. The colour is reddish brown. **Native**.

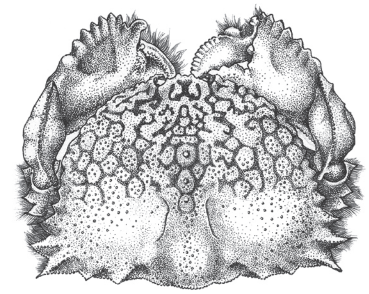


B, C

Crabs

B

Ocellated Box Crab
Calappa ocellata
This fascinating, chunky crab, about 10 cm (4 in) across the back, is difficult to find, as by day it lies buried in the surface of the sand, with which it is well camouflaged, being a mottled creamy-brown**.** If disturbed the crab becomes a very compact shape with all legs tucked out of sight. It is a nocturnal predator at the sand surface. **Native.**

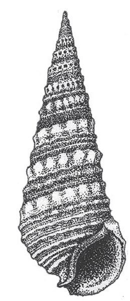


Gastropoda

Snails

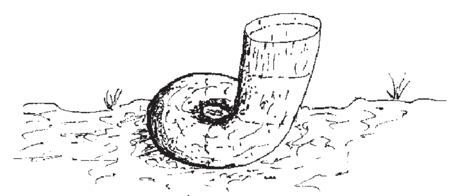
B, M

False Cerith
Batillaria minima
These little shells often occur in almost countless profusion on sheltered shores, particularly where there is both rock and sediment. Reaching only 15 mm (5/8 in) in length, the shell is very tall and slender with numerous whorls of ridges and small bumps. **Native**.



R

Large Tube Shell
Serpulorbis decussatus
This is the largest tube shell in Bermuda with an opening up to 7 mm (1/4 in) in diameter. The rim of the shell is exceedingly sharp and can puncture even stout footwear. The shell is white but the snail within comes in either white or red colour phases. There is no operculum. Usually, the shell is cemented to the rock, but sometimes the shells are cemented to each other in huge numbers to form Vermetid (Worm Shell) Reefs. **Native**.



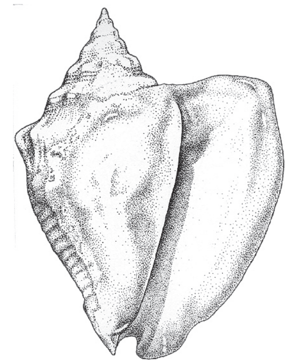
B, SG

Lettered Horn Shell
Cerithium litteratum
This is a tall, heavy-shelled snail up to 3 cm (1 1/4 in) in length. It is a very variable shell but the surface is usually ornamented with whorls of smooth bumps and patterned with small dots. Common in bays and seagrass beds. **Native.**

Milk or **Harbour Conch** **B**

Strombus costatus

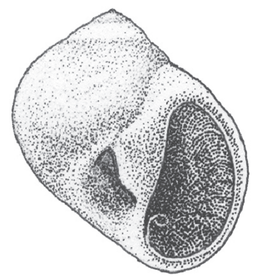
As an adult the Harbour Conch is virtually impossible to confuse with anything else. The shell is large and very heavy, measuring up to 20 cm (8 in) in length. The shell opening has a large flared lip. The colour is generally whitish often with tinges of pink. Juvenile Harbour Conchs are very common in many shallow bays and seagrass beds. They have a much less heavily built shell and there is no flared lip. **Native.**



Milky Moon Snail **B**

Polinices lacteus

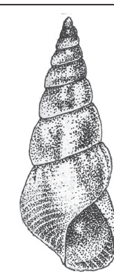
This moon snail has a very globose shell about 2 cm (3/4 in) long. The shell is glossy milk-white in colour and is commonly found empty on the sand surface. The living snail has a very large foot and it burrows randomly through the sediment in search of its clam victims. This snail makes a very distinctive egg collar found on the sediment surface**. Native.**



Varicose Alaba **B**

Alaba incerta

This elongated, almost smooth snail, reaching 7 mm (1/4 in) in length is common in sand. The shell has faint spiral grooves and is yellow to light brown in colour. Shells of this snail are commonly washed up on shore. **Native.**



Zebra Periwinkle **R**

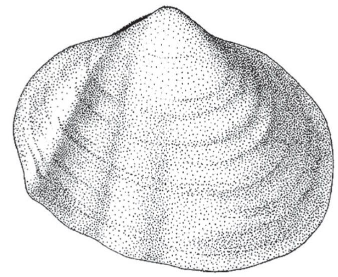
Littorina ziczac

The shell is oval-shaped, greyish-white in colour with irregular oblique purplish brown stripes. Found on exposed rocky shores in a narrow band at the top of the mid-littoral zone. To 2 cm (3/4 in). **Native**.

Clams and Mussels

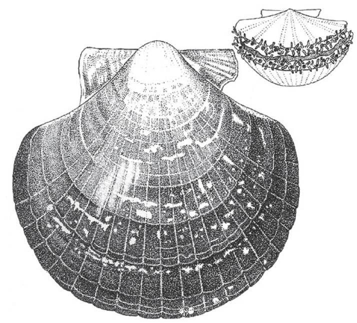
B

Atlantic Grooved Macoma
Psammotreta intastriata
The thin, rounded shell is a dull white and quite strongly inflated; length up to 6 cm (2 1/2 in). This deep-living clam has a siphon that reaches beyond the sand surface. The characteristic feature is that one end of the shell is twisted. **Native.**



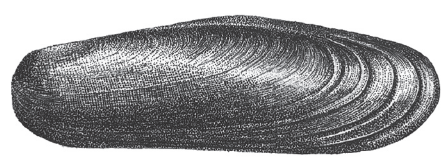
B

Bermuda Scallop
Pecten ziczac
Scallops lie just at the sediment surface where they may be camouflaged with a thin layer of sediment. If disturbed they can swim a short distance by flapping the shells. The Bermuda Scallop up to 8.5 cm (3 1/4 in) across has a flat upper and strongly convex lower shell. Variable in colour but usually a reddish brown. **Native**.



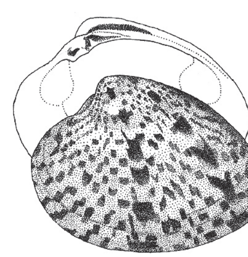
B, C

Black Date Mussel
Lithophaga nigra
This is a species which can only be seen as an oval hole showing the mouth of the burrow in the limestone. The mussel looks very like a large date pit, with ridges on the larger end of the shell. Up to 4 cm (1 1/2 in) long these shells can be present in very large numbers. To enlarge the burrow as they grow they both dissolve the limestone and scrape it away. They are filter feeders. **Native**.

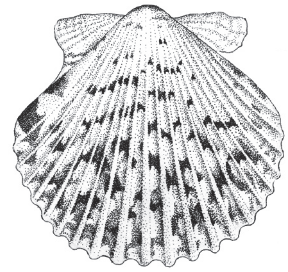


B

Calico Clam
Macrocallista maculata
Shell thick and shiny, up to 8 cm (3 in) long and 6 cm (2 1/4 in) wide. Shell ornamented with very attractive checkerboard-like markings in brown on a beige background. A shallow burrower. A filter feeder. **Native.**

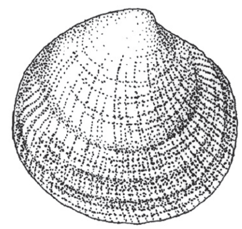


Calico Scallop
Argopecten gibbus
Like the Bermuda Scallop the calico scallop lies on the sediment and can swim briefly. One shell, the lower, is slightly more convex than the other is. Growing to 7 cm (2 3/4 in) across the scallop is mottled in brown, red, purple and yellow on white. **Native**.



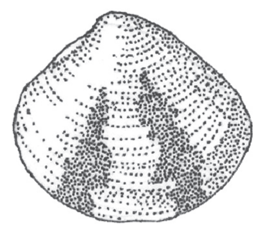
B

Dwarf Tiger Lucina
Codakia orbiculata
This is a dwarf version of the Tige Lucina, being up to 3 cm (1 1/4 in) across. The rough, dull, thick, chalky-white shell has circular and radial ridges. **Native.**



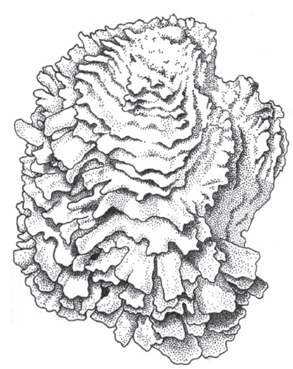
B

Gould's Cerina
Gouldia cerina
This small clam about 1 cm (3/8 in) lives in the deep mud bottom of Harrington Sound. The rounded shell, slightly heart-shaped, is bone white with brown mottlings. **Native**.



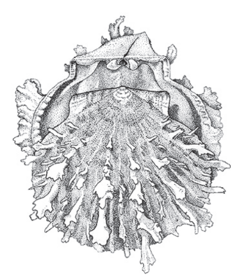
B

Leafy Jewel Box
Chama macerophylla
This is a very heavily built shell that is found cemented by one valve to the surface of the reef. The surface of the shell, shaped like an irregular circle, about 8 cm (3 in) across, is ornamented with many scale-like plates. The colour may be very varied from yellow to orange, red, or lavender, but the outside is often overgrown with other organisms. The interior is very smooth and colourful, hence the common name. **Native**.



B, C, R

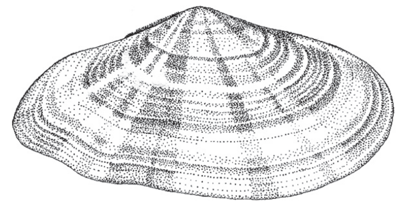
Rock Scallop
Spondylus ictericus
The rock scallop may be found living with its lower shell firmly cemented to the reef surface. The upper shell, which is almost circular, is ornamented with numerous, flattened spines. The colour may be white, yellow orange or red. To 13 cm (5 in) across. **Native**.



C, R

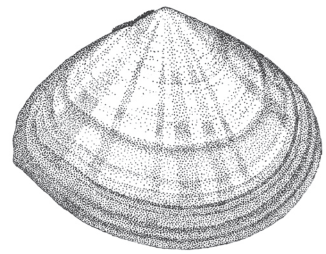
B

Sunrise Tellin
Tellina radiata
A deep-burrowing clam that feeds on detritus at the sediment surface through a long siphon. The elongate-oval, thin shell, up to 10 cm (4 in) long has radiating pinkish-red rays on a creamy background. **Native.**



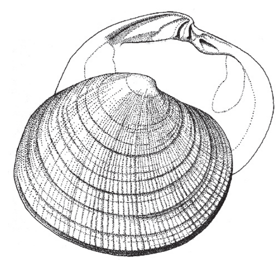
B

Sunset Clam
Tellina laevigata
This clam has a deep burrow but feeds at the sand surface by means of a long extensible siphon. The smooth, creamy, rounded-oval shell may reach 10 cm long. The shell is ornamented by salmon-pink radiating rays. **Native.**



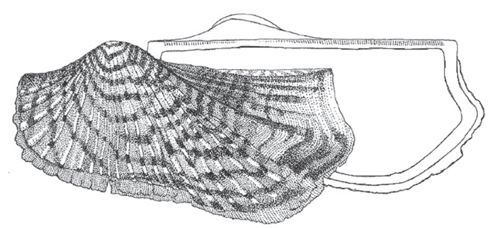
B

Tiger Lucina
Codakia orbicularis
This probably **extirpated** species has a very rounded shell up to 9 cm (3 1/2 in) across, that is chalk-white and robust. There are obvious radiating and circular ridges, making the shell rough in texture. A shallow, burrower. **Native.**



B

Zebra Mussel
Arca zebra
Often called the 'Bermuda Mussel' and formerly used in mussel pie, this shellfish has an elongated thick shell which is absolutely straight along the long hinge between the shells. As suggested by the common name, the light brown shell has prominent dark brown zigzag markings. This mussel is normally attached to hard surfaces by means of strong dark threads called byssus. Grows to about 8 cm (3/4 in) long. **Native.**

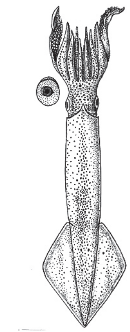


Squids and Octopusus

Squids

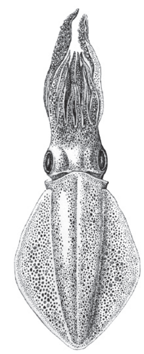
B, C

Arrow Squid
Loligo plei
This squid can reach 30 cm (1 ft) in length but ones seen inshore and over seagrass beds may be half this size. The body is long and slender with the fins at the hind end only. The greyish colour is enhanced by small brown spots. Like other squids this species may swim slowly forward or dart rapidy backward. **Native.**



B, C

Reef Squid
Sepioteuthis sepioidea
Up to 30 cm (12 in) long, these squid occur in groups over the reefs and inshore waters. They are quite transparent but are covered in small brown dots and show iridescent blue colour as they move. They feed on small fish and swimming crustacea. When threatened they can produce a cloud of ink and retreat backwards at high speed. **Native**.



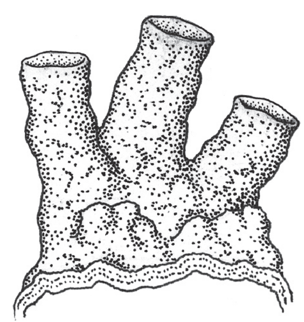
Moss Animals

B, SP

Greybeard Sea Moss
Zoobotryon verticillatum
This moss animal or Bryozoan is constructed of a series of transparent very light grey coarse threads. It usually hangs down from the notch top, but may be on a buoy or submerged branch. Up to 10 cm (3 in) long. **Native**.

B

Pink Sea Moss
Schizoporella errata
This is an encrusting seamoss in which the colony forms a thin, flat sheet with a slightly upturned edge, attached to the rock. In colour it is an orangy-pink and the texture is quite rough. The tiny individual animals are just visible to the naked eye. Colonies may be at least 15 cm (6 in) across. **Native.**

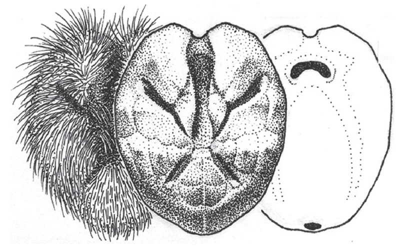


Echinoderms

Sea Urchins

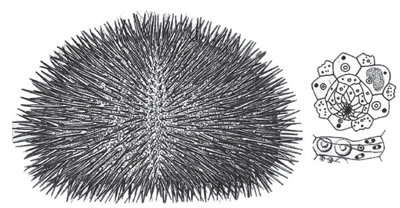
B

Heart Urchin
Moira atropos
This small heart urchin is delicate and burrows deeply in the mud or muddy sand. If seen it is a delicate orange brown and covered in short spines. Only reaching 5 cm (2 in) long it is almost spherical in shape and the small mouth is on the underside. **Native**.

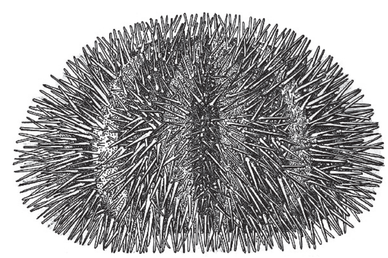


B, SG

Purple Urchin
Lytechinus variegatus
This is the commonest urchin of sandy bays and seagrass beds. It is deep purple in colour and the body commonly about 8 cm (3 1/4 in) in diameter. The spines are quite short and thickly placed. This urchin often carries pieces of flotsam and seaweed on its back for camouflage. **Native.**



White Urchin
Tripneustes ventricosus
This handsome urchin of the seagrass beds has white spines which contrast with the somewhat darker body. Growing up to about 10 cm (4 in) in diameter this species has been getting less common in recent years. **Native.**

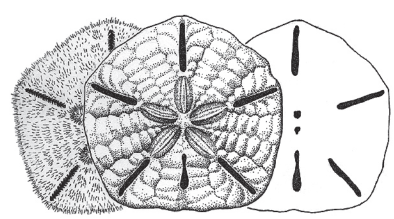


SG

Sand Dollars

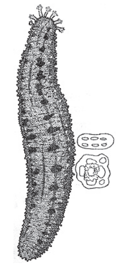
B

Sand Dollar
Leodia sexiesperforata
This very flattened echinoderm has a virtually circular body which has six slit-like perforations one of which is keyhole-shaped**.** This pale brown animal moves just beneath the sediment surface leaving an irregular meandering trail. Commonest where there is some current. About 8 cm (3 1/2 in) across. **Native.**

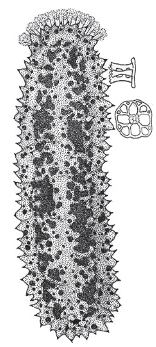


Sea Cucumbers

Burrowing Sea Cucumber B
Holothuria arenicola
This deeply burrowing, large sea cucumber is very rarely seen but is common. The body reaches 25 cm (10 in) long and 4 cm (1 1/2 in) wide. It is dark-brown with darker patches. **Native.**

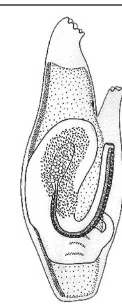


Sea Pudding B
Isostichopus badionotus
The sea cucumber known in Bermuda as the sea pudding. Cannot be confused with anything else. The elongated, rubbery body is domed on top and forms a flat foot-like organ on the bottom. The colour varies from entirely light brown to near black, or is blotched in these colours. A large animal reaching 35 cm (14 in) long. **Native**.

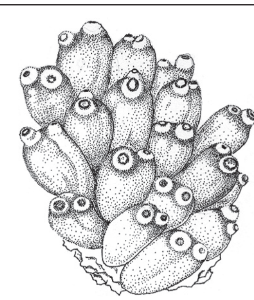


Sea Squirts

Black Sea Squirt B
Phallusia nigra
This is a very obvious, solitary sea squirt commonly attached in the notch or on underwater cliffs. The colour is jet-black and the body smooth. The sac-like body is up to 7 cm (2 3/4 in) in length and has two prominent openings. **Native.**

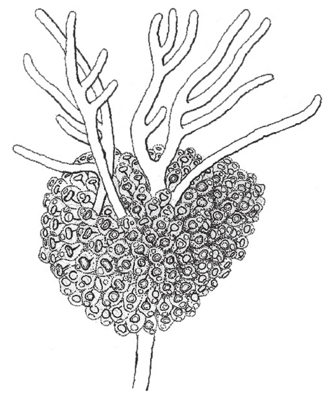


Orange Sea Squirt B, SP
Ecteinascidia turbinata
This species lives in just the same habitat as the Purple Sea Squirt but the individuals are a little smaller as are the colonies reaching only about 15 cm (6 in) across. The colour is a fairly uniform soft orange with a darker ring at the apex. **Native**.



B, SP

Purple Sea Squirt
Clavelina picta
This sea squirt and the following species may often be found in colonies on the stalks of soft corals. Each individual is of great beauty, consisting of an almost transparent sack about 1 cm (3/8 in) in length, through which can be seen the internal organs. The colonies can reach 40 cm (15 in) across. At the top of the sack a brilliantly iridescent purple ring, with an inner margin of white is very obvious around the larger of the two openings. Sea squirts are filter feeders. **Native**.

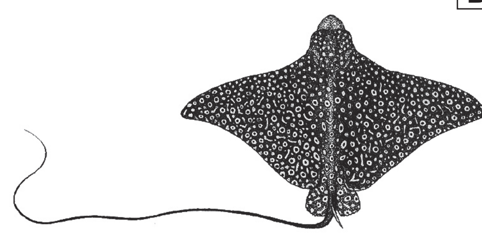


Fish

Rays

B, O

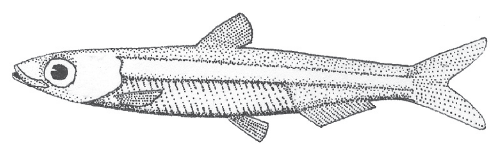
Spotted Eagle Ray
Aetobatus narinari
This ray, common over sandy bottoms where it hunts its shellfish prey, is unmistakable. Up to 1.5 m (4 1/2 ft) across, but commonly smaller, The Spotted Eagle Ray has a very wide flat body and a long tail. The back is dark-grey and covered with light spots with a dark centre. **Native.**



Anchovies

B

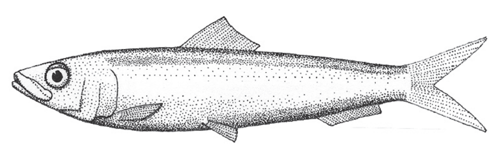
Blue Fry
Jenkinsia lamprotaenia
A very small, silvery fish with a streamlined body and large eye. The mouth is small, ending at the front edge of the eye. Grows to 6.5 cm (2 1/2 in) but is usually half this length. Swims in large schools with other fry. **Native.**



Herrings

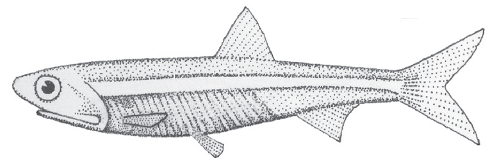
B

Anchovy
Sardinella anchovia
This fish is the largest of this group of small herrings found in bays and over seagrass beds. It may reach 30 cm (1 ft) in length. The eye is medium in size as is the mouth which extends back to the centre of the eye. **Native.**



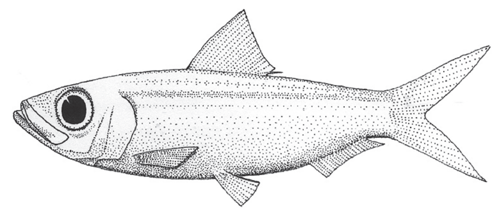
B

Bermuda Anchovy or **Hogmouth Fry**
Anchoa choerostoma
This is one of the tiny fish called 'fry', that are much used as bait. The body is streamlined, silvery, and up to 10 cm (4 in) long but usually about 4 cm (1 1/2 in). The mouth is large, extending to well behind the eye. **Endemic**.



B

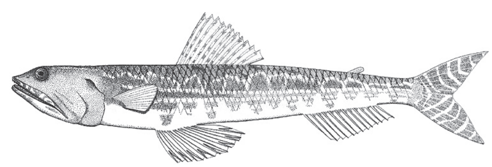
Pilchard
Harengula humeralis
A larger member of the 'fry' group, the Pilchard grows up to 15 cm (6 in) in length. The eye is very large, the body somewhat flattened from side to side. Silvery with a blueish tinge it is common in bays. **Native.**



Lizardfishes

B

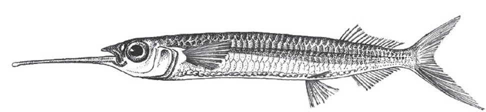
Sand Diver or **Snakefish**
Synodus intermedius
This 30 cm (12 in) long fish is a real bottom dweller. Usually seen resting on the sand, the Sand Diver has a large head leading to a steadily tapering body, longitudinally striped in blue and yellow. The distinctive feature is a dark spot at the upper end of the gill cover. The mouth is upturned. **Native**.



Needlefish and Halfbeaks

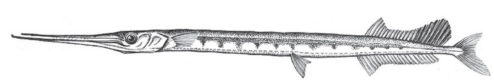
B

Bermuda Halfbeak or **Garfish**
Hemiramphus bermudensis
This fish is often referred to as the Garfish. It is a lightly built, slender fish averaging about 30 cm (1 ft) long. The eye is very large and the Bermuda Halfbeak has the lower jaw prolonged into a needle-like structure. **Endemic**.



B

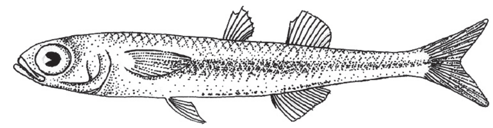
Needlefish or **Houndfish**
Tylosurus acus
The Needlefish is a very slender silvery fish up to 1 m (3 ft) in length but those commonly seen are about 50 cm (1 1/2 ft). The eye is large and both jaws are elongated and very thin. **Native.**



Silversides

Rush Fry
Hypoatherina harringtonensis
Although very similar to the fry described previously this fish is actually in a different family. It can be distinguished from the other 'fry' by its having a larger head and a body which tapers steadily from the back of the head. Grows to 8 cm (3 in) but is usually about 4 cm (1 1/2 in) long. **Native.**

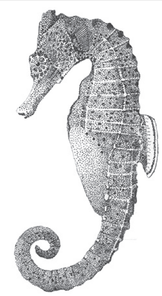
B



Seahorses

Longsnout Seahorse
Hippocampus reidi
Unfortunately these amazing little fish are becoming rare in Bermuda. Found on seaweeds and seagrass beds where they attach themselves with the tail. Usually about 8 cm (3 in) tall, seahorses can change colour to blend in with the background. **Native**.

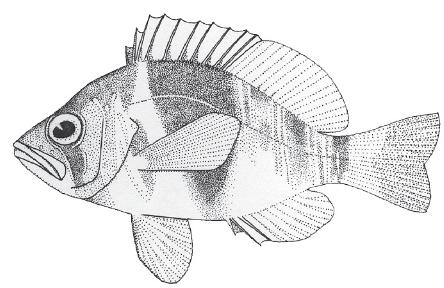
B, SG



Groupers

Barred Hamlet
Hypoplectrus puella
This fish is a small member of the grouper family. It is a charming little fish that is quite deep in the body and having a tan to yellowish overall colour with 4-5 dark bands on each side. The band below the spiny dorsal fin is much broader than the others. There are also blue and yellow diagonal streaks especially on the head. Up to about 13 cm (5 in) in length. Common in bottom rubble in deeper bays. **Native.**

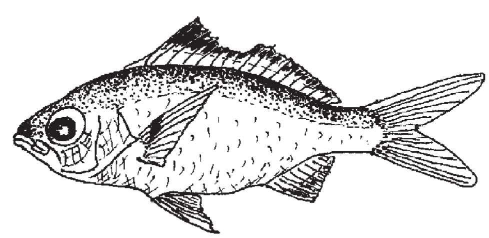
B



Mojarras

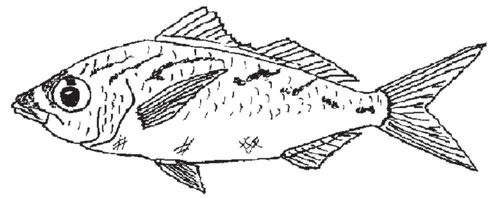
Bigeye Mojarra
Eucinostomus havana
This fish while very similar to the Spotfin Mojarra described above is distinguished by its larger eye and the black border on the front dorsal fin. The length is up to about 13 cm (5 in). **Native**.

B



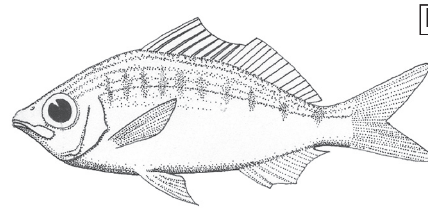
B

Mottled Mojarra
Eucinostomus lefroyi
Quite similar to the Spotfin Mojarra below, and about the same size, up to 13 cm (5 in). However, this species can usually be distinguished by the mottling on the back and always by the square dark spot in the upper part of the eye. **Native.**



B, SP

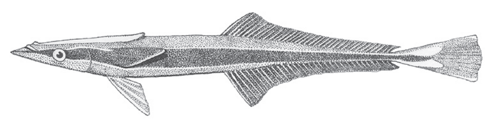
Shad or **Silver Jenny**
Eucinostomus gula
This deep-bodied silvery little fish grows to about 13 cm (5 in) long. The back, or dorsal fin has a dark smudge at the top front. Shad often occur in large numbers. **Native**.



Remoras

B, O

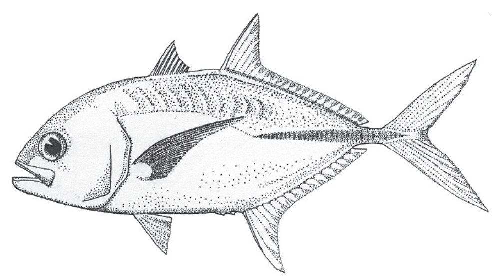
Sharksucker or **Remora**
Echeneis naucrates
This is a very slim fish up to 1 m (3 ft) long, with its dorsal fin modified to form an elaborate sucker on top of the head. While, as their name suggests, this sucker can be used to attach to sharks or rays, many Remoras swim freely around. They have been known to attach to many other things, including underwater cameras and even human swimmers! **Native**.



Jacks and Pompanos

B, O

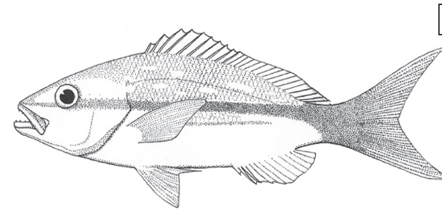
Horse-eye Jack
Caranx latus
The Jacks are silvery-blue or silvery-green fishes with a fairly deep body and a deeply forked tail. In the Horse-eye Jack, the tail is yellow and there is a black spot on the edge of the gill cover. The body is dark blue-grey on top and silver below. Feeds mainly on small fish. Length to 100 cm (3.3 ft) but those in the sound are usually half this. **Native**.



Snappers

B, SP

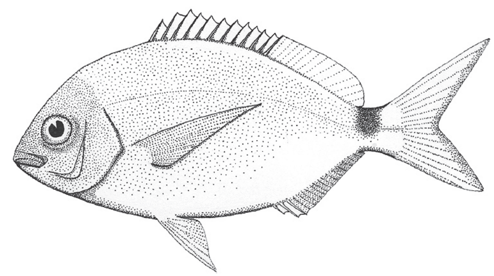
Yellowtail Snapper
Ocyurus chrysurus
A very attractive fish with a silvery-blue body, about 30-60 cm (1-2 ft) long, with a very prominent yellow stripe from the eye, extending into the deeply-forked tail. **Native**.



Chubs and Breams

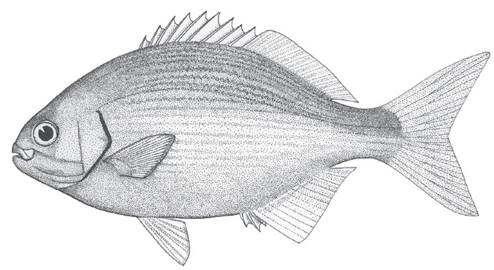
B

Bermuda Bream
Diplodus bermudensis
The Bermuda Bream is similar to but smaller than the Bermuda Chub growing to 40 cm (16 in). Bermuda Bream have relatively small heads and eyes, and are a dull silvery-grey in colour. The Bermuda Bream and the Bermuda Chub are easily told apart by the presence on the Bermuda Bream of a large dark spot, just above the base of the tail. **Endemic.**



B

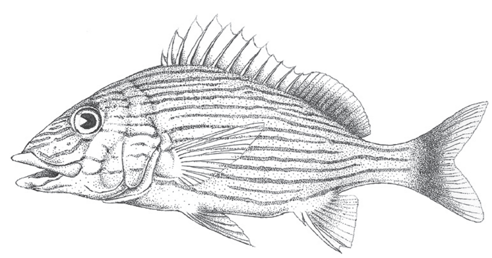
Bermuda Chub
Kyphosus sectatrix
The Bermuda Chub can reach 76 cm (30 in) and a weight of up to 9 kg (20 lb). Bermuda Chub have relatively small heads and eyes, and are a dull silvery-grey in colour. The overall colour is relieved by many narrow, darker stripes running along the body. **Native.**



Grunts

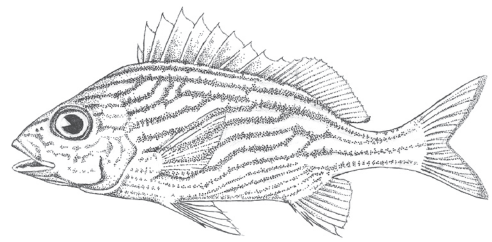
B

Blue-striped Grunt
Haemulon sciurus
From the side the grunts have an arched back and flattish lower side. The Blue-striped Grunt growing to 35 cm (14 in) long is a basically yellow fish with numerous, bold, blue stripes on the head and body and a dark tail and hind dorsal fin. **Native.**



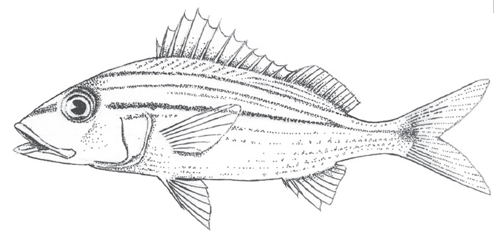
B

French or **Yellow Grunt**
Haemulon flavolineatum
This is one of eleven members of this family found in Bermuda. The French Grunt, has a relatively deep body, blue in colour with many yellow stripes. The stripes are parallel close to the back but become diagonal lower down. Grunts may form large schools, often with more than one species present. By day, they tend to be around, reefs, rocks and other cover, but at night they disperse over sandy bottoms and grass beds to feed on small crustaceans. The length in adults ranges from 15-25 cm (6-10 in). **Native.**



B

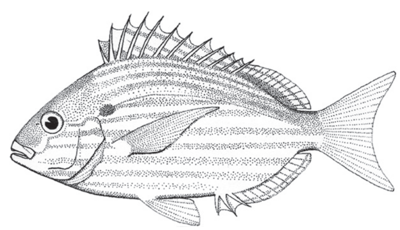
White Grunt or **Tomtate**
Haemulon aurolineatum
This very common fish of bays and sounds is basically a silvery colour ornamented with two bold stripes, one through the eye and the other above it. There are other faint yellow lines. This fish reaches 25 cm (10 in) long but is mostly half this size. **Native.**



Porgies

B, SP

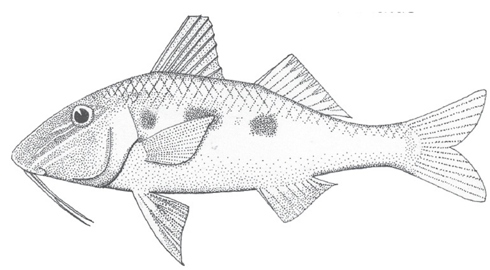
Pinfish
Lagodon rhomboides
The Pinfish is relatively deep in the body and takes its name from sharp spines in the dorsal and pelvic fins. Growing to about 20 cm (8 in) long it has blue, longitudinal stripes on a yellowish to greenish-silver body. **Native.**



Goatfishes

B

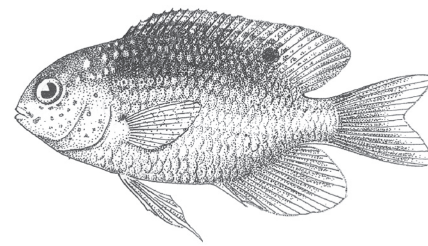
Spotted Goatfish
Pseudupeneus maculatus
This interesting fish reaching 23 cm (9 in) long. When swimming up in the water the two barbells beneath the chin are distinctive. The eyes are large and the body heavy. The active colour phase shows three large, dark spots on the body. In the inactive phase the spots fade and rusty-red patches appear. **Native.**



Damselfishes

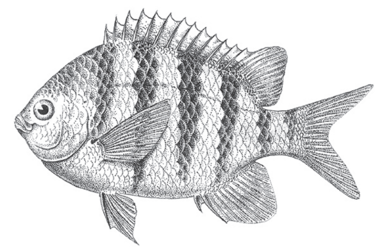
B, C

Beaugregory
Stegastes leucostictus
Beaugregories are quite small damselfish up to 10 cm (4 in) long. Except in older individuals, the body is blue on top and yellow beneath. Older fish become more dusky in appearance with blue spots on the dorsal fin. About 10 cm (4 in) long. **Native.**



B, C

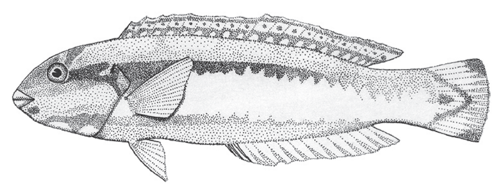
Sergeant Major or **Cow Polly**
Abudefduf saxatilis
The Sergeant Major is one of the damselfishes, and is strikingly coloured with a blue head, and with vertical dark bars on a yellow background along its back, grading to light blue beneath. It is a very active small fish, up to 15 cm (6 in) long.



Wrasses

B

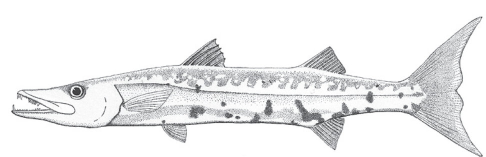
Slippery Dick
Halichoeres bivittatus
Like many of the wrasses this 18 cm (7 in) long wrasse of bays and seagrass beds, goes through a bewildering series of colour changes as it matures**.** Juveniles are whitish with a dark stripe down the centre of each side. Intermediate phase individuals vary greatly but are mostly greens with brown markings. Terminal phase adults have longitudinal bars of green, yellow and pinkish-brown. **Native.**



Barracudas

B, C, O

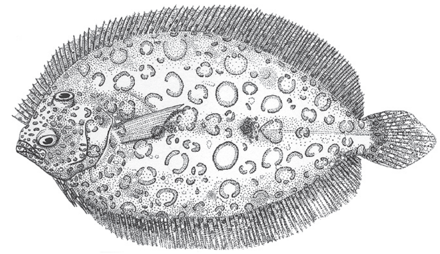
Great Barracuda
Sphyraena barracuda
Juveniles, up to about 45 cm (18 in) in length, are very frequent in the bays. Adults up to at least 1 m (3 ft) long may be seen on the reefs. This elongate fish is best recognised by the very large mouth with needle-sharp teeth, and elongated silvery body with dark markings. **Native**.



Flatfishes

B

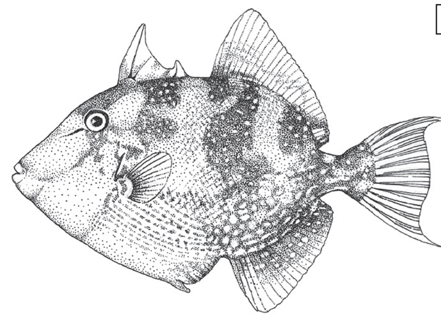
Peacock Flounder
Bothus lunatus
This flounder is one of the flatfishes, which are a group of fish that lie on the bottom on one side. Both eyes are on the upward side. Most flatfishes are very adept at changing their colour to match that of the bottom. The Peacock Flounder not only does this but also wafts some of the bottom sand over its body. Often just the eyes remain visible. Common on sandy bottoms. Up to 45 cm (18 in) long. **Native.**



Triggerfishes

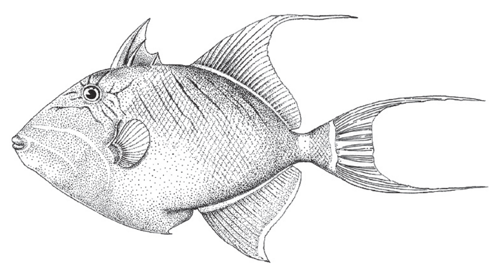
B, C

Grey Triggerfish
Balistes capriscus
Triggerfish have a medium deep body with the eyes set back on a long sloping forehead, it reaches about 35 cm (1 ft) long but those seen in shallow water are usually half this length or less. The basic body colour may be grey to yellowish-brown but there are always blue spots and lines on the upper body and fins. **Native**.



B, C

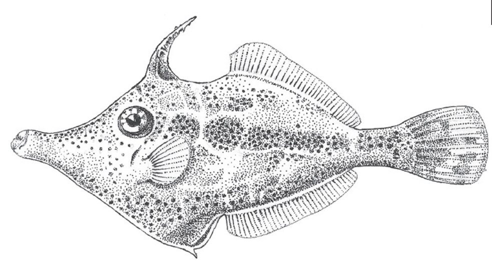
Queen Triggerfish
Balistes vetula
Triggerfish have a medium deep body with the eyes set back on a long sloping forehead. This is the most striking of all triggerfish, with a purple-blue lower body and fins, and a yellowish back and head. The large fins have trailing edges. There are two diagonal clear blue stripes on the head. Large adults reach 45 cm (18 in) long. **Native**.



Leatherjackets

B

Slender Filefish
Monacanthus tuckeri
The Slender Filefish has a very distinctive body shape and is only 10 cm (4 in) long. The snout is almost tube like but gives way to a high head with very large eyes. Above the eye on the back is a stout, curving spine. The brown body usually has a white chequerboard pattern. **Native.**



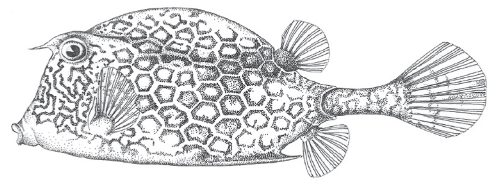
Trunkfishes

Honeycomb Cowfish

B

Acanthostracion polygonius

This is one of the Boxfish family, growing up to about 30 cm (1 ft) long. It has two little horns between the eyes and a box-like, very firm body, covered with blackish polygons on a cream background. The tail is large and set on a narrow stalk. **Native**.

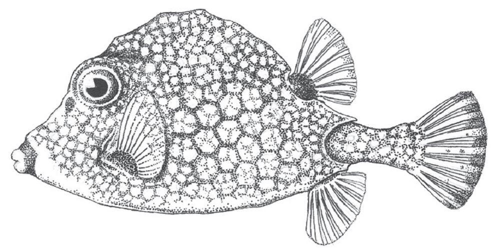


Smooth Trunkfish

B

Lactophrys triqueter

Like the Honeycomb Cowfish this species grows up to about 30 cm (1 ft) long and also has a box-like, very firm body. This species also has polygons on the body but they are less obviously displayed in a black background with light spots. The tail is large and set on a narrow stalk. **Native**.



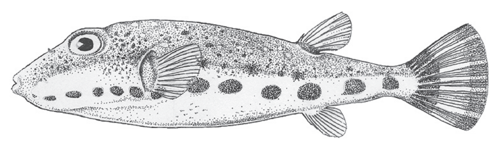
Puffers and Porcupine Fishes

Bandtail Puffer

B

Sphoeroides spengleri

Like the Sharpnose Puffer the Bandtail Puffer has a large head and tapering body. The Bandtail Puffer has a brown back and white belly and grows up to about 30 cm (1 ft) long. This species can inflate just like the Sharpnose Puffer below. **Native**.



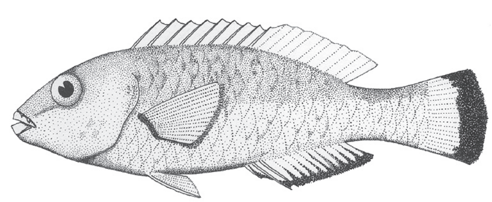
Parrotfishes

Bucktooth Parrtofish

B. SG

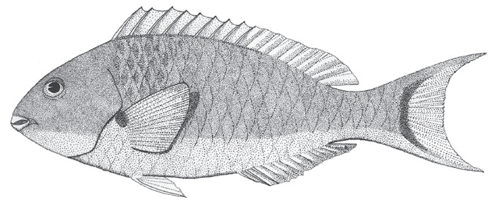
Sparisoma radians

This is the characteristic parrotfish of seagrass beds. It is smaller than most other parrotfish reaching a size of 19 cm (7 1/2 in) long.
The colour is very variable, having mottles, patches or stripes of muted browns, yellows and reds. There is a distinctive black margin to the tail. Juvenile specimens are mottled in greens, yellows and browns to blend in with the seagrasses. **Native.**



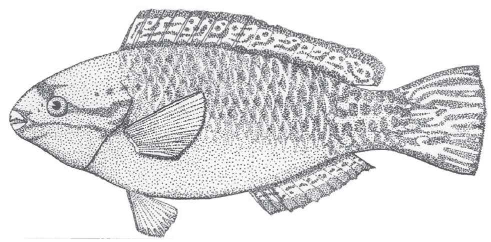
B, C

Redtail Parrotfish
Sparisoma crysopterum
This Parrotfish has a distinctive crescent-shaped mark on the tail. The primary colour phase is olive-green on the back, a mottled reddish colour on the sides and with a pale belly. Terminal males are green with brown-bordered scales. On the sides the body is blue-green becoming clear blue lower down. The fins are all reddish. One of the smaller parrotfish reaching about 35 cm (13 in). **Native**.



B, C

Striped Parrotfish
Scarus croicensis
The primary phase shows three broad, dark brown stripes running the length of the body. The lowest stripe is lighter in colour. The body is whitish with a yellow snout. The terminal male has a pink lower head and chest. The top of the head is orange and a green-blue stripe runs through the centre. The body is blue-green and orange with a central pink stripe on the forward half. Fins are blue and orange. Grows to about 35 cm (13 in). **Native**.

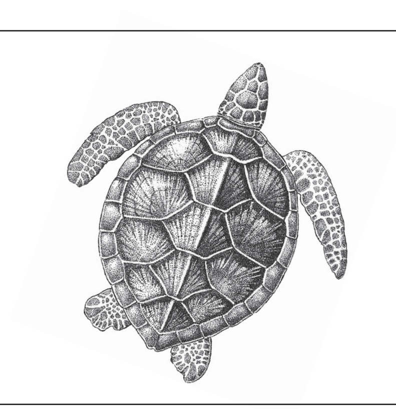


Turtles and Terrapins

Turtles

B, O, SG

Green Turtle
Chelonia mydas
The Green Turtle is the commonest of the marine turtles seen in Bermuda and used to breed here. Up to at least 1 m (3 ft) long, they may be any shade of colour between dull, dark green and virtually black. The adults feed on sea-grasses and seaweeds and the occasional sessile invertebrate. Always present in Walsingham Pond and occasionally seen in others. **Native**.

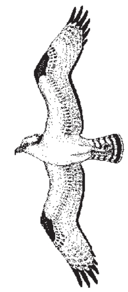


Birds

Hawks

B

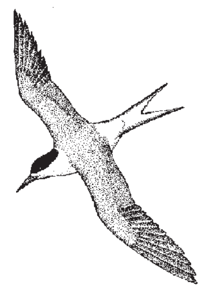
Osprey
Pandion haliaetus
This fish-hawk is a regular visitor to Bermuda but does not breed here. The beak is strongly hooked and there is a broad dark stripe through the eye. When fishing it swoops down to the surface and carries off the prey in its strongly hooked claws. About 55 cm (18 in) long. **Native**.



Terns

B

Common Tern
Sterna hirundo
This tern used to breed in Bermuda in large numbers but now only about 25 pairs do so. Terns fish in shallow waters, diving to catch fry or other small species. 35 cm (about 1 ft) in wingspan they can be recognised by the black top to the head and the V-shaped tail. **Native.**



Tropic Birds

B, CL, O

White-tailed Tropic Bird or **Longtail**
Phaethon lepturus
The Longtail or White-tailed Tropic Bird is a summer breeder in Bermuda. It nests in holes in the cliffs and suffers competition from Rock Doves and predation from rats. The distinctive feature of this bird is the extremely long and graceful tail feathers. The wingspan is about 90 cm (3 ft). **Native.**

Field Trips

General Notes

Field trips to Harrington Sound should be very thoroughly planned in advance with the advice of the Bermuda Aquarium. A suitable boat is an absolute necessity. If possible the teacher in charge should visit the chosen site and make sure that it is suitable. It is an advantage to go at low tide as more material will be exposed in shallower water. Tide times are given in the daily newspaper. However, at any state of the tide, it will help in observing animals and plants to actually wade in the water. In doing this it is advisable for everyone to wear a pair of old running shoes, mud shoes etc, to guard against sharp objects on the bottom. Even while just wading, a face mask can help in seeing things clearly in the water. All that people need to do is to bend forward so that the glass is immersed in the water. In deeper locations of about a meter (3 ft) it may be better to actually swim slowly through the water using a mask and snorkel. This is particularly effective in observing seagrass beds since it prevents sediment and detritus being stirred up into the water. If students are to swim, a light wet suit top or body surfing jacket is a good idea especially for field trips numbers 5 and 6.

The field trip should always be thoroughly gone over with all participants well in advance. An introductory trip to the Aquarium is a very good idea, and will help students to be able to identify some of the invertebrates and fishes.

There are some plastic field guides to marine animals available that can be taken into the water and do help with the identification of some common fauna.

There are few hazards in these shallow water environments, but accidents are always possible and a good first aid kit is essential. Someone in authority in the group should also have a cellular telephone in case help is needed. The first aid kit should include a bottle of rubbing alcohol as it is a good treatment of stings in the unlikely event that some occur and is also a good general cleanser and antiseptic.

No collecting of any material alive or dead should be permitted on field trips. Try to identify everything that you see from this guide. If rocks are turned over they must be carefully replaced as they were. It is suggested that no digging be permitted as this is likely to kill buried animals rather than retrieving them. If any shallow excavations are made by hand fill them in.

Field Trip # 1, The Aquarium and Flatts Bridge

Introduction. The Aquarium is situated on the shores of Harrington Sound and houses examples of most of the organisms that can be seen in the sound. The visit to the aquarium can stand alone or be used as a preview and training session for any of the Harrington Sound field trips described below. In any case concentrate on the main aquarium building and the invertebrates in Local Tails. Flatts Bridge, adjacent to the aquarium is great for observing the sound in general and in understanding the tidal flow and currents in and out of the sound. If you happen to go at slack-water, the time when the level of the sound and the sea are the same, return after the Aquarium visit. Slack water only lasts a very short time.

Approach. By private vehicle or bus.

Preparation. Either have each student read this field guide or go over it in reasonable detail prior to the trip.

Equipment and Supplies. As many copies of Project Nature 'The Ecology of Harrington Sound' as possible. A clipboard, pencils and paper for each student.

Dress. No special dress required.

Observations:

<u>Flatts Bridge.</u>

1) Look out into the sound and observe some of its typical features. Things to look for are the rocky shoreline cliffs, the islands, the current either going into or out of the sound and any birds that are around. Note the traffic light to regulate boat passage under the bridge. Without this accidents could easily happen.

2) Look down into the water. Note the direction of water flow. Is it entering the sound or leaving. Look both above and below the bridge; you can see the difference in water levels. In the water look for a) fish; b) animals or plants on the bottom. Try to find the big orange patches of Boring Sponge that occur there. Write down your observations on the water and the fish and other life.

<u>The Aquarium.</u>

3) Start with the smaller tanks in the main hall. Try to find fish and invertebrates that occur in Harrington Sound, many of them do. Look at the North Rock tank but realise that it represents an environment far more exposed than that of the sound. The inhabitants of the North Rock tank will be different from those of the sound. Pick out a few exhibits that you think are typical of Harrington Sound and note them on your clipboard.

4) Move on to Local Tails which houses mainly invertebrates such as sea cucumbers, sea urchins, sponges, snails etc. Look at all the exhibits and decide which you think best show the creatures you would expect to find In Harrington Sound. Write these down in your notes. Additionally, note those exhibits which do not show characteristics of the sound.

Be very careful of traffic, it is very heavy at this location. Close supervision is needed.

Notes

Flatts Bridge.

1) List typical Harrington Sound features observed from the bridge.

2) Looking down into the water:

Is the water going into or out of the sound? ______________________________

Is it fast or slow? ______________________________

Is the water level higher in the sound or in Flatts Inlet? ________________________

Write down notes on everything you can see in the water.

The Aquarium.

1) The Main Hall.

Which exhibits in this area show typical features of Harrington Sound?

Write down notes on what it is in the tank that you would find out in the sound.

Which exhibits do not show Harrington Sound inhabitants?

What exhibit in the main hall was most useful to your understanding of the sound?

2) Local Tails Building.

Which exhibits in this area show typical features of Harrington Sound?

Write down notes on what it is in the exhibit that you would find out in the sound.

Which exhibits do not show Harrington Sound inhabitants?

What exhibit in the Local Tails exhibit was most useful to your understanding of the sound?

Field Trip # 2, Green Bay

Introduction. A boat is needed to get to Green Bay. Green Bay is a small bay at the west end of the sound. Green Bay cave, an underwater cave lies at the extreme inner end of the bay. The bay is shallow but just too deep for wading and therefore this location is restricted to groups that are good swimmers and can snorkel. However, it has excellent examples of shallow sandy bottom fauna and flora and a very nice notch with wonderful biodiversity

Approach. Board the boat at the Aquarium Dock within the sound and proceed to the bay. Look at typical Harrington Sound features on the way. Once in the bay the boat will anchor or tie up. It is best for the group to enter the water then come out and make notes. Possibly, this can be repeated a couple of times. The use of small groups each with a supervisor is best.

Preparation. Either have each student read this field guide or go over it in reasonable detail prior to the trip.

Equipment and Supplies. As many copies of Project Nature 'The Ecology of Harrington Sound' as possible. A clipboard, pencils and paper for each student. A 30 cm metric ruler that can stand immersion in water for each group of students. A pair of binoculars (or more) for the group in case interesting birds come close-by.

Dress. Students should wear sturdy, washable clothing and carry a towel. Take old footwear suitable for wading in the water. A swimming mask is needed for observation in the water. Take appropriate swimming gear and a snorkel.

Hazards. Problems to watch for are few but both Fire Sponges and Fire Corals are present in the bay. It is best just to observe and not touch anything. If the group snorkels to the inner end of the bay, nobody, however good a swimmer they are, is to dive down near the cave mouth. Restrict observations here and everywhere else, to those that can be made from the surface. The sediment can be kicked up and obscure observation; because of this it is best to swim horizontally at the surface and not to hang vertically with the feet down!

Observations:

1) <u>General.</u>

On the way from the Aquarium to Green Bay observe the sound in general and try to pick out some of its typical features such as, the steep rocky shoreline, the calm water, the islands, rock falls etc. Look at the rocky shore to observe the colour zones resulting from animals and plants living above the water surface.

2) <u>The Sandy Bottom in Green Bay.</u>

Using a mask and snorkel swim slowly over the sandy bottom. Note the following things:

a) Calcareous green seaweeds anchored in the sediment;
b) Harbour Conchs grazing on the bottom;
c) Dead shells including those of the Calico Clam lying about;
d) Holes going down into the bottom showing the presence of buried creatures;
e) Sea urchins and sea cucumbers;
f) Fish and other swimming animals;

3) <u>The Notch.</u>

Swim up to the rocky edge of the bay. Observe the notch starting just below the surface of the water as well as the intertidal zone just above the surface of the water. Estimate its height and depth. Look at all the animals and seaweeds in there. Look particularly for a) Corals such as the Chinese Hat Coral. b) Sponges, note the range of colour and form. c) Sea squirts. d) Sea anemones. e) Any other animals being aware that some such as Moss Animals may look like plants. f) All the seaweeds. Try to find both stiff calcareous examples and soft ones. Look for pink encrusting algae.

4) <u>The Littoral Zone.</u>

a) Look just above the water. If the tide is low, the midlittoral zone will be yellowish. The supralittoral fringe will be black;
b) Try to find characteristic organisms of the zones, particularly barnacles, periwinkles and blue-green cyanobacteria.

Notes on Green Bay

1) General Observations.

List features seen from the boat that are typical of Harrington Sound:

2) The Sandy Bottom in Green Bay.

a) List any anchored green seaweeds that you can identify.

b) How common were Harbour Conchs and what was their approximate size?

c) List as many dead shells as you can see. Look especially for the Calico Clam.

d) Did you notice any burrow mouths? If so were they single holes or pairs of holes?

e) List the sea urchins and sea cucumber species seen.

f) List any fish and other swimming animals you were able to identify.

3) The Notch.

a) Sketch a vertical cross section (profile) of the notch, showing the locations of any organisms you could identify.

b) List all the animals and plants that you were able to find in the notch. Put them in the categories: corals, sponges, sea squirts, sea anemones, other animals and seaweeds.

4) The Littoral Zone.

a) Approximately how high were the midlittoral zone and the supralittoral fringe.

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b) List as many animals and plants as you can from each zone.

Midlittoral Zone:

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Supralittoral Fringe:

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Field Trip # 3, Abbott's Cliff

Introduction. Abbott's Cliff in the northern part of the sound is an important terrestrial location as well as a good marine one. Because of the precipitous nature of the cliffs many uncommon native and **endemic** land plants have survived there. The area is a reserve. The water behind the island (Cockroach Island) is shallow and very protected. This is the best location to take younger pupils.

Approach. Board the boat at the Aquarium Dock within the sound and proceed to the location. Look at typical Harrington Sound features on the way; you will pass several islands. Once in the field location the boat will anchor or tie up. It is best for the group to enter the water then come out and make notes. Possibly, this can be repeated a couple of times. The use of small groups each with a supervisor is best. Wading is possible at this site but additional material can be observed using a mask and snorkel.

Preparation. Either have each student read this field guide or go over it in reasonable detail prior to the trip.

Equipment and Supplies. As many copies of Project Nature 'The Ecology of Harrington Sound' as possible. A clipboard, pencils and paper for each student. A pair of binoculars (or more) for the group in case interesting birds come close-by. A water resistant ruler at least 30 cm long is a distinct advantage.

Dress. Students should wear sturdy, washable clothing and carry a towel. Take old footwear suitable for wading in the water. A swimming mask is needed for observation in the water. Take appropriate swimming gear and a snorkel.

Observations:

1) General.

On the way from the Aquarium to Abbott's Cliff observe the sound in general and try to pick out some of its typical features such as, the steep rocky shoreline, the calm water, the islands, rock falls etc. Look at the rocky shore to observe the colour zones resulting from animals and plants living above the water surface.

2) The Sandy Bottom at Abbott's Cliff.

Carefully and slowly wade through the shallow water or even better, use a mask and snorkel; swim slowly over the sandy bottom. Note the following things:-

a) Calcareous green seaweeds anchored in the sediment;
b) The numerous mounds made by the Burrowing Shrimp and hollows and castings made by other creatures. Refer to **Figure 2** which represents the bottom at precisely this location;
c) Dead shells including those of the Calico Clam lying about;
d) Holes going down into the bottom showing the presence of buried creatures;
e) Sea urchins and sea cucumbers
f) Fish and other swimming animals.

3) The Notch. (Only for snorkellers).

Swim up to the rocky shore to the sides of the sandy beach. Observe the notch starting just below the surface of the water as well as the intertidal zone just above the surface of the water. Estimate its height and depth. Look at all the animals and seaweeds in there. Look particularly for:-

a) Corals such as the Chinese Hat Coral;
b) Sponges, note the range of colour and form;
c) Sea squirts;
d) Sea anemones;
e) Any other animals being aware that some such as Moss Animals may look like plants;
f) All the seaweeds. Try to find both stiff calcareous examples and soft ones. Look for pink encrusting algae.

4) The Littoral Zone.

a) Look just above the water. If the tide is low, the midlittoral zone will be yellowish. The supralittoral fringe will be black;
b) Try to find characteristic organisms of the zones, particularly barnacles, periwinkles and blue-green cyanobacteria.

Abbott's Cliff Notes

1) General Observations.

List features seen from the boat that are typical of Harrington Sound.

2) The Sandy Bottom in Green Bay.

a) List any anchored green seaweeds that you can identify.

b) Look at the sandy bottom and using **Figure 2** identify and list as many burrowing animals as you can from the mounds, hollows and burrows on the surface.

c) List as many dead shells as you can see. Look especially for the Calico Clam.

d) List the sea urchins and sea cucumber species seen.

e) List any fish and other swimming animals you were able to identify.

3) The Notch

a) Sketch a vertical cross section (profile) of the notch, showing the locations of any organisms you could identify.

b) List all the animals and plants that you were able to find in the notch. Put them in the categories: corals, sponges, sea squirts, sea anemones, other animals and seaweeds.

4) The Littoral Zone.

a) Approximately how high were the midlittoral zone and the supralittoral fringe.

____

b) List as many animals and plants as you can from each zone.

Midlittoral Zone:

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Supralittoral Fringe:

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Field Trip # 4, Hall's Island

Introduction. The field trip to Hall's Island **must be restricted to senior students** who are good swimmers and experienced in the use of mask and snorkel. Hall's Island probably has the highest biodiversity of notch animals and plants in Harrington Sound. It was once the site for a birth control experiment using monkeys, hence the local name of Monkey Island. Some of the cages used are still visible on the island. This is probably the most exposed site in the sound so strong winds would prevent a useful trip there. Only the notch and intertidal zone are available at this location. It is best reserved for senior students who have previously looked at other Harrington Sound sites.

Approach. Board the boat at the Aquarium Dock within the sound and proceed to the location. Look at typical Harrington Sound features on the way; you will pass several islands. Once in the field location the boat will anchor or tie up. It is best for the group to enter the water then come out and make notes. Possibly, this can be repeated a couple of times. The use of small groups each with a supervisor is best..

Preparation. Either have each student read this field guide or go over it in reasonable detail prior to the trip.

Equipment and Supplies. As many copies of Project Nature 'The Ecology of Harrington Sound' as possible. A clipboard, pencils and paper for each student. A pair of binoculars (or more) for the group in case interesting birds come close-by.

Dress. Students should wear sturdy, washable clothing and carry a towel. Take old footwear suitable for wading in the water. A swimming mask is needed for observation in the water. Take appropriate swimming gear and a snorkel.

Observations: At Hall's Island, observations are limited to the notch and the littoral zone. The water is too deep to see the bottom. Swim along the rocky coast on the sheltered side of the island looking carefully at both the notch and the littoral zone above. This is a very rich community of organisms and you will probably see many that you cannot identify from this guide. However, try to at least assign each animal to its group and remember features such as shape, colour and size so that you can note these later. This is also a good location for a variety of fish; identify as many as you can.

Hall's Island Notes

1) The Notch.

   a) List all the animals and plants that you were able to find in the notch. Put them in the categories; corals, sponges, sea squirts, sea anemones, other animals and seaweeds.

   b) List all the fish and other animals observed in the water while swimming along the notch.

2) The Littoral Zone.

   a) Approximately how high were the midlittoral zone and the supralittoral fringe?

   b) List as many animals and plants as you can from each zone.

   Midlittoral Zone:

Field Trip # 5, Shark Hole

Introduction. Shark Hole is a special field trip that must be restricted to senior students adept with mask and snorkel and who are good swimmers. The main feature at Shark Hole is the cave. This cave is only partly underwater and no currents enter or leave. It is therefore a relatively safe location. However, it is not for those who are nervous of caves or dim lighting. One can safely swim into the cave and observe the organisms therein. However, as at other locations do not touch the organisms. The dim light results in lighter colours than in more open sites and the normally red Fire Sponge may be only a pinkish white

Approach. Board the boat at the Aquarium Dock within the sound and proceed to the location. Look at typical Harrington Sound features on the way; you will pass several islands. Once in the field location the boat will anchor or tie up. It is best for the group to enter the water then come out and make notes. Possibly, this can be repeated a couple of times. The use of small groups each with a supervisor is best.

Preparation. Either have each student read this field guide or go over it in reasonable detail prior to the trip.

Equipment and Supplies. As many copies of Project Nature 'The Ecology of Harrington Sound' as possible. A clipboard, pencils and paper for each student. A pair of binoculars (or more) for the group in case interesting birds come close-by.

Dress. Students should wear sturdy, washable clothing and carry a towel. Take old footwear suitable for wading in the water. A swimming mask is needed for observation in the water. Take appropriate swimming gear and a snorkel.

Observations:

1) The Cave.

   Very slowly swim into the cave keeping a few feet from one wall. As you go, notice the high biodiversity particularly of sponges. Try to memorise the appearance of the cave wall near the mouth of the cave. Proceed about half way in and again carefully study the wall, then go nearly to the end of the water without getting into the abrupt shallowing area. Repeat the observations on the wall. You will find that seaweeds have steadily diminished and animals have done the same thing to a lesser extent. Think about the reasons this may be so. Swim back out of the cave along the opposite wall, repeating the observations. As you swim look about for fish, squid etc and try to identify them.

2) The Littoral Zone.

   a) Look just above the water. If the tide is low, the midlittoral zone will be yellowish. The supralittoral fringe will be black;
   b) Try to find characteristic organisms of the zones, particularly barnacles, periwinkles and blue-green cyanobacteria.

Shark Hole Cave Notes

1) The Cave.

a) When you get back to the boat make notes on the appearance of the cave wall at each location.

Outer: ______

______

______

Mid: ______

______

______

Inner: ______

______

______

b) List as many different seaweeds and invertebrates from the cave walls as you can identify. Sponges can be listed by colour. ______

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2) The Littoral Zone.

a) Approximately how high were the midlittoral zone and the supralittoral fringe?

______

b) List as many animals and plants you can from each zone.

Midlittoral Zone: ______

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Supralittoral Fringe: ______

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Field Trip # 6, Trunk Island Seagrass Beds

Introduction. The bay on the N. side of Trunk Island has a quite nice small seagrass bed in shallow water. The water is shallow enough to wade at low tide. Further out is a nice sand bottom rich in shells which students who can snorkel can reach. This is a good location to take younger pupils.

Approach. Board the boat at the Aquarium Dock within the sound and proceed to the location. Look at typical Harrington Sound features on the way; you will pass several islands. Once in the field location the boat will anchor in shallow water. It is best for the group to enter the water then come out and make notes. Possibly, this can be repeated a couple of times. The use of small groups each with a supervisor is best. Wading is possible at this site but additional material can be observed using a mask and snorkel.

Preparation. Either have each student read this field guide or go over it in reasonable detail prior to the trip.

Equipment and Supplies. As many copies of Project Nature 'The Ecology of Harrington Sound' as possible. A clipboard, pencils and paper for each student. A pair of binoculars (or more) for the group in case interesting birds come close-by. Water resistant rulers 30 cm long.

Dress. Students should wear sturdy, washable clothing and carry a towel. Take old footwear suitable for wading in the water. A swimming mask is needed for observation in the water. If swimming take appropriate swimming gear and a snorkel.

Observations

1) General.

On the way to and from the Aquarium to Trunk Island observe the sound in general and try to pick out some of its typical features such as, the steep rocky shoreline, the calm water, the islands, rock falls etc. Look at the rocky shore to observe the colour zones resulting from animals and plants living above the water surface.

2) The Seagrass Bed at Trunk Island.

Carefully and slowly wade through the shallow water or even better, use a mask and snorkel; swim slowly over the seagrass bed. Note the following things:

a) The identity size and shape of the seagrass. This is almost entirely a Turtle Grass bed but look for other seagrasses around the edge;
b) Look for other organisms living in and over the seagrasses;
c) Look for dead shells including those of the Calico Clam lying about;
d) Look carefully for holes going down into the bottom showing the presence of buried creatures;
e) Note the presence of any sea urchins and sea cucumbers;
f) Identify fish and other swimming animals.

Trunk Island Seagrass Bed Notes

1) Trunk Island Seagrass Bed.

a) Seagrasses.

Measure the approximate height of the seagrasses in cm at three locations.

1] ____________________ 2] ____________________ 3] ____________________

b) About how far apart are the seagrass plants? Take several measurements (cm) at one location.

____

c) List the animals and seaweeds observed in the seagrass bed.

Sea Urchins and Cucumbers: ____

____

Seaweeds: ____

____

Shells: ____

____

Fish: ____

____

d) Holes, shells, burrows etc. outside the seagrass bed. ____________________________

____

____

____

e) Look carefully at a seagrass plant and the surface of the leaves. Do you see what looks like a white powder there. Yes: ________ No: ________.

If you see this it is an example of one plant growing on another; it is called scaleweed.
Do you see any other animals or plants on the leaves? If so describe them.

____

____

____

____

____

Questions about Harrington Sound and the Field Trips

1) Name 3 unique features of Harrington Sound that can be seen from the bridge or a boat.

   a) ______

   b) ______

   c) ______

2) What are the two main ways that seawater gets into Harrington Sound? ______

3) Name one cause of cliff collapse in Harrington Sound. ______

4) What is bioerosion? ______

5) Where in the sound are Date Clams very numerous? ______

6) If you went back 12,000 years what would you expect to find where Harrington Sound is today? ______

7) Approximately how long ago did the sound become a marine habitat? ______

8) What often happens to the deep water in Harrington Sound in late summer or early winter? ______

9) Name three of the commonest fish in Harrington Sound. ______

10) Where would you find the following two sediments in Harrington Sound?

    a) Sand.

    b) Fine mud.

11) Which habitat was destroyed in the dredge fishery for Zebra Mussels? ______

12) Name a green calcareous seaweed common on sandy bottoms. ____________________

13) What is a population explosion?____

14) What was the result of the population explosion of the Common Pincushion? _______

____

15) Name one animal that has had a population explosion in Harrington Sound.________

____

16) What is the name of the commonest seagrass in Harrington Sound? ________________

17) Name one scallop found in Harrington Sound. ___________________________________

18) What animal makes the volcano-like mounds on the sandy bottom? _________________

19) Where might you find a Sea Pudding and what is it? _____________________________

____

20) Name one stinging animal from Harrington Sound. ________________________________

21) Name one animal for which there had been a fishery in the past. __________________

22) Name one animal in Harrington Sound that is protected from fishing. ______________

____

23) Name a habitat where blue-green cyanobacteria are common. _____________________

24) Name one bird that breeds in Harrington Sound. _______________________________

25) What is the main food of the commonest fish in the sound? _______________________

Glossary

Aeolianite	Rock formed on land, from the solidification (lithification) of wind-blown sand.
Algal Mat	A cohesive layer of algae of one or more species.
Anoxia	A lack of oxygen.
Benthic Organisms	All the **biota** living on or in the bottom of bodies of water.
Benthos	All the **biota** living on or in the bottom of bodies of water.
Biodiversty	In its simplest form biodiversity is measured as the number of different species occurring in a given habitat. More complex aspects also include the relative abundance of the species array.
Bio-erosion	The breakdown of rock resulting from biological activity.
Biological erosion	See bio-erosion above.
Brackish	Seawater measurably diluted with freshwater.
Calcareous Seaweeds	Seaweeds that lay down calcium carbonate in their tissues. They are usually firm or hard to the touch and of a pastel hue.
Casts	Characteristically shaped faecal material found on the bottom. Casts can be used in some cases to identify animals that can't otherwise be seen.
Colonial Animal	An animal consisting of more than one inter-connected individual.
Conservation	The husbandry of natural systems aimed at preserving or restoring a natural situation.
Corals	Relatively simple marine animals which generally form colonies consisting of groups of polyps, which resemble small tubes with a mouth at the top, which also have a ring of tentacles.
Crustose Calcareous Algae	Seaweeds of the red algal group which lay down very hard, sheet-like, deposits of calcium carbonate. These algae look like pink rock and are also called **Crustose Coralline Algae**. Crustose calcareous algae are vital to the formation of coral reefs.
Crustose Coralline Algae	See Crustose Calcareous Algae above.
Detritus	Particles resulting from the decay of living material. An important food source in water.

Dinoflagellate	A planktonic, single celled flagellate often with an armoured cover.
Endolithic	Living inside rock.
Filter Feeder	An organism that obtains its food supply by filtering living or dead particles from the water.
Flagellum	A hair-like organ that beats to move material or cause locomotion or spinning.
Flushing Rate	The rate at which water in a water body is exchanged with water from an adjacent body. Often expressed in tidal cycles (12.5 hr. units).
Gulf Stream	A very large, swift ocean current arising in the Gulf of Mexico, passing through the Straits of Florida and proceeding north and east along the east coast of North America. The Gulf Stream passes just to the west of Bermuda.
Habitats	Natural locations where a specific assemblage of animals and plants exist.
Hot Spot Island	An island in the ocean arising by volcanic action at a place in the crust where the magma wells up through a thin crust
Hydrography	The study of the characteristics of a body of water.
Intertidal Zone	The zone around water bodies that is regularly covered and uncovered by the tides.
Invertebrates	Animals without backbones.
Island Arc	Groups of oceanic islands formed along the collision zones of tectonic plates.
Landlocked	Surrounded or almost surrounded by land.
Lithification	The formation of rock from sediment.
Littoral Zone	The zone around water bodies that is subject to wetting by tides, splash or spray.
Magma	Molten rock beneath the earth's crust.
Mass Mortality	Unusually heavy mortality of one or more species at one time.
Marshes	Wetlands dominated by grasses or other low-growing plants.

Mechanical erosion	See physical erosion below.
Midlittoral Zone	The main, broad zone on the rocky seashore that in sheltered locations lies roughly between the high and low tide marks, but rises higher in exposed locations. The top of this zone is marked by barnacles.
Moat	A shallow, circular depression filled with water.
Native	A native animal or plant is one that has come to live in its habitat by natural means but that is also found naturally elsewhere.
Oceanography	The study of the characteristics of sea water bodies.
Peat	The organic remains of plants that accumulate as an acid layer in water-saturated ground.
Physical erosion	The breakdown of rock, or particles of rock, into smaller particles by physical means such as wave action, wind, gravity water currents and grinding.
Phytoplankton	Plant plankton.
Plankton	The drifting life of water bodies. Plankton are mostly small and if they can swim, cannot do so against a water current.
Ponds	Shallow freshwater bodies. Sunlight reaches the bottom at all depths.
Population explosion	A sudden and very rapid increase in the population density of a species. Often linked to a change in environmental conditions.
Predator	An animal or plant that eats animals.
Rhizoids	Root-like organs developed by green algae to enable them to colonise sedimentary habitats. Rhizoids act only as anchors and do not function as true roots.
Ridge Islands	Oceanic islands formed by volcanic action along mid-ocean ridges between tectonic plates.
Salinity	The total quantity of salts dissolved in water. Usually expressed in parts per thousand by weight.
Sand Dunes	Wind-blown mounds of sand.
Sea Cucumbers	Echinoderm animals shaped like a cucumber.
Sea Urchins	Spiny, near spherical echinoderm animals.

Stratification	Horizontal layering of water in a water mass. Usually the result of temperature or salinity differences and always involving changes of density.
Supralittoral Fringe	A narrow zone on the seashore lying immediately above the midlittoral zone, characterised by the presence of periwinkles.
Tectonic Plates	Large plates of the earth's crust which are produced at mid-ocean ridges or rift valleys and which are destroyed at subduction zones.
Temperature Range	The highest and lowest temperature encountered in a specific situation.
Thermocline	A horizontal layer in water in which the temperature changes rapidly.
Tidal Current	A current in water resulting from the rise and fall of the tides. Tidal currents usually reverse with the tides.
Water mass	A distinctive body of water.
Zooplankton	Animal plankton.

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