The seashore food cycle

Teaching approaches for food types and feeding methods

This unit covers much of the fundamental science concerning

- the conditions that shoreline animals must tolerate while in the parts of the shore where they feed
- the food they eat and how they catch and eat it
- their physical and behavioural adaptations for coping with the environmental conditions.

The five distinct feeding types and the large number of different species gives ample opportunity for every student in a class to complete a project on a different animal's feeding method and the problems it must cope with to obtain and eat its food.

There are already good amounts of reference material and scope for senior students to complete simple original studies of such details as feeding time, frequency of feeding, amount of food eaten and details of the workings of an animal's mouth parts.

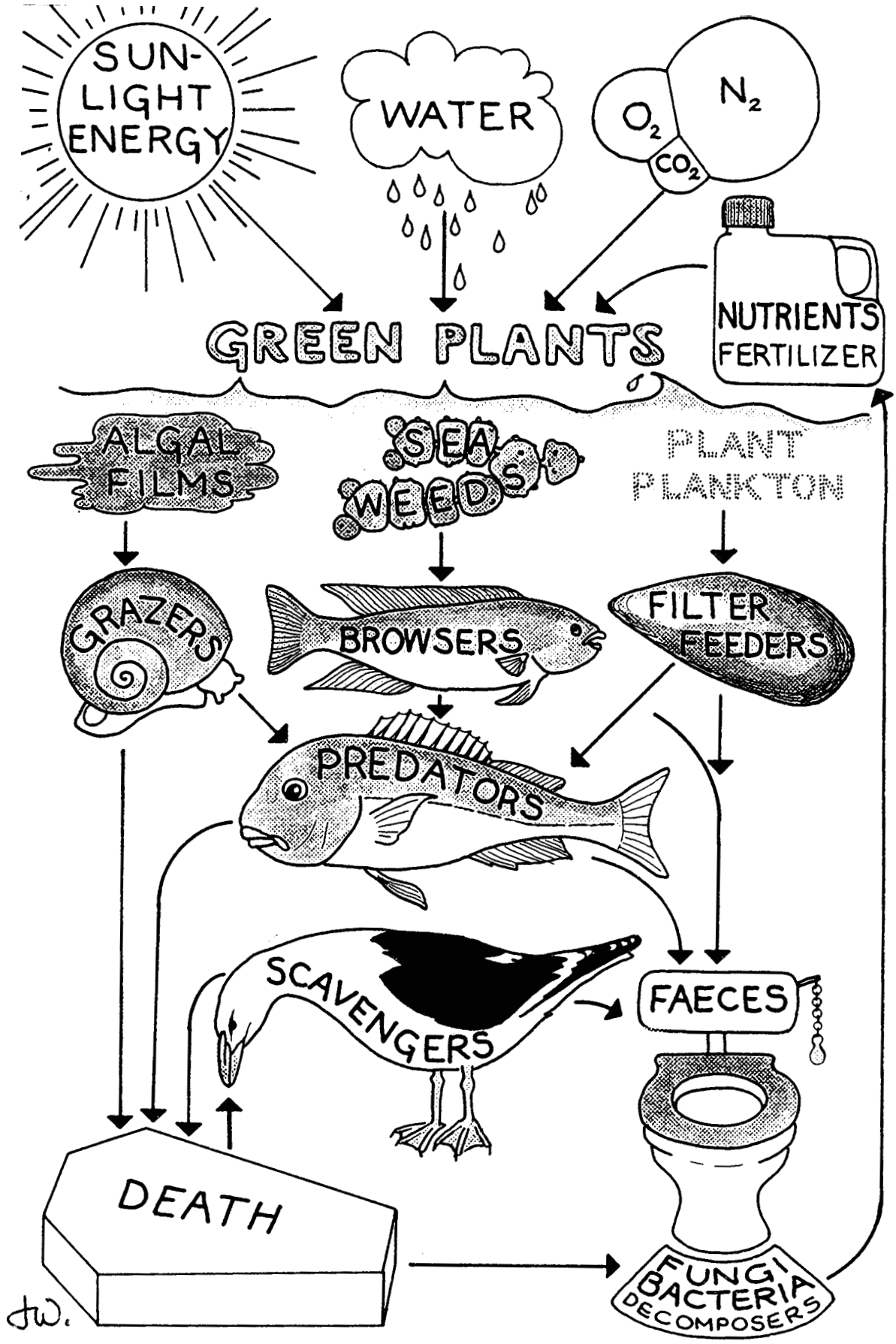
The food cycle

Species diversity and the fascinating lives or adaptations of marine creatures can both be taught through a study of the different **feeding methods**. This is a good starting approach for all levels from primary through to senior secondary because it covers the essential topics of biodiversity, interspecific relationships, habitat opportunities and, by describing the varied feeding mechanisms, the wonder factor.

There are six trophic levels across every shore:
- seaweeds (algae)
- grazers & browsers
- filter feeders
- predators
- scavengers
- deposit feeders

A seashore can be considered as a place where representatives of each one of these feeding levels are found right across it. **'Right across the shore'** is the key phrase to emphasise when covering each of the six trophic levels to make the point that the whole of the marine life across a rocky shore is like a rich inter-woven biological blanket. Each trophic level represents a different thread type that is intertwined with the others to make a complex and beautiful fabric.

As teaching aids a series of five *Feeding Methods* pamphlets produced for the Cape Rodney – Okakari Point Marine Reserve shores, by John Walsby, covers the problems and challenges of each feeding opportunity and shows how different animals are adapted to exploit the different foods.



The seashore food cycle. From 'Nature watching at the Beach' by John Walsby

The book *Nature Watching at the Beach* by John Walsby (held in many school libraries) is largely structured around the different feeding methods and is designed in short sections suitable in content and layout for classroom lessons.

Food types and feeding methods

Seaweeds

Right across every hard shoreline perfect conditions exist for growing plants. The five essentials are all present. These are **water**, **sunlight** and **carbon dioxide** for photosynthesis, **oxygen** for respiration and **nutrients** to provide the range of minerals necessary to make the varied constituents of plant tissue.

Seawater is rich in dissolved nutrients and the turbulence of the sea and waves breaking on the shore keeps the surface waters saturated with air containing oxygen and carbon dioxide. Levels of sunlight are always high because seashores are usually exposed to full daylight.

A seashore can therefore be separately considered as a place where plants grow. Because of different levels of wave stress (wrenching and scouring) and desiccation stress, different types of plants are found at different heights on the shore but some that are able to cope are found at every level.

Just out from low tide mark (but sometimes washed up in the drift line where they can be studied) are kelp plants and as a fringe around extreme low water are swathes of bladder wracks. In the lower intertidal zone are beaded strings of Neptune's necklace weed and some other seasonal seaweeds. Further up the shore where conditions are more difficult are swards of low-cropped coralline turf and encrusting leathery or rubbery algal scabs. At the very top of the shore is a zoned sequence of different lichens.

Grazers and browsers

Plants present a feeding opportunity for animals wherever they grow and right across every shore are plant feeders. These are mostly grazing snails that scrape up algal films but sea urchins, sea hares and some crabs are all browsers of larger seaweeds.

Around the high tide mark the rocks often look quite bare of plants but they are still places where plants grow. This is certain because the bare rocks are covered with grazing snails dependant on algal films for food, which they scrape from the rock surface when the tide is in. Although these rocks appear bare they must produce plenty of algal food for so many grazing snails to be living there. The rocks look bare because the snails do nothing but feed and every day they strip the surface of algae that begin to develop from newly settled spores.

Filter feeders

Algae grow on the rocks but there is another algal resource delivered right across the shore twice every day. This is the microscopic plant plankton (phytoplankton) suspended and growing in the surface waters of the sea where the light is strong.

There are filter feeding animals right across every shore that exploit this reliable food resource, and representatives from almost every animal group have some examples that have evolved as filter feeders. Animals from different groups use a variety of methods to sieve and strain this food from the sea.

Predators

Grazers and filter feeders are herbivores that turn plant matter into animal flesh and therefore they in their turn become a food resource for carnivores. As the herbivores are found wherever algae grow or the plankton laden sea flows, there are predators right across every shore.

Catching mobile prey or penetrating the external armour of both mobile and fixed herbivores in difficult wave-swept conditions presents predators with complex challenges, and many are specially adapted to feed on particular prey species. Revealing the secrets of predators, their captures, kills and methods of feeding gives students opportunities to enjoy wildlife drama as exciting as any they might see in the best television nature programmes.

Scavengers

All animals eventually die – millions die every day – but shores are not littered with smelly, rotting bodies because scavengers, the undertakers of the seashore, rapidly and efficiently clear away the corpses. Indeed so competitive is this business in the sea that many animals are disposed of as soon as they become sick and too weak to protect themselves. And as death occurs, of course, right across every shore, scavengers are also found from the bottom to the top.

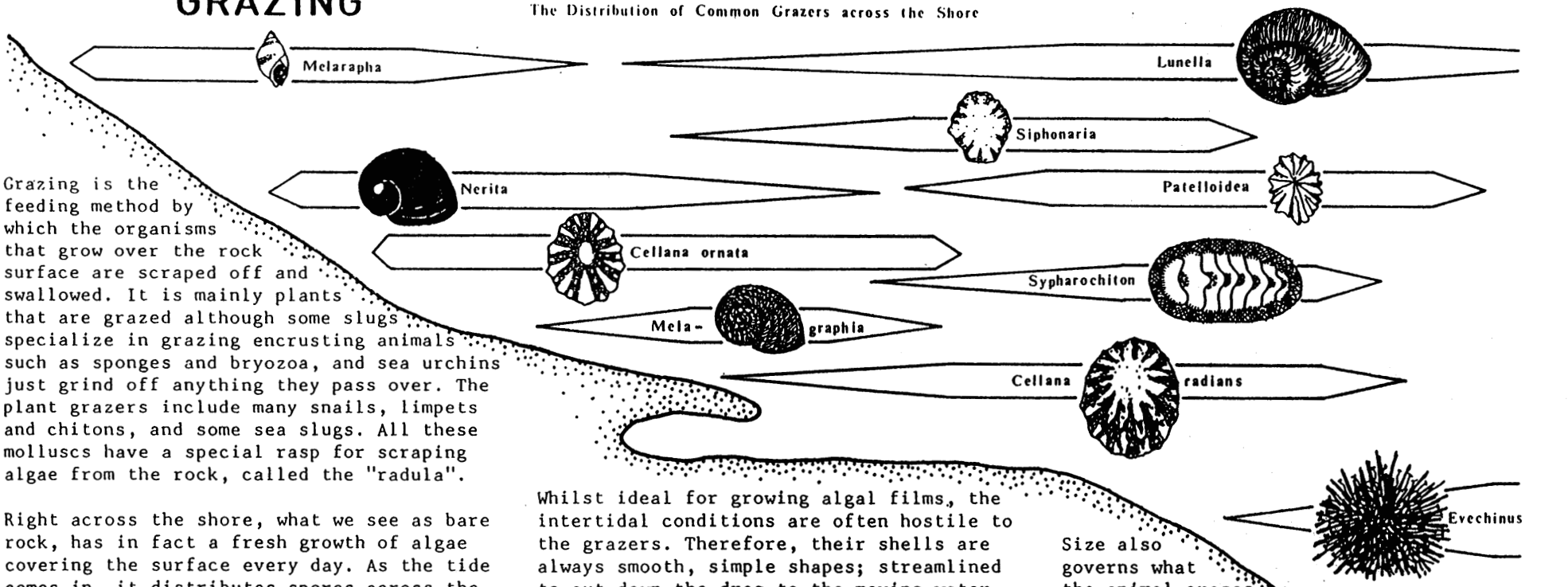
The stories of how different scavengers locate dead and dying food, penetrate any passive armour and compete with other scavengers, make good teaching topics on the adaptations of different animal groups for solving common problems.

Deposit feeders

All animals that feed must defecate and the masses of faeces produced everyday (but generally overlooked in most shore studies), along with rotting fragments of animal and plant matter broken up by wave action or sand scour, make another food resource that is found right across every shore. Animals from a number of different groups specialise in exploiting this valuable resource and thereby assist in the process of recycling animal and plant remains.

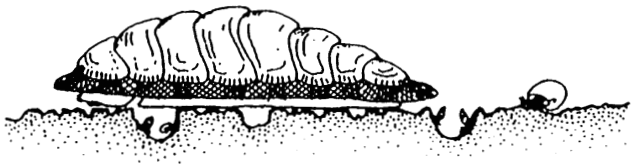
Where these animals live on the shore and how they gather up the fine fragments can be taught as a separate study. The lives of deposit feeding species are also good topics for individual senior project studies as many of the numerous examples feed on surface debris, making them easy to observe in the field or in classroom aquaria.

GRAZING



Grazing is the feeding method by which the organisms that grow over the rock surface are scraped off and swallowed. It is mainly plants that are grazed although some slugs specialize in grazing encrusting animals such as sponges and bryozoa, and sea urchins just grind off anything they pass over. The plant grazers include many snails, limpets and chitons, and some sea slugs. All these molluscs have a special rasp for scraping algae from the rock, called the "radula".

Right across the shore, what we see as bare rock, has in fact a fresh growth of algae covering the surface every day. As the tide comes in, it distributes spores across the shore, waters the plants already there and supplies nutrients essential to vigorous growth. In the intertidal, the light levels are always high, so the conversion of water and carbon dioxide to sugar, using sunlight energy, by a process called photosynthesis, proceeds very efficiently. Some of these plants can multiply every twenty minutes in ideal conditions, and at this rate, one cell can produce one million others over a six hour tidal period. The grazer's food supply is therefore abundant and reliable.



Large and [illegible] grazers feeding over a rough rock surface

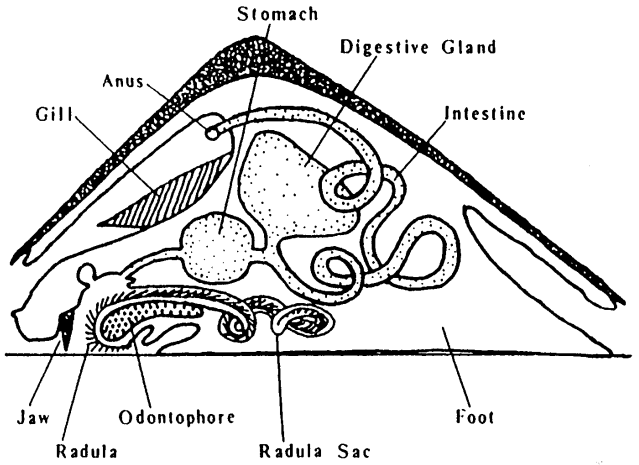
Whilst ideal for growing algal films, the intertidal conditions are often hostile to the grazers. Therefore, their shells are always smooth, simple shapes; streamlined to cut down the drag to the moving water that might dislodge them. The shells are tough so that if they are washed-off, they can survive considerable rolling around by the waves until they can reattach again. They have a large foot area for tenacious attachment to the rock as the waves break, and easy movement during feeding forays.

Where wave action is generally severe and the rock surface smooth, only the most streamlined grazers (chitons and limpets) are found. When the rock is rough, cracked or undulating, the water flow close to the surface is disturbed and some microshelter provided. Here taller and less streamlined forms can survive, as they can also do in deep pools and calmer waters. On exposed shores it is more difficult for the larger animals to maintain their position.

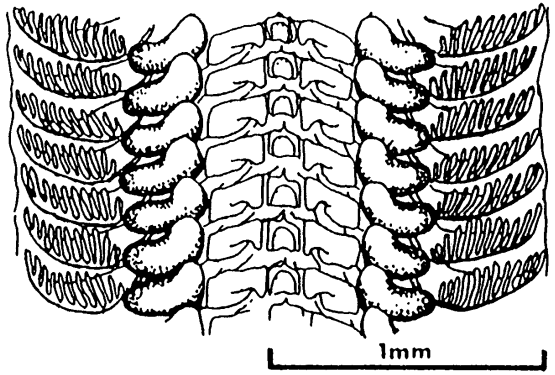
Size also governs what the animal grazes. On rough surfaces, a large grazer (eg. an adult Sypharochiton) may scrape across the top, and a small snail then graze between the surface bumps and ridges of the same area. What is an obstacle or a step, or what is "smooth", is related to just what size the animal is.

When the tide is out, especially during daytime, grazers must protect themselves from drying out. They all stop feeding and stay motionless, holding water under their shells. Lunella commonly congregate along crevices, and the black Nerita cluster in large groups, as a communal method for retaining water between as well as within their shells.

The Radula. This is a very long belt with many rows of teeth. It is like a flexible rasp, but only the tip abrades the surface. The remainder lies within the radula-sac, where a tough outer layer is secreted over the new teeth. About four rows of teeth are worn out every day but new rows are brought into service constantly as the radula grows out.

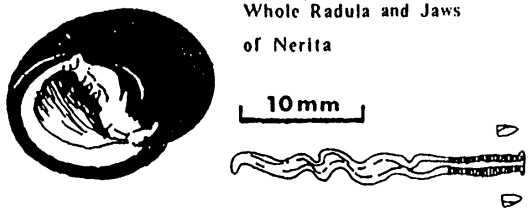


The radula lies strapped around a tongue-like cartilage, called the odontophore. This is rhythmically protruded and pushed foreward to scrape the radula across the rock, and then withdrawn into the mouth.



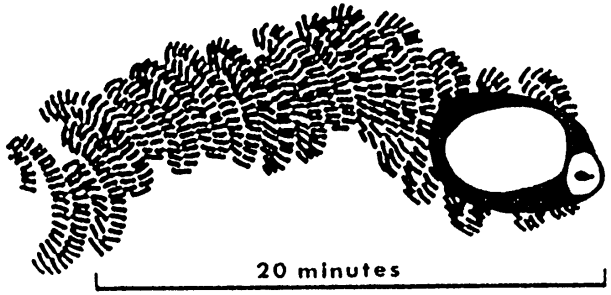
Portion of the Radula of Nerita

A pair of jaws, attached to the roof of the mouth, are briefly held against the rock to anchor the head and give purchase to the radula during the grazing stroke. When the radula is withdrawn into the mouth, it rolls in from the edges and the scraped-up particles are squeazed from between the teeth into the buccal cavity.



Whole Radula and Jaws of Nerita

Molluscs graze methodically. When they move and feed, the head is swung through a wide arc. They harvest but do not strip the surface. About 85% of the cover is cleared and the remaining algal traces soon grow and reproduce to re-cover the rock. The figure below shows the radula strokes and clearing pattern of Lunella feeding on an algal film grown on a glass plate.

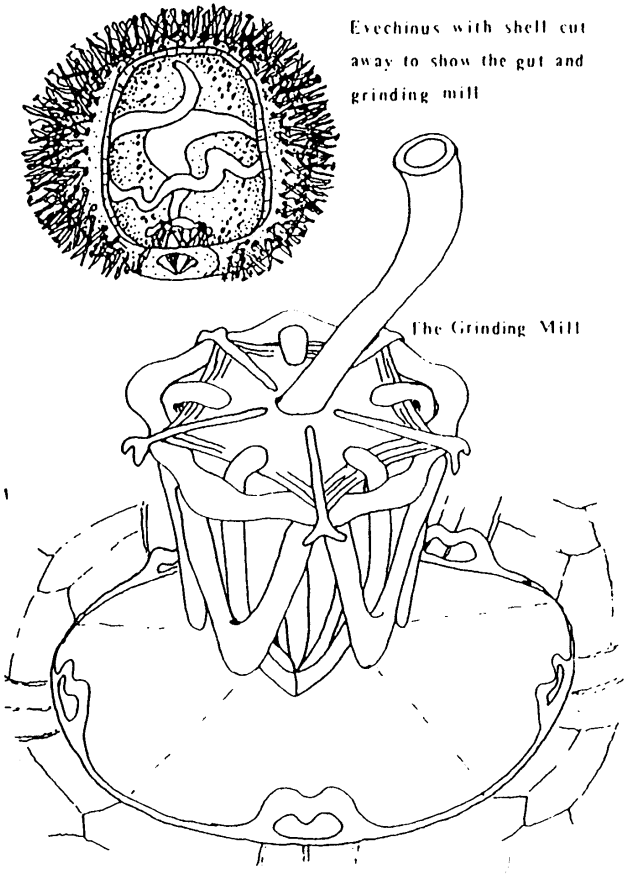


Homing. Some grazers, particularly some limpets, daily graze over the same area and rest in exactly the same position, to which the shell grows to fit the rock. Cleared areas are sometimes quite marked around such limpets, and when they are grazing, the home-site or scar is often obvious as a worn ring in the rock.

Sea Urchins

The kina, Evechinus chloroticus, is our commonest sea urchin and is often found in great numbers. Its range extends from the depths of the off-shore kelp forrest, up into the pools exposed at low tide.

They are quite unselective when they graze and clear the surface of any non-living or living encrustation. The grazing apparatus is a complex system of levers. It operates a grinding mill of five teeth, that are protruded through the mouth as a beak. To abrade the surface, these teeth are opened and closed, raised and lowered, or they can cut and chew like pincers to tear up pieces of kelp and other sea weed.



Evechinus with shell cut away to show the gut and grinding mill