1 Long Bay, Hauraki Gulf

OUR TOUR OF New Zealand shores begins in the Hauraki Gulf with one of Auckland's coastal regional parks at Long Bay on the east coast – a fitting introduction to the world of the shore. The cliffs and wave-cut platforms to the north of the beach at Long Bay are some of Auckland's most familiar shore forms. Like most of the shores within the Gulf these reef platforms are moderately sheltered from heavy waves and can show us the general pattern of animal and plant zonation. Here, there is neither excessive exposure nor the close shelter that allows sediment to build up on the more land-locked shores.

The high cliffs of Long Bay, as in the rest of the Gulf, are built of the sandstones and siltstones of the Waitemata series, known collectively as 'papa'. Though they have alternating layers of differing hardness, they are all relatively soft and very susceptible to erosion. Laid down beneath the shallow seas of the Miocene epoch, up to 25 million years ago, they were uplifted during the Pliocene epoch to form a large part of the North Island coastline.

Since Pliocene times the cliffs have been constantly receding, by wave attack from below, and by weathering from above with fluctuations of heat and cold, dry and wet. The wave-cut platform that is left after cliff erosion is seldom smooth. The resistant edges of harder strata will crop out at intervals, being tilted at varying angles from the horizontal, as may be seen also in the cliff itself. Where the harder sandstone layers remain horizontal they form resistant pedestals, with the softer mudstone and siltstone eaten out beneath. Such erosion is the work not only of the waves but also of the boring and tunnelling ('bioerosion') of animals.

All these rock structures offer a wide choice of habitat space. There are large overhangs receding into deep shade; narrow crevices between adjacent strata; and rock-pools of every size and shape, etched by erosion. Broken-off slabs of sandstone form movable rock cover for a huge variety of animals. At the seaward edge, a vertical step is being slowly cut back, with urchins, rock-boring bivalves (piddocks) and even eroding sponges augmenting the work of the waves.

A shore such as this, with its broad stepped platform from high to low water, is one of the best places to get a first appreciation of shore zonation. The belts and zones of different organisms that the marine biologist likes to distinguish are not so diagrammatic as on a short steep slope, but their order can be seen clearly at a good low tide by walking down the shore from high to low water. The great horizontal spread means that each zone in turn is given wide representation on its gently sloping or nearly horizontal platform.

All the zones of the standard shore between tides can be picked out on the descending steps at the north end of Long Bay. The widest belt – the mid-littoral zone – is covered and uncovered twice a day, by every tide of the month, both neap and spring.

Above and below this broad middle zone, but still within the range of spring tides, are the two narrower fringes – the littoral fringe above and the sub-littoral fringe below. During neap tides the littoral fringe stays wholly dry or is visited by splash only during brief periods. By contrast the sub-littoral fringe remains continuously submerged at all tides except low springs.

Each of these levels has its distinctive forms of life, adapted to the special conditions but unable to compete or hold their own anywhere else. The upper half of the shore is the domain of animals well protected against evaporation by their hard shells. These become smaller in body size and much fewer in species as we move higher up the shore. The lower half of the shore is permanently more moist – an easier habitat – and can thus be dominated by the less resistant algae.

Plate 1 Long Bay in the Hauraki Gulf, looking south to the volcanic island cone of Rangitoto. The reef platform in the foreground is wave-cut from the Waitemata strata in the cliff behind, and dissected into stacks, with barnacles (*Epopella*), mussels (*Xenostrobus*) and rock pools on top, oysters (*Crassostrea*) at the edges, and tubeworms (*Pomatoceros*) and pink coralline (algal) 'paint' on the shaded sides.

The most primitive and hence the smallest and simplest of the algae live not on the lower shore, however, but high in the littoral fringe and would pass quite unnoticed but for the slipperiness, when wet, of their 'blue-green' (actually dull-black) film. Conspicuous in the winter, particularly on shaded surfaces, is the bright green alga, *Enteromorpha*, especially common where there is freshwater seepage. Usually found grazing upon these high level algae are crowded rows and clusters of the banded periwinkle (*Littorina unifasciata*) [Fig. 2], a tiny snail, grey and bluish banded, or dull and eroded.

At Long Bay the mid-littoral (Fig. 2) can itself be naturally divided into three levels. The first and the highest is the home of acorn barnacles. These are not molluscs, as they could first appear, but in fact tiny, highly modified crustaceans with a hard tent-like shell. This opens at the top by means of movable plates to allow the feathered limbs to be put out to collect food by straining microscopic plankton from the water.

Acorn barnacles are immensely numerous and densely crowded, being – as we say – 'sessile' or permanently attached. They are perhaps most familiarly seen on the bottom of our wooden boats, but the species at Long Bay, *Chamaesipho columna*, is a different one, found more commonly on hard sandstone. Mudstones are too soft and friable to allow it to settle successfully. A little lower down, also on outcrops of sandstone, is a second and much larger species, the ridged barnacle (*Epopella plicata*).

The second level of the mid-littoral is distinguished by its bivalved molluscs and tubeworms. First and highest, sometimes intermingling with the barnacles, are patches of the black mussel (*Xenostrobus pulex*) [*p.61*]. This little bivalve has become fully adult at its length of 2 to 5 centimetres and is quite distinct from the larger mussels found at low tide.

Below the black mussels regularly occurs a belt of rock oysters (*Crassostrea glomerata*) [*p.46*]. On the sheltered coasts of northern New Zealand this is perhaps the most typical mollusc of the middle shore. Essentially a warm-water species, it is found hardly at all beyond the Auckland province. Oysters prefer clean hard surfaces, above the reach of silt and they settle well on eroded pedestals and vertical faces.

In a narrow strip immediately below the oysters is the blue tubeworm (*Pomatoceros caeruleus*) [*p.63*]. This species is most numerous and closely crowded in sheets or crusts and on shaded faces, but it is easier to see close up in the small shallow pools on the flat surface at rock oyster level. Here each worm puts out a circle of indigo-blue tentacles for respiration and to filter plankton.

Beyond the tubeworms begins the third and last level of the mid-littoral, a zone permanently clad with algae. The most common plant, so familiar as often to pass unnoticed, is the turf-forming *Corallina*, technically one of the red algae (*pp.29 and 74*). A close study of a small tuft shows that the fronds are divided into tiny joints, each with a hard limey axis like an internal skeleton. *Corallina* turf holds a lot of water and silt, thus being kept permanently moist while the tide is out.

Regularly found with *Corallina* are other seaweeds. Largest and most conspicuous is the Venus' necklace (*Hormosira banksii*) [*p.45*], which retains water in its strings of bladders and is perfectly 'amphibious', being able to respire and carry on photosynthesis when the tide is out as well as in. *Hormosira* grows largest around the fringes of rock pools. Common also on the coralline turf in spring and early summer are two algae that form golden-brown bladders or vesicles. *Leathesia difformis* is convoluted like a brain, while *Colpomenia sinuosa* is smaller and thinner (*p.137*). The most delicate alga amongst *Corallina*, growing in small, mossy green cushions, is *Microdictyon mutabile*.

Everywhere on the middle shore one can find gastropod molluscs. Some, such as the periwinkles at the top fringe, are grazers on minute algae. One of these grazers is the greyish-mauve top shell (*Melagraphia aethiops*), most at home at the oyster and barnacle level. Further down, on the coralline turf, is the catseye (*Turbo smaragdus*), distinguished by its shelly green and white operculum or lid that closes the shell. (*Smaragdus* means 'emerald'.) The youngest catseyes found in the coralline fringe of pools are spirally ridged. Many of the old ones carry around the curvature of their shell a white slipper limpet (*Maoricrypta monoxyla*), which is a plankton filterer (*p.41*).

The true limpets, however, are algal grazers. There are two species at Long Bay: the ornate conical limpet (*Cellana ornata*), found among the barnacles and oysters (*p.21*); and the rayed limpet (*Cellana radians*), lower down, pushing back clearings in the forest of coralline algae (*p.80*). Also feeding at this level is the chiton or coat-of-mail shell *Sypharochiton pelliserpentis* (*p.135*) which grazes like a limpet, but with its flexible shell

can fit into and crawl over irregular spaces. Both chitons and ornate limpets make feeding forays and return to their 'home' scars amongst the barnacles.

Some gastropods do not graze but live as predators, either on barnacles or other molluscs. Very numerous at high levels is the small 'oyster borer' (*Lepsiella scobina*) which drills small holes in mussels or oysters with its tooth ribbon, aided by acidic saliva. Smaller barnacles are smothered with the predator's foot and the proboscis is then inserted.

A larger cousin of the oyster borer, *Haustrum haustorium*, feeds on top shells or catseyes. By contrast, the *Cominella* whelks scavenge on dead or moribund animals. *C. maculosa* is the most common among oysters, while the more slender *C. adspersa* lives on the coralline turf (Fig. 2).

Where the turf drops off vertically to the sub-littoral fringe, the chief plants are the large brown algae, notably the *Carpophyllum* species, that are peculiar to New Zealand. The most common at Long Bay and one found regularly on all shores with a medium exposure, is the herringbone weed (*C. maschalocarpum*), with dark brown flattened branches bearing pointed leaves and big oval bladders (*p.29*). A second species, the plumed weed (*C. plumosum*), has finely cut leaves and small bladders.

Common at the same level and also in rock pools at Long Bay is the Sargasso weed (*Sargassum sinclairii*) with more crinkled foliage than *Carpophyllum*, a lighter yellowish-brown colour and leaves that have fine serrations and a slight mid-rib. This plant belongs to a warm-water genus, some of whose species break free to float in huge expanses as are found on the surface of the Sargasso Sea.

The most elegant of the small brown algae at Long Bay is the fan weed (*Zonaria angustata*), which grows in dark places, in the deeper pools.

Beyond the *Carpophyllum* fringe, only briefly exposed at low tide, grows the smallest of our kelps, *Ecklonia radiata* (*p.29*), a simply constructed species with branched holdfast, narrow stipe or stalk, and shiny ribbons. It is intolerant of strong light and reaches its greatest size, 3 metres tall, in the sub-tidal kelp forests familiar to scuba divers.

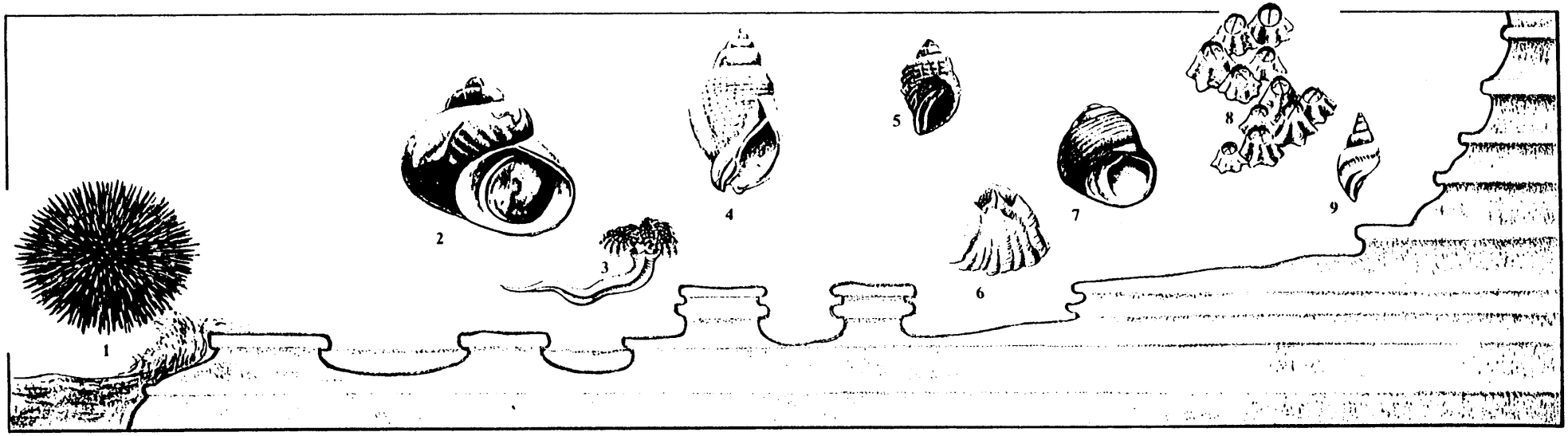

Fig. 2 A reef section from Long Bay with typical species of marine life, positioned above their actual location on the shore.
From left: 1. Sea egg (*Evechinus chloroticus*), 15cm dia.; 2. Catseye (*Turbo smaragdus*), 20mm dia.; 3. Tubeworm (*Pomatoceros caeruleus*), gills 10-12mm; 4. Speckled whelk (*Cominella adspersa*), 75mm; 5. Oyster borer (*Lepsiella scobina*), 25mm; 6. Acorn barnacle (*Epopella plicata*), 10-15mm dia.; 7. Black top shell (*Melagraphia aethiops*), 30mm; 8. Column barnacle (*Chamaesipho columna*), 2-3mm dia.; 9. Blue periwinkle (*Littorina unifasciata*), 10mm.