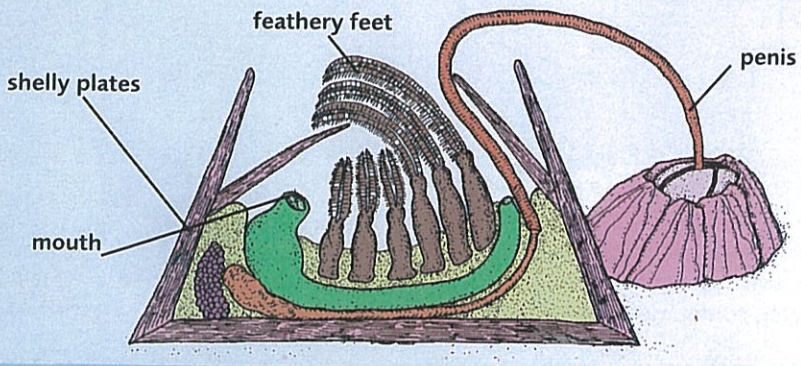
Ref: Stace, Glenys (2005) 'Blue New Zealand'. Puffin Books Publishers

BARNACLES

Barnacles, cirripedia (thread feet), are crustaceans in disguise. They begin life looking like shrimps, swimming free in the sea. The tiny larvae finish moulting before settling on a hard surface. Here they build their shelly box and kick up their long hairy legs to catch organisms in the water, passing them down into their mouths.



DIVING DEEPER

Reproduction presents a pr for animals that are permane attached to rocks. Some spe such as mussels, simply relea eggs and sperm into the wat where fertilisation takes place This is a very wasteful proces Barnacles are gregarious and near other barnacles so a rece neighbour is never far away. T barnacle simply uncoils its long flexible, tubular penis and prob about for a nearby mate. Most barnacles are hermaphrodites (both male and female sex organ so any adjacent adult of the sam species will do. In proportion to size, the barnacle has the longes penis of any animal.

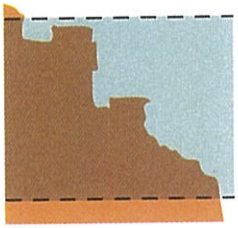
The barnacle uses its **feeding legs** to catch plankton.

Then it pushes the plankton into its mouth with its legs.

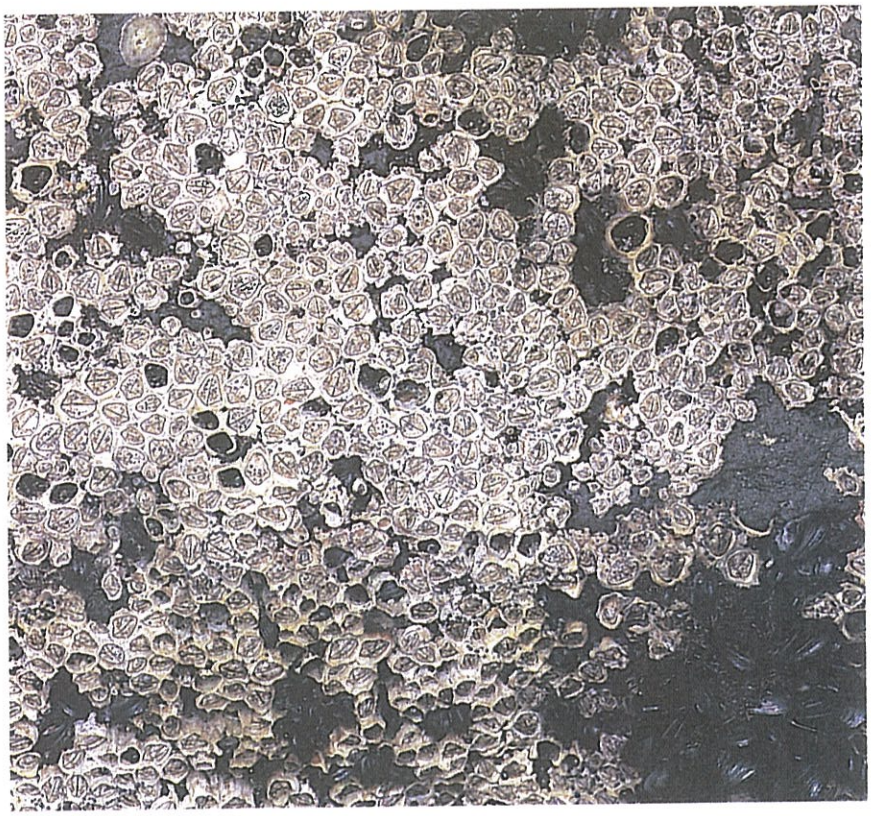
Ref: Schaefer, Lola (2003) 'Barnacles.' Raintree publishers, U.K.

Column barnacle Brown surf barnacle

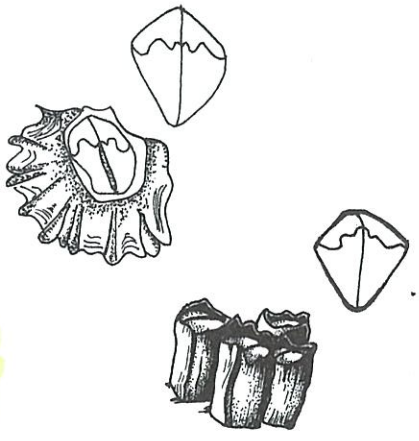
Chaemaesipho columna *Chaemaesipho brunnea*



SIZE:
Column barnacle 2–3mm, brown surf barnacle up to 8mm



Column barnacles (*Chaemaesipho columna*) are small, dull greyish-white and low-pitched, with flat opening plates and characteristic wavy edges which fit neatly together. They form a continuous cover on the rocks, or when very crowded become taller and hexagonal in shape. The brown surf barnacle (*Chaemaesipho brunnea*) has hexagonal grey shells, slightly larger and flatter than their smaller cousins.



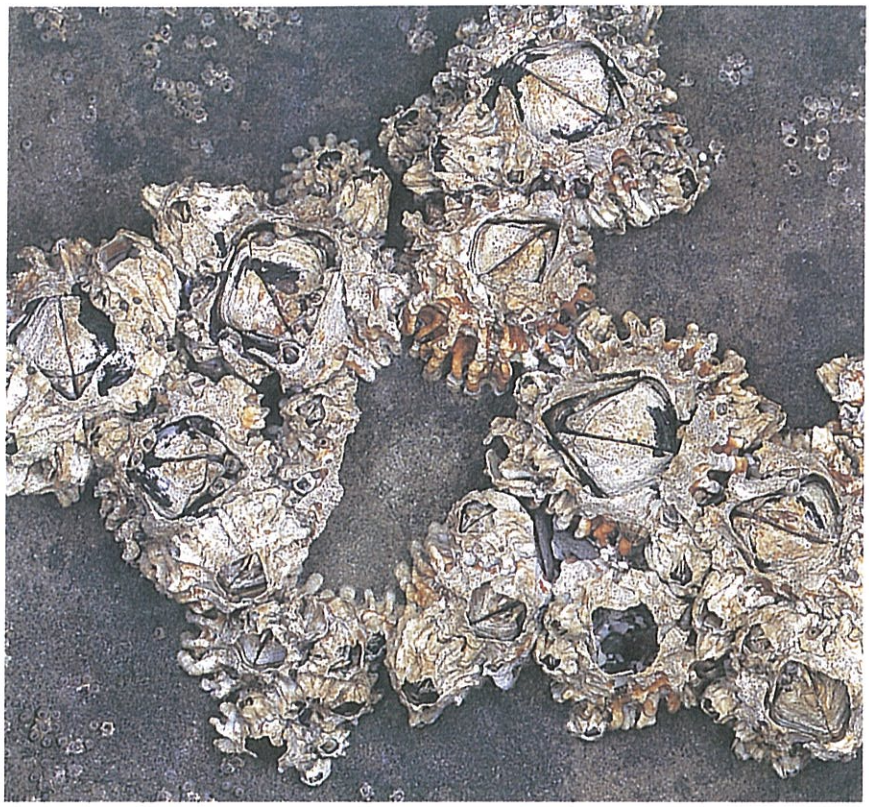
WHERE: The column barnacle (*C. columna*) lives on rocky shores where the waves are moderately strong, in a zone determined by the lowest of high tides and the highest of low tides. That means it is always exposed during low tide and is often found in damp crevices quite high on the shore. It can withstand very high temperatures.

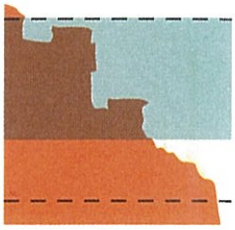
The brown surf barnacle (*C. brunnea*) usually lives slightly lower on the shore than the column barnacle but is often found on very exposed rocky surfaces. It sometimes forms very close-packed, honeycombed colonies.

Ref: Stace, Glenys (1998) 'What's around the rocks, A simple guide to the rocky shore.' Penguin books publishers.

Plicate barnacle

Epopella plicata



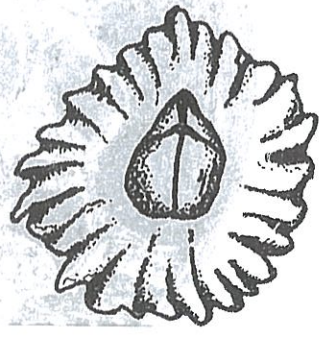


SIZE:
10mm

A yellowish-brown, strongly-ridged barnacle with deeply folded shell plates. Plicate means folded. It grows quite tall and steep-sided in relative shelter, but can be quite flattened in strong surf. Cemented to a rock, they often grow in clusters.

WHERE: Plicate barnacles need to be covered by the tide every day. Beds of these barnacles are often interspersed with beds of the little black mussel (*Xenostrobus pulex*) high on the shore, and with beds of rock oysters (*Saccostrea cucullata*) slightly lower down. These barnacles have adapted to life high on the shore, where they can be exposed for hours every day, by trapping water within their shells. Of the crabs and carnivorous gastropods that prey on barnacles only the oyster borer (*Lepsiella scobina*) can remain this high on the shore while the tide is out.

RELATIVES: The modest barnacle (*Elminius modestus*), described in *What's on the Beach*, is very common on more sheltered coasts.



Ref: Stace, Glenys (1998)

Primary consumers: herbivores

In the broadest sense, herbivore is the term for all those animals cropping any part of the plant production of the sea. Two sorts of marine pasture exist. First, growing on the rocks, there are the multicellular algae sometimes known as **lithophytes**, and ranging from simple filaments up to the massive kelps. These are the food of the numerous mobile grazers, chiefly molluscs but including importantly echinoderms and fishes.

Second, and in aggregate biomass far more important, there is the plant food deriving from the **phytoplankton**. This constitutes the fodder of the sessile invertebrates that make up the zoned communities of the shore. It is these consumers that we shall introduce first, using filterers as the comprehensive term.

Filterers

Zoning animals that strain off a diet of plankton are arranged in predictable patterns, both in their order of settlement and in their level on the shore. **Operculate barnacles** are generally the earliest to settle and largely monopolise the upper eulittoral. In the middle eulittoral, dominance tends to pass to **bivalve molluscs**, typically mussels in our cooler waters and rock oysters in the warm north.

Directly below the bivalves, polychaete **tubeworms** appear: first serpulids, then, in the north, the sandy-tubed *Neosabellaria*. On our eastern offshore islands — as on tropical shores — the tubeworm habit has been adopted by the sessile, unwound gastropods called **vermetids**.

The lowest zoned of the filter feeders are usually the **ascidians** or sea squirts, beginning at the level of coralline turf. On open surfaces these are relatively unimportant in New Zealand, but come into their own chiefly under boulders.

Barnacles are the highest sessile animals on the shore, and generally the smallest-sized. Along with the bivalves they are the most effectively sealed against evaporation. At their upper levels their feeding time is limited to the brief arrival of waves or swash. Like all crustaceans, the barnacles lack cilia, and instead sweep for plankton with casting nets of paired limbs called *cirri*. Worked by muscular effort, these are far superior to cilia in yield per unit time.

Next down the shore, **mussels** and **oysters** grow larger than barnacles, with the smaller flea mussel (*Xenostrobus pulex*) living towards the top of the range. The shells can be tightly closed against evaporation by sustained contraction of their adductor muscles. Tubeworms and vermetids — exposed to the air for shorter time — are sealed less tightly, by a stopper-like operculum. The sea squirts have no shelly covering but instead a tough coat of *tunicin*. Left only for short intervals, they enjoy a prolonged feeding time, and grow fast to large individual size.

Barnacles: Cirripedia

Hard-shelled and fastened to rock, the barnacles were in former times classed with molluscs. In 1830 the naval surgeon and naturalist J. Vaughan Thompson, using an early plankton net in Cork Harbour, discovered their six-limbed *nauplius* larvae, revealing their affinity with other crustaceans. At metamorphosis the final stage *cypris* larva fixes itself by its head and with special cement glands becomes attached. Shell plates are now secreted, in acorn barnacles taking the form of a conical tent, opening at the top by movable opercular plates. In their basic plan, the stalked barnacles are not essentially different from the operculates. In both types, dissection at once reveals a crustacean, highly modified for sessile life.

As occupants of the highest sites on the shore, the barnacles have a long history and today they are the most individually numerous eulittoral animals. Charles Darwin suggested the present might be called the Age of Cirripedes, just as past eras have been ages of Graptolites, Trilobites or Brachiopods.

The terminology of the operculate barnacle shell is explained in Fig. 2.5. The eight original plates of the *column* become fused to differing extents. The operculum is made up of two pairs of sutured plates, the *terga* and *scuta*, diverging along the mid-line to give exit for the limbs. These six pairs of jointed *cirri* fringed with bristles or *setae* form the sweeping net for feeding. The small body is slung beneath the scuta inside a wide mantle cavity, into which the cirri curl up when retracted. The three posterior pairs of cirri are longer and their setae strain the plankton as they sweep through the water. Brushed off by shorter anterior cirri, this food is passed to the mouth.

Barnacles are hermaphroditic, and are unusual among sessile animals in continuing to practise copulation. In operculate barnacles the slender penis is long enough when extruded to reach neighbours some distance away.

The largest order of the barnacles, **Thoracica**, has two suborders, the **Lepadomorpha** or stalked barnacles and **Balanomorpha**, sessile acorn barnacles. The **stalked barnacles** are the earlier group, having an ovate *capitulum* with shell plates, carried on a flexible *peduncle*. At first, there were no distinct capitular plates, only a thick investing mantle, as still to be seen in the small New Zealand *Heteralepas*. Almost as archaic is *Ibla idiotica*, a small stalked barnacle living in crevices, having chitinous terga and scuta and the peduncle invested with hairy bristles.

Evidently quite early, the stalked barnacles fixed

Ref: Morton, John (2004) Seashore Ecology of New Zealand and the Pacific
David Bateman Ltd Publishers

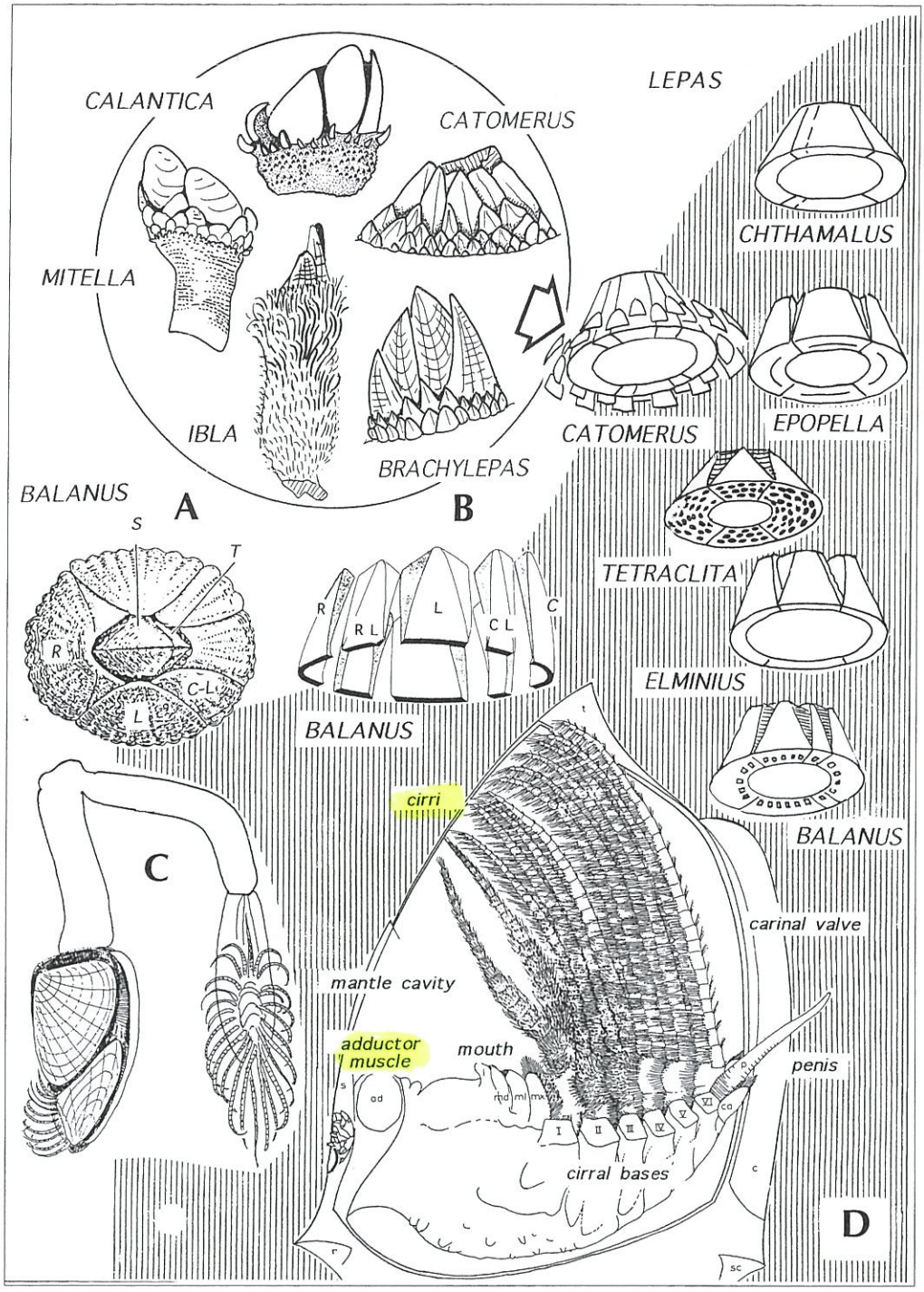


Fig. 2.5 Morphology of barnacles (Cirripedia)
(Top) Some primitive pedunculates with the derivation of operculate barnacles shown with detail of plates and in relation to shore level. **(Centre)** A *Balanus*, shell plates viewed from above B the eight column plates of an operculate barnacle before fusion (C carinal, CL carino-lateral, L lateral, R rostral, RL rostro-lateral, S scutum, T tergum) **(Bottom left)** C pedunculate barnacle, *Lepas anatifera*. **(Bottom right)** D internal anatomy based on *Calantica*. (After Brian Foster.)

upon the five-plated capitulum, that is today the standard pattern of the pelagic goose barnacles, **Lepadidae**. The shell plates have become reduced and functionless in the oceanic lepadomorph *Conchoderma*, fixed by its peduncle to the large balanomorph *Coronula*, that itself lives attached to whales.

Some of the most primitive stalked barnacles today are the *Calantica* species, secluded survivors in caves and crevices (Fig. 14.11). Their capitulum still remains many-plated. As well as the differentiated terga and scuta, median rostrum and carina, there are also tiers of small platelets round the capitular base.

Ref: Morton, John (2004)

CIRRIPEDIA Barnacles

When observed, exposed on the rocks, the shell of the barnacle is closed. Most genera and species can be recognised by the form and arrangement of the plates or valves as they may be called. They consist of the parietal valves forming a volcano-shaped ring enclosing the whole body and two pairs of movable plates which can open or close the kite-shaped aperture at the top; these are the terga (the narrow posterior plates) and the scuta (the two larger flatter plates) (Fig. 91).

Elminius plicatus Fig. 91

This is a common shore barnacle on exposed rocks. It is fairly large, reaching over $\frac{1}{2}$ inch in diameter. There are four parietal valves which are plicated (finely ridged) on the inside of the base. The animals often occur isolated or in twos or threes.

Elminius modestus Fig. 92

This is also a common shore barnacle, but is much smaller than *E. plicatus* being $\frac{1}{4}$ inch or less in diameter and tending to occur in clusters. Individuals are star-shaped but in masses the shape is often affected by adjacent ones. There are four parietal valves which are smooth at the base.

Typical Barnacle Structure Fig. 93

A specimen of *E. plicatus* is taken as an example to show barnacle structure. There is a membranous base which is part of the mantle and above this the tissue contains the ovary and muscles which work the tergum and scutum. The small rather bulbous thorax (abdomen is absent)-is reflexed within the cavity enclosed by the mantle so that its morphologically ventral surface is directed towards the carina or posterior plate. The sixth thoracic limbs are the largest and all the limbs curl forwards at their tips. When the animal performs its feeding movements, the terga and scuta are pulled down sideways and the mantle lips open so that the limbs emerge as a curved fan which is withdrawn with a rapid grasping motion straining the water for small particles which constitute the barnacle's food. This is repeated rhythmically and can easily be observed in barnacles covered by water. Respiration is effected at the same time, oxygen from the water passing through the thin tissues to blood sinuses within. The barnacles are hermaphrodite and in addition to the ovary which has invaded what are morphologically tissues of the head there are testes in the thorax. The products of both organs reach the exterior by thoracic apertures.

Ref: Leslie, M. A. (1968) 'Animals of the Rocky Shore of New Zealand' A.H. & A.W. Reed Publishers

CIRRIPEDIA
Barnacles

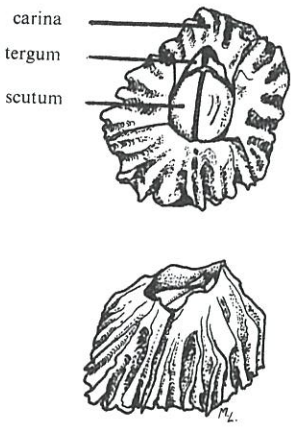


Fig. 91 *Elminius plicatus*

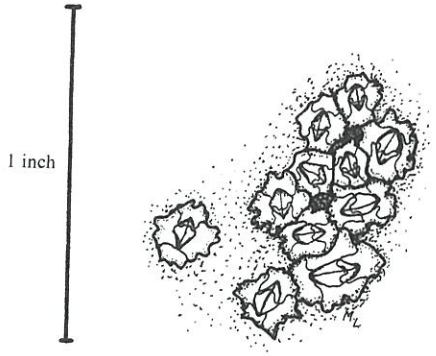


Fig. 92 *Elminius modestus*

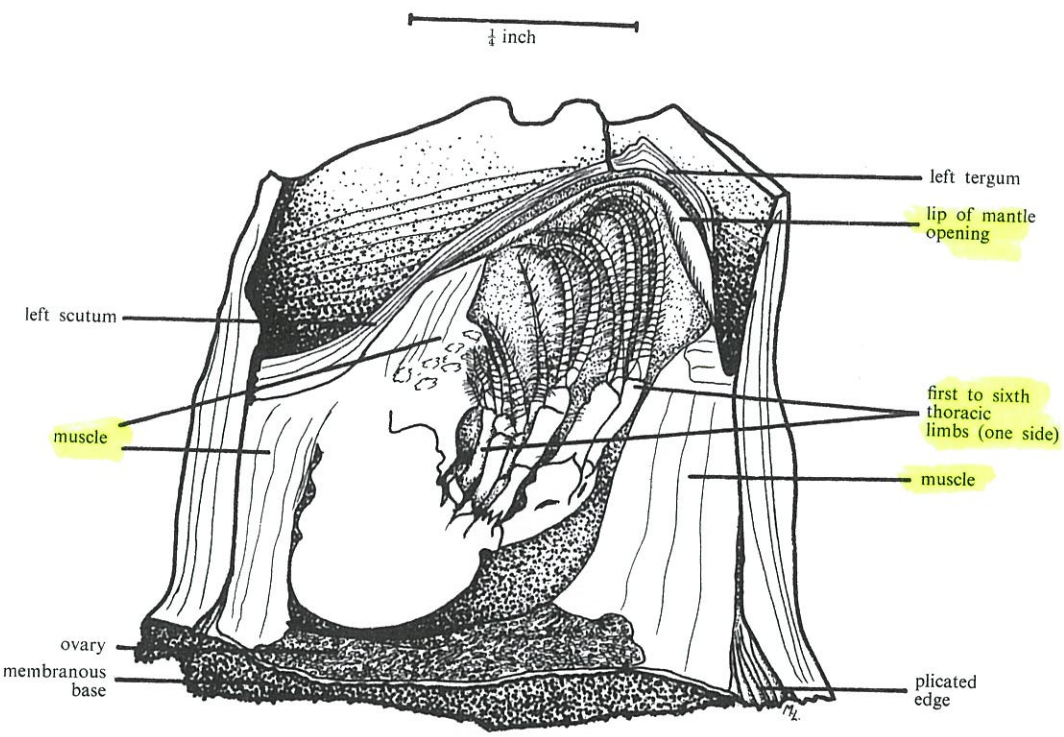


Fig. 93 *Elminius plicatus*
from right side with parietal valves, scutum, tergum and mantle of right side removed

Ref. Leslie, M.A. (1968)

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other habitats away from the tidal shore, for the larvae spend some weeks in the coastal plankton before they settle.) Barnacles breathe, excrete waste products, and mate through the same opening in the shell. They are hermaphrodite, so may swap sperm to fertilise each other's eggs. The barnacle's penis is extremely long in relation to the creature's size; it has to be, for neither partner can move. Like a tiny tentacle it reaches across to ejaculate sperm inside a neighbour's shell. Eggs hatch inside the parent and the larvae are emitted in a cloud.

Modest barnacles go through eight stages of development after hatching from the egg. Seven of these stages are planktonic, usually developing over a period of two to four weeks, and the eighth stage is the adult. When first hatched, the larvae are 0.2 mm long and have a shield-shaped shell with one eye and two little horns at the front, a spiny tail and six hairy limbs with which they swim and filter-feed. Like other crustacean larvae, they bear no resemblance to the adult. They moult five more times, each time producing a virtually identical but slightly larger larva. These larvae are called nauplii, and feed on plant plankton.

The last moult produces something only slightly larger, but which no longer feeds and looks quite different. It has a compact round shell without spines, there are two eyes, and the front antennae have cement glands. It has just one feature in common with the adult: there are twelve legs, but these are very small, and only the precursors of the feeding-net which will develop in the adult. This stage is called the cyprid. It is a special form — a kind of landing craft — adapted to search for and attach to somewhere the adult can develop.

Even as the cyprids search for homes, their problems are not about to end. Many are seen and eaten by the small fish of tide pools and rocky ground, especially blennies, which pursue them in much the same fashion as fantails chase moths on the wing.

Cyprids are extremely selective about where they settle. They take some time about making the decision, as once attached there is no possibility of shifting again. They crawl about on possible sites, testing them with their antennae. The presence of adults of their own kind is an encouraging sign. If there is more than enough space for it, the cyprid will even position itself the optimum distance from neighbours, leaving plenty of space to grow. It then kicks off its shell for the last time, and soon loses any superficial resemblance to a crustacean. Cemented firmly by its front antennae, it dramatically changes form. The plates and jointed lid characteristic of barnacles soon appear. It has become an adult.

Barnacles occupy the highest zones possible for sessile animals on the tidal shore. The higher up they live, the safer they are from predators during the most vulnerable time just after settling, but the higher levels of the shore are dry for longer and there is less time to filter-feed when the tide is high. A compromise must be struck. The upper level of this compromise is marked by the top of the barnacle belt.

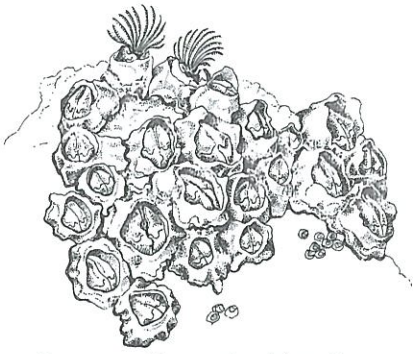
It also follows that upper-shore barnacles have evolved the greatest filtering efficiency. They have even learned to orientate themselves side-on to the direction from which the waves sweep in. This makes it less difficult to turn the filtering nets back and forth to use the surge as it sweeps both up and down the shore. They also keep effort to a minimum, not actively combing through the water but allowing it to sweep through their outstretched limbs.

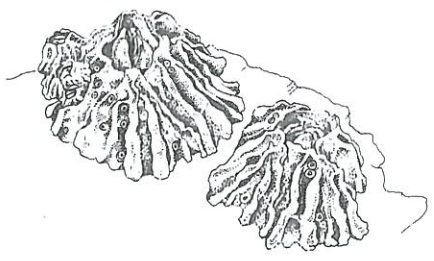
The **brown surf barnacle** (*Chamaesipho brunnea*) and the taller but often narrower barnacle (*Chamaesipho columna*) of exposed shores are able to live above the actual high tide level where only the splash of waves can reach to bring food and moisture; a prolonged spell of calm weather, especially combined with neap tides, can kill them.

The brown surf barnacle is exceptionally hardy and paves rock surfaces exposed to direct sun. Its smaller relative opts for patches of localised shelter, cracks or pits in the rock being favoured sites not only for their shade, moisture, and shelter, but also because they trap or funnel the trickles of water splashed up by the waves. Both these species can comfortably tolerate temperatures of 28°C and do not become comatose except at temperatures in the mid-30s. In experiments, it takes an hour at a scorching 48°C to kill the brown barnacle.

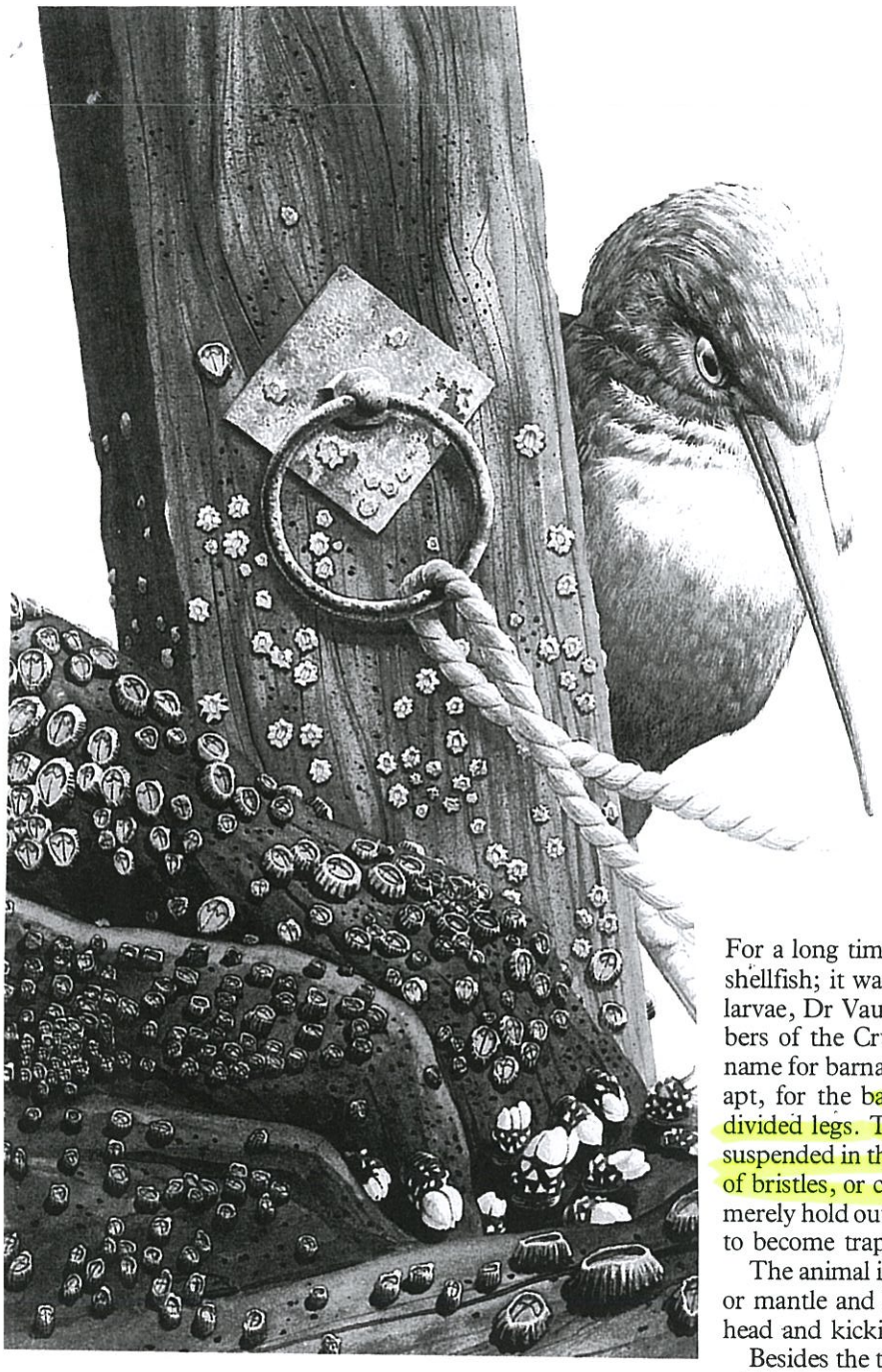
Lower on the shore barnacles gradually become less abundant. They yield to the more successful competitors for space, and are kept in check by the more abundant predators which may attack the adults as well as settling cyprids. So the barnacle's upper limit is set by the elements, and the bottom limit by other life-forms. Distribution limits of many other shore organisms are set just the same way, but at different heights.

There is a great deal of similarity between barnacles and the porcelain crabs mentioned earlier in this chapter. The big difference is only in structure. Both, however, eat the same food, which they collect in exactly the same fashion. Also, their early lives are both spent in the plankton, after the fertilised eggs hatch from the parents. The hard but jointed external skeleton of crustaceans has successfully evolved into many forms capable of living in a variety of situations.





Brown surf barnacles (above) survive in one of the harshest places of all: on the upper levels of exposed rocky shores, where they must withstand direct sunshine at low tide then breaking waves at high tide. The largest common shore barnacle, *Epopella plicata* (below), inhabits sheltered or shady spots. Both species filter-feed in the wake of waves, as water trickles back down the shore. (Both twice natural size.)



Gunson, Dave (1983)
'A Guide to the
New Zealand Seashore'
Penguin Books Publishers

For a long time it was supposed that barnacles were actually a form of shellfish; it was not until 1830 that by careful examination of barnacle larvae, Dr Vaughan Thompson correctly classified them as being members of the Crustacea, which includes crabs and crayfish. The proper name for barnacles is Cirripedia, which means 'curled feet'. This is most apt, for the barnacle actually sweeps the water with feather-like subdivided legs. The fine bristles on the legs catch the food and plankton suspended in the water and transfer them to the mouth where further sets of bristles, or cirri, draw off the particles. Some less energetic barnacles merely hold out their legs instead of sweeping and allow the food particles to become trapped of their own accord.

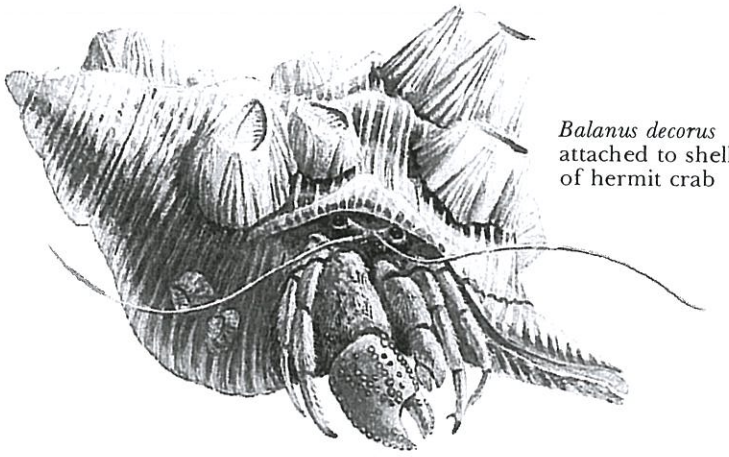
The animal is permanently affixed to the inside of the calcareous shell, or mantle and has been suitably described as 'a crustacean fixed by its head and kicking food into its mouth with its legs'.

Besides the thick plates of the mantle are two pairs of moveable plates which form a tight stopper or operculum when the barnacle is exposed, protecting the animal and helping to retain moisture until the next immersion by the tide.

Barnacles are most unusual crustaceans in that they possess both male and female reproductive organs, cross-fertilisation being achieved by the placement of sperm from one barnacle to the shell of another by means of a long flexible stalk. The eggs are incubated inside the shell. When hatched, the young larvae, or nauplii, swim free to go through several skin moults before undergoing a metamorphosis to a small larval form called a cyprid. The cyprid attaches itself to a suitable firm surface, secreting a special cement to achieve adhesion. A further moult then takes place, the cyprid taking on the adult shape, forming the calcite plates and further cementing the entire shell cone to the rock. This cement is extremely durable, and is under investigation by scientists for analysis and possible synthesis so that it may be of use in bone surgery, dentistry and industrial applications. Once cured, the barnacle cement is impervious to bacteria, and will resist corrosion by acids, alkalis and protein solvents; even temperatures over 200°C have little effect.

Some barnacles may produce as many as 10,000 offspring three times a year for the first few years of life. Even taking into account natural predation, this massive reproduction rate combined with the extraordinary cement has caused headaches for traders for thousands of years by

Under inspection from the blue reef heron *Egretta sacra* are (from rear): the modest barnacle, *Elminius modestus*, brown barnacle, *Chamaesipho brunnea*; columnar barnacle, *Chamaesipho columna*, plicate barnacle, *Epopella plicata*. At centre is the stalked barnacle, *Mitella spinosa*



Balanus decorus attached to shell of hermit crab

fouling ships' hulls and severely affecting performance. The Phoenicians tried painting their ships with pitch, the Greeks tried wax and tar, but the best protection yet found is copper oxide paint. Even this very expensive product lasts only a couple of years before the oxides have leached away and encrustation begins afresh.

Barnacles will attach themselves to just about anything; wharf piles, moorings, turtles, ships, jellyfish, shellfish, rocks, whales, crabs and even penguins' feet. In 1970, Thor Heyerdahl observed barnacles in the Atlantic Ocean happily clinging to blobs of solidified oil.

These indiscriminate creatures will even make the best of a bad situation by settling on the shells of their predators, such as crayfish and the oyster borer *Lepsiella scobina*.

The stalked barnacle *Mitella spinosa* can be found crowded in small colonies in dark damp cracks and crevices of rocks from mid-tide to low water on open shores. Usually no more than 40 mm long, *Mitella* has body plates that emerge from a tough leathery outer skin which is suspended on a short wrinkled stalk.

Several species of stalked goose barnacle are washed up on our shores. These creatures attach themselves to any floating object, and while they remain permanently attached as do their shore cousins, at least they manage to travel about a little. The goose barnacle *Lepas fascicularis* has no need to hitch-hike on passing flotsam, for it actually secretes its own raft. *Lepas anatifera*, usually attached to driftwood, is the species most often found left behind by the tide.

In medieval times goose barnacles, because of their feather-like limbs and beak-shaped plates, were believed to grow into real geese. The belief

persisted to the extent that certain Catholic priests regarded real geese as fish, rather than birds, and allowed their consumption on otherwise meatless holy days. Even in the 16th century the poet Du Bantas explained driftwood-borne barnacles thus: 'first a green Tree, then a gallant Hull, lately a Mushroom, now a flying Gull'. Obviously to this poet, goose barnacles were still embryonic birds, but passing through a mushroom stage.

A real monster of the barnacle family can be found off the west coast of America. Weighing more than 1.5 kg, and standing over 140 mm in height, *Balanus nubilis* is served to gourmets steam-cooked in the shell with a seafood sauce. Fortunately for the mercantile world, this giant grows only on rocks and shows no inclination to settle on ships' hulls.

Related to the American giant is our own *Balanus decorus*, though only growing to 75 mm across the base and rarely more than 85 mm in height. *Balanus* usually remains below low tide, but small specimens are often found attached to shells washed up by the tide. The mantle is made up of six distinctively ridged plates, coloured pink and lilac. A southern species, *Balanus campbelli*, shows red and gold markings between the main plates.

The columnar barnacle *Chamaesipho columna*, 2-3 mm across, has an elongated mantle and the plates are fused together leaving no trace of joints. *Chamaesipho* can be found on all exposed rocky coasts and like all shore barnacles, it will modify its shape to accommodate to awkward spaces. Sometimes entire colonies will grow stretched and distorted due to chronic overcrowding.

Slightly higher up on the shore is the brown barnacle *Chamaesipho brunnea*, the name referring to the body parts rather than the exterior mantle. A little shorter and wider than its cousin, the brown barnacle is rarely found in the lower half of the South Island.

The plicate barnacle *Epopella plicata* (10-15 mm across) is the largest of the common shore barnacles. A distinctive yellow-brown colour, it has a strongly ridged shell, and may be found in quantity low down on open coasts. Both the plicate and modest barnacle *Elminius modestus* (2-3 mm across) have four plates forming the main structure of the mantle. Of more than 60 species of barnacle in New Zealand, *Elminius* is the most numerous species found in sheltered waters and harbours where it attaches itself to practically anything firm, even mangrove trunks in the north. *Elminius* spread to Britain during World War II on vessels sailing from Australia and New Zealand. From there it spread across the English Channel to the Continent and can now be found in the Baltic Sea and southern Spanish waters.