ZONES OF LIFE

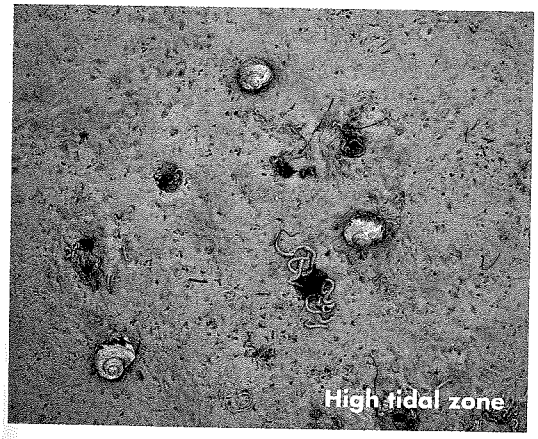
When the **tide is high**, the seashore is a haven for marine life. The habitat is bathed in seawater, which moderates the temperature, delivers food to those anchored to the substrate (sediment or rock) and transports young. Sunlight abounds and oxygen is plentiful. Not all is rosy, though, as predators may move in from deeper water and in some areas significant wave action or run-off from land and rivers may affect living conditions.

When the **tide is low**, the seashore is exposed to terrestrial conditions and land-based predators. Physical stresses are highest towards the top of the shore, where animals and plants are exposed to desiccation (drying out due to the sun and wind), extremes of temperature (depending on the time of day or year), intense solar and ultraviolet radiation, and occasional dousings of fresh water (rain). Variations in salinity may increase in estuaries (where rivers meet the sea) and areas where there is high rainfall (e.g. fiords). Nutrients for algal growth and suspended food for filter feeders are absent at low tide. Moving, breathing and reproducing become more difficult when out of the water, affecting a marine organism's ability to survive.

Tidal gradient

The seashore is one of the few habitats where the change in community over an environmental gradient is easily seen and understood. The transition from terrestrial to marine may occur over a space of a few metres or a couple of kilometres, depending on the slope of the shoreline. The change in water level creates a vertical gradient, with species high on the shore exposed to air for longer than those low on the shore.

Intertidal species are distributed in distinct bands or zones, depending on their ability to cope with environmental conditions. When dominated by 1 or 2 species these zones appear as different bands of colour on the shore, most obviously on vertical rock faces. These zones are less obvious on a mudflat, as most species are found beneath the surface.


High tidal zone


Mid tidal zone

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However, observant explorers will see changes in the species present, or their tell-tale signs as they walk to the water's edge (photos below).

Species distribution

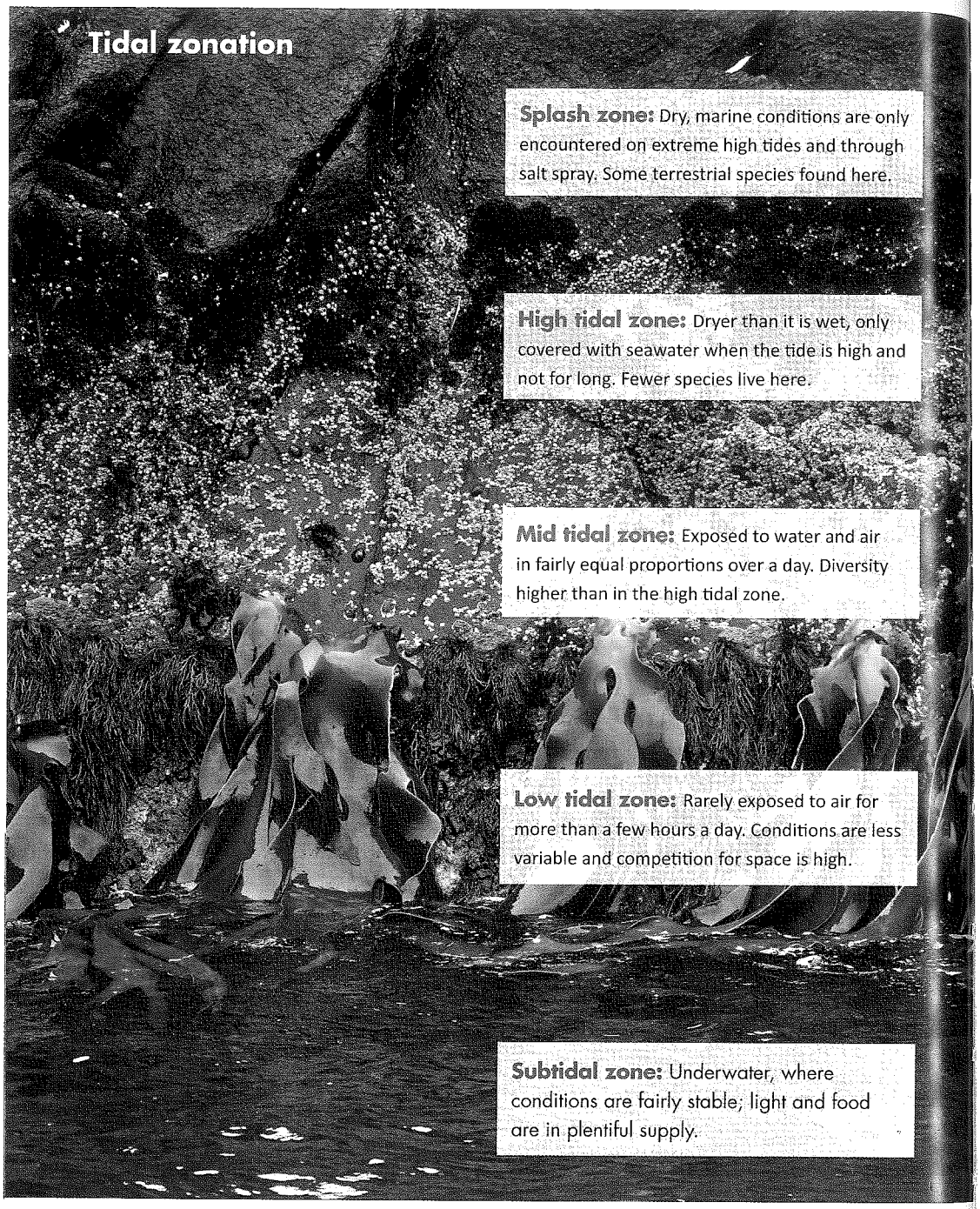
Despite the often harsh environment, the seashore is rich with life. Some species' distribution is well defined, but for others it may not be so clear.

The **upper distribution** of a species is usually attributed to physical stress, and an organism's ability to survive out of the water and tolerate terrestrial conditions. For filter feeders like mussels, the absence of planktonic food may affect the upper distribution. The presence, or absence of other species, may also influence their position on the shore. For example, a seaweed may provide shelter, allowing some species to survive higher on the shore than they would if there were no shelter.

The **lower distribution** is mainly controlled by biological factors. Competition with other species for space and food comes into play in the low tidal zone. For example, the reef star (right) controls the lower limits of the mussel's distribution through predation. Other predators will also move in from deep water when the tide comes in.


Low tidal zone

Tidal zonation



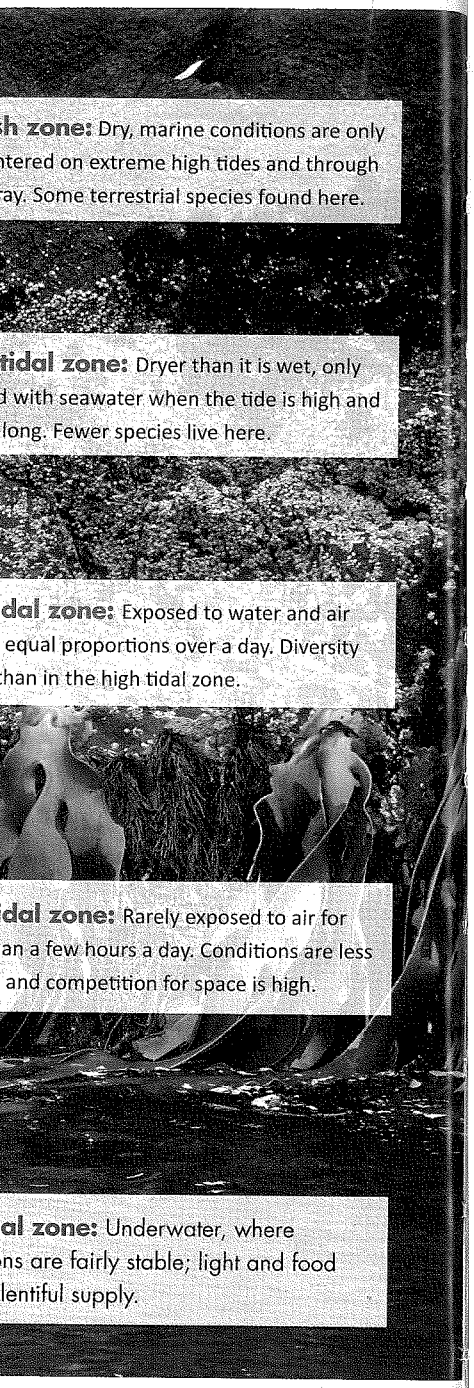
Splash zone: Dry, marine conditions are only encountered on extreme high tides and through salt spray. Some terrestrial species found here.

High tidal zone: Dryer than it is wet, only covered with seawater when the tide is high and not for long. Fewer species live here.

Mid tidal zone: Exposed to water and air in fairly equal proportions over a day. Diversity higher than in the high tidal zone.

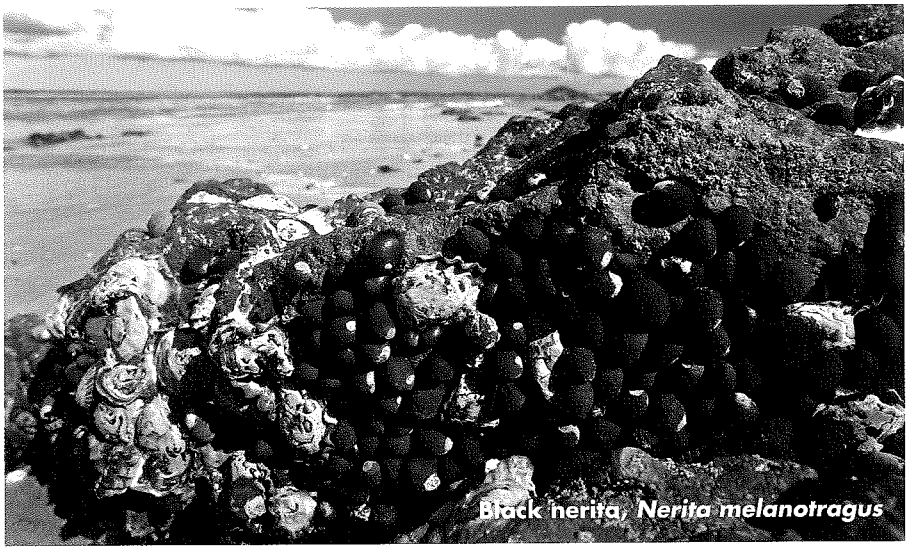
Low tidal zone: Rarely exposed to air for more than a few hours a day. Conditions are less variable and competition for space is high.

Subtidal zone: Underwater, where conditions are fairly stable; light and food are in plentiful supply.



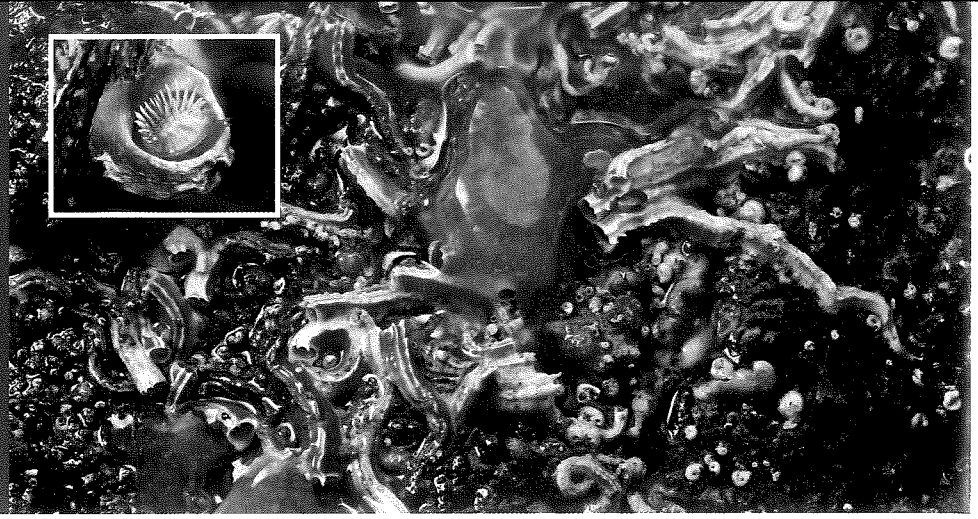
ROCKY SHORES

Rich in real estate, rocky shores provide a wide selection of places to call home. Steep cliffs, rocky platforms and reefs are found where the wave action is strongest. In quieter waters, piles of cobbles and smaller rocks provide cover from the sun, wind and rain. The lush growth of seaweeds offers a protective cloak to smaller invertebrates. As the physical environment changes from wet to dry and sheltered to exposed, so too does the community of plants and animals that lives there. Keeping a low profile and being able to hang on to the rocks becomes more relevant as the exposure increases.


Black nerita, *Nerita melanotragus*

Tidal pools may appear as a luxury home, but on closer inspection the conditions are variable. Isolation from the ocean water results in changes in temperature, salinity and dissolved oxygen, especially when the pool is small. With high air temperatures, the pool warms, the oxygen level decreases and evaporation occurs, leaving salt behind. Rain lowers the salt levels. And the incoming tide may cause temperature shock as the cold ocean water crashes into warmed pools. Photosynthesis and respiration can significantly alter the oxygen, carbon dioxide and pH levels. Release of waste products may support algal growth but can be toxic for some animals.

High diversity reigns, with representatives from almost every major group of invertebrates present. Hard shells, low profiles and strong means of attachment are useful physical features. Moving towards shade and shelter, clumping together and attempting to feed only when the tide is high are behavioural strategies for survival. Slowing down of internal processes (metabolism) is a physiological adaptation that lowers the need for food and oxygen, both of which are in short supply at low tide.



Red tubeworm • Toke pā

Galeolaria hystrix · Other name: Red reef tubeworm

Two whorls of branched **feathery red tentacles** are attached to the head of this segmented worm. They are extended out of a calcium carbonate tube when the tide is high. At low tide, they are retracted and sealed in the tube with an elaborate plug covered with white spines, called an operculum. The lower surface of the tube is cemented to the rock, and twin ridges run along the upper surface to form horn-like structures at the opening. It is mainly white with bright orange red on top.

HABITAT The red tubeworm is found very low on the shore and into the subtidal zone, anchored to rocks and other firm surfaces. Small clusters are located on vertical faces where there is good water flow. In sheltered subtidal locations, massive colonies form that may be several metres across and 1m or more high.

LIFESTYLE This worm's feathery tentacles are used for respiration and to capture plankton and small particles for dinner. If it senses danger they will quickly retract this feathery headgear and shelter in their tubes until the threat passes.

The hard tubes may form complex 3-dimensional structures with lots of little nooks and crannies. These structures provide hiding places for a variety of small bottom-dwelling invertebrates and fish, and often increase the biodiversity in the area where they are found.

SIZE Length to 50mm · HABITAT ROCKY shores
TIDAL ZONE LOW tide · DISTRIBUTION NZ

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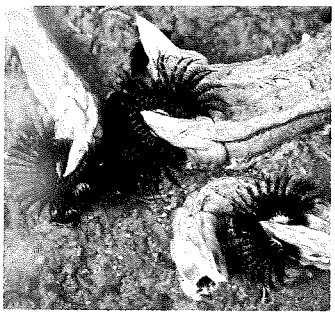
Blue tubeworm • Toke pā

Spirobranchus cariniferus · Other name: Spiny tubeworm

The **hard white tubes** of this worm are often overlooked by seashore explorers, as they do not resemble anything living. The only evidence of life at low tide is the flat black plug at the tube opening. If that is present, then the worm is home and sealed inside where it is dark and cool. When the tide comes in, a fan of dark blue tentacles emerges out of the protective calcareous tube, but will quickly retreat at the slightest of movements. The worm found within never leaves its home.

The white tube is triangular in cross-section, with the base cemented to the rock and an upper ridge running along its length. This ridge extends like a protective spine from the upper side of the tube opening and can easily cut fingers when rocks are turned over.



HABITAT This species is very common on shaded rock faces in the mid and low tidal zone of southern rocky shores. The calcareous tubes can reach densities of 1000/m^2 in some areas and can form tangled masses up to 30cm thick. Individual worms may be found attached to small rocks and empty shells.

LIFESTYLE The crown of tentacles is made for filtering plankton and organic particles from the surrounding water and acts as gills. Eggs and sperm are released into the water in late spring and a planktonic larval stage follows. The larvae settle near other adults.

SIZE Length to 40mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ

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BARNACLES • TIOTIO

Although one of the most common animals on the rocky shore, barnacles remain anonymous to most seashore explorers due to their small size and encrusting form. Those who do notice them often think they are dead because there is no movement.

The presence of shell doors pulled tightly closed is actually a sign of good health in the barnacle world, and the main reason they can live in the high tidal zone. Sealing their shell tight to hold moisture, reducing their activity level and waiting until the tide returns are the rules of the game for many intertidal creatures, and barnacles are the masters. But once barnacles are covered with water, their behaviour becomes more interesting.

These crustaceans were once assumed to be molluscs on the basis of their calcium carbonate shells. Barnacles look most like a crustacean during the first few months of their lives as free-swimming larvae with jointed limbs, before they settle down and cement their heads to a hard surface. Their body organs are then rearranged for living upside down and a calcareous tent-like shell is formed around them.

Their **sessile** lifestyle, anchored to a rock, has resulted in their jointed legs being adapted for a very different purpose. At high tide, they open the upper doors of their shell, the **operculum**, and kick out 6 pairs of jointed legs, called **cirri**, to filter plankton from the water. These limbs have an exoskeleton, which is moulted as the barnacles grows, and a new, larger one is formed. It is not uncommon to find a barnacle **moult** floating in a tidal pool.

Reproduction is difficult for an animal that doesn't move, and barnacles are famous for their reproductive strategy. The male has a very, very long penis that when extended can reach his neighbour! And finding a female is not as hard as you might expect. Most barnacles are **hermaphrodites**, with both male and female sex organs. Although they prefer to mate with another barnacle, if they are on their own they have the ability to fertilise their own eggs.

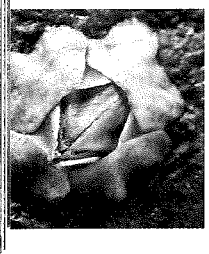
Modest barnacle, *Austrominius modestus*, feeding and moult

Modest barnacle • Tio piripiri

Austrominius modestus · Other name: Estuarine barnacle

Resembling **tiny white stars** on the rock, these barnacles have a tent-like shell featuring 4 wall plates with folds (operculum). The diamond-shaped opening is closed with 4 hinged plates. At high tide, the plates are pulled back and the feet, called cirri, extended. When the tide drops, the feet are withdrawn and the plates close to seal the animal inside the shell and protect it from drying out. This species has a membranous rather than a hard shell base.

HABITAT This barnacle is found in very large numbers on sheltered rocky shores. Usually its shell is glued to rocks, but on muddy shores it is found attached to cockle shells and mangrove branches and roots. It is able to survive in water with minimal current, low salinity and high turbidity (cloudiness). In shaded areas, individuals may be found higher on the shore and their shells may be thinner.



LIFESTYLE As this species is often found in quiet water, the cirri actively pump in and out to create a water current for filter feeding. The cirri are covered with tiny hairs that form a net to trap small plankton. Smaller cirri clean the larger cirri and the food is pushed to the mouth.

Through commercial shipping this NZ native was accidentally introduced to Europe, where it is now considered a pest species. It reproduces throughout the year, so is able to colonise clear surfaces at any time. It covers wharf piles and the bottoms of boats, and on some shores has outcompeted Britain's native barnacles.

SIZE Diameter to 12mm · HABITATS ROCKY shores, MUDFLATS
TIDAL ZONES HIGH, MID tide · DISTRIBUTION NZ, Australia

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barnacle

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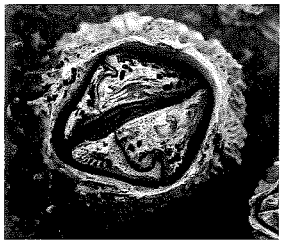
MUDFLATS
Australia

Plicate barnacle • Tiotio

Epopella plicata · Other name: Koromāungaunga

Volcano or column-shaped, this species is larger than other shore barnacles. It is easy to identify because of its 4 distinct side wall plates. The external surface of the shell is often thickened by longitudinal ribbing and yellow due to a thin protein layer. The 4 plates at the top (operculum) fit together like puzzle pieces with a single step join on either side of centre.

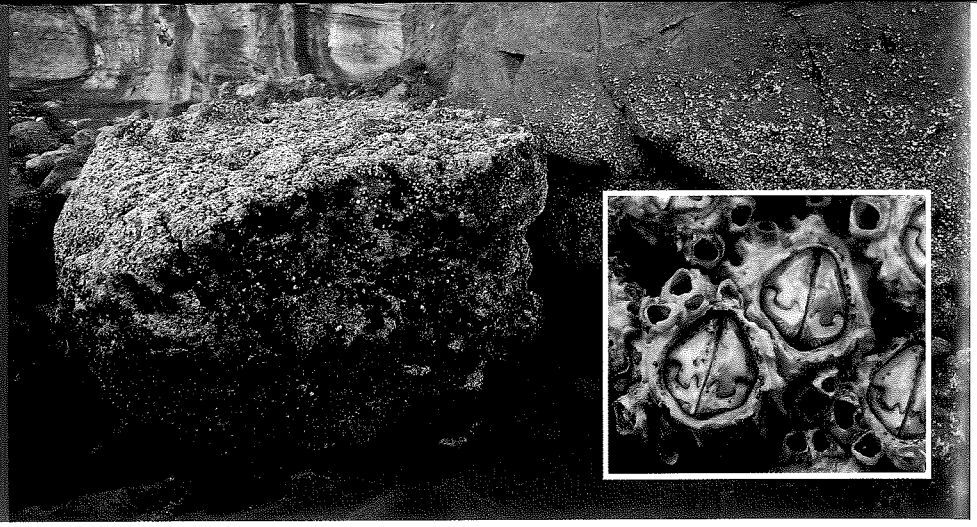


HABITAT Most common on exposed rocky shores, this barnacle is often found co-occurring with the columnar barnacle in the mid tidal zone and occasionally with the gooseneck barnacle in the low tidal zone. On sheltered shores, it may live a long time, with the shell becoming greatly eroded.

LIFESTYLE Filter feeding is effective for an animal that can't move. It simply extends its jointed legs and orients this feeding net across the water current. The legs are swept downwards and tiny planktonic food is brought to its mouth.

In all barnacle species, the embryos develop within the parent and hatch as tiny planktonic larvae. They are free-swimming for up to 4 weeks until they settle down on a suitable rock surface. After reaching the rock surface, the larva will crawl until it encounters the shell of another barnacle, a sign that it can survive in the region. Then it will continue to crawl to map out a place where it can settle with room to grow. It must choose its home carefully, as once attached it cannot move for the rest of its life.

SIZE Diameter to 25mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ



Brown surf barnacle • Tiotio

Chamaesipho brunnea · Other names: Koromāungaunga, werewere

A **horizontal white band** characterises the upper tidal zone of most exposed rocky shores. Look closely and you will see that the rock surface is completely encrusted with these small barnacles. The white colour of their shells deflects the sun's rays and may keep internal temperatures slightly lower.

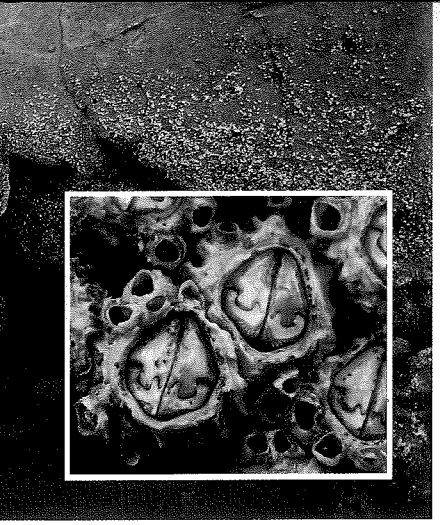
There are 6 wall plates, but they are usually fused together to form a continuous wall. They are normally wider than they are tall. Like most barnacles, the lid, called the operculum, has 4 plates that fit together like puzzle pieces, with a distinctive square join on either side of centre. The animal living in the shell is light brown in colour, hence its common name.

HABITAT This high tide species encrusts the rock surface on exposed coasts in northern NZ. Individuals may be found as much as 4m above the high tide level on shores where there is lots of wave action and water spray.

LIFESTYLE The cirri (jointed legs) are extended into the turbulent water to capture plankton. No pumping of the cirri is required and the size of the food particles caught is related to the distance between the hairs on the feeding legs.

This species is very hardy, as it may be without seawater for several weeks at a time and must tolerate very high temperatures. The upper limit of its distribution on the shore is controlled by total dryness and the lower limit is controlled by competition with the columnar barnacle for space on the rock.

SIZE Diameter to 24mm · HABITAT ROCKY shores
TIDAL ZONE HIGH tide · DISTRIBUTION NZ



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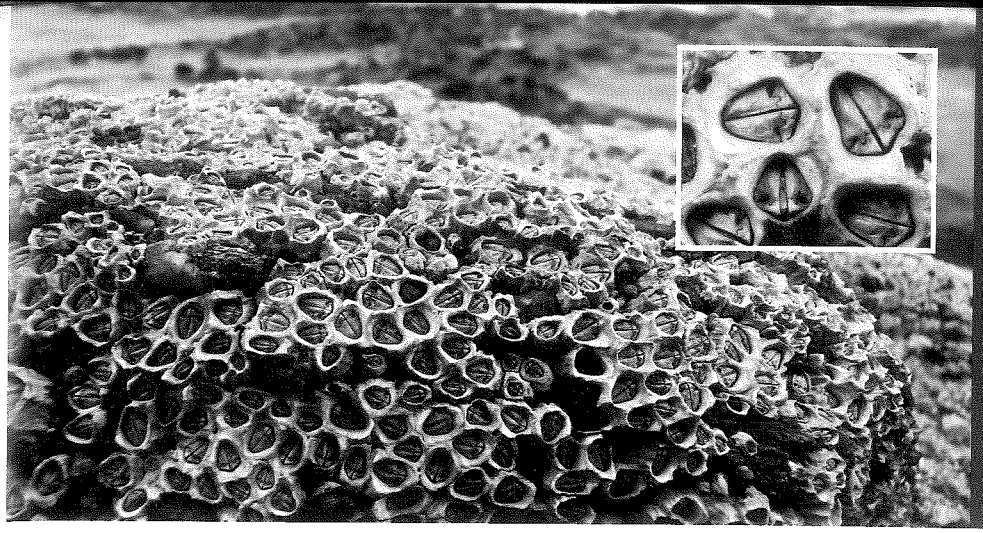

Columnar barnacle • Tiotio tai pari

Chamaesipho columna · Other name: Koromāungaunga

Honeycomb mats form where columnar barnacles are found in high densities, as their shells merge together. The close packing of the shells helps to offset external erosion and reduce water loss.

The vertical sides of an individual barnacle create a column shape, hence the name. This species starts life with 6 side plates but they fuse together in the adult stage. The shell is often taller than it is wide. Although similar to the brown surf barnacle, this species is smaller and the puzzle pieces of its lid fit together in a more rounded, less defined way. Also, the internal animal is dark blue rather than brown.

HABITAT This species survives well in the upper reaches of semi-exposed and exposed rocky shores. In northern NZ it co-occurs with the brown surf barnacle, but does not extend as high on the shore. In southern NZ, where the brown surf barnacle is absent, the columnar barnacle extends to the top of the tidal zone.

This species can withstand extremes of temperature and can be exposed to air for extended periods. The upper distribution is controlled by the level of dryness and the lower limit is controlled by competition for space on the rock from brown algae and other invertebrates. This barnacle shares its lower range with the plicate barnacle and will attach itself to the shell of this larger barnacle.

LIFESTYLE To feed, this species extends its cirri (jointed legs) to form a filtering net that swivels to cross the water current and capture tiny plankton.

SIZE Diameter to 9mm · HABITAT ROCKY shores
TIDAL ZONES HIGH, MID tide · DISTRIBUTION NZ

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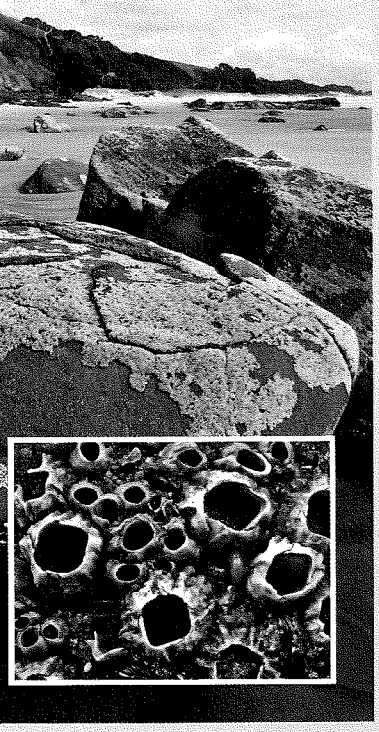
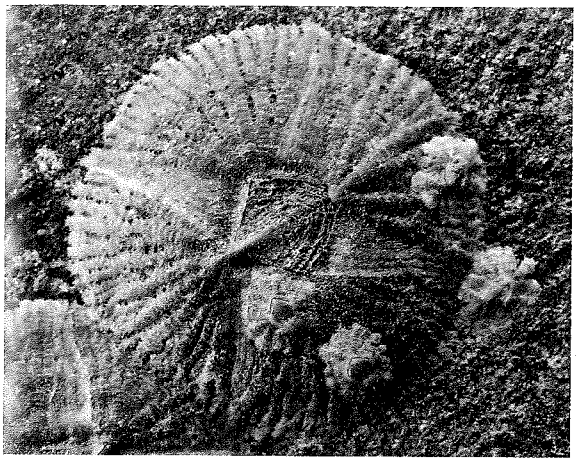


Flat barnacle • Tiotio

Tetraclitella depressa · Other name: Koromāungaunga

Keeping a **low profile**, this barnacle is easily recognised by its flattened shape. Its 4 wall plates are almost horizontal to the rock surface. Its shell is a dirty white colour, with distinct longitudinal ribs in uneroded specimens. The central opening has 4 opercular plates with relatively straight edges.



HABITAT This species is found in the mid tidal zone on moderately exposed shores in areas that are free of silt and sediment. It is common under rocks, where it is shady and remains damp at low tide.

LIFESTYLE Field experiments have shown that this barnacle is capable of settling and growing on cleared areas of rock low on the shore, but is soon outcompeted for space by algae and tubeworms, which overgrow it.

SIZE Diameter to 20mm · HABITAT ROCKY shores
TIDAL ZONE MID tide · DISTRIBUTION NZ

Hairy trumpet snail,
Cymatium parthenopeum

nd 'soft body', the phylum
the fossil record. Three
chitons, gastropods,
se in the world. Many are
s are treasured for their

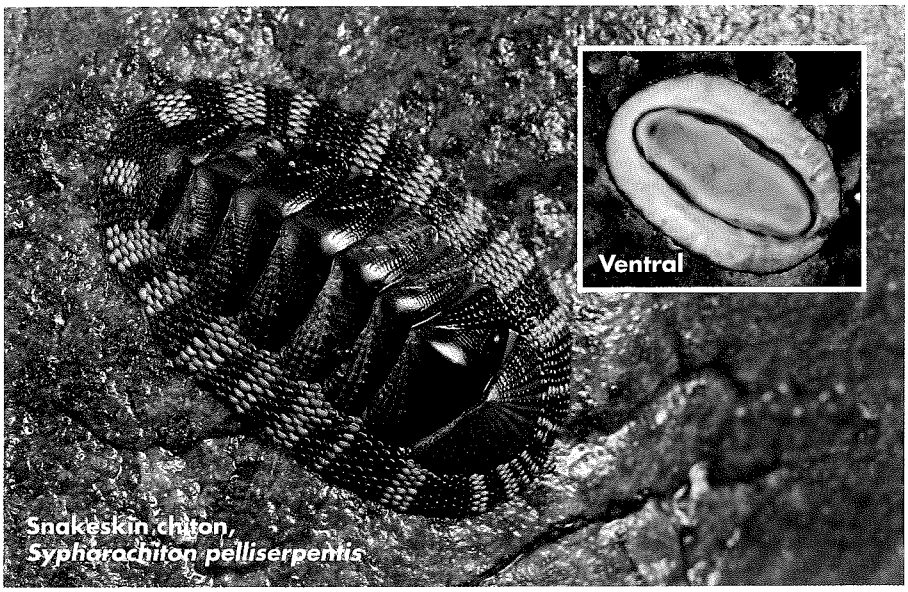
CHITONS • PAPATUA

Molluscs are found in fresh water and terrestrial environments but the vast majority are marine. Of the more than 3500 NZ species known, almost one-third are yet to be formally described.

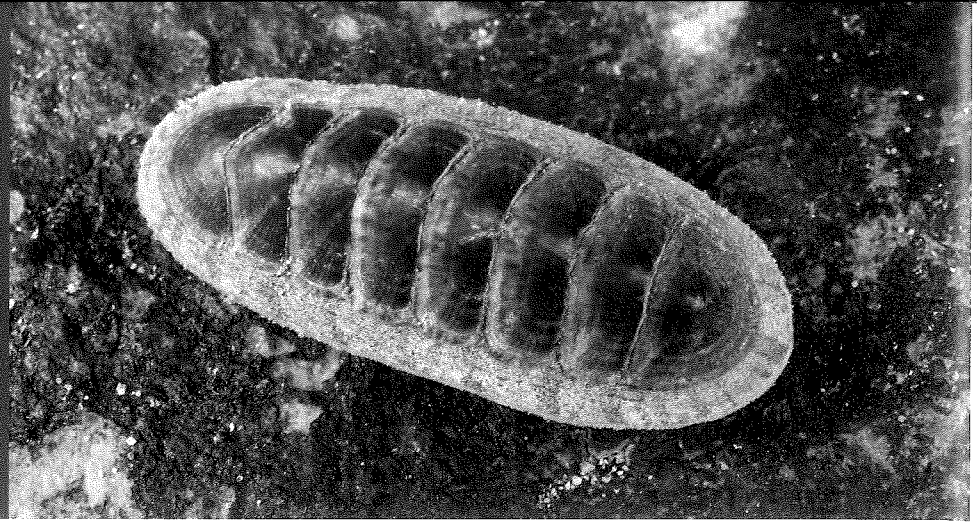
Chitons are a primitive group of molluscs that have not changed in form in over 80 million years, according to the fossil record. NZ is a hot spot for chitons (pronounced 'kite-ons'). Turn over a small boulder and you may find 3–5 different species and numerous individuals. More than 55 species of chitons are found in NZ waters, representing 8.5% of species worldwide.

Chitons always have 8 shell plates, called **valves**, that overlap each other like fish scales. The separate valves allow the chiton to bend around rock edges and prevent exposure of the fleshy foot to the wind and sun. The thick, leathery **mantle** forms a girdle around the animal, holding the valves together. The mantle fits tightly against the rock surface to reduce water loss and lower the chiton's chances of being dislodged by predators or surf. On the **ventral** (lower) surface, the mouth is at the front end and the gills are sandwiched between the mantle and foot.

Although chitons are prominent members of the rocky shore community, we know little about their reproductive cycle, growth rate, life span, and how populations respond to changes in the environment. Chitons are thought to be slow growing and may live for several decades.



Snakeskin chiton,
Syphorachiton pelliserpentis

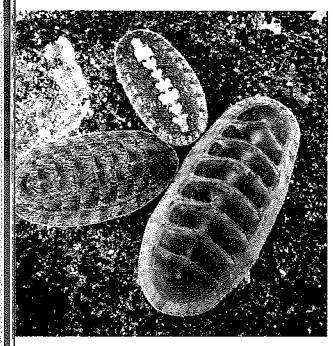


Brown chiton • Papatua

Ischnochiton maorianus · Other names: Kaokaoroa, variable chiton

A **shade seeker**, this chiton moves away from direct light. The cigar shape and the narrow girdle are key characteristics. Although most individuals are brown or pale green, some are mottled with orange, green, blue, black and more. A fine white streak across the top of the valves or fine dark lines on a light background are other colour variations observed. The narrow girdle is covered in tiny scales. The head and tail valve are both semi-circular in shape and the tail valve is longer.

HABITAT This species is found on the under-surface of rocks sitting on sand or mud from the mid tidal zone to 20m. It is most common in relatively sheltered environments and is able to cope with black, oxygen-depleted sediment.

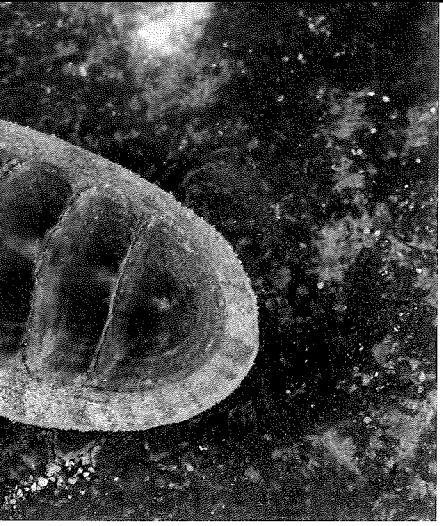


LIFESTYLE Rather than venture to the upper surface of rocks in search of encrusting seaweeds, this chiton prefers to feed on drifting or broken-down plant material that falls on or around the bottom of rocks and boulders.

When exposed to sunlight this chiton moves faster than you expect. Heading for the dark side of the rock, it settles only when its dorsal surface comes in contact with the ground beneath.

The brown chiton's foot does not hold on as tightly as many other chiton species, so when a rock is overturned, it will often curl up and fall off.

SIZE Length to 40mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ



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ground are other colour variations
The head and tail valve are both

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venture to the upper surface of rocks
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ht this chiton moves faster than you
k side of the rock, it settles only when
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does not hold on as tightly as many
n a rock is overturned, it will often

Noble chiton • Papatua

Eudoxochiton nobilis

A **NZ giant**, this is the largest species of chiton encountered on the shore. The 8 shell valves of the adults are eroded and often heavily encrusted with pink coralline algae or green microalgae. The wide leathery girdle is red, although the colour is often masked by short, dark bristles. The muscular foot is pale orange. The head and tail have the smallest valves.

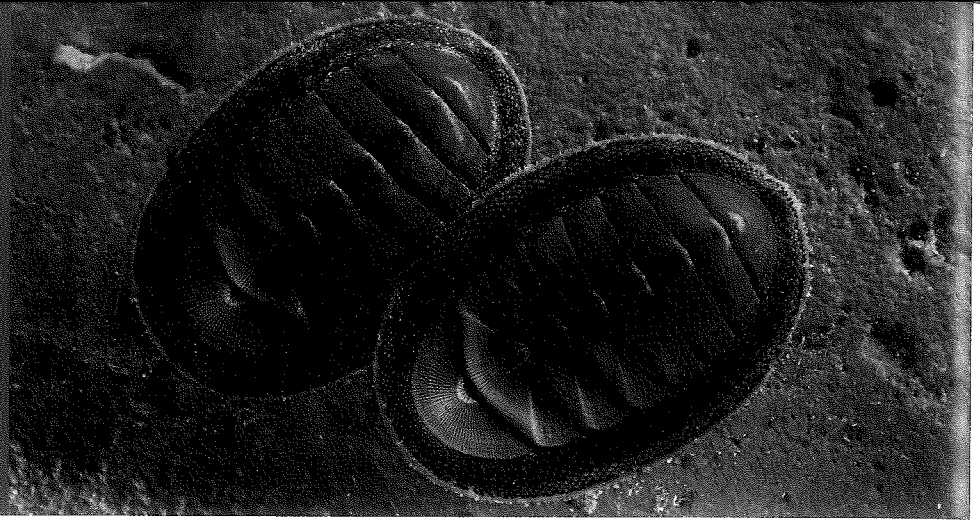
Their cryptic colouration and the low profile means that these chitons are often unnoticed and are also very difficult to lift off the rock surface. The juveniles are brightly coloured in shades of pink, brown, yellow and green. Tiny eyes, embedded in their shell, may be visible as black dots on the juvenile shell. Encrusting algae often cover the valves, and these eyes on adults.

HABITAT Juveniles tend to live under large rocks and boulders in the intertidal zone. Adults live on open rock surfaces in kelp beds and on top of boulders in the low intertidal zone to depths of 30m on semi-exposed to exposed rocky shores.

LIFESTYLE Chitons feed at night when the tide is high so that they avoid the drying action of the sun and wind. They are grazers, scraping off microscopic algae growing on the rock surface with their zipper-like radula. They are in turn are eaten by various species of crab, sea star and fish.

Chitons are often referred to as 'coat of mail' shells, as the overlapping plates are thought to resemble armour.

SIZE Length to 11cm · HABITAT ROCKY shores
TIDAL ZONE LOW tide · DISTRIBUTION NZ



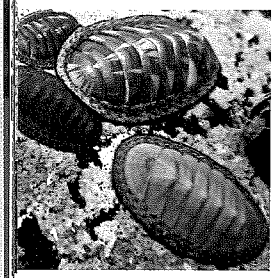
Green chiton • Papatua

Chiton glaucus

Glossy green, this oval-shaped chiton is easily recognised by the uniform colour of its valves. As its name suggests, it is generally dark green, but brown, buff or pale blue individuals can be found, especially in northern NZ. The girdle is narrow and usually the same colour as the valves.

The valves are held together by the mantle tissue, so when the chiton dies, the valves separate. The internal colour of the valves is a pale bluish green.

HABITAT Found in the mid and low tidal zone, the green chiton lives under rocks and in dark spaces on sheltered and exposed shores. Most common on rocky shores, it may also be found attached to cockles on the mudflat, but it doesn't like low-salinity water. Found also in Tasmania, it was probably transferred from NZ with shipments of Bluff oysters.

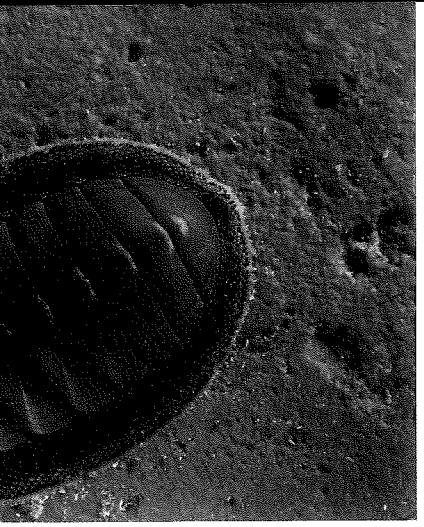


LIFESTYLE The green chiton hides under rocks and in crevices during the day and only ventures onto the open rock to feed at night when the tide is high. It scrapes microalgae off rocks and cockle shells with its radula, a zipper-like tongue.

Watch carefully when a rock is overturned and this chiton is exposed to direct sunlight – you may see the chiton move. Simple seashore experiments can be done to determine what is causing this movement (e.g. light levels, gravity) and if its behaviour differs at night.

SIZE Length to 35mm · HABITAT ROCKY shores

TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ, Australia



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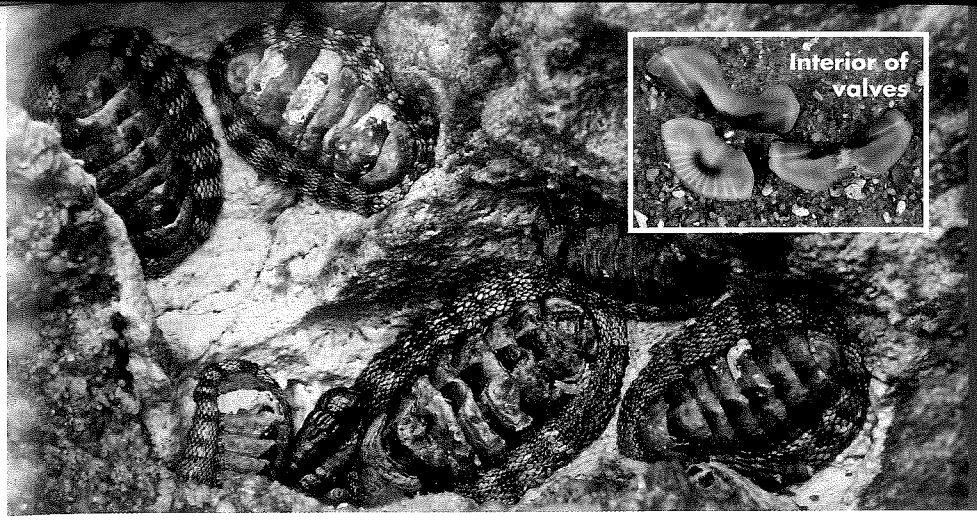
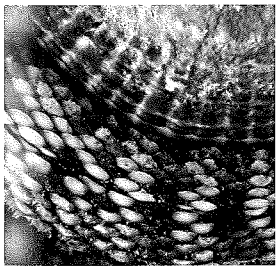


Snakeskin chiton • Papatua

Sypharochiton pelliserpentis

Large calcareous scales and **light and dark bands** on the girdle resemble snakeskin and give this chiton its name. Flattened and oval in shape, it has 8 shell valves. Radial ribs may be visible on the head and tail valve and on both sides of the middle valves. However, this sculpturing may be difficult to see as the shell erodes or becomes encrusted with algae or barnacles. The internal colour of the valves is bright blue, so they are easy to spot on the shore after the chiton has died.

HABITAT This species is widespread throughout the intertidal zone because of its ability to tolerate temperatures over 30°C and cope with significant water loss. Found on both exposed and sheltered shores, the adult finds a depression on the upper surface of the rock, which it often returns to after feeding excursions. In addition to holding moisture, this depression helps the chiton maintain its position on wave-exposed shorelines.



LIFESTYLE The teeth on this chiton's radula contain magnetite iron, so are not worn away when the radula is continually scraped against hard rock during feeding.

Juveniles have a higher surface area to volume ratio than adults, and are more likely to dry out. To survive, they move away from the light and seek shelter under rocks, thanks to tiny eyes in their shell. Many of the adults have lost this sensory ability, as their shells become eroded or covered with encrusting algae.

SIZE Length to 60mm · HABITAT ROCKY shores

TIDAL ZONES HIGH, MID, LOW tide · DISTRIBUTION NZ, Australia

ns, limpets, pāua and snails are
ominant grazers of many intertidal
s. The rasping of their radula – long
r-like tongues covered in tiny teeth –
a significant role in maintaining the
ution and abundance of habitat-
g seaweeds. But it is not just the
eed that gets scraped; so does the
urface. So unless these tiny teeth
n long) are made from something
they are quickly worn down.
niton teeth are made of iron –
etite, to be precise – and are harder
ne rock itself, and 3 times harder
ne enamel on human teeth. The
and arrangement of the teeth are
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a must be removed and placed
a microscope before you can see
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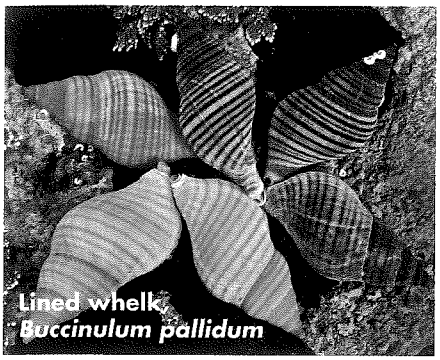
's clear when the radula is placed on
et of paper and a magnet is moved
: the radula will follow.
mpet teeth, however, have an even
r claim to fame. They have recently
found to consist of the strongest
gical material ever tested, about 5
stronger than spider silk. The secret
material's success is in the thinness
ightly packed mineral fibres: they
t of goethite, an iron-based mineral,
through a protein base in much the
way as carbon fibres can be used
ngthen plastic. Understanding how
fibres are put together could help
ve man-made composites used to
things like aircrafts, cars and boats,
ll as dental fillings.

GASTROPODS

Single-shelled molluscs, known as **univalves** or gastropods, account for more than three-quarters of the mollusc group. Most have a shell with a series of spirals, called a whorl, although in pāua the whorls are reduced and in limpets they are only seen at the larval stage.


Lined whelk, *Buccinulum pallidum*

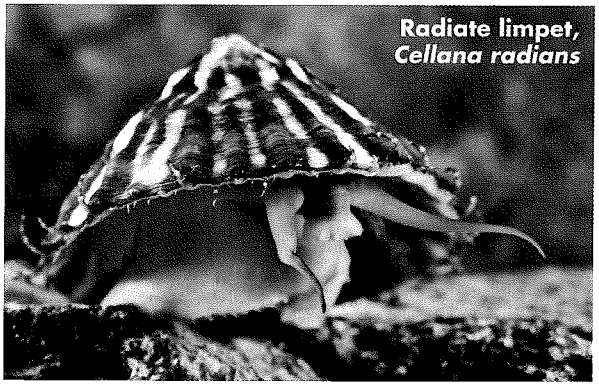
How the snail got its twist is one of the main features that unites this group. During the change from the larval stage to the juvenile, the body rotates 180° relative to the head, so the digestive, circulatory and nervous systems are twisted in comparison with other molluscs.

This group exhibits a range of feeding strategies, from grazing to scavenging and predation. Most gastropods have sensory tentacles and primitive eyes on their head. Like the chitons, most have a **radula**, a rasping tongue for scraping or drilling into their prey. Gills are typically used for respiration but a few gastropods are air breathers and have developed a primitive lung.

Limpets and **pāua** have a low shell with a wide opening (**aperture**) where the large muscular foot extends. The limpet is characterised by a cone-shaped shell and the pāua's shell is ear-shaped.

Snails can fully withdraw into their spiral-shaped shell. Most have an **operculum**, or door, that is pulled closed to seal the animal inside where it can avoid predators and the hot sun.

Sea slugs have lost their shell, or it has decreased in size and become internal. Their large muscular foot glides over the bottom and many use bright colours to warn off predators.


Radiate limpet, *Cellana radians*

Ornate limpet • Ngākihi

Cellana ornata · Other name: Kākihi

Eleven radial ribs adorn the cone-shaped shell of this limpet. They are light coloured and extend from the central tip of the shell down to the outer margin. The space between the ribs is dark brown or black, with a series of white bumps forming a secondary ridge. Although prominent on juveniles, the colouration and ribbing are often greatly eroded on older specimens, making identification difficult.

Oval in shape, the muscular foot is almost the full size of the shell opening. The mantle lines the shell, and the mouth and tentacles mark the front end. Water flows through the groove around the foot and over the secondary gills.

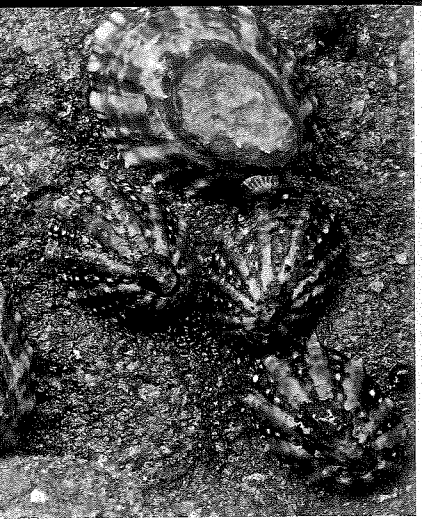
HABITAT Found from the top of the barnacle zone down to the oysters, the ornate limpet is most common in the mid tidal zone on open rock surfaces. The height of the shell is lower on exposed shores, where limpets are in danger of being dislodged by waves. The shell height increases on more protected shores.

LIFESTYLE This vegetarian scrapes the algal film off the rock with its radula. It travels over the rock to feed when the tide is high and remains in one position when the tide is low to retain moisture.

The species exhibits a strong homing behaviour. It returns to the same spot on the rock, a home scar, each low tide. On hard rock, the shell is ground down to fit the rock's shape exactly, this close fit allowing it to hold moisture. How the limpet finds its way home is still a mystery.

SIZE Length to 40mm · HABITAT ROCKY shores

TIDAL ZONES HIGH, MID tide · DISTRIBUTION NZ



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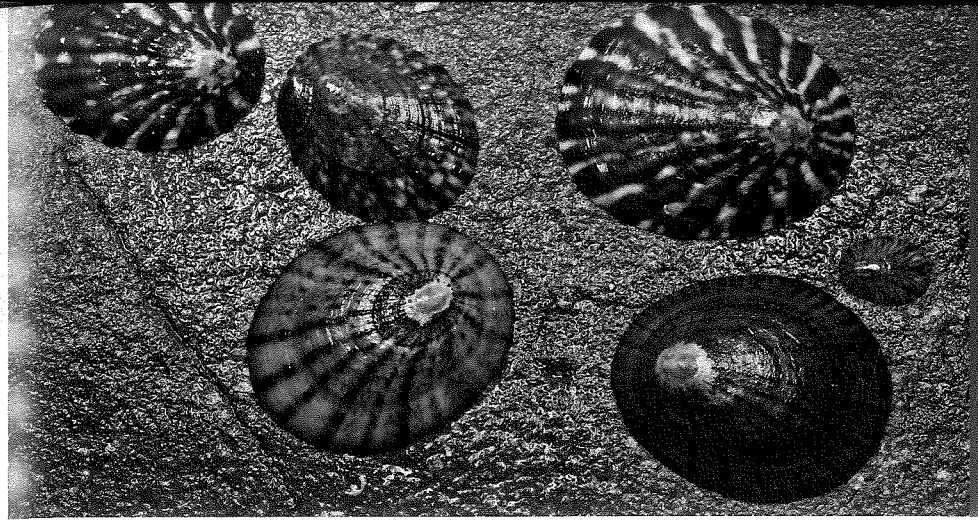

Radiate limpet • Ngākihi

Cellana radians · Other name: Kākihi

Twenty-plus low radial ribs, dark in colour, decorate the shells of this species in the south. In the north, the shell is smooth and coloured with radial streaks of brown and white, or yellow or mottled. However, the colouration and ribbing are highly variable, even within a single location. This oval-shaped limpet looks similar to the ornate limpet, but its shell is generally wider and lower-pitched. The top of the shell is not quite central and is positioned closer to the front end. The large muscular foot is used for movement and for gripping the rock surface. Firm attachment is important to prevent dislodgement from waves, drying out and predation.

HABITAT This species is very common on rock flats and the sides of boulders on both protected and exposed shorelines in the mid and low tidal zones.

LIFESTYLE Limpets use a mucous secretion and a series of wave-like muscular contractions across the length of the foot to travel over the rock surface. This grazer has been recorded as travelling more than 1m during high tide at night, while feeding on the microalgal film on the rock surface. It will return to the same area, often grouping with others in or around damp depressions in the rock, but it does not return to a home scar like the ornate limpet does.

All the *Cellana* limpets are broadcast spawners, with a relatively short planktonic larval stage of 3–11 days. They spawn multiple times throughout the year. They have been recorded to live up to 7 years, but most live only 2–3.

SIZE Length to 40–50mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ

Seashore spinning tops

Top shells are a dime a dozen on the intertidal zone. The name tends to be applied to any snail with a shell shaped like a spinning top: round or conical with a pointed spire and a broad base. The problem with common names is that they vary from region to region, may refer to more than one species, and for many marine plants and animals do not exist.

To avoid confusion, it is worth learning the scientific names. They may be long and more difficult to remember, but they reflect the taxonomic classification of the species, are unique to one organism and do not vary with location or language. Scientific names will help you find further information about a specific animal or plant, but be aware that as our scientific understanding of the species and their relationships changes, names may change as well.

More than 600 species in the top shell family, Trochidae, have been recorded in tropical and temperate regions worldwide. They are best known for their smooth, white, shiny interior shell layer, and some of the larger tropical Pacific species are harvested commercially to make pearly white buttons.

The names of many members of this group have changed recently, as scientists are now able to use molecular tools to better understand their evolution. In NZ there are close to 50 species and almost as many still to be described and given a name.

Many species of top shells look similar, but it is worth taking a closer look on the seashore to see how many different types you can find.

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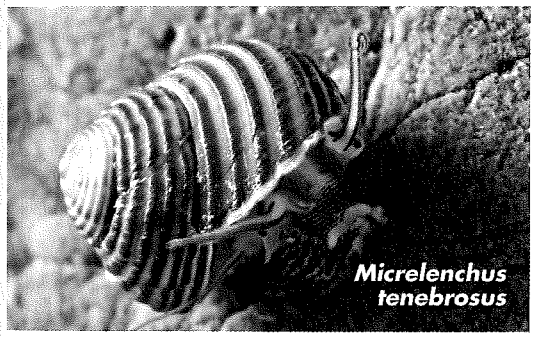
Small top shells

***Micrelenchus* spp.**

Variable in colour, these small snails have the conical shape typical of top shells and are easily confused with other species. Most are chequered or striped with various combinations of yellow, white or green, red, brown and black. When wet, the surface of the shell is shiny and appears polished.

The black and yellow spotted top shell, *Micrelenchus tesselatus*, has a highly polished surface and is often chequered with dark grey on a light background. The colour variations include yellow, white and green with irregular blotches of red or brown.

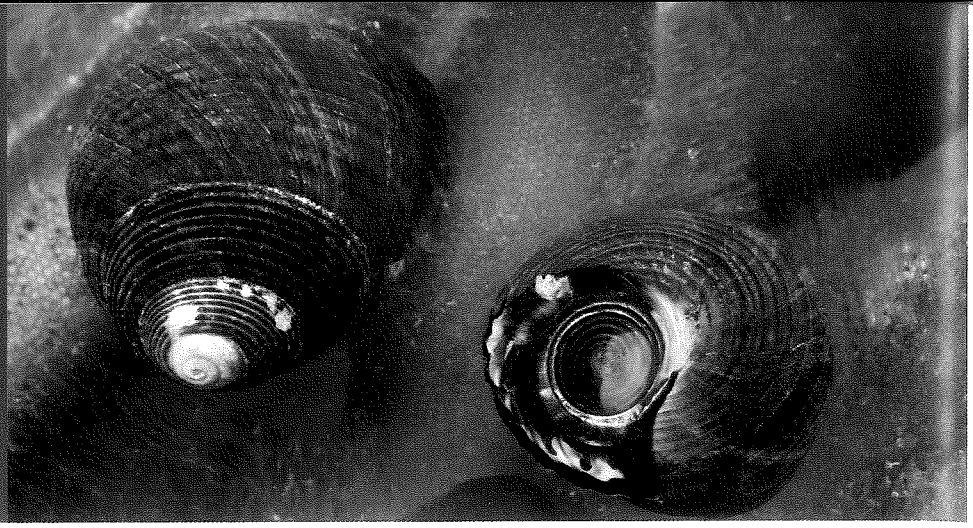
The ribbed top shell, *Micrelenchus tenebrosus*, is recognised by its light background colour and darker spiral cords in shiny black, brown or olive green. The longitudinal dark lines on the side of the foot and on the upper surface of the head are also quite distinctive.



HABITAT These snails are common around kelp holdfasts and in tidal pools in the mid to low tidal zone of semi-exposed to exposed rocky shorelines.

LIFESTYLE They feed on microalgae covering rock and seaweed surfaces and have been found browsing on succulent red seaweeds.

SIZE Height to 8–12mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ



Small black top shell

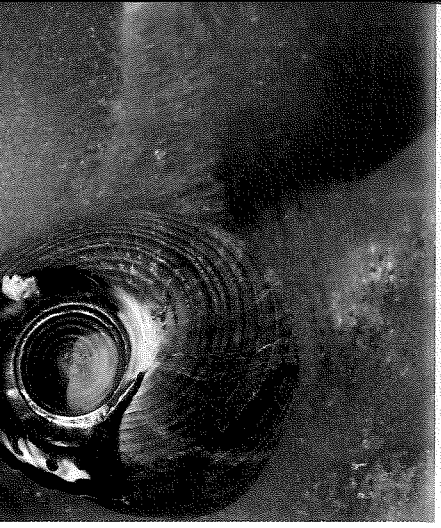
Micrelenchus huttonii

Dark and dull, this top shell is conical in shape and a bluish black colour. The tip is often worn to white, the outer edge of the opening is black and the shell may be covered with spiral ribs. A strictly intertidal species, it is found in harbours and sheltered areas on sand and mud. Look among seaweed and seagrass in the mid and low tidal zones to find this NZ species. It only grows to 15mm high.

Red top shell

Micrelenchus purpureus

A **pink cone-shaped shell** is the key feature of this species. Distinctive oblique lines and occasionally reddish streaks cross the shell. The shell interior is an iridescent pink and the foot and mantle are also pink. It is found on large kelps at the edge of the low tidal zone and extends to the subtidal. This NZ species extends as far south as Christchurch, on semi-exposed to exposed coastlines. Northern snails are slightly narrower than their southern relatives. They grow to 31mm high.



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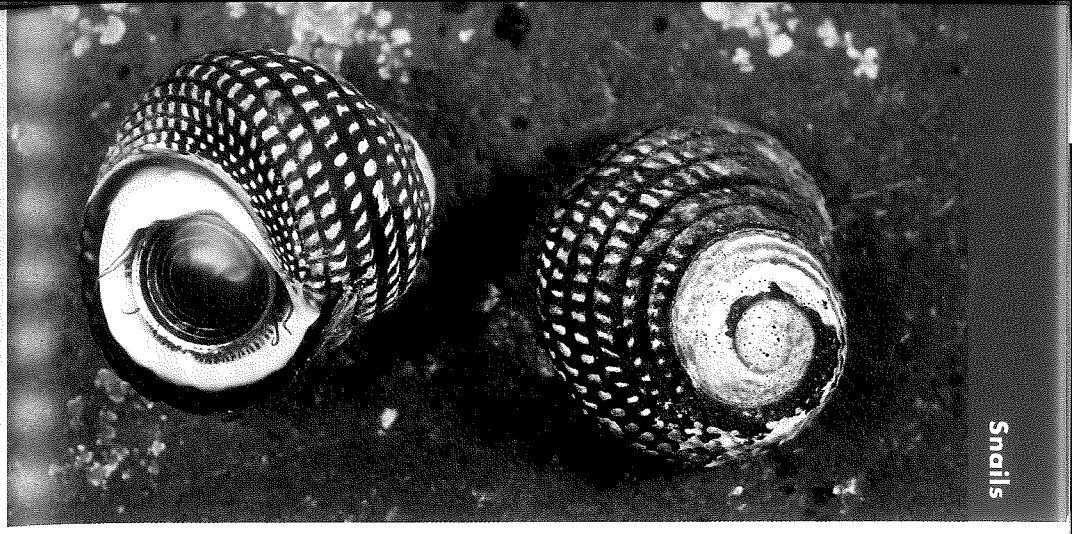
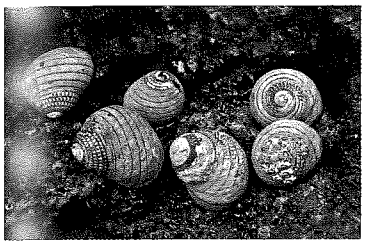


Spotted black top shell • Māihi

Diloma aethiops · Other names: Pūpū, pūpū-mai

A **chequered pattern** of spiralling white dashes on a dark purple or brown background is a key feature of this top shell. However, the pattern may only be visible when the snail is turned over. Its upper surface is often a dull brown or purplish black colour. The edge of the opening is black and the operculum is thin and round. Young snails have obvious spiral grooves, while older shells are often greatly eroded, especially at the tip.



HABITAT This is the most common top shell on rocky shores throughout NZ and the only one found on open rock surfaces. It is very common on sheltered and semi-exposed rocky coastlines and is occasionally found on mudflats, but only in areas where there is rock and minimal fresh-water input. The juveniles are less obvious, as they live under rocks or in crevices.

LIFESTYLE This species scrapes the algal film from the rock surface and grazes on sea lettuce and sponge using its radula. It browses widely over open surfaces and is one of the few snail species that is random in its feeding movements, exhibiting no homing behaviour.

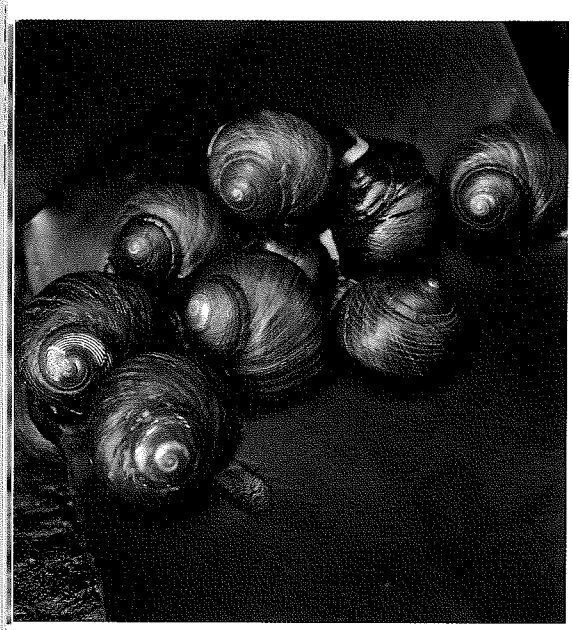
When attacked by a mudflat whelk, this snail lifts its shell above its fleshy foot and swings it around violently to dislodge the predator, then moves away at a surprising speed. The foot is small in relation to the size of the shell so these snails are relatively easy to dislodge from the rock. Individuals live for 3 years and are sexually mature after 1 year.

SIZE Height to 30mm · HABITAT ROCKY shores
TIDAL ZONES HIGH, MID, LOW tide · DISTRIBUTION NZ

Green-banded black top shell

Diloma zelandicum

A **green lip** on the outer edge of the shell opening, a greenish black shell and clearly defined spiral ridges help to identify this top shell from the others. Although similar in appearance to the bluish top shell and the sparse-spotted black top shell, this species is more common on northern rocky shores. Feeding excursions are made night and day when the tide is high. It grows to 25mm high.



Bluish top shell

Diloma nigerrimum

Blue and rounded, this snail lives higher on the shore than any other top shell. The shell apex, or tip, is always eroded, exposing the white iridescent interior. Common in southern NZ, large numbers can be seen feeding on beached bull kelp. This is the only *Diloma* species that is not endemic to NZ, as it is also found in Chile. As top shells have a short-lived planktonic larval stage, dispersal of this species to Chile is likely to have occured by rafting of adults on naturally buoyant bull kelp drift plants. It grows to 25mm high.

s snail's shell, which are especially
bers. The shell's background colour is
e spokes of a wheel. The iridescence is
's eroded.
ter of up to 22mm. The base of the shell
ther areas. The body of this top shell is
highlights and its muscular foot is very
vling through the sand.

his snail is commonly found buried
n semi-exposed to exposed shores. Its
from the low tidal zone to depths of 5m.

Primarily a filter feeder, the wheel shell
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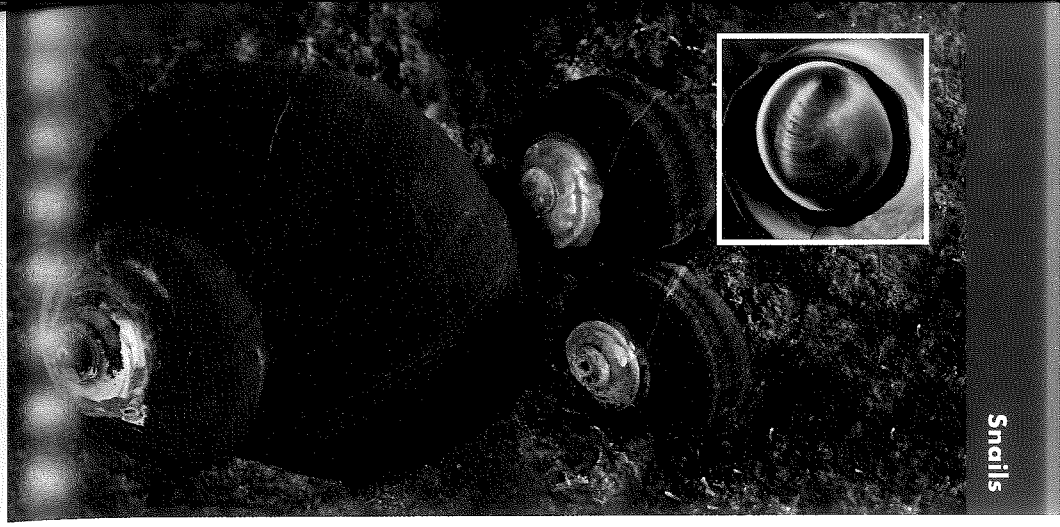
ons have been affected in areas where



Cat's eye snail • Pūpū

Lunella smaragda · Other names: Ataata, kaitangata, kōrama, mātangata, pūpū-atamanama, pūpū-kōrama

The **green operculum** acts like a door and is pulled shut when the snail retreats into the shell at low tide. The white calcareous, circular operculum, with its broad crescent of green colour, is one of the key identification features. This snail may initially be confused with the black top shells, as it is similar in colour and shape, until you turn it over and see this distinctive green 'cat's eye'.

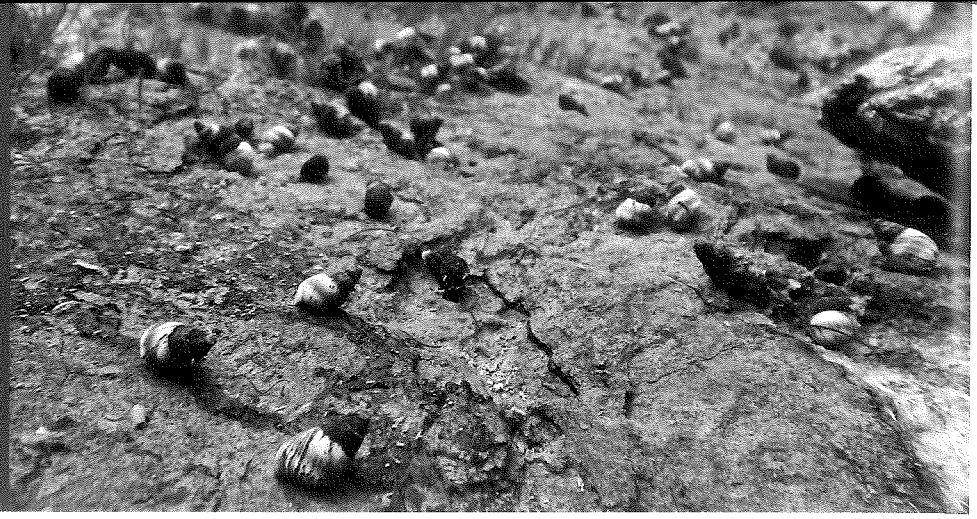
This turban snail (family Turbinidae) grows larger than the top shells. The adult shell is strongly marked with growth lines and the juvenile shell has prominent ridges on the whorls. The snail itself is black except for the bottom of the foot, which is white.

HABITAT This is one of the most characteristic snails of NZ's rocky shore, found on a range of exposures. Juveniles hang out in crevices and among coralline algae turf. Adults are resistant to drying out, as large amounts of water are held within and under their shell.

LIFESTYLE This snail travels to feed on a variety of seaweeds then returns to the mid or low tidal level. It in turn is eaten by the dark rock whelk, which takes a day and a half to bore through the shell and another day to kill the snail.

Most cat's eye snails live for 4 years but the largest may be over 20. Mortality is caused by wave damage, overheating and predation. In some areas the larger snails are difficult to find. This may be a result of recreational harvesting by Asian and Māori cultures.

SIZE Height to 60mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ



Blue-banded periwinkle • Ngaeti

Austrolittorina antipodum

This **high tide resident** is very abundant. It is easy to identify thanks to its distinctive creamy white shell with a broad spiral band, deep blue in colour. The tiny shell is conical in shape and the opening, or aperture, is a dark purple brown colour. Often the top of the shell is eroded.

HABITAT This snail lives in the upper reaches of the high tide zone on most rocky shores. It can survive above the high tide mark on exposed shorelines where there is a lot of wave action and salt spray. Larger individuals are often found higher on the shore and juveniles can be found sheltering in empty barnacle shells.

LIFESTYLE It grazes on the microalgal film on the rocks, and on inconspicuous lichen. The teeth on the radula are rapidly replaced from a reserve length of radula when they become worn.

To conserve moisture at low tide, this snail completely retreats into its shell and pulls the operculum (shell door) tightly closed. Like the horn snail, it releases a thin thread of mucus to anchor it to the rock surface. It can remain in its shell, without feeding, for a couple of weeks. After just a splash of seawater it is reactivated and able to crawl away. Tagging studies have shown that this tiny snail species can travel an average of 24m over an 8-month period.

SIZE Height to 8mm · HABITAT ROCKY shores

TIDAL ZONES SPLASH, HIGH tide · DISTRIBUTION NZ

ce experiments

atory lifestyle and their keen sense
the lower end of their aperture from
around and tastes the water, helping

can detect dead or dying cockles
source. Large numbers of whelks can
next meal on a warm, sunny day. But
re. These snails burrow into the mud
it is cold, raining and dark, unless

entists. Open a cockle and put it
what happens. Draw a large circle
e number of whelks in the area and
d see how the number of whelks has
our?
o whelks react to other types of
n the shore? How far do they travel
ons are key skills that contribute

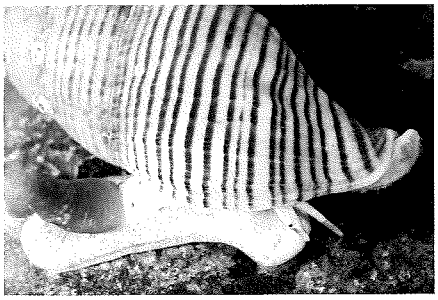
Lined whelk • Huamutu

Buccinulum linea · Other name: Spindle shell

The **spindle shape** of this whelk's shell is wide in the middle and tapering at both ends. This shape is created by the tall spire at one end and the extension of the aperture (opening) to form a narrow canal at the other end, from which its inhalant siphon extends. The light brown or grey shell has narrow spiral lines that are usually much darker than the shell colour. The whorls are smooth and rounded. The shell aperture and operculum (door) are shaped like a beech leaf.

Although this whelk is very common, there are at least 5 closely related and similar-looking species in the genus *Buccinulum* that are also found in the intertidal zone.

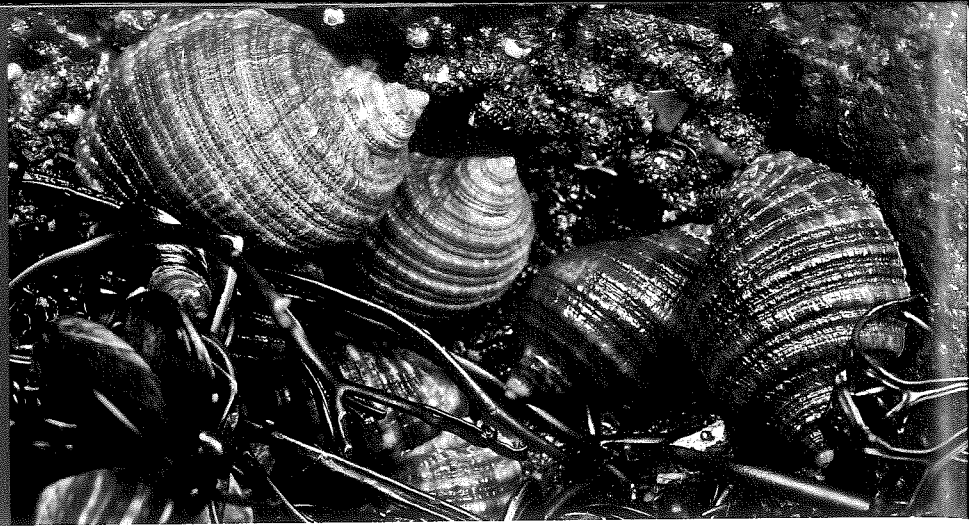
HABITAT This whelk is very common in the mid to low tidal zone on sheltered to open coastlines. It is found under stones and ledges on rocky shores.



LIFESTYLE This predatory whelk eats spiral tubeworms, ascidians, mussels and other molluscs. The toothed tongue, called a radula, drills through the calcium carbonate shell and the whelk's acidic saliva helps to dissolve the shell. An easier meal is to scavenge on dead animals.

In the early spring, several honeycomb-shaped egg cases, containing several hundred larvae, are laid on the rocks.

SIZE Length to 40mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ



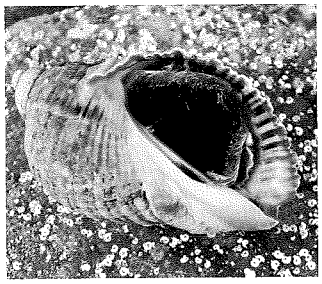
Ridged whelk • Hopetea

Dicathais orbita · Other names: Cart rut shell, white rock shell

White and ridged, the heavy shell of this whelk has strong spiral cords and deep grooves. However, not all have distinct ridges and a small percentage are almost smooth. The cream-coloured shell is grey brown and more elongated on the more exposed North Island west coast. It has a low spire and a large opening with a notched edge and lined with reddish brown. The operculum (shell door) is dark in colour.

HABITAT This northern whelk extends from the mid tidal zone to depths of 5m on protected and exposed shorelines. It is often found among green-lipped mussel beds.

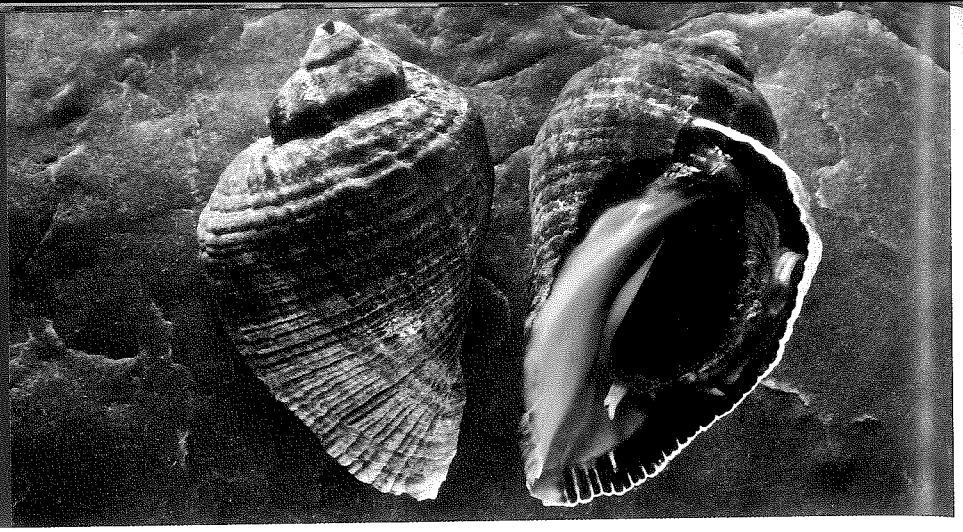
LIFESTYLE This predatory snail is skilled at dislodging the operculum of top shells and cat's eye snails. When young, they remain on the lower part of the shore, flipping over small limpets. When they are more than 35mm in length they move up the shore and feed on plicate barnacles, which they smother with their foot. They then drill through the barnacle shell and release a purple-coloured relaxant. Barnacle shells often become stained with this purple secretion.



Adults congregate to mate. Fertilised eggs are laid in straight-sided egg cases that are crowded together in a honeycomb fashion among barnacles and mussels. The egg cases are white with a purple tinge. Early development occurs in the case and then planktonic larvae are released into the water.

SIZE Length to 70mm · HABITAT ROCKY shores

TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ, Australia



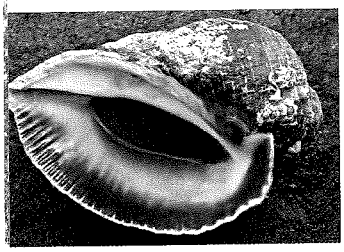
Dark rock whelk • Ngāeo

Haustrum haustorium · Other names: Brown rock shell, kāeo, kākara

A **long wide aperture** and a very short spire characterise the rounded shell of this whelk. Less obvious are the weak spiral grooves and the dull, dark grey or purple black colouring. The interior is dirty white to dark purple with a distinct white rim around the outer lip of the aperture.

HABITAT Although it is common on sheltered to semi-exposed rocky shores, you will need to look closely to find this whelk. It shelters in crevices and under rocks and ledges, and its colouring blends in with the rock surface. It is more common in northern NZ.

LIFESTYLE This predatory whelk is famous for 'leaping' onto the back of prey species. The wide aperture is lifted over the top of cat's eye and top shells. The whelk then places its foot on the side of the shell and violently twists until its prey loses its grip on the rock. The prey is then turned so its aperture is facing upward and the whelk can easily reach its dinner. This species also preys on oysters and mussels by prising open the shell using the lip of its own shell as a wedge. Juveniles (>15mm long) feed on small limpets by flipping their shells over.



Egg capsules are anchored to rocks or kelp fronds during the winter months. These white capsules resemble honeycomb and each capsule has a small hole on top, through which the planktonic larvae escape after hatching.

SIZE Length to 55mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ

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ock shell, kāeo, kākara

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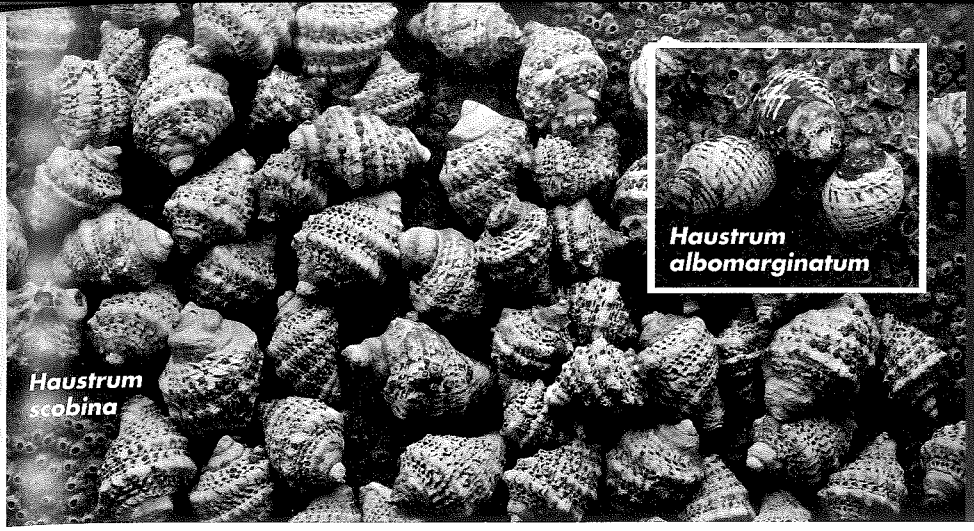

Oyster borer • Kaikai tio

Haustrum scobina · Other names: Dog winkle, oyster drill

Usually **sitting on oysters or barnacles**, this whelk is most commonly found near its favourite foods. It is well camouflaged, as its shell is usually dull white or grey in colour, making it hard to distinguish from its prey. The small holes and strong angles on the shell are characteristic of this species.

HABITAT Found in the mid tidal zone of rocky reefs on both exposed and sheltered shorelines, it may reach a slightly larger size on sheltered shores.

LIFESTYLE By drilling a hole through the shell of its prey (small oysters, mussels, barncles) with its radula, the thin proboscis (feeding tube) is inserted. Digestive enzymes are released and the prey's tissues are sucked up through the tube.

In recent decades, populations of this whelk have been affected by a condition called imposex, in which female snails grow a penis and are unable to reproduce. The cause was found to be tributyltin (TBT), a chemical in marine antifouling paints used by the NZ shipping industry. Since the banning of the chemical, the occurrence of this condition has reduced.

This snail deposits, on average, 235 eggs per dome-shaped capsule. Juveniles hatch out after 7–10 weeks.

A similar species, *Haustrum albomarginatum*, is found alongside the oyster borer around the North Island, and replaces it around the South. Its shell is more rounded, it may extend higher on the shore and it is common near fresh-water sources.

SIZE Length 25–35mm · HABITAT ROCKY shores
TIDAL ZONE MID, LOW tide · DISTRIBUTION NZ

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they are capable of secreting new
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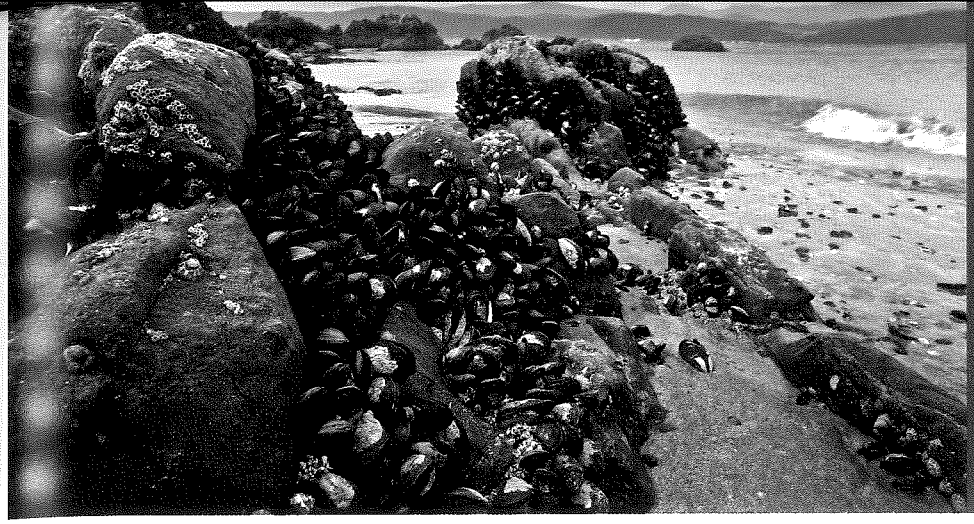


Blue mussel • Toretore

Mytilus galloprovincialis · Other name: Pōrohe

Teardrop-shaped, the valves of this mussel are pointed at one end and widely rounded at the other. This species is common around the world, although the shell structure may vary with different environmental conditions. Its common name reflects the colour of its shell, which ranges from dark blue to slate blue to light grey where erosion has occurred. The interior of the shell is a grey blue. The shell is often encrusted with other invertebrates.

The beard of the mussel is a tuft of 50–100 byssal threads that are formed by the byssal gland at the base of the foot.

HABITAT This mussel is common in the mid and low tidal zones on semi-exposed to exposed rocky shores. Although found throughout NZ, it is more common in the south, where large numbers form a band of colour across the lower shore. This species may also be found on mudflats and estuaries, attached to rocks and mangrove roots.

LIFESTYLE As it does not move, this mussel relies on water movement to bring phytoplankton to it. Its valves gape to allow the plankton and oxygen-rich water to flow over its gills. Tiny hairs on the gills filter out the plankton. This is a good eating species, but watch out for the pea crab, which may be found within the shell of this species and the green-lipped mussel.

SIZE Length to 10cm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION Worldwide

Green-lipped mussel • Kuku

Perna canaliculus · Other names: Kūtai, pōrohe

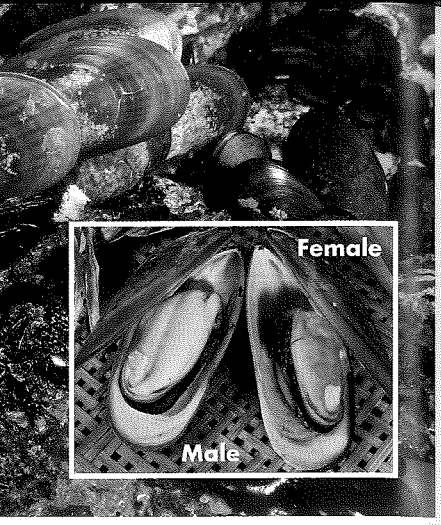
Not always green, the shell may be encrusted with other invertebrates or coralline algae with the bright green colouring only visible at the edge of the shell. The colouration, most vivid on animals grown on aquaculture farms, ranges from light greenish gold to emerald and dark green. The narrow end is browner and often eroded. Internally the valves are pale grey-blue and slightly iridescent, usually with a green border. The shell is more elongated and larger than that of the blue mussel. Reddish brown lines may radiate from the hinge to the edge of the shell and fine growth lines may also be visible.

HABITAT Dense beds are found in the low tidal zone of semi-exposed to exposed shores. They are firmly attached to rocks, other mussels or aquaculture ropes with byssal threads.

LIFESTYLE This species is delicious to eat and is commercially farmed in NZ through rope culture. Aquaculture farms are often placed in areas where there is a current to increase the mussel's exposure to plankton-rich water.

Externally males and females look the same, but when you steam the mussel open the females have orange eggs and the males have white sperm. Mussels are broadcast spawners and have a planktonic larval stage. When the mussel larvae settle onto a hard surface and develop into tiny mussels, they are called spat. Most of the seed mussels for aquaculture farms are sourced as wild spat collected from the North Island's Ninety Mile Beach.

SIZE Length to 20cm · HABITAT ROCKY shores
TIDAL ZONE LOW tide · DISTRIBUTION NZ



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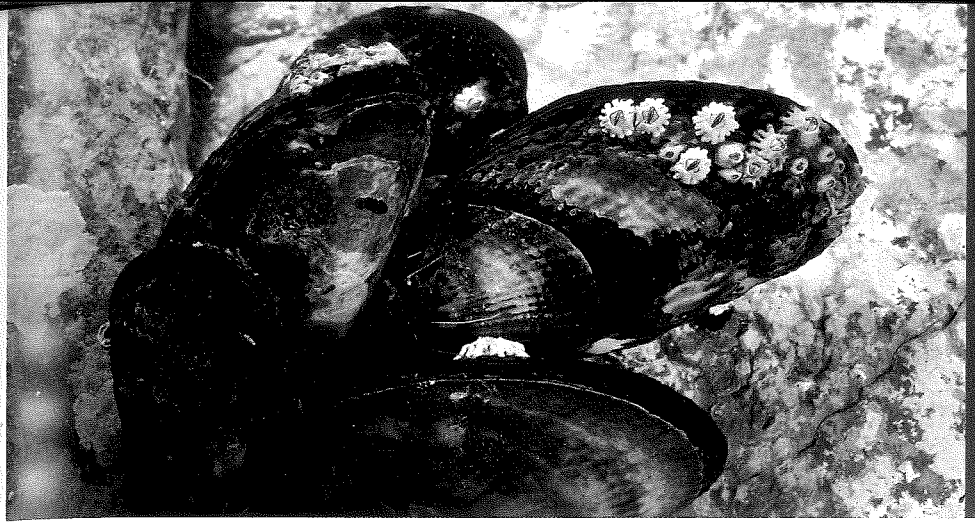


Ribbed mussel • Pūkanikani

Aulacomya maoriana · Other name: Kūtai

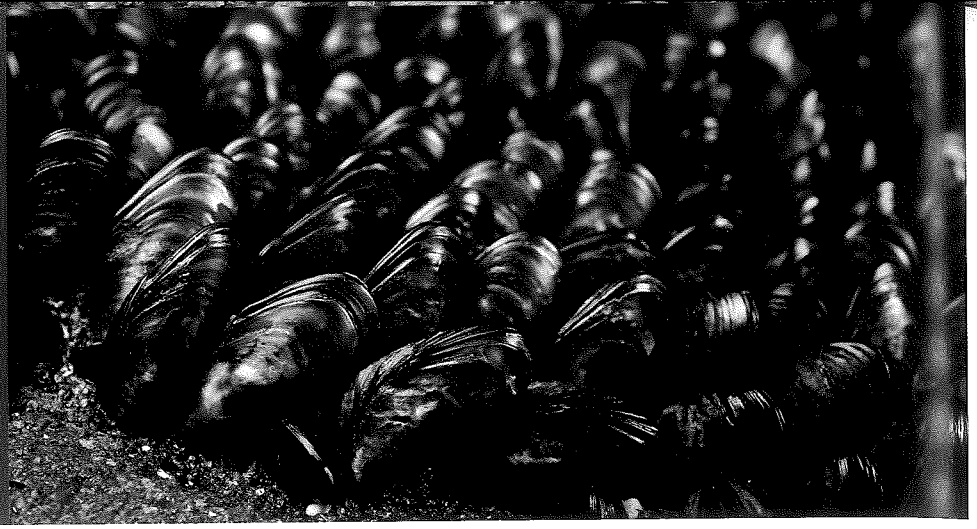
Strong radial ribs running the length of the shell distinguish this species from the blue mussel. The shell is purple blue and is often heavily eroded. The outer organic layer, or periostracum, covering the shell gives it a more yellow brown colour and is most prominent in juveniles. This layer can also give the adults a rich red-brown or black colouration. The shell may be encrusted with barnacles and coralline algae. The interior is white, stained with reddish purple.

HABITAT This mussel can withstand the heavy wave action on exposed shores. It is also common on semi-exposed shorelines under rocks and ledges. It is found growing with blue mussels and in beds dominated by the green-lipped mussel.

LIFESTYLE When the tide is high, feeding occurs. The valves gape open allowing the plankton-rich water to flow over the gills. Tiny hairs on the gill filter out the phytoplankton. At low tide, the mussel stops feeding and pulls the valves tight together to retain moisture while it waits until the tide returns.

This species is edible, but due to its small size is seldom harvested for food.

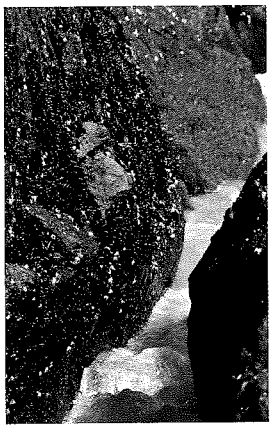
SIZE Length to 80mm · HABITAT ROCKY shores
TIDAL ZONES MID, LOW tide · DISTRIBUTION NZ



Little black mussel • Kukupara

Xenostrobus neozelanicus · Other names: Flea mussel, hānea, niania

Black mats form in the mid tidal zone where high numbers grow very close to each other. The shell is shiny and very dark in colour externally; internally is blue grey and semi-iridescent. The adult is much smaller than both the blue and green-lipped mussels, but the juvenile stages of all 3 species are similar. The shell has the same teardrop shape but is thicker. This mussel is tolerant of water with high sediment levels and can withstand sand scouring.



HABITAT Found attached to any firm surface on semi-protected and exposed shorelines, this species lives higher on the shore than any other mussel.

Dense mats of this mussel form a distinct dark band in the mid tidal zone, with the upper distribution being controlled by physical factors like temperature. During the summer, the body temperature of this mussel may rise to 25°C when exposed to air, then plummet to 10°C when the tide rushes back over the shore.

Often found on rocky areas adjacent to surf beaches, these mussel beds will trap sand and may be completely buried for short periods without any ill effects.

LIFESTYLE The incoming tide brings phytoplankton to this mussel. Tiny hairs on the gills trap the microscopic food, bind it up in mucus and transport it to the mouth.

SIZE Length to 30mm · HABITAT ROCKY shores
TIDAL ZONE MID tide · DISTRIBUTION NZ, Australia

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DIVING DEEPER

For further information we recommend you look at the following books, articles and websites.

Books/Articles/Guides

Adams, Nancy M., *Common Seaweeds of New Zealand*, Canterbury University Press, 1997.

Andrew, Neil, and Malcolm Francis, eds, *The Living Reef: The Ecology of New Zealand's Rocky Reefs*, Craig Potton Publishing, 2003.

Cook, Steve de C., *New Zealand Coastal Marine Invertebrates*, Canterbury University Press, 2010.

Crowe, Andrew, *The Life-Size Guide to the New Zealand Beach*, Penguin Books, 2004.

Denny, Mark W., and Steven D. Gaines, *Encyclopedia of Tidepools and Rocky Shores*, University of California Press, 2007.

Gordon, Dennis P., ed., *New Zealand Inventory of Biodiversity, Vols 1–3*, Canterbury University Press, 2012.

Gordon, Dennis P., Jennifer Beaumont, Alison MacDiarmid, Donald A. Robertson and Shane T. Ahyong, 'Marine biodiversity of *Aotearoa* New Zealand', PLoS ONE 5(8): e10905, 2010.

Gordon, Dennis, Sadie Mills, Michelle Kelly and Blayne Herr, 'Bountiful bryozoans: A guide to the bryozoans of New Zealand', Version 1.0. NIWA interactive pdf. www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets, 2016.

Jones, Malcom B., and Islay D. Marsden, *Life in the Estuary: Illustrated guide and ecology*, Canterbury University Press, 2005.

Kelly, Michelle, and Blayne Herr, 'Splendid sponges: A guide to the sponges of New Zealand', www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets, 2015.

Mills, Sadie, Kate Neill, Owen Anderson, Niki Davey, Michelle Kelly and Blayne Herr, 'Extraordinary echinoderms: A guide to the echinoderms of New Zealand', www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets, 2014.

Ministry for the Environment and StatsNZ, 'New Zealand's Environmental Reporting Series: Our marine environment 2016', www.mfe.govt.nz and www.stats.govt.nz, 2016.

Morley, Margaret, *A Photographic Guide to Seashells of New Zealand*, New Holland, 2004.

Morton, John, and Bruce Hayward, ed., *Seashore Ecology of New Zealand and the*

Pacific, Bateman, 2004.

Morton, John, and Michael Miller, *The New Zealand Sea Shore*, 2nd edition, Collins, 1973.

Neill, Kate, Wendy Nelson, Michelle Kelly and Blayne Herr, 'Beautiful browns: A guide to the large brown seaweeds of New Zealand', www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets, 2016.

Nelson, Wendy, *New Zealand Seaweeds: An Illustrated Guide*, Te Papa Press, 2013.

Page, Mike, Michelle Kelly and Blayne Herr, 'Awesome ascidians: A guide to the sea squirts of New Zealand', www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets, 2014.

Paulin, Chris, and Clive Roberts, *The Rock Pool Fishes of New Zealand: Te Ika Aaria o Aotearoa*, Museum of New Zealand Te Papa Tongarewa, 1992.

Paulin, Chris, and Paddy Ryan, *The Rocky Shore: A Guide to the Intertidal Plants and Animals of Wellington's Taputeranga Marine Reserve*, fishHook Publications, 2014.

Roberts, Clive D., Andrew L. Stewart and Carl D. Struthers, eds, *The Fishes of New Zealand*, Vols 1–4, Te Papa Press, 2015.

Rush, Nicola, and Michelle Kelly, 'Splendid sponges (Intertidal): A guide to the intertidal sponges of New Zealand', www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact- sheets, 2017.

Schiel, David R., *Guide to the Common Intertidal Species of the South Island, New Zealand*, Marine Ecology Research Group, University of Canterbury, 2006.

Wilkens, Serena, and Shane Ahyong, 'Coastal crabs: A guide to the crabs of New Zealand', www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets, 2015.

Wing, Stephen, *Subtidal Invertebrates of New Zealand: A Divers' Guide*, Canterbury University Press, 2008.

Useful websites

AlgaeBase – www.algaebase.org/

Auckland Museum, NZ Marine Field Guide – www.aucklandmuseum.com/collections-research/collections/remix-play-share/nz-marine-life-app

Department of Conservation, Te Papa Atawhai, Marine Protected Areas – www.doc.govt.nz/nature/habitats/marine/marine-protected-areas

Fishbase – www.fishbase.org/

King Tides Auckland (citizen science project) – auckland.kingtides.org.nz/

Land Information New Zealand, Toitū te Whenua, Tides – www.linz.govt.nz/sea/tides

Marine Metre Squared (citizen science project) – www.mm2.net.nz

a Shore, 2nd edition, Collins,

err, 'Beautiful browns: A guide
niwa.co.nz/coasts-and-oceans/

Guide, Te Papa Press, 2013.
ascidians: A guide to the sea
-oceans/marine-identification-

New Zealand: Te Ika Aaria o
va, 1992.
le to the Intertidal Plants and
FishHook Publications, 2014.
rs, eds, *The Fishes of New*

rtidal): A guide to the intertidal
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of the South Island, New
of Canterbury, 2006.
guide to the crabs of New
-identification-guides-and-fact-

A Divers' Guide, Canterbury

andmuseum.com/collections-
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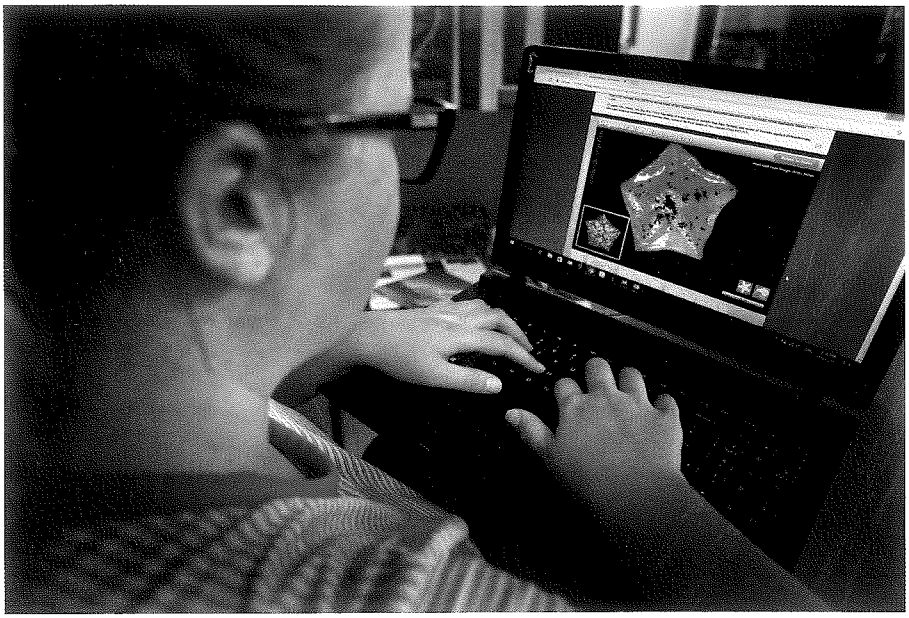
kingtides.org.nz/
www.linz.govt.nz/sea/tides
m2.net.nz



Ministry for the Environment, Manatū Mō Te Taiao, Environmental Reporting, Marine – www.mfe.govt.nz/more/environmental-reporting/marine-0

Ministry for the Environment, Manatū Mō Te Taiao, Overview of Climate Change – www.mfe.govt.nz/climate-change/overview-climate-change

Ministry for Primary Industries, Manatū Ahu Matua, New Zealand Marine Pest ID Guide – www.mpi.govt.nz/document-vault/10478

Museum of New Zealand, Te Papa Tongarewa, Collections Online – collections.tepapa.govt.nz/

National Institute of Water and Atmospheric Research (NIWA), Taihoro Nukurangi, Marine Identification Guides and Fact Sheets – www.niwa.co.nz/coasts-and-oceans/marine-identification-guides-and-fact-sheets

NatureWatch (citizen science project) – naturewatch.org.nz/

New Zealand Association for Environmental Education (NZAEE) Seaweek (national public awareness campaign) – seaweek.org.nz/

New Zealand Marine Studies Centre, Resources – www.otago.ac.nz/marine-studies/resources/index.html

Project Hotspot (citizen science project) – www.hotspot.org.nz/

World Register of Marine Species (WoRMS) – www.marinespecies.org/