Life at the margins of the continents

An examination of the intertidal marine life of the southwestern Cape

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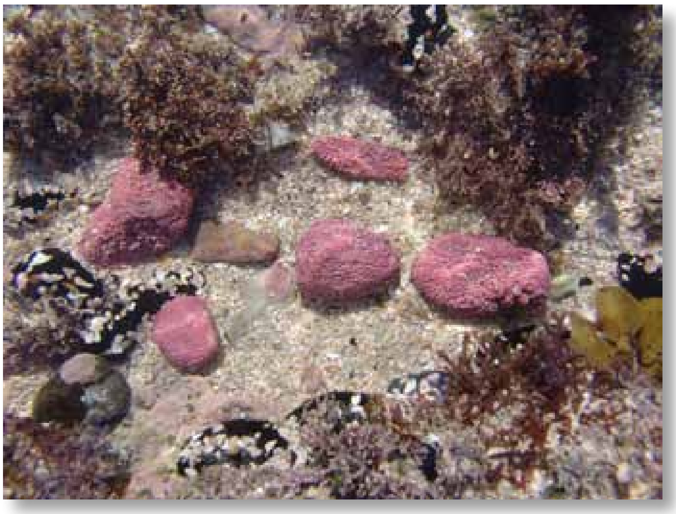


Heydrichia cherry-red

Imagine surviving in an environment that is neither truly marine nor truly terrestrial. That area just beyond the low-water mark of neap tides along the seashore is an example of just such an environment. The organisms living here have to cope with the combined extremes of both land and sea environments: salt spray, immersion in salt water, emersion in air, drenching by heavy rainfall, heating by the sun, freezing winter temperatures, unstable substrates (such as sand, gravel or boulders), and exposure to strong winds. Just how do they cope? Animals generally find it easier coping in this harsh environment because among other ways, they can simply get up and move when the going gets too tough. Plants (both terrestrial and marine) on the other hand, have to either tolerate, or succumb to it.

The following is an account of some of the astonishing ways in which both plants and animals from a typical southwestern Cape shore have evolved to adapt and cope in the harsh environment of the intertidal zone.

Flora

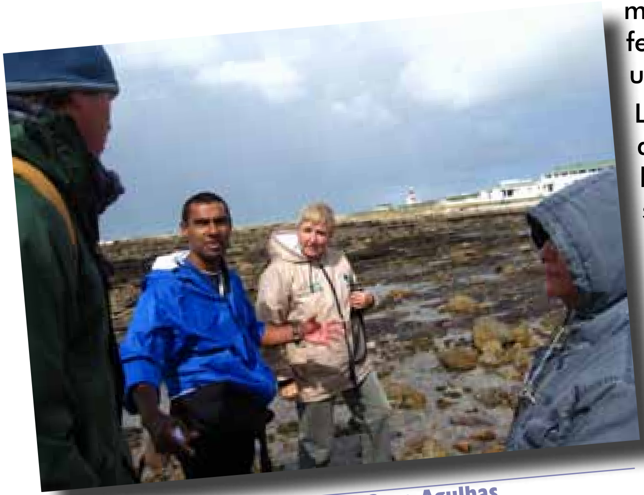
For terrestrial plants living on or near the seashore (we will call them maritime plants) the main problem is how to survive in a salty environment. A characteristic feature of many of these plants is succulence. Maritime plants have to store lots of fresh water in their tissues, as seawater is too salty for them to use it directly, and they must store it whenever it is available. Such plants are often subjected to the desiccating effects of salt laden wind that deposit toxic salts on them, they get blasted by sea sand or buried in it, and are subjected to intense solar radiation both direct and reflected. To top it all, they grow in organically poor soils that have little water holding capacity.

Maritime plants use a variety of mechanisms to cope in this saline environment. Some can selectively control salt absorption at the root level. Others secrete excess salt via salt glands on the surfaces of leaves. Some, like glassworts and the soutbossie Chenolea diffusa, concentrate salt in their tissues, diluting the salt by storing it in their succulent parts (they compartmentalize the salt in parts of the plant where high salt concentrations will not affect normal metabolism). Glassworts with their waterproof bodies are so tough they are one of the few flowering plants that can truly be said to live in salt water as many are covered by the sea at almost every high tide. Some glassworts can even tolerate salinity concentrations of up to 75 parts per 1000. Considering that the ocean is on average only about 33 parts per 1000, one can readily appreciate the resilience of these plants.

This environment is also a prime habitat for the establishment of lichens (composite organisms consisting of a symbiotic association of a fungus with an alga), which are able to survive extremes of heat, cold and drought. They are able to survive in this hostile environment because of their ability to dry out completely, shutting down their metabolism when conditions become too severe. It is also believed that their complex chemistry allows them to control light exposure, repel herbivores, kill attacking microbes and discourage competition from true plants. These are important adaptations for life in this marginal habitat.

Seaweeds too have a hard time surviving in this environment for they have to cope with problems (desiccation stress and temperature extremes) associated with prolonged exposure to air. All the vital functions of life such as respiration, photosynthesis, growth and reproduction must be adapted to two completely different environments. Porphyra or purple laver, an abundant seaweed on rocky substrates within this zone, is able to lose almost all its body fluid, drying out to a crisp, paper thin film only about 10 % of its original mass. For this very reason, it is often also called cellophane seaweed. While many other seaweeds would die if they lost this much turgidity, this species readily recovers once re-hydrated. Often this seaweed has to rely on salt spray for re-absorption of valuable life-giving seawater. This species has a remarkable rate of recovery, with some plants having been reported to remain dried out for several days to weeks. Thin seaweeds like Porphyra also lose their water content very fast, but overcome the problem by growing in dense populations where they can cover and shade each other when exposed.

Other seaweeds, less tolerant of desiccation stress, survive in high shore tide pools. Here, however, they have to cope with salinity stress as these tidepools become extremely saline under hot, dry conditions and tend toward fresh water under rainy conditions. The few seaweeds (mostly green seaweeds like Ulva and Monostroma) adapted to this environment have a high salinity tolerance ranging from as little as 3 parts per 1000 to as much as 115 parts per 1000. They are able to regulate the amounts of dissolved internal salts, keeping their internal osmotic pressures somewhat higher than the surrounding medium. This process prevents loss of water to the surrounding saline environment allowing them to maintain a fairly constant turgidity.



Marine Week at Cape Agulhas

Professor Gavin Maneveldt and Emmerentia de Kock, (head of People and Conservation, Agulhas National Park), exploring the rocky shores at low tide. In spite of the inclement weather, the public turned out in a large group, curious to comb the sea edges and find out about the fascinating and abundant life found there.

Surprisingly, besides mangroves (tropical and subtropical trees and shrubs that grow in salty coastal habitats), there appear to be no true plant specialists within this environment. Some terrestrial plants such as Sarcocornia (glassworts) are saltmarsh plants while others like Tetragonia fruticosa (sprawling duneweed or kinkelbossie) are early colonizers of sandy, calcareous areas typical of beach dunes. The reason that these plants survive in this harsh environment is probably a combination of two factors: a greater tolerance of extreme conditions; and reduced competition from other terrestrial plants that can otherwise not survive here.

Fauna

Unlike plants, animals generally find it "easier" to cope in this harsh environment because they can simply get up and move. Mobility, however, is an abstract concept because different animals move at different paces. High up on the shore is found the little African periwinkle from the genus Afrolittorina. For a marine snail, juveniles of this little winkle are only ever immersed in seawater three to four days every fortnight during high-water of spring tide events. Juveniles are particularly susceptible to wave action and so remain high up on the shore. The snail is able to survive in this environment and reduce water loss by: aggregating in high numbers; hiding in cracks and crannies during times of high light intensities and temperatures; cementing themselves to each other and the rocky substrate during hot, dry conditions by only a thin mucilaginous thread; and by feeding only during night time and under overcast conditions.

Lower down the shore is an assortment of limpets and false limpets (low conical-shelled snails), all competing with one another for food and space in this environment of limited resources. All have a large, flat, muscular foot, an appendage that is of vital importance for strong attachment in the harsh, exposed, wave-beaten intertidal zone. To reduce resistance limpet shells are streamlined. But, even among these snails, differential susceptibilities to the conditions in the intertidal zone cause different species to zone themselves at different heights on the shores. Some zones are so well delimited by certain species of limpets that entire zones have been named after them. One such example is the cochlear-zone, so named because the territorial, gardening limpet Scutellastra cochlear dominates this zone, often in numbers in excess of 3000 individuals per square metre.

A host of other animals live on the mid to low shore. Some, like barnacles are sedentary and cannot move. These highly modified crustaceans (related to crabs, sea lice, shrimps and rock lobsters) once started life as free-swimming shrimp-like larvae. With time, the larva searches for a place to settle and then cements itself, head-first, to the place it has chosen. The larva then undergoes metamorphosis into a juvenile barnacle, encasing itself in a hard, heavily calcified shell. Still fixed upside down by its forehead, the animal is forced to use its feet, which have now become modified into long feathery limbs, to capture and trap microscopic food particles. Here this barnacle will grow and remain for the rest of its natural life, well adapted to its intertidal environment and protected from the elements.

Similarly like many seaweeds, those animals less tolerant of desiccation stress and wave exposure have to confine themselves to intertidal rockpools. Here too, however, they have to cope with salinity stress, but also high light stress (intensity). Similar to seaweeds, rockpool animals are also able to regulate the amounts of dissolved internal salts, keeping their internal osmotic pressures somewhat higher than the surrounding medium. This way they do not loose precious body fluids to the surrounding environment. Sea urchins are particularly susceptible to high light intensities. They overcome this by literally shading themselves with bits of seaweed, shell and stone, creating what appears to be little umbrellas, using their little tube feet to manoeuvre these shades. As a consequence of this action, barefoot beachcombers are often pieced by sea urchin spines largely because the urchins become nearly invisible when shaded in this way.

While many intertidal animals are very obvious (once you know what you are looking for), there are a host of animals that are also very cryptic. Most will simply hide from plane sight, but there are those that are blatantly exposed and yet, nearly invisible to the naked eye. These animals employ a kind of mimicry or camouflage. Once such example is the dwarf cushion sea star Patiriella exigua. The dorsal surface of this sea star is made up of hundreds of mosaic-like tiles and spots and it is these colours and patterns that assist the sea star to camouflage it from predators. Also, they have a bony, calcified skin, which not only protects them from predators, but also provides protection against the harsh environment of the intertidal zone. While most sea stars are carnivorous, the dwarf cushion sea star is one of the few completely herbivorous sea stars. As a matter of interest, sea stars are often referred to as starfish. However, the sea star is not a fish; it's an echinoderm, closely related to sea urchins and sand dollars. The examples presented here are but a few of the many ways in which those organisms living along the margins of the land survive this seemingly hostile environment. But, perhaps this environment with all its extremes is not as stressful as one might imagine it to be. These conditions may actually be less stressful to the organisms living here compared with those in places where they do not occur. These same "stressful" conditions could possibly have prevented these species' demise by limiting the occurrences of potentially competitively dominant species that might otherwise have excluded them. Whatever the case may be, these organisms have long lived under, and evolved to these changing and variable conditions.

A formidable team the FGASA Honorable SKS's for our area

Patrick Cardwell – Birding
Deborah Robertson Andersson – Marine
Gavin Maneveldt – Marine
Peter Chadwick – Conservation
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Annelise Le Roux Botany – Namaqualand
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