# Module 3
## Sea Plants

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1. SEA PLANTS (ALGAE) AND THEIR BIOLOGY

INTRODUCTION

The term algae is a general name that can be given to ‘seaweeds’ or sea plants, as they should more correctly be called. Sea plants are simple marine plants that grow in the shallow waters at the edge of the world’s oceans. Together with microscopic algae called phytoplankton, sea plants contribute to the food chain in the sea, provide homes for many different sea animals, lend beauty to the underwater landscape, and are directly valuable to man as food and as industrial raw material.

Algae make their own food (primary producers)

Sea plants use solar energy to produce carbohydrate food from carbon dioxide and water through the process of photosynthesis. During this process, oxygen is given off as a by-product.

Algae are considered simple ‘plants’

Sea plants are simpler than most land plants because they have no roots or shoots. Sea plants absorb their nutrients directly from the surrounding seawater; they therefore have no need for roots or complex conductive tissue. Some large sea plants like the kelps, do however, have root-like attachment structures called holdfasts, stem like stipes and leaf-like fronds.

Algae can be grouped based on their colour

Sea plants can be divided into three groups: green, brown and red. They are so grouped according to the photosynthetic and accessory pigments that they possess which in turn will reflect certain colours of light producing what appear to be green, brown and red sea plants. All sea plants contain chlorophyll a – the photosynthetic pigment.
• **Green Algae:** Like land plants, green algae contain chlorophyll $a$ & $b$, which they use to capture light energy during photosynthesis. These chlorophyll pigments reflect green light making them appear green in colour.

• **Brown Algae:** Brown algae are usually yellowish-brown with grey or blackish tinges. This is so because of the presence of chlorophyll $a$ and $c$ plus an additional accessory xanthophyll pigment called fucoxanthin from which brown sea plants derive their colour. Some brown sea plants however are often totally black in colour and are often mistaken for red sea plants that are dark in colour.

• **Red Algae:** Red algae possess only the chlorophyll $a$ – the principal photosynthetic pigment. They appear red because they possess a series of accessory pigments known as phycobilins that absorb blue and green light and reflect red light. Although they are commonly called red sea plants, some may appear black, blue, yellow and even green. This is especially true for intertidal red sea plants whose red pigments may become masked by the chlorophyll and other pigments present in them. Since blue light penetrates water to a greater depth than any other light, the phycobilins present in red sea plants allow these sea plants to photosynthesise and survive at great depths; some red sea plants are known to occur to depths of up to 250 meters!

2. **GREEN ALGAE (DIVISION CHLOROPHYTA)**

Green algae are thought to be ancestors of land plants because they possess the same green pigments (chlorophyll $a$ & $b$). Below are the common green sea plants of the Cape Peninsula.

**Sea lettuce (**Ulva sp**)**

*Ulva* species are called sea lettuce. These green sea plants may form dense clumps of membranous blades, only two cells thick that resemble lettuce leaves. It is regarded as edible and used extensively in oriental cooking.

**Green sea intestines (**Enteromorpha intestinalis**)**

This is aptly named the green sea intestines because the sea plant is made up of membranous green tubes (often collapsed) only one cell thick, resembling an intestine.

Sea lettuce and green sea intestines are fast growing opportunistic sea plants that have a wide salt and temperature tolerance. These features enable them to rapidly colonise any part of the rocky seashore if the conditions are right. They are often very abundant high up the shore where desiccation stress is the primary factor controlling sea plant distribution. Under sheltered conditions, these sea plants may be the only sea plants to occupy entire high shore tide pools with sea lettuce plants often attaining lengths in excess of half a meter. When areas of the seashore become disturbed, these are the sea plants that would be the first to appear because of their ability to rapidly colonize free space.
**Upright codium (Codium fragile)**

Upright codium is a forked, upright, somewhat velvety, spongy sea plant that is able to regulate the movement of its chloroplasts to maximize photosynthesis. This sea plant’s thallus is internally composed of interlocking filaments that end in club-like structures bearing the chloroplasts and the reproductive structures. *Codium fragile* belongs to a group of sea plants that are unique in that their internal filaments lack cross-walls. Thus, instead of being divided into cells, each filament is a giant cell with many nuclei. *Codium fragile* is particularly abundant in intertidal rockpools that are also prone to sand inundation.

**Strap caulerpa (Caulerpa filiformis)**

Strap caulerpa grows as a tangled mass of root-like rhizomes giving rise to cylindrical stipes bearing bright grass green, flattened blades. The blades that are often mottled with dark-green spots are once or twice dichotomously (into two) branched. Like the Codiums, this sea plant's internal structure is composed of multinucleated filaments, lacking cross-walls and thus essentially lacking a cellular structure. Despite this, strap caulerpa is amazingly tough and has a complex morphology. This sea plant maintains its form due to the presence of a complex mesh of cellulose ribs formed within an otherwise hollow structure. Also, like the Codiums, the lack of cross-walls allows this sea plant to regulate the movements of its chloroplasts, maximizing its photosynthetic capacity. It is not surprising that sea plants such as these are quite frequently found dominating areas prone to sand inundation.

#### QUICK REVIEW

1. What colour groups of marine algae do we find, and explain (without going into detail of chemical names) why they exhibit these colours.
2. Are marine algae only found near to the coastline? Explain.
3. What are some general uses of sea plants?
4. Where are Sea lettuce and Sea intestines likely to be found?
5. Where are Upright codium and Strap caulerpa likely to be found? What structural feature makes this possible?

### 3. BROWN ALGAE (DIVISION PHAEOPHYTA)

Unlike the green sea plants, brown sea plants are generally slower growing and are less tolerant of salinity and temperature extremes and thus more prone to desiccation stress. They therefore tend to occur lower down on the shore than the green sea plants. Below are the common brown sea plants of the Cape Peninsula.

**Cape cord-weed (Chordariopsis capensis)**

*Chordariopsis capensis* is a stringy, limp sea plant often abundant in sheltered high shore and mid-shore tide pools. Here it occurs in a flaccid untidy mass that easily becomes dislodged by any significant amount of wave action.
**Dead-man’s fingers (Splachnidium rugosum)**

*Splachnidium rugosum*, aptly called the dead-man’s fingers, has spotted; elongated, cylindrical branches that resemble withered and callused fingers. The branches, sometimes also berry-like are filled with clear viscous mucus. It is this mucus that enables the plant to withstand a high degree of desiccation stress within the mid-intertidal when it becomes exposed at low tide.

**Ralfsia (Ralfsia verrucosa)**

*Ralfsia verrucosa*, is an olive brown to khaki encrusting brown sea plant that occurs abundantly in low shore tide pools. Here it often forms large, flat, smooth expanses giving the impression that someone had accidentally dropped khaki paint into the tide pools. *Ralfsia* can occur in high abundance because of its relatively fast growth rate and also because it produces a chemical which seems to deter most grazers. However the periwinkle and the long-spined limpet like to eat *Ralfsia*, and the latter even ‘gardens’ this brown sea plant.

**Hanging wrack (Bifurcaria brassicaeformis)**

The hanging wrack commonly dominates that part of the low shore just above the subtidal zone where it forms extensive mats of long, tough, cylindrical branches looking very much like an unmown lawn. This sea plant achieves dominance of the low shore by rhizomatous spreading of its holdfast. Some local scientists have recorded individual sea plant bases measuring as much as 1m in diameter. This species is endemic to South Africa, having a very restricted distribution; it occurs only from Cape Agulhas to around Sea Point in Cape Town.

**Long-leafed sargassum (Anthophycus longifolius)**

The long-leafed sargassum is a somewhat twisted, robust and knobbled sea plant that can easily dominate large areas of low shore tide pools and the immediate subtidal. The blades of this species are characteristically toothy with those blades near the surface bearing little bladders in their axils. These bladders keep the sea plant afloat enabling it to maximise its photosynthetic abilities. Long-leafed sargassum is one of the largest non-kelp brown sea plants, often attaining lengths in excess of 1m. This sea plant is the sole species in the genus *Anthophycus* and this genus is known only from Southern Africa. This species is therefore endemic to South Africa.

**Kelp**

In the subtidal and intertidal gullies of the southwest Cape, the west coast and east coast, we can see the giant brown sea plants known as kelp. Like trees in an ancient forest, kelps dominate the canopy of the subtidal zone in the cool, nutrient-rich waters of South African. The word ‘kelp’ originally referred to the ash of these plants, which was used as a fertilizer in Europe. Kelp is the largest and fastest growing of the sea plants, growing as much as 13 mm in a day. Some of these sea plants such as the giant kelp (*Macrocystis pyrifera*) of central and southern California are known to grow to over 30 m in length, growing at the incredible rate of up to 50 cm per day.
Unlike most sea plants that are relatively simple in structure, kelp plants have reached a level of specialization near to that of the higher green plants. Because they are so large, these brown sea plants have developed specialized tissues and organs. Such specialized tissues include conductive tissue for transporting the products of photosynthesis internally; yet others include reproductive, photosynthetic, and strengthening tissue. Specialized organs include an elaborate root-like holdfast purely for attachment, a stem-like stipe that bears the photosynthetic and reproductive blades, and many possess floats that keep the sea plant and its blades erect in the water column. All these features have improved the kelps photosynthetic ability, allowing them to form extensive beds, dominating the subtidal zone.

Below are the common kelp species of the Cape Peninsula.

**Sea bamboo (Ecklonia maxima)**

_Ecklonia maxima_, is the largest of the local kelp species, dominating the inshore regions of the southern and west coast. This sea plant possesses a massive holdfast that extends into a long, hollow, gas-filled stipe up to 15 m in length that ends in a bulb (float) at its apex. The bulb further extends into a flat, solid primary blade from which secondary blades emerge. These secondary blades can reach 3 m in length. Because of its hollow stipe and bulb, this species is buoyant, its blades frequently breaking the surface of the ocean at low tide. So, when you see kelp at the ocean’s surface, this is most often sea bamboo. This also means that sea bamboo constitutes the canopy of the kelp forest and it is here that three species of red sea plant and a limpet occur epiphytically on the sea bamboo. While this species is the dominant kelp in inshore waters of the southern and west coast, it becomes progressively replaced by another kelp species, the split-fan kelp, in deeper waters and also further north up the west coast.

**Split-fan kelp (Laminaria pallida)**

_Laminaria pallida_ lacks the buoyant structures found in sea bamboo (although the stipes of several plants have been shown to be hollow), so it rarely breaks the surface in deeper water. This species grows to about 10 m in length and possesses a single broad, fan-shaped blade that becomes irregularly split, giving the kelp its name. Unlike sea bamboo, which is more common in relatively shallow water, split-fan kelp occurs to depths of 30 m. Adult split-fan kelp plants have warty stipes whereas they are smooth in the sea bamboo. Both of these sea plants are common on wave-exposed rocky shores.

**Bladder kelp (Macrocystis angustifolia)**

The bladder kelp, _Macrocystis angustifolia_ is the least common of the west coast kelp species. This kelp is a relatively delicate, vine-like species bearing numerous blades at regular intervals along its slender stipe. At its apex, the new blades are fused, gradually separating as they grow. The blades possess numerous marginal spines and a single gas-filled bladder at their bases. It is these bladders that allow this kelp to remain afloat and erect in the water column. Unlike the other two species of kelp, an individual rhizomatically
spreading holdfast in this species can bear multiple stipes. Large populations of this sea plant are found only at two locations near Cape Town; one at Kommetjie, the other at Robben Island in the Melkbostrand region. Unique to this species of kelp are its haphazardly rippled blades. This feature is especially important, as it allows for increased absorption of nutrients in relatively low flow environments typical of sheltered lagoons or embayments.

**QUICK REVIEW**

1. If you show Dead man’s fingers to a child at the touch pool, what two features can you ask them to look at/feel?
2. What does endemic mean?
3. Although they look superficially similar, how do Long leaf sargassum and Bladder kelp differ structurally?
4. Why do many sea plants found in deeper water have bladders?
5. How do Sea bamboo and Split fan kelp differ?
6. How are rippled blades, as seen on bladder kelp, useful to them?
4. KELP FOREST STRUCTURE AND FOOD WEBS

Ecologically, the kelp forest provides an important, complex, three-dimensional habitat for a number of species of fish, invertebrates and other sea plants. The kelp limpet, *Cymbula compressa* for example, occurs only on sea bamboo. Kelp beds are among the most productive ecosystems on earth, supporting high primary production levels. This high productivity forms the base of many coastal food webs in cool water environments worldwide. So, both directly and indirectly, they are an important food source for a large variety of invertebrates, fish, mammals and seabirds. Furthermore, kelp is tough and resilient, and stretching into the sea, often for many kilometres, they help break the great force of the waves offering protection to the near-shore ecosystem.
4.1 KELP FOREST STRUCTURE

**Canopy species:** In the kelp beds typical of the southern-west coast, the blades form a canopy layer near the surface. The canopy absorbs much of the light reaching the water surface, so most of the stipes of mature plants is in a twilight zone.

**Epiphytes:** Like terrestrial creepers and ferns, marine epiphytes grow attached to the kelp blades and portions of the stipes near the surface and so doing receive as much light as the blades. Epiphytes are generally delicate in nature, as they have to bend as the kelp sways in the waves.

**Under storey species:** On the rock, underneath the kelp canopy occur numerous species of sea plants that make up the under storey layer. These species live in a dim world, since the canopy and the epiphytes intercept much of the incoming light. Nevertheless, there is enough light to support a broad variety of under storey flora, many of which are able to photosynthesize even at very low levels of light. Many of these under storey sea plants are flat, to capture as much light as possible.

4.2 FOOD WEBS IN THE KELP FOREST

The South African kelp ecosystem has been described as a sun-powered system, with additional energy input in the form of wind and waves.

- Energy from sunlight drives primary production, as well as setting up a thermally stratified water column.
- Wind energy drives the upwelling process, which brings nutrients up to the surface waters in which the kelps grow. The uptake of nutrients is enhanced by water motion due to wave action, and this allows the kelp and associated sea plant to make better use of the sunlight for primary production.
- Energy from waves can also uproot kelp plants and wash them up onto the shore, where they provide food for a wide variety of organisms, especially amphipod and isopod crustaceans. Wave energy contributes to the erosion of the blades, producing particulate and dissolved organic matter.
- Wave action keeps kelp plants in motion, and prevents grazers from climbing and damaging the plants.

4.3 ENERGY FLOW

This is the movement of energy through the food web of an ecosystem, from sunlight to the primary producers, and from primary producers to consumers and decomposers.

**Kelp energy** is not used only within the kelp bed it also helps to support other adjacent ecosystems. Every winter the South African west coast is pounded by large waves arising from south Atlantic storms. Large amounts of kelp are uprooted, and washed up onto the shore, where it decomposes and is eaten by amphipods, isopods, and fly larvae.
PERSONAL FOOD WEB WORKSHEET

1. Construct a simplified food web from the kelp tank using examples from each trophic level as indicated below. Draw arrows connecting the categories, suggesting energy flow, and the direction of energy flow. Note that these organisms are interdependent.

Primary producers

Herbivores

Secondary consumers

Suspension feeders

Decomposers
2. Energy Flow through the kelp community. Complete the flowchart.
5. RED ALGAE (DIVISION RHODOPHYTA)

The mid to lower intertidal of the Cape Peninsula is dominated to a large extent by red algae. These form by far the largest group of sea plants on the Peninsula. Like the brown algae, many of the reds are fleshy and bulky and generally occur lower down the shore because they are less tolerant of salinity and temperature extremes when compared with some of the common green sea plants. Below are the common red algae of the Cape Peninsula.

**Purple laver (*Porphyra* sp)**

*Porphyra* species, commonly called purple laver, are extremely thin (only one cell thick), flat, membranous plants. This sea plant looks like a sheet of wrinkled cellophane when dry, crumpled and folded upon itself. They vary in colour from yellow to purple to almost black. Species of *Porphyra* are abundant high up on the shore where desiccation stress is at its greatest. While most sea plants are intolerant of the conditions this high up the shore, *Porphyra* species are able to survive here due to their remarkable recovery capabilities; this sea plant has been shown to survive dehydration for over seven days. Purple laver is often collected to use as the wrapping around sushi and can be dried, ground up and reformed to make *nori* sheets, also used for sushi.

**Tar crust (*Hildenbrandia lecanellierii*)**

Another species tolerant of the desiccation stress high up on the shore, is the encrusting red sea plant (*Hildenbrandia lecanellierii*). Looking remarkably like splashed tar, this sea plant may form large expanses in the upper intertidal, in crevices, and in places prone to sand inundation. Older parts of the plant often become detached from the substrate, but it shows a remarkable rate of recovery from physical disturbance and often may regenerate from a few cells.

**Slippery orbits (*Aeodes orbitosa*)**

Commonly known as slippery orbits this is another flat, slippery, foliose sea plant that is also very tough. Its colour varies from yellow-brown to reddish-brown. This sea plant is especially common in the mid- to lower intertidal zone where it often forms large expanses. In sheltered intertidal pools, this sea plant has been known to grow to 2 meters in diameter.

**Tongue weed (*Gigartina polycarpa*)**

This is a tough, fleshy sea plant bearing oval blades. Individuals of this species are characteristically rough and bear numerous papillae (sometimes the blades are even rippled) giving the appearance of a rough tongue. The colour in this species varies from yellow-brown to reddish-brown to almost black. Along with *Aeodes* it is also quite abundant in the mid- to lower intertidal zone.
**Hedgehog sea plant (Nothogenia erinacea)**

Aptly called the hedgehog sea plant because of its appearance, this sea plant consists of elongated foliaceous blades that are tough and leathery when wet, becoming papery when dry. The blades bear numerous densely packed tuft-like outgrowths giving the sea plant its hedgehog-like appearance. This species varies in colour from yellow-brown to almost black. It is also very common in the mid to lower intertidal.

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**Green tips (Hypnea spicifera)**

Commonly called green tips, this alga occurs as dense green and purple clumps on the lowest parts of the shore and is only visible during low spring tides. The upper parts of the clumps are covered with numerous short green fleshy spines. The colour in this species is characteristically purple-brown at the base and a luscious translucent green at the tips. In this species the chlorophyll completely masks the red pigment near the sea plant’s upper surface. This sea plant is able to form extensive mats on the lowest reaches of the shore because of its rhizomatically spreading holdfast system. This plant was used by early settlers (and, up to the present, by suitably informed people) for the making of jelly and thus has commercial potential due to its high level of jelly producing chemicals.
5.1 ENCRUSTING CORALLINE ALGAE

Beside the fleshy red sea plants mentioned above, there is another group of red sea plants that are especially important in the formation of coral reefs, an activity with which they have been intimately involved in for millions of years. These reef-building red sea plants are the encrusting coralline sea plants. They are widespread in shallow water in all of the world’s oceans, where they often cover close to 100% of rocky substrates and equally abundant throughout the intertidal zone of the Cape Peninsula. However, they are relatively unfamiliar, even to many marine scientists. Encrusting coralline sea plants are readily recognizable as pink, pinkish-grey, red, mauve or purple blotches as though a clumsy painter’s apprentice spilled them all over the rock surfaces, animals and even other sea plants.

Like all red sea plants, coralline algae possess the phycobilin photosynthetic pigments that give them their red coloration. Unlike fleshy sea plants though, coralline algae are calcified (they have their cell walls impregnated with lime) so that they are extremely hard. These are some of the common encrusting coralline sea plants of the Cape Peninsula.

**Cochlear coralline (Spongites yendo)**

Cochlear coralline is the most abundant encrusting coralline in the intertidal, occurring from the mid intertidal to the immediate subtidal. Its colour varies from grey-pink in well-lit areas, mauve in shaded areas. Individuals of this species generally fuse together when crusts meet so that large expanses of the coralline are often thought of as a single sea plant. This coralline is closely associated with the territorial gardening pear-shaped limpet, where it forms an extensive covering of limpets’ shells and the base of limpet zone. For this reason, this coralline is commonly known as the cochlear coralline.

**Dinner plate coralline crust or velvety coralline crust (Heydrichia woelkerlingii)**

Dinner plate coralline algae are by far the most abundant encrusting coralline alga within the immediate subtidal. It is extremely thick (up to 20 mm), smooth, porcelain-like encrusting coralline with individuals easily attaining the diameter of a dinner plate, therefore the name dinner plate coralline algae. It is also called the velvety coralline crust because of its smooth velvety nature.
REPRODUCTION IN ALGAE (For interest)

The cycle of reproduction and growth to produce the next generation in organisms is referred to as the life cycle of the organism. The life cycle of sea plants is varied and fascinating. Since they are fixed to the substratum they depend on their spores for dispersal. Furthermore, as the chance of the spores surviving is so slim they have to produce vast quantities. As an example, the sea bamboo produces 10 000 spores per hour from each square centimetre of its fertile blades.

Life cycles involve two basic and simple processes: meiosis (cell division leading to the production of spores) and syngamy (or fusion).

- During meiosis, the number of chromosomes in a cell is halved.
- During syngamy, the number of chromosomes is restored when two nuclei with half the number of chromosomes are fuse together. The resulting nucleus has the full set of chromosomes.

Reproduction in the sea plants common to the Cape Peninsula is generally of two kinds: gametic and sporic life cycles.

1. GAMETIC LIFE CYCLES

In gametic life cycles, the product of meiosis (where the number of chromosomes is halved) is gametes. This type of life cycle is common in humans and most animals. Although not as common in algae various species of Codium have such a life cycle.

2. SPORIC LIFE CYCLES

In sporic life cycles, the product of meiosis is spores. This is the life cycle common to mosses for example. On land the dominant free-living form that one sees is called the sporophyte. In sporic life cycles, spores produced by the sporophyte give rise to free-living male or female gametophytes that in turn produce the gametes by simple asexual reproduction.
6.USES OF ALGAE

Together with microscopic algae called phytoplankton, sea plants form the basis of the food chain in the sea and are directly valuable to humans. Although we can neither smell nor taste them, many ingredients in our foods and household products come from the sea and from sea plants.

GREEN ALGAE

- Sea lettuce (Ulva species) as a whole plant has long been eaten in the Far East as a green vegetable in salads and soups.
- Beta-carotene, a natural pigment derived from green sea plants, is used as a yellow-orange food colorant in cheese, coffee creamers, egg substitute, margarine, mayonnaise, multivitamins, salad dressing, and many more.

BROWN ALGAE

A characteristic feature of brown sea plants is that their cell walls are made of cellulose strengthened by calcium alginate. Alginate is a substance of considerable economic importance as it is used as a gelling and emulsifying agent in a number of industries. Surprisingly though, at present, only kelp is harvested commercially in South Africa for alginate extraction. Perhaps it is because no other group of brown sea plant occurs in large enough densities to be commercially viable.

In South Africa, the sea plant industry is based on sea bamboo and split-fan kelp, but includes some other brown and red sea plants.

USES OF KELP

Internationally, a huge market exists for the harvesting of kelp and other brown sea plants for alginate production.

- Fertilizer
  Kelp is widely used as a fertilizer and is harvested extensively as feed for commercially farmed abalone.

- Nutritional supplement.
  Sea bamboo is also used as a nutritional supplement for farm animals. In local agriculture, this kelp is well known for the production of a very successful plant growth stimulant. It is also a great source of micronutrients.

- Food industry.
  It makes water-based products thicker, creamier, and more stable over extreme differences in temperature, pH, and time. For example, alginites prevent the formation of ice crystals in ice cream. Other products containing alginate include brownie mix, frozen foods, desserts, relishes, salad dressing, sauces, gravies and even beer.

- Cosmetics, pharmaceutical, paint, textile and welding industries.
  Alginate aids in the suspension and stabilizing of agents over ranges of temperature and pH. In the paper industry, for example, alginate is important as it enables sizing and polishing of the finished paper product. Did you know that alginate from kelp is even used to make fibres for high quality audio speakers?
• **Medical industry.**

  Kelp is especially important as its alginate is used to **encapsulate many things such as tablets** in powder form, fracture castings and moulds, and even organs for transplant. Kelp also contains an astonishing amount of **vitamins and minerals**. The most important of these supplements though is probably **iodine**. Iodine has a normalising effect on the thyroid gland (this gland controls the body’s growth and development). In Namibia, scientists are looking to use sea bamboo and split-fan kelp as a **treatment of goitre** and prevention of (or reduction in the occurrence of) cretinism in southern Africa. Similarly, because iodine feeds the thyroid, kelp is even used in **weight loss formulas**. Japanese studies have even shown a direct relationship between alginate contained in kelp and the **prevention of breast cancer**.

**RED ALGAE (FLESHY)**

While the algae industry in the Western world is based mainly on sea plant extracts, in the East Sea plants are cultivated in huge volumes for **human consumption**. Much of this industry is based on the red sea plants.

Of all the sea plants, the reds are probably the most valuable to humans economically.

• **Purple laver** (*Porphyra*) constitutes an astonishing **80% of all sea plant harvesting** all over the world. In Asia, purple laver is known as **nori** and is eaten as complete plant either dried or in soups, or as tasty wrappings for sushi and rice. The iodine and high vitamin and protein content of nori makes it attractive, as does the relative simplicity of its mariculture (sea farming), which began more than 300 years ago in Japan.

Beside food for direct consumption, red sea plants are also important for their **phycocolloid** extracts. Phycocolloids are sea plant derivatives that cause particles to remain suspended in solution and are therefore excellent as stabilizing and gelling agents. The main phycocolloids derived from red sea plants are **carrageenan** and **agar**.

• **Carrageenan** is highly sought after in western societies where it is especially important in the **dairy industry**. Milkshakes, cheese, yoghurts, powdered milk (including baby formula), etc all possess red sea plant extracts. Believe it or not, carrageenan is even used in **pet food, cosmetics, shampoos, paints and toothpaste**. A number of carrageenophyte sea plants are being investigated in South Africa. These include green tips and various species of tongue weed, twisted gigartina, and slippery orbits.

• **Agar** on the other hand, has its most important use as a **medium on which to culture fungi and bacteria in microbiological and medical pathology research**. In food for human consumption agar can be found in **baking and confectionary products** and is also widely used to clarify wine, juice and vinegars due its excellent protein binding properties. In larger industries, agar is used to make **adhesives and capsules for tablets**. South African agarophytes include the sea plant genera **Gracilaria** (which is harvested extensively in Saldanha Bay) and especially **Gelidium**.

**RED ALGAE (CALCIFIED)**

Encrusting coralline sea plants too are important in the ecology of marine ecosystems where they serve as food and shelter for many marine animals. Despite their hard, calcified nature, however, they also have a number of economic uses.

• They are used in medicine, and in more modern medical science coralline algae are used in the preparation of **dental bone implants**.
- Coralline rubble known as *maerl* is used in calcium mineral supplements, as soil pH conditioners, in the filtration of acidic drinking water, and even as food additives for livestock.
- They are also used as “live rock” in the marine aquarium industry.
- Coralline rock has even been used as building stones.

**Commercial use of algae in South Africa.**

At present a small industry utilising mostly brown and fleshy red sea plants. The increasing use of local representatives of sea plants has now resulted in a state policy to ensure the sustainable use of these commercial resources. This awareness has greatly increased research on local sea plants and considerably increased our knowledge of most of the species. It is only with this increased awareness that we have been able to bring to you the knowledge that we have gained regarding this fascinating group of marine organisms. Now that you’ve come to know the green, brown and red sea plants in a bit more detail, we hope that you will see them with a positive view and not just that smelly stuff lying on the beach.

**QUICK REVIEW**

1. What chemical is commercially extracted from kelp?
2. Explain uses of kelp and the chemical mentioned above in the Farming sector, Food industry, Medical field and Elsewhere...
3. What chemical is extracted from plants like Sea lettuce, and what are some of its uses and applications?
4. Name the two chemicals that can be extracted from fleshy red plants and some uses and applications of each chemical.
5. Mention 3 or 4 uses for calcified red algae.
6. After the children have felt the texture of some tongue weed, explain to the parents what economically useful chemical(s) it contains, and some of their uses...
7. GLOSSARY

Algae  
Algae are aquatic or live in damp habitats on land and include unicellular organisms and multicellular green, red and brown sea plants and freshwater algae such as *Spirogyra*.

Blade (or Frond)  
Synonymous with leaves in green plants.

Dimorphic  
Having two different forms.

Endemic  
Occurring nowhere else in the world.

Epiphytic  
Living on or attached to plants.

Foliose  
Leaf-like in form or appearance.

Holdfast  
The root-like organ of attachment.

Kelp  
Giant brown sea plants that dominate the subtidal area.

Spring tide  
That tide occurring every two weeks during new and full moon phases. At this time, low tides are at their lowest, and high tides at their highest.

Rhizomatous  
A creeping stem-like structure.

Stipe  
The flexible “stem” in sea plants.

Thallus  
A plant body not differentiated into true leaves, stems and roots. It is often a flattened structure.

Upwelling  
An oceanographic process whereby cold nutrient rich subsurface water moves to the surface to replace offshore moving surface water. This phenomenon is especially prevalent on our west coast.

8. REFERENCES


Life cycles, coralline sea plants and community illustrations by R. Frans.

Energy Flow illustration from the Pick ‘n Pay envirofacts sheet no 11.

Source of M.L. Branch and R.H. Simons illustrations:


# Sea Plants Made Simple


Notes and worksheet compiled by Philke Borgelt. Illustrations - fact sheets by Margo Branch

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SHAPE</th>
<th>COMMON NAME</th>
<th>ZONE FOUND</th>
<th>ZOA EXHIBIT</th>
<th>DESCRIPTION</th>
<th>USES TO MAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GREEN</strong></td>
<td>Chlorophyll a + b + carotenoids</td>
<td>Sea lettuce <em>(Ulva)</em></td>
<td>Upper Balanoid</td>
<td>Touch Pool</td>
<td>Looks like green cellophane (wet). Two cells thick, colonises easily. Wide salt and temperature tolerance.</td>
<td>Food especially in Far East in salads, soups. Beta-carotene as a yellow-orange colorant in cheese, margarine, mayonnaise etc.</td>
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<tr>
<td></td>
<td></td>
<td>Sea intestine <em>(Enteromorpha intestinalis)</em></td>
<td>Upper Balanoid</td>
<td>Touch Pool</td>
<td>Tube one cell thick. Colonises easily, opportunistic. Wide salt and temperature changes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upright codium <em>(Codium extricatum)</em></td>
<td>Sandy rock pools</td>
<td>Touch Pool</td>
<td>Forked, velvety, spongy filaments. Lack cross-walls Chloroplasts moveable.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strap caulera <em>(Caulerpa filiformis)</em></td>
<td>Sandy rocky pools</td>
<td>Intertidal &amp; Seahorse</td>
<td>Annulated stipes diagnostic. Flat blades with dark green spots. Chloroplasts moveable.</td>
<td></td>
</tr>
<tr>
<td><strong>BROWN</strong></td>
<td>Chlorophyll a + c + fucoxanthin</td>
<td>Dead-man’s fingers <em>(Splachnidium rugosum)</em></td>
<td>Lower Balanoid</td>
<td>Touch Pool</td>
<td>Turgid (wet). Wrinkled (dry). Filled with thick mucilage to withstand desiccation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sea bamboo <em>(Ecklonia maxima)</em></td>
<td>Infratidal</td>
<td>Kelp Forest</td>
<td>Hollow stipe, float at apex. Canopy of kelp forest dominant kelp of SW coast.</td>
<td>Kelp (means ‘ash’) used as fertiliser. Root hormone → increase crop yield Food for abalone farming.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bladder kelp <em>(Macrocytis angustifolia)</em></td>
<td>Infratidal</td>
<td>Kelp Forest</td>
<td>Rippled blade with gas filled bladder. Found in sheltered water only at Kommetjie and Robben Island.</td>
<td>Natural population too small to warrant harvesting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slippy orbit <em>(Aeodes orbitosa)</em></td>
<td>Lower Balanoid</td>
<td>Touch Pool</td>
<td>Yellowish or olive-brown. Tough and very slippery. Unpalatable to grazers.</td>
<td>Carrageenan – binding properties used in toothpaste, paints, baby formula, ice-cream, beer foam.</td>
</tr>
<tr>
<td></td>
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<td>Tongue weed <em>(Gigartina radula)</em></td>
<td>Lower Balanoid</td>
<td>Touch Pool</td>
<td>Yellow-brown to red-brown. Tough, gametophyte - many papillae tetrasporophyte -ridges and grooves.</td>
<td>At Saldana Bay Beach-cast Gracilaria collected, dried and exported for agar extraction. In Eastern Cape, Gelidium jelly weed is harvested for export. Used in confectionery, culture medium, clarifying wine.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hedgehog sea plant <em>(Nothogenia erinacea)</em></td>
<td>Lower Balanoid</td>
<td>Touch Pool</td>
<td>Yellow-brown to black. Tuft -like outgrowths more in gametophyte than tetrasporophyte.</td>
<td>At Saldana Bay Beach-cast Gracilaria collected, dried and exported for agar extraction. In Eastern Cape, Gelidium jelly weed is harvested for export. Used in confectionery, culture medium, clarifying wine.</td>
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