An Introduction to the Seaweeds of British Columbia

by Colin Bates, Dept of Botany, University of British Columbia. Adapted from an account originally published on E-Flora BC website. All photos by Colin Bates.

Many people are unaware that British Columbia is a veritable hot spot of seaweed biodiversity. At last count, there were approximately 650 macroalgal species found in waters of the Pacific Northwest (Scagel et al. 1989, Gabrielson et al. 2000). Of these, 530 are known to occur in BC.

Why are so many people unaware of the diversity of seaweeds that inhabit British Columbia's waters and shores? Many initial encounters with seaweeds can be unpleasant, especially if you are wading into the ocean for a swim, or trying to maintain your footing while scrambling on the rocks. As well, detached seaweeds end up washing ashore and amassing into smelly decomposing piles. Seaweeds generally get a bad reputation in the press (if any at all). Books like "Killer Algae" (Meinesz, 1999), which describes the invasive nature of a green seaweed species called *Caulerpa taxifolia,* and talk of 'Harmful Algal Blooms" (a microalgal phenomenon) do not help. All of these factors contribute to the idea that seaweeds are a nuisance. Yet, it is my experience that seaweeds are most certainly not a nuisance, and instead are beautiful organisms with fascinating natural history, diverse economic uses, and essential ecological roles.

Seaweeds are a subset of a larger group known as the algae. When most people think of algae, they picture a green scum on the side of a pond or fish tank, but in reality algae can be large or small, helpful or harmful, and believe it or not, stunningly beautiful and head-scratchingly interesting.

Unlike plants and animals, the algae do not arise from a single common ancestor (a condition referred to as monophyly). Instead, they are a group composed of many lineages (group composed of many lineages; *i.e.* polyphyletic (Graham & Wilcox 2000). Throughout the history of algal taxonomy, various characters have been invoked to describe this disparate group: simple bodied organisms, reproductive propagules lacking well-developed structures as in flowers or cones, mostly aquatic, and generally photosynthetic. Yet, because the algae are polyphyletic, arising from various ancient ancestors, there are myriad exceptions to these characters as well as many non-algal taxa that possess them.

The tie that binds all algae together is a concept known as the 'serial endosymbiosis hypothesis' (Bermudes & Margulis 1985, Bhattacharya 2000), which suggests that the commonality among all algae is that, at one or more points in their lineage, they acquired photosynthetic abilities through either the uptake of a photoautotrophic bacterium (known as a primary endosymbiotic event), or through the uptake of a heterotroph that had previously taken up a photoautotrophic bacterium (a secondary endosymbiotic event). A current hot topic in algal phylogenetics is determining if one or two primary endosymbiotic events gave rise to red and green algae (e.g., Moreira et al. 2000). It is generally accepted that there were multiple secondary endosymbiotic events. With the advent of molecular tools, algal systematics is in the midst of a substantial reworking of these and other questions.

Molecular tools have also provided the opportunity to examine relationships between algae and land plants (Bhattacharya & Medlin 1998). Mounting evidence suggests that land plants are derived from an ancestor of the green algal order Charales (Mishler & Churchill 1985, Surek et al. 1994). Land plants are excluded from algae because they do not conform to the character set described above; these plants have complex bodies, typically with flowers or cones, and are normally terrestrial.

The study of algae is called phycology, from the Greek root *phykos* meaning algae. Algae are a vast group including many classes of unicellular and multicellular organisms. Below, I focus on the multicellular macrophytes, and in particular, the benthic marine macrophytes that most refer to as the seaweeds.

Seaweeds are a macroscopic subset of marine algae (as opposed to the microscopic subset known as phytoplankton). The west coast of British Columbia has a diverse flora and arguably is home to the widest variety of kelp (Order Laminariales) in the world.

The seaweeds are split into three major groups, originally delineated by their pigment complement (and hence color): the green algae (Division Chlorophyta), the brown algae (Class Phaeophyceae, Division Ochrophyta), and the red algae (Division Rhodophyta). I will refer to them henceforth as the greens, browns and reds.

Green seaweeds

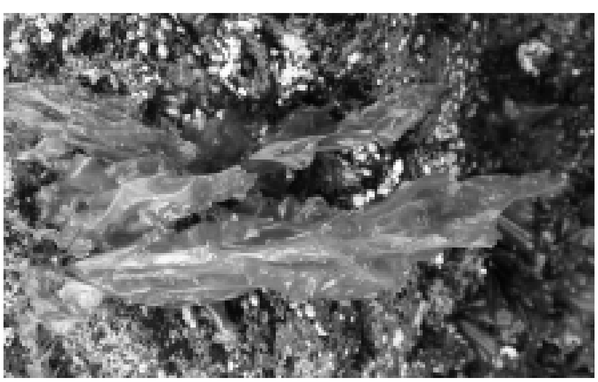
The greens are often a brilliant grassy green, although a few such as *Codium setchellii* are so dark that they appear almost black. The bright green stems from a lack of accessory pigments to mask the chlorophyll a pigments used in photosynthesis. There are many freshwater green algae, but some classes of greens are almost exclusively marine (e.g. Ulvophyceae, which contains the genera *Ulva* and *Acrosiphonia)*. Green seaweeds come in a wide variety of morphologies, ranging from unicells and filaments to blades and fleshy forms.

In general, the greens are encountered in the intertidal zone. The diversity of greens in the Pacific Northwest includes 117 taxa in 51 genera (Gabrielson et al. 2000). Common genera of green algae in British Columbia include: *Ulva* (including *Enteromorpha)*, *Acrosiphonia, Cladophora, Codium,* and *Prasiola.*

Codium setchellii

Ulva is represented by eleven species in British Columbia. Traditionally, *Ulva* was recognized as a thin distromatic (two-cell layer) green blade, which is fast growing and weedy. You may confuse *Ulva* with numerous other less-common green blades, such as *Ulvaria, Monostroma,* or *Kornmannia*. These three genera are monostromatic (one-cell layer) blades. Recent molecular evidence (Hayden et al. 2003) demonstrated that *Ulva* also encompasses the genus previously called *Enteromorpha*. Traditionally, it was separated from *Ulva* because of its tubular growth form. As a result, species previously known as Enteromorpha are now known as Ulva, (e.g. *Enteromorpha intestinalis* = *Ulva intestinalis*).

Acrosiphonia is a branched filamentous green. The locally abundant species *Acrosiphonia coalita* grows in clumps resembling green dreadlocks due to the presence of tiny hooked branches. Consequently, its common name is "Witches Hair." Interestingly, for part of its life history, *Acrosiphonia* is endophytic inside certain red algal species (Sussmann & DeWreede 2001), such as *Mazzaella splendens* and the *'Petrocelis'* phase of *Mastocarpus* (see the section about red seaweeds below).



Ulva sp.

Cladophora is a genus represented by up to eight species in the Pacific Northwest. *Cladophora* is superficially similar to *Acrosiphonia* but is usually shorter and lacks hooked branches. Patches of *Cladophora* look instead like tufts of moss on exposed rocks or spreadout filaments in tidepools.

Codium is locally represented by three species, but only two are common: *C. setchellii* and *C. fragile*. The cells of *Codium* are 'coenocytic,' meaning that they lack cross-walls in their cells. As a result, a an individual of *C. fragile* measuring up to 25 cm can be composed of a single multi-nucleate cell!

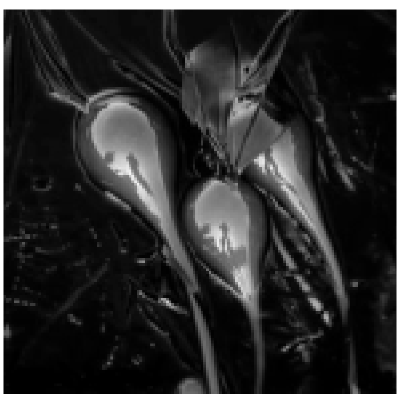
Economically, kelps and rockweeds are harvested and used in their raw form for food products, cosmetic and luxury spa items, and fertilizers. In addition, through processing, their cell wall components (alginic acids and other polysaccharides) can be removed and used as emulsifiers, anticoagulants, and in the production of textiles and rubbers.

Ecologically, kelps and rockweeds are major habitat providers and nursery environments for fish, invertebrates, and for other algae. Their extensive biomass provides a large amount of primary productivity, carbon and oxygen to nearshore food webs. Further, nearshore kelp beds protect shorelines from erosion by decreasing the impacts of water motion.

The fucoids are represented in British Columbia by four genera: *Fucus, Sargassum, Cystoseira*, and *Pelvetiopsis*. *Fucus* is likely the most conspicuous seaweed in British Columbia, represented by two species: *Fucus distichus subsp. evanescens* (also known as *Fucus gardneri*) and *Fucus spiralis*. *Sargassum* is represented by one introduced species, *S. muticum*, which is suspected of entering

British Columbia prior to 1940 as a byproduct of oyster spat importation from Japan (Scagel 1956). To keep oyster spat moist and cool during transport, *S. muticum* was used as wrap, and presumably was dumped into British Columbian waters. *Cystoseira* is a less common alga that resembles *Sargassum,* and *Pelvetiopsis limitata*, which looks much like juvenile *Fucus* but lacks a midrib, is common in the upper intertidal zone of wave-exposed British Columbian shores.

The diversity of kelp in British Columbia is nearly unparalleled. Over 30 species of these beautiful brown algae can be found in most outer coast rocky habitats, ranging from the mid intertidal to the subtidal zones. The most conspicuous are the kelp forests composed of the giant kelp, *Macrocystis integrifolia*, and bull kelp, *Nereocystis luetkeana*. Among the most unique, the sea palm, *Postelsia palmaeformis*, is found on the most wave-battered shores. Its rarity and palm tree-like appearance make it a treat to view.



Nereocystis sp.

Other interesting brown algae on BC shores include the bizarrely convoluted and brain-like *Leathesia difformis*, 'sausage-weed,' *Scytosipon lomentarius*, and the bracket fungus-like *Ralfsia fungiformis*. Also, a particularly interesting genus is *Desmarestia,* the acid seaweeds. Some species have an anti-herbivory adaptation that involves the release of sulfuric acid (pH approximates 2; the same as your stomach!) when disturbed or exposed to air for too long. You may see it digesting itself after being swept ashore after a storm. If collecting, make sure this one goes into its own bag with plenty of seawater.

Red algae are economically important. Directly or indirectly (through extraction), red algae are part of daily life for many North Americans as food, for compounds made with their cell wall components, and for their potential as sources of natural chemicals.

Food: Many red algae are eaten. The most familiar is 'nori' (*Porphyra yezoensis*), used to make sushi rolls. Nori is farmed extensively in Asia and was grown briefly in BC in the 1980s. Local species are harvested here for personal use by First Nations (Turner 2003) and others. Species of *Palmaria,* related to the dulse of the Maritimes, are also harvested for personal consumption.

Cell wall components: Red algal cell wall components, in particular agars and carrageenans, are used in cosmetics, food preparations, and biomedical and biotechnology research. Ice cream contains carrageenan to emulsify milk and water. Toothpaste has red algal byproducts included to keep the calcium carbonate component mixed with the aqueous component. So, it seems red algal byproducts play an integral role in causing and preventing tooth decay!

Natural Chemicals: Red algal species are being intensively surveyed for medicinal properties and antiviral agents. Evidence suggests that chemicals from red algae can help fight viral infections (Richards et al. 1978), including herpes (Dieg et al. 1974) and HIV (Luescher-Mattli 2003).

Postelsia palmaeformis

Common reds along the BC coast include: *Mazzaella splendens, Porphyra spp., Chondracanthus exasperatus, Microcladia coulteri, Mastocarpus papillatus, Prionitis lanceolata*, and various coralline algae.

Mazzaella splendens is a common red blade in British Columbia, recognized by its iridescent sheen in the lower intertidal zone and tidepools. This sheen is caused by the same phenomenon as the iridescence caused by oil on water: multiple layers (of cuticle in the case of *Mazzaella)* cause light to be differentially refracted, giving the multiple colors of reflected light.

Chondracanthus exasperatus is commonly known as the "Turkish Towel." Its red blade is distinguished by its very bumpy (papillate) texture. It grows in the lower intertidal zone, though blades can be washed up on the beach after a storm. As implied by name, this is excellent for use in the shower as a natural exfoliating cloth!

Microcladia coulteri is a finely branched and beautiful species. It is generally found as an epiphyte (a plant growing on another plant) on *Mazzaella splendens* and *Chondracanthus exasperatus* in southern BC.

Mastocarpus papillatus is a common alga with two very different growth forms. The upright form, known commonly as the 'Turkish Washcloth,' is associated with the genus name *Mastocarpus*. It is a small, typically bifurcating, dark reddish brown blade with papillae. However, the alternate phase is a blackish crust that looks like tar on the rocks. For a long time this phase was thought to belong to a totally separate species known as *Petrocelis franciscana*. Culture experiments demonstrated that the two phases were different parts of the life cycle of one species. Hence, we refer to the crust as the '*Petrocelis* phase' of the *Mastocarpus* life history.

Microcladia coulteri

Prionitis lanceolata is known as 'bleach weed.' It usually grows in the lower intertidal zone, though it can be found in tidepools higher on shore. Its common name stems from the scent of bromine the plants emit. Presumably, the bromine acts as a chemical defense to herbivory.

The coralline algae (Order Corallinales) have a unique adaptation to herbivory. This group incorporates calcium carbonate into its cell walls, resulting in a very hard skeleton. Both crustose forms and upright geniculate forms can be found in the Northeast Pacific and are identifiable by their pink color.

The reds are among the most beautiful algae, but usually the most underappreciated because of complex life cycles and the difficulty of identification. However, I assure you that if you spend some time getting to know the reds, they will become your favorite group of seaweeds!

There are numerous marine macrophytes and other marine organisms with photosynthetic endosymbionts that are not considered seaweeds.

Seagrasses (*Zostera* spp.) and surfgrasses (*Phyllospadix* spp.). These genera are angiosperms that have moved into the marine environment. Although they are photosynthetic marine macrophytes, they reproduce using flowers and seeds. Both genera are important marine plants and hosts to various epiphytic marine algae, but are not seaweeds.

Marine lichens (e.g. *Verrucaria* spp.). Although lichens are a symbiosis between cyanobacteria (an alga) and a fungus, and marine lichens do exist, but are not considered seaweeds.

Corals and Sea Anemones. Corals are actually colonial animals, though deriving some energy from algal symbionts. Sea anemones also have endosymbiotic algae (which can affect the colour of the anemone), but sea anemones are also animals.

I hope this summary convinces you that benthic marine algae (seaweeds) are important, interesting, and integral components of the coastal ecosystem. True, there are some nuisance algae, but the majority are unimposing, simply 'going with the flow' of the waxing and waning tides. Next time you are on the rocky shore, take some time to discover these natural wonders!

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Indian Plum in the Salmon River Valley

by Rose-Marie Silkens

Oemleria cerasiformis doesn't occur in the wild on northern Vancouver Island. When I lived in Victoria I enjoyed seeing its unbelievably-green early leaves along roadsides in Saanich, but never noticed it north of that rarefied environment. It appears sporadically as far north as Comox, but not in my current home in Sayward, 50 miles north of Campbell River. That city is at the end of Georgia Strait, whose wide sweep has a moderating effect on the east coast of Vancouver Island. Sayward is close to the narrow Johnstone Strait, which sends bitingly cold winds well into spring. I've assumed that the very early blossoms on *Oemleria* would lose any viability to February and March frosts.

Nonetheless, when we saw a small patch of *Oemleria* in the Cowichan Valley, clearly destined for destruction, I decided to try taking some back to Sayward. They were growing at the edge of a pushout in the path of road construction, so that weekend would have been their last. It was March 1996, and cold; I took a few cuttings before planting out my new treasures.

I chose a spot in open woodland, mixed trees and shrubs, quite sheltered from both winter southeasters and cold, dry northwesterlies. The soil is reasonably good as we are on the old floodplain of the Salmon River, alluvial deposits topped up with a few decades of humus-rich duff from alder, fir and hemlock. One plant went into a more open site, at the edge of this woodland. I had purchased a native Oregon ash, *Fraxinus latifolia*, on the same trip and planted it nearby.

I was surprised when every plant survived that first season, though growth was very modest. There were no flowers for the first five or six years. The first plant to bloom, in 2000, was in the open site, and by the next two years all were blooming by February. The only plant to set fruit is the more exposed one. Its fruit set was reasonably generous this year, despite a cold, damaging early spring. Many normally-hardy cultivated plants in my garden suffered significant damage in March.

I have never cultivated or interfered with the transplanted *Oemleria*, other than occasionally to remove encroaching thimbleberries. In the last four years they have begun to grow more quickly and are now about four feet high and as wide or wider. The exception is the plant in the more open site, which has taken on a tree-like habit, and is well over six feet tall. It was outstripping its neigh-bour, the ash, until two years ago. That tree took its time to establish, but has come along very well also.

There is a note in Pojar and MacKinnon (1994) that native people reportedly ate Indian plum found near the head of Knight Inlet, "although *O. cerasiformis* has not been recorded there." It's interesting to remember that Knight Inlet is very near us, although the head is somewhat further north.

My hope now is that fruit from my imported *oemleria* will produce some seedlings here and there. Certainly, it wouldn't be hard to spot that spectacular spring green when the surrounding world is still dark.

Reference: Pojar, J. and A. MacKinnon (Eds.) 1994. Plants of Coastal British Columbia including Wahington, Oregon & Alaska. Lone Pine Publishing, Vancouver. 526 pp.