Seaweeds... Not So Yucky! They Are Part of Our Everyday Lives!

by Thierry Chopin

Only in English do the large (macroscopic) and small (microscopic) marine algae have this bad connotation (the weeds of the sea). They are algae marines in French, algas marinas in Spanish, Meeresalg in German, and the Chinese who have a long tradition of using them, call them 海藻 (haizao) or the colorful/beautiful plants of the sea.

Did you know that your start your day with seaweeds in your orange juice (a microscopic mesh of carrageenans, extracted from red seaweeds, keeps the pulp in suspension) and you go to bed with seaweeds (your toothpaste would be a liquid without alginate extracts, extracted from brown seaweeds)? Did you also know that every second molecule of oxygen we inhale was produced by an alga (macro- or microscopic), and every time you eat seaweed soup, it will be re-used by an alga! Coral reefs would not have formed without the help of seaweeds and it would be more difficult to identify, they do not produce and they are not as easy to identify, they do not produce flowers, they do not sing like birds, and they are not as funny as mammals!

Giving a simple definition of what seaweeds are is not that simple because this heterogeneous group is only a fraction of an even less natural assemblage, the “algae.” Since the Greeks and the Romans, algae – as a misunderstood, unappreciated and understudied group of organisms – have been lumped together in a very artificial manner. Algae are not a closely related group but a diverse group of organisms sharing only a few characteristics: they are doing photosynthesis and provide oxygen; they do not make flowers; and their anatomy is relatively simple (no roots, stems, leaves, conductive tissues, and simple reproductive structures). We now realize, especially with the progress in molecular techniques, that the “mixed bag” is completely unnatural, with normal coelacanths and with species spread over most kingdoms of organisms.

We should not be using the term “marine plants”, any longer to describe seaweeds. If green and red seaweeds are still considered plants, brown seaweeds now belong to the Chrysomonad group. In fact, the well-known green seaweed, sea lettuce, is close, at the molecular level, to a spruce tree than to the well-known red seaweed, nori, even if their morphology is very similar (a green blade versus a red blade) and they are found close to one another on the shore. I always get a mixture of traditional botanists when I tell them that these are in fact algae that californian land! Exclusively speaking, that is correct!

There are approximately 15,000 known species of seaweeds. Around 500 of them have been used for human food and medicinal purposes for centuries. There are, however, only approximately 220 species of seaweeds cultivated worldwide. You will be surprised to learn that the largest group of organisms being cultured at sea is seaweeds, the aquaculture of which represents 46% of the total world mariculture (aquaculture in the marine environment), while fish aquaculture, of which we hear so much, represents only 10%. The reason for this is that 98.19% of the 15.9 million tons of cultivated seaweed (worth US$74 billion) come from China, Indonesia, the Philippines, Korea and Japan, hence our ignorance in the western world. But, yes, in other parts of the world, aquaculture is not necessarily equal to salmon culture! Most of the world seaweed supply (33.8%) is through cultivation.

The seaweed island myriad. Its best known sectors in the western world is that of the phycocolloids, gelling, thickening, emulsifying, binding, stabilizing, and protective agents known as carrageenans, agar and alginates – used in the food, brewing, textile, pharmaceutical, biotechnology, coating, drilling etc. industries. Why is your ice cream smooth and not full of big crystals? It contains carrageenans! The cocoa powder of your chocolate dainty drink is not all at the bottom of the bottle, and you believe the product is fresh (has not stayed on the shelf long) the microscopic carrageenan mesh did it again! Green olives with pimento stops inserted in the pit hole? Sorry, a carrageenan paste with a colander and 2 hours, some black pepper, and you have a clarifying step for your beer that makes the red seaweed, Irish moss, mostly coming from Prince Edward Island. Fine printing on telluric ink is only possible if the material has been soaked in a carrageenan or alginate solution which will then keep the dye in place. For fast relief of heartburn, you can take alginate tablets or liquids, which block acid reflux from your stomach. All these DNA analyses, on the CT1 television series, used to identify who did the crime, bonding patterns or your genetic identity? Why is the gypsoz in your garage flame retardant CS2 certified? It is coated with alginate. Wonder why the water does not go through the paper pulp of your water fountain at work? They are coated with carrageenans. Underground drilling is quite tough on bits, you need to be coated down with alginate mud. The physicochemical sector, however, now represents only a minor part (11%) of the tonnage and value of the entire seaweed-derived industry. The use of seaweed as sea-vegetables for direct human consumption has become more significant (90% of the tonnage and 88% of the value). Various, Laminaria/Gigartina (or kombu, for dashi broth), Porphyra/jo (for nozomi), and Undaria (or wakame, for miso soup) dominate the edible sector. Applications of seaweeds are emerging: on one hand a wide range of bio-based, high-value food and feed products/ ingredients/supplements, biopolymers, fibre and bulk chemicals, soil additives, agrochemicals, biostimulants, pharmaceuticals, cosmetics and cosmeceuticals, nutraceuticals, functional foods, antioxidants, bio-eds, botanicals, pigments, colorants, aromatics, bioactive compounds, artificial agents, and, on the other hand, lower-valued commodity energy carrying molecules such as biobutanol, biodiesel, bioethanol, biofuels, biomaterials and heat/power generation. In the last two decades, there has been a renewed interest in the mariculture of seaweeds, not only for the valuable biomass they represent, but also for the biotechnological services they provide as one of the extraction components of integrated Multi-Trophic Aquaculture (IMTA). IMTA is the farming, in proximity, of several species at different trophic levels, and with complementary ecosystem functions. For example, it combines the cultivation of fish species (forth) with inorganic extractive species (seaweed) and organic extractive species (shellfish and other invertebrates). This ecologically engineered ecosystem management approach provides environmental sustainability (biomimetic services for improved ecosystem health), economic stability (product diversification, risk reduction and job creation in coastal communities) and societal acceptability (better management practices, improved regulatory governance and appreciation of differentiated and safe products). That is what we have been developing in the Bay of Fundy since 2001, and with Cooke Aquaculture Inc. since 2005. The biomimetic services of seaweeds are often not recognized by the rest of the aquaculture world and society in general. Seaweeds should be considered as candidates for nutrients/carbon trading credits (CCT and CTC) within the broader context of ecosystem services. Considering the average composition of seaweed, and the value of NTC and CTC – which should be around US$50 to 100 per kg for nitrogen, US$4 per kg for phosphorus and US$500 per tonne for carbon – the biomimetic marine algina latissima should be Australia! We now have an opportunity to reposition the role, applications and values seaweeds have in coastal ecosystems, the economy and our society, and demonstrate how relevant they can be in many of our everyday activities and in solving global issues (we could also talk about the role of seaweeds in energy generation and biodiesel production!). A long-term responsible and gradual implementation strategy should be adopted. It will be up to us to bring aquaculture to a new ERA of ecosystem responsible aquaculture, based on the concept of marine agronomy, implemented at the level of each farm, or bay, so that extractive aquaculture breams as much as a part of the natural daily operation as farming.

Dr. Thierry Chopin, well-known seaweed expert, and Scientific Director of the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTA). (Photo credit: Hemming-House Pictures)

An aisle in a supermarket in Japan dedicated entirely to seaweed products. (Photo credit: Thierry Chopin)

IMTA kelp (Saccharina latissima) wrapped salmon-avocado tartare, sesame “cran-apple” vinaigrette, citrus-soy glaze, cilantro and chives… one of the delicious dishes prepared by Chris Aeni, Chef and owner of the Rauschhorn in St. Andrews. (Photo credit: Thierry Chopin)