

Editorial

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Seaweed resources of the world: a 2020 vision. Part 2

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The special issue series of *Botanica Marina: Seaweed resources of the world: a 2020 vision* is well and truly off and running. Part 1 and now Part 2 of the special issue have been published, with more geographies and applications still to come. Watch this space! The philosophy has been that each part of the special issue contains papers with country-facing analyses as well as papers bringing systems insight. Taking stock of the special issue to date, from the outset in Part 1, Mouritsen et al. set the scene for future seaweed cuisine, fashioning a new term – phycogastronomy. Taste, visuals, quirky narratives and celebrity chefs brandishing fresh, dried, or extracts of seaweeds are *en vogue* for countries discovering (or rediscovering) sea plants. Following that we were reminded by Freile-Peigrín and Tasdemir that there are still plenty of opportunities to fight disease by harnessing the biodiversity of seaweeds – why not search yet more extensively and intensively in a group of photosynthetic organisms that is more ancient and diversified than land plants? They identify “forgotten” tropical diseases, those not on “big pharma’s radar”, to frame the direction of future bioactives research. The two papers could not seem more different, technically speaking. However, emerging links between food and health are compelling and key components of selective seaweeds can be active as both functional foods and pharmaceuticals. Here in Part 2 of the special issue more aspects for seaweed applications are covered, from the sustainable harvesting of coastal seaweeds to the commercialisation success story of *Chondrus*.

The spread of biogeographies in Part 1 included five countries, from cold to warm waters, each with distinct focus and lessons. In Alaska we learnt of the “spawn on kelp” harvests of herring eggs as a culinary delicacy, traditional use of nori and the ongoing transition of kelp harvest to mariculture. In Chile we learnt of the rich biodiversity of seaweeds along its coast, the long history of harvest for hydrocolloids and that of national research effort, with a renewed focus on local processing and culture supported by government. In Italy we learnt of

the effort to characterise the marine flora, including non-indigenous species, as well as a new ecosystem of start-up companies looking to exploit lagoonal blooms or beach wrack for gels, paper and biostimulants. In the tropics of Malaysia, we read of the benefits of ongoing efforts in marine algal taxonomy over the last 10 years in characterising the flora, although cultivation remains centred on *Kappaphycus*, *Eucheuma* and *Gracilaria* with new areas of research needed to enhance gel yields and quality. In Mexico, we were informed that long-term harvests of seaweeds for industrial purposes including gels, biostimulants and cosmetics cannot meet new demands, because mechanical harvests have been regulated, hence culture efforts are growing to provide the shortfall of biomass necessary. Now in Part 2, we are privileged to have five additional countries in the mix with more insights and lessons covering unique biodiversity, traditional uses and new cultivation endeavours, to name a few.

In our first editorial for the special issue we posed many questions. Some were questions that we have all fielded as scientists in one line of enquiry or another, from the public, friends and family or colleagues. Some were rhetorical questions for our own reflection as phycologists. Some were questions for which there are no clear answers (yet!), but ones we should keep asking ourselves and society nevertheless. We all have burning “why” and “how” questions when we hear something new; a new application, a new way of doing things, or a new claim. The most pleasing thing about the special issue series is that we can draw on precedents from across the globe for our own national or regional discussions. Insights and images of different seaweeds or research activities, trends in production data or new economic/commercial directions. These examples include the role of governments in providing responsible and sustainable management of various seaweed resources for their economic and ecosystem service functions and/or facilitating innovation – these contexts allow us to fashion our own dialogue and pathways forward. As phycologists we are united by purpose but also in the preservation of the resource. Investors and new entrants are now shining a different light on our field and developing their own

narratives – sometimes with and sometimes without expert advice. There are still many things to learn, but now, more than ever, we need knowledge and scientific enquiry to sit squarely across the domain.

We said in the previous editorial that the knowledge generated is critical for navigating claims for bioactivity and efficacy, and that the generation of new knowledge should lean on multidisciplinary collaborations across academia, government and industry. We also commented on the need for phycology to accommodate new entrants from the cross-over science and business space. It may seem that knowledge sometimes takes the back seat to business development. But it does not have to be the case. For example, investment in aquaculture development may initially rely on sustainable harvesting. Here the role of government is regulation, and businesses must drive innovation but also prove that they have the scientific answers to any technical, environmental or societal questions posed. Industry can be vehicles for positive change, and we need to support this in a measured way without compromising our integrity. Investors need to be educated that new developments and activities best proceed hand-in-hand with quality and repeatable research in order to deliver confidence in their claims. Similarly phycologists need to be educated that each step of development is critical to frame the next business step, whether this be a research question, a win-win scenario, or the next “lowest hanging fruit.” Lofty goals can only be reached by measured, incremental steps.

Applied phycologists must also adapt to new and emerging models of investment. For those that remember the heady days of the latest algal biofuels boom (and bust) it was dominated by institutional venture capitalists. The environment was part of the picture but did not play a leading role in the business case. The investment trajectory is different this time around as we move towards impact-investing and crowd-funding for small (to medium) enterprises. Both are highly emotive, and global connectivity means that investors and entrepreneurs are looking across country borders to finance and deploy their ideas. The normal ways that researchers engage with businesses wishing to commercialise their ideas, e.g. as purveyors of intellectual property and know how, may well be less important to the current protagonists. However, the over-arching principles remain the same – those that succeed in new endeavours will need to factor in business, environmental and socio-economic elements and responsibilities. The type of person involved is also changing, whether this be people purposefully transitioning between different fields, looking for new job opportunities, or environmental entrepreneurs – all of them are

excited about the myriad of seaweeds yet coming from quite different backgrounds and ethical perspectives. Finding the balance between researcher knowledge, skills and economic priorities will be critical to these rapidly evolving business narratives.

Phycologists should develop their own narratives. We need to be more comfortable to put on a different hat and speak to the public. Emerging claims about production potential of seaweeds now seem to hinge on the environment and public good. Growing seaweed to mitigate climate change is possibly shaping up as the next “algal biofuels” investment. Seaweeds will save the environment! No. People must save the environment. If we are at a point where seaweed must be farmed at an unprecedented industrial scale to ultimately descend to the depths of the ocean, then we are too late. There are many practical and advantageous uses of various seaweeds, their biomass and extracts, and we need to find ones that maximise the environmental benefits and make social and economic sense. If that were to happen, then the scale-up would be more organic, but also more likely to happen and more importantly be successful. The age of industrialisation of seaweeds! It would still need to be a serious industrialisation of processes, dwarfing even China’s efforts of the mid-1900s and Indonesia’s of the last 30 years. However, imagine that scenario; markets would be saturated and the value of seaweed farming, and its social benefits, could be wiped out. Boom and bust (all over again?). We need to prepare to discuss these scenarios, and the simplest “back of the envelope” calculations can arm us with some due diligence to start with (e.g. current global volumes versus predicted scale). We then need to employ life-cycle or benefit-cost analysis and mass-balance approaches. These are not concepts easily covered with a news quote or sound-bite but need to be addressed nonetheless. This is precisely why the precedents you read here in the special issue are so important to developing new narratives. There are stories of long-term endeavours, of successful and failed enterprises, but also of renewal.

We need to spend time to understand what the public wants, or expects, from us as serious scientists, the days of rolling out the white coat for authority are over. What questions do they have about seaweed? Use Google and search the term: “seaweed” as a start. What topics are returned by this ubiquitous search engine? This gives a snapshot of questions about seaweeds in your country. At the time of writing we typed: “seaweed” (followed by a space) and recorded what came up across our four countries. Overwhelmingly this was about food, health and fertiliser with some country-specific nuances (seaweed gin in Canada?). Without much effort we can ascertain that

consumers are looking up seaweed recipes (salad, snacks, noodles or chips) and also seaweed extracts (for personal use and for soils and plants). People are inevitably asking questions about each term that are almost always – “is it good for you”? If you are feeling bold, we also recommend a foray into Google Trends for more in-depth analysis. So, most of the public’s interface with seaweeds is more about their role as consumers in the marketplace, not as consumers of knowledge. Personal health and gardening are front and centre. We know as scientists that “knowing your audience” is critical for presentations, but knowing your country’s seaweed zeitgeist may allow you to bring people along with a more personalised and nuanced conversation. We touched on this in the editorial for Part 1; “knowledge” abounds on the internet, but wisdom is far more elusive.

“Knowledge is knowing that a tomato is a fruit. Wisdom is knowing not to put it in a fruit salad.” What could the seaweed equivalent of this quote be? “Knowledge is knowing that seaweeds contain fibre, minerals, protein and omega-3 oils. Wisdom is knowing seaweeds are not high in all of these”? Probably we can all think of quite a few examples where: “seaweed wisdom” (ethnophycology) is more important than knowledge; culture growth rates and biomass productivities spring to mind. With the rise of the internet, and with so many papers in the literature, knowledge is arguably now the lesser currency to wisdom. Seaweed narratives will likely become more prominent, and for those who have studied seaweeds and their applications, whether you are in government, university or a practitioner, you may find yourself the unintentional arbiter of phyco-wisdom after lifelong pursuits. There is a vacuum that will be filled otherwise – best that we are part of new endeavours from the onset, especially if they are in our own backyard. We phycologists should be more assertive with our wisdom.

The papers in the special issue bring together the conventional wisdom of our field, as it stands across the globe. We can all learn and share from this. We need a multidisciplinary, holistic approach. We need to build on expertise across country borders. Sharing knowledge and wisdom alike.

For Part 2, we see the diversity and depth of analyses continue across five more countries: Ganesan and

colleagues on the *Seaweed resources in India – current status of diversity and cultivation: prospects and challenges*; McDermid and colleagues on the *Seaweed resources of the Hawaiian Islands*; Simioni and colleagues on the *Seaweed resources of Brazil: what has changed in 20 years?*; Trono Jr. and Largo on *The seaweed resources of the Philippines*; and lastly, Gaspar and colleagues on *The seaweed resources of Portugal*.

There are also two subject-matter papers in Part 2 that will arguably become best practice approaches in their own rights. Global seaweed production is dominated by aquaculture, but fisheries are locally important for food and regional economies. Here Lotze and colleagues synthesise what we know about *Ecosystem-based management of seaweed harvesting*. Maintaining seaweed biodiversity is crucial for protecting any potential future uses, especially under changing environments. Both researchers and entrepreneurs from all countries would do well to read Craigie and colleagues on *Commercialization of Irish moss aquaculture – the Canadian experience*. A story of adaptability... and the innovation process. Who will develop the next *Chondrus*?

We hope you enjoy the reading as much as we have enjoyed the editorial process.

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