



The 2nd Annual Atlantic BioRefinery Conference entitled "Fields, Forests & Oceans: Growing New Markets" was held in Charlottetown, Prince Edward Island, May 29-31. This conference focused on the how, when and why of turning Atlantic Canada's forestry, agriculture and aquaculture biomass resources into high value-added products for the global market. Business professionals, growers, fish processors, foresters, government officials and academics attended this event to hear from a wide array of regional and national experts talking about their field experience and addressing the key challenges of innovation, business management and commercialization of our regional bioresources. The opportunity to engage industry and researchers on a one-to-one manner was made available through two Business to Business (B2B) sessions to maximize the networking connections. The Lobster on the Wharf dinner only reinforced them in a warm ambiance.



Thierry Chopin was an invited speaker and gave a presentation entitled "An aquanomic approach to seaweed cultivation and applications: Integrated Multi-Trophic Aquaculture (IMTA) and Integrated Sequential BioRefineries (ISBR)".

The world-renowned phycologist Max Doty talked about "marine agronomy" in the 1970's and defined it in the Proceedings of the 9th International Seaweed Symposium more than 30 years ago, in 1979. However, the greener approach to the Blue Revolution, the Turquoise Revolution, is not only targeting practices in the marine environment, but also in the freshwater environment, and in open-water as well as in closed containment operations. Instead of talking about agronomy (in Greek, "the laws of the [land] fields") in marine or freshwater environments, it may now be time to give a proper name to this discipline and talk about aquanomy ("the laws of the aquatic fields"), especially if we want to responsibly produce large amounts of seaweeds as crops.

When freshwater IMTA and Aquaponics people meet to discuss their convergent approach. Having the 2013 Aquaculture Canada annual conference in Guelph, Ontario, June 2-5, was an excellent opportunity to be less "salty" and have two communities finally meet. On one side, we have been working on the development of IMTA at sea over the last 12 years (salmon/seaweeds/invertebrates). However, if salmon spend between 1.5 to 2 years in seawater pens, it is only after they have spent between 9 and 18 months in land-based, closed-containment, freshwater hatcheries. Consequently, it makes sense to now venture into developing IMTA in the freshwater/hatchery context so that IMTA practices can be developed from the egg to the plate. This would help in marketing differentiation and certification for obtaining premium prices. On the other side, the Aquaponics people are developing systems that are not to be confused with Hydroponics or Recirculating Aquaculture Systems (RAS). They are realizing that Aquaponics is also about multi-trophic food production systems, not merely a juxtaposition of animal aquaculture and plant



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hydroponic cultivation. There is a significant microbial digestion link for the systems to stabilize into a fully mature state. Microorganisms also form associations with plants enabling them to absorb nutrients more efficiently and protecting them from diseases ("probiotic horticulture").

The two communities share the same IMTA concept and vision of its environmental, economic and societal potentials and developments for improved aquaculture and agriculture practices (including using extractive species, which not only behave as biofilters recapturing expensive nutrients released by fish and therefore not needed to be added in the form of fertilizers, but also 1) become additional crops of commercial value, 2) extend water recirculating leading to both more efficient water usage/saving and reduced discharge to the environment, and 3) decrease costs associated with nutrient removal in hatcheries). The full day FIMTA/Aquaponics session at the conference, followed by a two day Advanced Aquaponics Workshop (June 6-7), organized by NOA Fisheries, allowed for much discussion, networking and plans for future collaboration.

During the session, Thierry Chopin and Hamid Khoda Bakhsh (CIMTAN - UNB) explained how they are looking at introducing FIMTA in the operations of the salmon hatcheries of industry partner Cooke Aquaculture Inc. Kathy Brewer-Dalton presented, on behalf of Troy Lyons, the view regulators of the province of New Brunswick have on the role and benefits of FIMTA: an additional method to further treat effluents as the regulatory system moves toward a new performance based standard. Nick Savidov (Alberta Department of Agriculture and Rural Development) gave an exhaustive review of Aquaponics and its evolution (presently working on 5th generation systems) and commercialization challenges. John Derksen gave an overview of 10 years of Aquaponics development and innovation at the Lethbridge College. Grant Vanderberg presented the collaborative work, with colleagues at Laval and McGill universities, on the observation that fish effluents reduce the growth of two greenhouse tomato pathogens. Charles Shultz started his presentation with the knowledge he gained from working on the University of the Virgin Islands system, with the grandfather of Aquaponics, Dr. James Rakocy, for over 14 years; he then discussed the factors to consider for successful adaptations to cold temperate climates.



The session closed with a roundtable to summarize the challenges ahead for the development of Aquaponics in Canada:

- How to change the image of FIMTA/Aquaponics from backyard operations into new large scale commercial operations.
- How to make FIMTA/Aquaponics work in our cold temperate climate. Appropriate site selection, greenhouse design, lighting and temperature control will be very important.



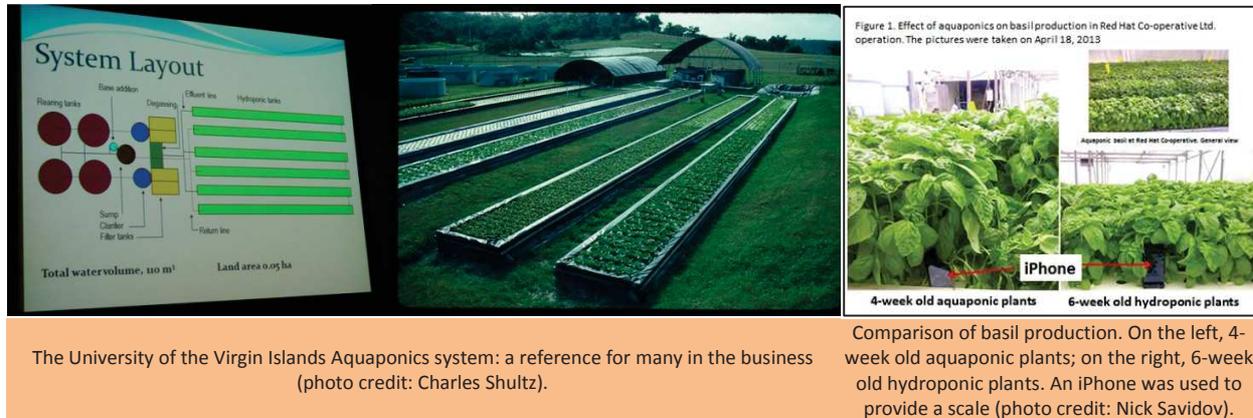
- The selection of appropriate fish and plant species will also be very important, not only from a biological angle, but also economically.
- Educating growers, regulators and the public on the advantages and benefits of FIMTA/Aquaponics will be key. Microbes are needed and high biological activity is a good sign of a balanced system.
- Regulations and biosafety policies will need significant changes, based on the evidence accumulated over the last decades, with respect to how to operate these systems sustainably for the production of safe food.

The two day workshop, organized by Tamar and Jason Oziel from NOA Fisheries, took place at the University of Guelph and gathered 42 participants from diverse horizons: couples looking at a career change and at growing their own food; high school teachers looking at practical ways to get their students interested in original science projects; hydroponic farmers intending to use fish as a nutrient source; fish farmers intending to use plants to treat their effluents; city officials interested in permitting integrated urban aquaculture/agriculture; and university students and researchers. They came from 9 provinces of Canada, the Bahamas, New York State and Saudi Arabia.

Charles Shultz and Nick Savidov went over the concepts, designs and guidelines (*e.g.* water quality) of Aquaponics operations in greater detail. Nick emphasized the need for understanding agro-ecology, plant physiology, microbiology and food safety. Steve Naylor described the strategy for sustainable aquaculture development in Ontario and the regulatory requirements for foods of plant origin. Donald Bailey explained, by Skype from the Virgin Islands, how to prepare an appropriate Aquaponics business plan and management strategy. Charles Shultz described the cultivation of tilapia from breeding to harvest, while Shawn Coyle (Kentucky State University) described the cultivation of freshwater prawn and largemouth bass, as well as low cost RAS systems.



At the end of the workshop, participants were divided into groups for a hands-on initiation into seed germination, water testing, tilapia sexing and plant harvesting for specific markets. It became clear that to succeed in FIMTA/Aquaponics, one needs a wet thumb, a green thumb and a microbial finger in between to make the link. It is also crucial to clearly identify your market before growing anything.



The University of the Virgin Islands Aquaponics system: a reference for many in the business (photo credit: Charles Shultz).

Figure 1. Effect of aquaponics on basil production in Red Hat Co-operative Ltd. operation. The pictures were taken on April 18, 2013

Comparison of basil production. On the left, 4-week old aquaponic plants; on the right, 6-week old hydroponic plants. An iPhone was used to provide a scale (photo credit: Nick Savidov).

The 4th Algae Technology Platform Americas took place at the Arizona Biltmore Hotel in Phoenix, Arizona, June 26-28. The conference was attended by approximately 40 people representing producers, product formulators, business developers, marketers, investors, engineers, processors, regulators and R&D academics. It was split into two parts. Day 1 was "Investor Day", during which investors could meet developers. In the second part of the afternoon, the participants visited the Arizona Center for Algae Technology and Innovation (AzCATI) on the Mesa Campus of the Arizona State University. AzCATI is a member of the ATP³ network of regional Algae Testbeds Public-Private Partnership, funded through a \$15 million grant from the US Department of Energy. Days 2 and 3 were the "4th Practical Smart Short Course" on algae growing, harvesting, downstream processing and marketing for value-added applications. **Thierry Chopin** was an invited speaker and gave a modified version of his presentation entitled "An aquanomic approach to seaweed cultivation and applications: Integrated Multi-Trophic Aquaculture (IMTA) and Integrated Sequential BioRefineries (ISBR)". After a rapid "Seaweeds 101" smart/crash/fast review, he developed the idea that we should rejoice at seeing a renewed interest in the mariculture of seaweeds and their use. However, how we can reposition the value and roles seaweeds have in coastal ecosystems, and demonstrate how relevant they can be in many of our everyday activities and in solving global issues, without "promising the moon" and risking another 40 year "purgatory period" in between each energy crisis, is a difficult balance to find. One of the solutions is to combine IMTA and ISBR. BioRefineries have often been interpreted as a series of intermediate steps until the ultimate products, biofuels, are finally produced. For Thierry Chopin, BioRefineries are tools of product diversification, as our attitudes and business models will need to evolve from the one species/one process/one product approach. It is becoming abundantly clear (and it is interesting to see some companies finally admitting) that after a few years of hype and generous subsidies, the market may not presently be ready for the production of low-value commodity energy from biofuels, but for a range of bio-based, high-value compounds, as people start to realize that some co-products of an ISBR platform could, in fact, be the real drivers for generating more immediate revenues. So, the question could really be which are the co-products of the others: the bio-based, high-valued molecules or the low-valued commodity energy carrying molecules?

The IMTA program in Eastern Canada is already developing an ISBR strategy for its IMTA products – seaweeds for ecosystem services, seaweeds for human consumption, seaweeds as partial substitution in fish feed, seaweeds in cosmetics (Exsymtal®), WiseSource™ salmon – and we are looking at developing freshwater IMTA (FIMTA) for salmon hatcheries and biogas production for energy at a realistic regional scale. In a few words: if you are going to produce a biomass providing ecosystem services, you may as well make it a crop with diversified value-added applications.