PhD - project: Efficient reuse of water and nutrients in aquaponic systems combining production of fresh water and marine fish with plants and algae.

Supervisors at NTNU Department of Biology:

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Background:

One of the greatest societal challenges we face in this century is to sustainably feed an increasing population while at the same time reducing the environmental impact. Re-using nutrients (nitrogen and phosphorous) and more efficient use of water are highly relevant for future development of bioproduction systems in general. Food production is dependent of the use of phosphate and nitrate, and both nutrients being considered as waste products in animal production systems. Closed bio-production systems that recycle nutrients can solve several challenges.

Combining aquaculture of fish with cultivation of plants/algae is defined as aquaponic systems where effluents from the aquaculture are utilized as nutrients supporting the growth of plants/algae, thus creating a symbiotic natural environment. Optimal management of nutrients and water quality requires fundamental understanding of system dynamics as nutrient turnover and biomass growth. In this PhD project we will study combining systems both of cold freshwater and seawater fish with plants and algae in a 100% closed system. Compared to traditional flow-through systems recirculating aquaculture systems offers several advantages as reduced water and energy consumption, improved waste control and increased stability of the water quality. In addition an aquaponic system offer efficient reuse of nutrient and cleansing of the water.

Aim:

Characterize concepts and dynamics for sustainable bio-production using closed recycled cultivation systems both in fresh -and sea water systems. The project will aim to understand and optimize mechanisms behind utilization and turnover of nutrients in different bio-production systems (fish integrated with plants and algae). Additionally, the project will generate data useful for biomonitoring i.e. molecular indicators for balance/imbalance which also will be of great value for monitoring and optimization of traditional cultivation systems.

Tasks:

The present PhD-project proposal includes the following tasks:

1. Design and planning of experiments
2. Experiments in lab scale using fish/plant or fish/copepod/algae cultivation systems.
3. Growth characteristics, growth parameters, biomass ratios and nutrient turnover
4. Microbiological analyses of the bacterial communities of the systems
5. Chemical analyses of elements and compounds in the cultivation media (toxic levels).
6. Molecular analyses and identification of bioindicators (host responses indicating stress etc)

The PhD candidate will take advance of the competence and infrastructure at NTNU Department of Biology: 1). NTNU Sealab with controlled experiments on fish, copepods and plants/algae, 2). Metabolite characterization including ICP-MS, GC-MS, LCMS, HPLC and NMR, 3). Gene/genome wide analyses to monitor pathway balance/imbalance (and stress responses).

Qualifications:

The applicant must have an MSc (or equivalent) and a documented background in biology, chemistry/biochemistry and/or molecular biological methods. Experience and knowledge in conducting biological experiments will be regarded as an advantage.