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"Emissions, Capture, Utilisation: Methodologies and Challenges for Ulva"

Report on Training School on "Emissions, Capture, Utilisation: Methodologies and Challenges for Ulva" in Koiguste, Sareemaa, Estonia

Dr Annette Bruhn, Aarhus University, WG5 leader
Dr Celine Rebours, Møreforsking, WG6 leader
Dr professor Georg Martin, local organisor

The COST Action SeaWheat (https://seawheatcost.haifa.ac.il/), the Estonian Marine Institute, Møreforsking and Aarhus University organized a 3½-days Training School on quantifying Ulva Ecosystem Services, and the legal and regulatory aspects of *Ulva* cultivation (WG5 and WG6), from May 14-17, 2024, at the Koiguste Marine Field station in Saarema, Estonia.

Rational and objectives

The main objective of the SEAWHEAT COST Action is to make a step-change towards a green economy based on *Ulva* mass production and utilization within the European community and beyond. The purpose is the development of *Ulva*-based blue-biotech industries and the utilization of *Ulva* as a model organism in European algaculture. The COST Action aims at facilitating the acceptance of *Ulva* as a new, sustainable, and safe food item in the traditional European diet. The Action will profit from the world-renowned quality standard of European food production, and for acknowledging the ecosystem services provided by Ulva aquaculture.
During this 3½-day training school, trainers with expertise in Ulva ecophysiology, aquaculture, and regulatory aspects of *Ulva* cultivation introduced the participants to theoretical and practical approaches to quantifying *Ulva* Ecosystem Services with the focus cycling of carbon and nutrients. The Training School included site visits to Estagar and a land-based RAS trout farm where the Estonian Marine Institute has established research facilities for optising the nutrient and carbon uptake by Ulva from the fish effluents (part of the Workshop) and social hiking tour to the Koigi Bog.

Trainers

The training school involved the participation of seven trainers, listed alphabetically:

1. Dr. Gerli Alberts from the Estonian Marine Institute, Tallinn, Estonia

2. Dr. Annette Bruhn from Aarhus University, Aarhus, Denmark (leader of WG5)
3. Dr. Jack Hall from the Estonian Marine Institute, Tallinn, Estonia
4. Dr. Karel Keesmann from Wageningen University, Netherlands
5. Dr. Georg Martin from the Estonian Marine Institute, Tallinn, Estonia
6. Dr. Liina Pajusalu from the Estonian Marine Institute, Tallinn, Estonia
7. Dr. Céline Rebours from Møreforsking AS, Norway (leader of WG6)

Additionally, the event was attended by the Action Chair and Scientific representative of the COST Action "SeaWheat," Dr. Prof. Muki Shpigel from the University of Haifa, Israel (refer to Figure 1).

Trainees

The call resulted in twenty-eight (18) applications being received. A selection committee consisting of 6 people assessed all applications, selecting 16 applicants. During the assessment process, various factors were taken into consideration, including active involvement in an on-going project with *Ulva*, experience in *Ulva* cultivation (minimum of one year), membership in a Small-Medium Enterprise, gender equality, and applicants from ITC countries.

The selected trainees, seven males and seven females were either masters, PhD students, postdoctoral researchers in academia or industry from seven different countries: Denmark, Estonia, Germany, Ireland, Portugal, Spain and New Zealand: 3 trainees from ITC countries; 3 from SMEs (Alles Alge, PureAlgae, Algabrava).

All trainees have been funded with a maximum of 740 € (up to 500 € air-ticket; 80 € D.A.) grant per participant. Unfortunately, two trainees did not accept the course invitation.

Host

The meeting was organized locally by Dr. Prof. Georg Martin, Jack Hall, Gerli Alberts, Liina Pajusalu and Kristina Tivel.

Figure 1. Group photo of the participants and trainers of Training School at the Koigi Bog.

Course design and training material

To plan the training school, trainers met on several occasions to design the program and develop the didactic materials. They created a practical and informative manual that included the Training School program, experimental design, various protocols for quantifying Ulva photosynthesis via oxygen production using micro optodes, determination of carbon and nitrogen in seaweed tissue as well as in seawater in dissolved organic as well as inorganic form, Pulse Amplitude Modulated fluorometry and Biolog Plates. The material also contained general information about the Baltic Sea, Ecosystem Services and Ulva.

Two weeks in advance of the training school, an on-line meeting was carried out with all students and trainers in order to prepare the trainees for the work at the Training School. A few days in advance of the training school, the trainees were provided with the manual and a folder containing scientific articles.

Throughout the training school the trainees carried out a specific two-day experiment, to analyse the differences in photosynthetic performance, and carbon and nitrogen cycling of two local Ulvas (one from the coast and one from the RAS cultivation system at the Ösel Harvest OÜ) exposed to three different water sources (natural coastal seawater, water from the vicinity of a coastal trout farm and water from the RAS producing trouts at the Ösel Harvest OÜ). The aim of the Training School was for the trainees to become familiar with fundamental methods for quantifying the capture of nutrients from the environment, and the uptake and excretion of carbon by Ulva. The focus was on nitrogen, phosphorus and carbon, and the methods included: 1) Measuring photosynthesis rate through oxygen production; 2) PAM fluorometry to investigate the efficiency of the photosystem II; 3) Quantification of dissolved inorganic nutrients in seawater; 4) Quantification of dissolved inorganic carbon (DIC) in seawater; 5) Quantification of dissolved organic carbon (DOC) in seawater; 6) Quantification of the wet weight, dry weight and dry matter composition of Ulva tissue; 7) Quantification of the Ulva tissue carbon and nitrogen content; 8) Modelling exercise of Ulva growth and nutrient uptake; 9) Evaluation of microbial activity using biologs; 10) Sampling for determination of the Ulva microbiome using molecular methods; and 11) sampling for genetic analysis of the two Ulva populations used. Regarding 10) and 11), we here contributed to the pan European studies carried out by SeaWheat partners in WP2 on Ulva genetics and microbiome.

Figure 2. Cleaning the Ulva material prior to setting up experiments.

Figure 3: Trainees working on setting up the Diving PAM to measure the photosynthetic performance of Ulva.

Figure 4: Trainees busy in the lab setting up experiments.

Figure 5. Trainees calculating and discussing results.

Figure 6. Networking between the trainees at Koiguste Marina who provided the meals during the Training School

Conclusions

The Training School in Saaremaa, Estonia, was an enriching experience for all involved trainers, trainees, and hosts. In addition, this Training School helped "SeaWheat" COST Actions to create a network between SMEs and researchers that we are sure will contribute to knowledge transference between academia to the industry, and between scientific fields. A survey will be developed after the TS3 and be sent to the trainees of TS3 in order to use the information to improve the format of the future Training Schools organized in the CA SEAWHEAT project.

The results obtained from the experimental work will form the basis for a joint peer-reviewed publication prepared by the trainees interested in following up and gaining even more scientific output from the TS. In this way the contribution to networking and scientific output for the involved young scientists will further improve.

ANNEX I

3rd SEAWHEAT Training School 'Emissions, Capture, Utilisation: Methodologies and Challenges for Ulva'

Training School Instructions Booklet