

## Experimental Mariculture

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# SEAPURA: Seaweeds Purifying Effluents From Fish Farms

An EU project coordinated by the Wadden Sea Station Sylt

Mass cultures of marine macroalgae (seaweeds) in the sea or on land serve as an "nutrient extracting aquaculture" reducing eutrophication along the Chinese coast or purifying outflow from intensive fish farms in Israel. This beneficial side-effect of seaweed cultures is also used in the recently SEAPURA project funded by the EU and coordinated by the Wattenmeerstation Sylt (AWI). Outdoor tank cultures of commercially important, perennial red seaweed species are used for extracting nutrients from fish farms in Spain and Portugal, and accompanying research is conducted in Germany and Northern Ireland. The cultivated seaweed biomass will be used for the human food market mainly in France, for extraction of pharmaceutical substances, or for fish feed additives, with possible antibiotic effects of the cultivated seaweed. Continuous short-day treatment with automatic blinds on top of the cultivation tanks will be used for year-round activation of cell division in the cultivated red algae for preventing the naturally occurring summer dormancy of perennial seaweeds.

## Introduction

Mariculture of seaweeds (marine macroalgae) in the sea or on land is an important tool for purifying eutrophicated waters. In the sea, an example is rendered by the Chinese mass cultivation of *Laminaria japonica* on floating ropes in bays near towns and along hundreds of kilometers along the shore, with use of the seaweed for human food and production of alginate and iodine. The beneficial side-effect of these cultures of *Laminaria* (kelp) as a "nutrient extracting aquaculture" has deteriorated in China since the 1990's when approximately 1 million tons of fresh weight of *Laminaria* were still produced per year. Since then,

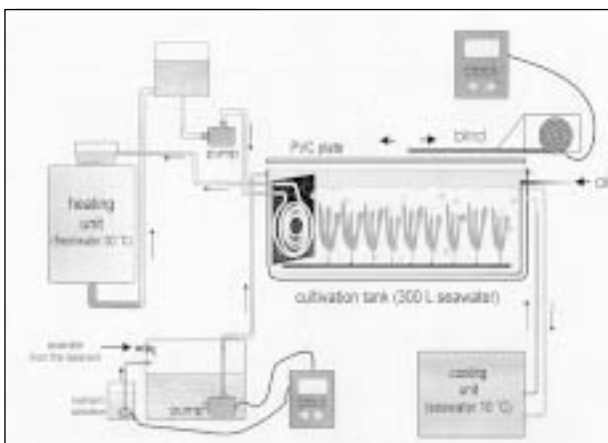
*Laminaria* cultures have been replaced increasingly by the more profitable production of invertebrates and fish in floating sea cages. These animal cultures add horrible loads of ammonium and phosphate to the coastal, domestic water runoff from the million-people towns, and the nutrient overloads in the bays that were formerly extracted at least partially by *Laminaria* are now causing the well-known blooms of unicellular and sometimes toxic algae. China will have to increase again nutrient extracting aquaculture, this was the recent take-home message issued by Prof. Charles Yarish and his Chinese marine botanical colleagues at the 17th International Seaweed Symposium held at Cape Town in January this year.

On land, a flourishing example for seaweed farms purifying outflow from fish farms can be seen at Eilat, Red Sea, set up by Dr. Amir Neori and his group during the last 10 years. Intensive fish culture is performed in tanks, and the overload of mainly ammonium and phosphate in the seawater flowing out from the fish tanks is largely absorbed by the green alga *Ulva* cultivated in raceways. A major question to be solved in such polyculture systems is of course "what to do with the seaweed biomass produced in polyculture?" This problem has been elegantly solved at Eilat by feeding the produced *Ulva* biomass to abalone, a mollusk feeding on seaweeds and a delicious and well-paid food for many gourmets throughout the world.

## SEAPURA Project: Red algae and Fish Farms

The EU announced to support studies on purification of fish farm effluents in the sub-program Sustainable Fisheries and Aquaculture (5.1.2) of the Quality of Life and Management of Living Resources Program. The project SEAPURA coordinated by the Wattenmeerstation Sylt (AWI) became funded with 1.1 M ECU, started in February 2001 and will run for three years. In this project, mass cultures of commercially important, perennial (longer than one year living) red seaweed species are used for extracting nutrients from fish farms in Spain near Telde, Gran Canaria, and Portugal,

Figure 1: Experimental outdoor tank system at the Wattenmeerstation Sylt. Marine macroalgae are cultivated at ambient daylength or in in tanks with motor-driven blinds for year-round activation of cell division in continuous short-days, at 8 hours light per day.



near Faro and Porto, and the produced seaweed biomass will be channelled to different markets. Targets are uses of the seaweed biomass for human food mainly in France, where 11 seaweed species are allowed for human consumption, extraction of pharmaceutical substances, or as an additive to fish feed, with possible antibiotic effects of the cultivated seaweed, a special research aspect in one of the workpackages of SEAPURA.

### Main Danger: Summer Stop of Growth in Red Algae

A major cultivation problem with perennial seaweeds is caused by their natural growth dormancy during summer resulting in overgrowth by fast-growing annual algae or animals and potential loss of the cultivated perennial algal biomass. In the SEAPURA project year-round, high growth activity of selected, perennial seaweed species will be tried to be achieved by cultivation in continuous short-days, at 8 h light per day. Outdoor, experimental seaweed tanks (EST) fitted with motor-driven blinds are used for this purpose. The background for this comes from basic chronobiological research: in perennial brown algae growth dormancy in summer is caused by enzymatic deactivation of the cell division zones (meristems) due to the environmental long-day signal. The ecological purpose of summer dormancy is to direct the photosynthates produced in summer within the seaweed thallus into carbohydrate reserve materials to be used up during the light-poor winter, when new growth starts in many perennial seaweeds. Usually this happens in December or January, and even in complete darkness in polar zones or in turbid waters, e.g. at Helgoland in winter. Well ahead of the plankton spring bloom, the benthic seaweeds are thus able to use the rich load of nitrate and phosphate available in the sea in winter after remineralization of the plankton in late autumn. Endogenous, circannual clocks control the timing of seasonal development in perennial brown algae cultivated in the laboratory (Lüning, 1993) and the environmental annual course of daylength synchronizes (entrains) these clocks to exactly 365 days, as in many animals (Gwinner 1986). The artificial, continuous short-day signal throughout the year blocks the circannual oscillator and thus the natural sequence of "growth-on" and growth-off" in brown algae and leads to continuous high growth rate. Is this possible also in outdoor tanks, with changing light intensity all over the day? Probably yes, since summer dormancy in the

brown alga *Laminaria digitata* was recently successfully prevented in outdoor tanks with natural insolation at Sylt using artificial blinds on top of the cultivation tanks (Gomez and Lüning, 2001). It is a special aim of the SEAPURA project to find out whether the same is true also for commercially important, perennial red algae. Specialized, accompanying research in this respect is conducted at the Wadden Sea Station Sylt and at the Marine Biology Station Portaferry of Queen's University, Northern Ireland.

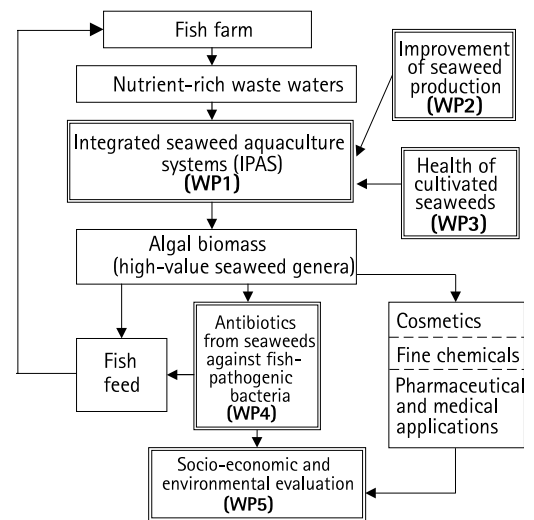


Figure 2: Function flow sheet of SEAPURA research steps

### References

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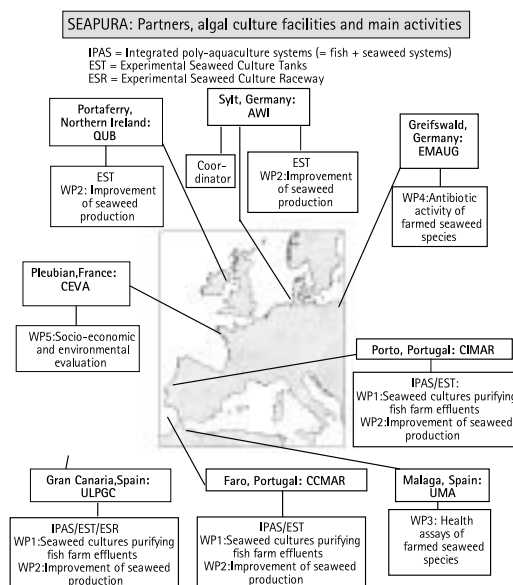


Figure 3: Partners and tasks of the SEAPURA project

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