EXPERIMENTAL RESULTS ON THE LIGHT AND TEMPERATURE REQUIREMENTS OF *FURCELLARIA LUMBRICALIS* (HUDSON) J.V.LAMOUROUX FROM THE PUCK LAGOON (SOUTHERN BALTIC SEA)

Zgrundo A.* Jakubowska-Lehrmann M.**, Kozłowska O. *, Łądkowska H.*, Dmochowska B.*

* University of Gdańsk, Institute of Oceanography, Al. Piłsudskiego 46, 81-378 Gdynia, Poland; *aleksandra.zgrundo@ug.edu.pl*

**National Marine Fisheries Research Institute, ul. Kołłątaja 1, 81-332 Gdynia, Poland; *mjakubowska@mir.gdynia.pl*

INTRODUCTION

Clawed Fork Weed *Furcellaria lumbricalis* (Hudson) J.V.Lamouroux is a species native to the waters of the Baltic Sea, which formed rich communities on the bottom of the Puck Lagoon (Southern Baltic) until the 1960s. As a result of anthropopressures from exploitation by dredging, rapidly increasing levels of eutrophication and industrial pollution, between 1970 and 1980, the lagoon's environment was severely degraded, which ultimately led to the disappearance of the seaweed population. *F. lumbricalis* has been observed again in the waters of the lagoon since 2019 and the population is gradually increasing its range.

Due to the fact that this taxon has a very high commercial potential and is exploited in another area of the Baltic (Estonia) any information on the biology and ecology of the taxon is extremely valuable. In this study, we will present the results of an experiment to explore the ecological requirements of the current *F. lumbricalis* population in relation to temperature and light in the context of biomass growth.

Fig. 1. *Furcellaria lumbricalis* from the Puck Bay. The line represents a distance of 10 cm.

Fig. 2. Free-floating thalli of *F. lumbricalis* in the Puck Lagoon in 2019.

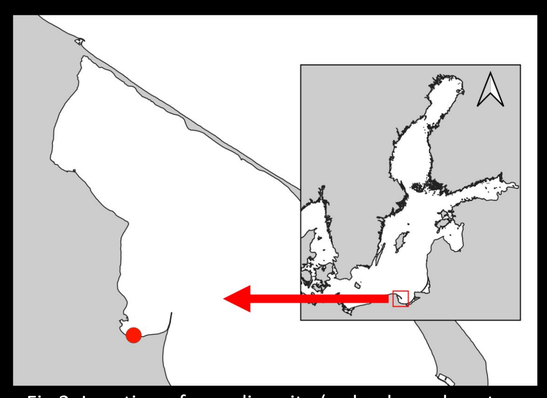

Fig 3. Location of sampling site (red-coloured spot.. The inset shows the location of the Puck Lagoon in the Baltic Sea.

MATERIALS & METHODS

F. lumbricalis (Fig. 1-2) was collected from a beach near the waterline in June and October 2021 in the Puck Lagoon in the vicinity of Rewa (54°40'18.18 "N; 18°32'19.39 "E), southern Baltic Sea (Fig. 3). After being transported to the laboratory, the tissues were cleaned of overgrowing plant and animal organisms and organic and inorganic particles. Only undamaged specimens, visually in the best possible condition, were selected for the experiments. Before starting the experiment, the initial weight of specimens was determined, after draining excess water. The experiment was carried out on plants acclimatised to the experimental conditions for a period of 7 days.

The study was carried out in an aquarium flow-through system, consisting of three circuits with four aquaria in each (tank dimensions: 50 x 35 x 30 cm; volume: 50 l)(Fig. 4). Light of four, different intensities of photon flux density was used for the experiment, i.e.: 50, 110, 170 and 200 µmol photons $m^{-2}s^{-1}$ and three water temperature values, i.e.: 10, 15 and 20 °C (Fig. 5). Each experimental treatment was performed in three independent replicates by placing 1.7 dm^3 glass tanks inside each aquarium. Three to four specimens of about 2.91 g m.m were placed in each tank.

The plants were maintained in a 1.5 l culture solution (West and McBride's Modfied ES Medium) with a salinity of 7 PSU, prepared on the basis of artificial marine seawater. The experiment lasted for a total of 50 days and biomass measurements were taken when the culture medium was changed, i.e. every 7 days. Based on the results of the biomass measurements, the Daily Growth Rate (DGR) was determined.

Fig. 4. Experimental flow-through aquarium system.

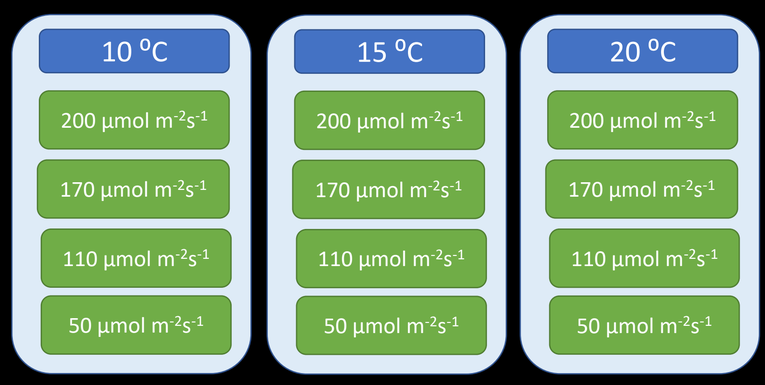

Fig. 5. Scheme of the experimental set-up

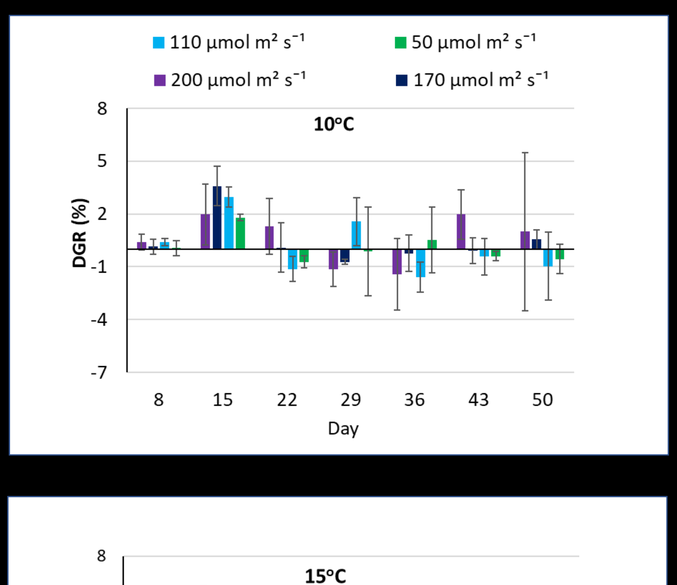

Fig. 6. Diagrams showing the Daily Growth Rate (DGR) of *Furcellaria lumbricalis* in relation to temperature and light in subsequent days of the experiment

Fig. 7. *F.lumbricalis* in an experimental vessel with undesirable algae.

Fig. 8. Examples of cyanobacteria growing on *F. lumbricalis*.

Fig. 9. Example of thallus covered with *Gaillona rosea* (red filaments), *Ulva* sp. (green filaments) and *Vertebrata fucoides* (black branches).

Fig. 10. *Ulva sp.* ingrowing in *F. lumbricalis*.

Fig. 11. Example of a desintegrating *F. lumbricalis* thallus .

RESULTS

At 10 °C, the DGR rate varied from -1.59 % to 3.58 % on average (Fig. 6). The highest values were observed on the 15th day of measurements, while negative values of the index occurred on the 22nd day after the start of the experiment. Considering the magnitude of the light, the highest values of the DGR rate occurred in high light of 200 µmol photons $m^{-2}s^{-1}$, even on the last day of the test, despite the high necrosis of the fronds, the DGR was 1.0 %. On the last day of measurement, only at light 50 and 110 µmol photons $m^{-2}s^{-1}$ the DGR index had a negative value.

At 15 °C, the DGR index ranged from -4.19 % to 4.58 %, with the highest values on the 15th day of measurement. Negative values of the index occurred after the 22nd day of the experiment, at which time fragmentation of the fronds was observed. Considering the light intensity, *F. lumbricalis* had the highest growth values falling mainly on the 15th day of the test. The positive values of the DGR indicator were observed mainly in the low light of 50 µmol photons $m^{-2}s^{-1}$.

At 20 °C, the DGR ratio ranged from -12.98 % to 5.41 %. The highest values were observed on the 15th day of measurement, and negative values of the index were observed 22 days after the start of the experiment. It was then that strong necrosis and decay of the fronds was observed. After day 29 of the experiment, there was a strong loss of biomass in each light variant.

In all temperature variants (10, 15 and 20 °C), maximum DGR values occurred at aquaria with high light (170-200 µmol photons $m^{-2}s^{-1}$), and minimum values occurred at low light (50 µmol photons $m^{-2}s^{-1}$). The first signs of decomposition and the successive decrease in biomass always occurred between days 15 and 22 of the experiment. The lowest DGR rates were determined for *F. lumbricalis* in circulation with a water temperature of 20 °C. After 8 and 15 days of exposure no synergistic effect of temperature and light was observed (p.0.05).

The decreasing growth of the thalli was associated with the appearance of undesirable associated taxa in the experimental vessels (Fig. 7). At 10 °C the thalli were mainly overgrown by diatoms, cyanobacteria and *Gaillona rosea* (red algae) and at 15 °C and 20 °C by *Ulva* sp. and cyanobacteria (Fig. 8-10). In addition, at 15 °C and 20 °C mass blooms of *Chlamydomonas* sp. (green algae) appeared. As a result, all thalli experienced necrosis and disintegration into smaller fragments (Fig. 11), making it necessary to remove rotting dead plant fragments that were not suitable for further biomass change measurements.

CONCLUSIONS

The growth of *F. lumbricalis* was most influenced by temperature, followed by light. The most optimal conditions for growth with respect to water temperature were in the range of 10-15 °C, and for light in the range of 170-200 µmol photons $m^{-2}s^{-1}$. Maintaining cultures at high temperature combined with high light values led to significant fragmentation and necrosis of the thalli due to severe overgrowth with unwanted algae.

The use of artificial seawater for laboratory cultures and cleaning of *F. lumbricalis* thalli prior to and during experiment shown to be an insufficient way to avoid overgrowth of *F. lumbricalis* and culture tanks by unwanted organisms. In future studies, we plan to optimise conditions to ensure the growth of *F. lumbricalis* and reduce the occurrence of unwanted associated flora by lowering the light intensity and/or shortening the photoperiod.

ACKNOWLEDGEMENT

Scientific work published is a part of an international project AquaVIP, INTERREG South Balltic, co-financed by the of the Minister of Science and Higher Education program funds entitled "PMW" in the years 2020-2022; Agreement No. 5126 / SPB 2014-2020/2020/2