The influence of *Hydrodictyon reticulatum* (L.) LAGERH. on diurnal changes in environmental variables in a shallow pool

Vliv řasy *Hydrodictyon reticulatum* na diurnální průběh fyzikálně-chemických parametrů vody v mělké tůni

Eva Lelková & Aloisie Poulíčková

Department of Botany, Faculty of Science, Palacký University, Šlechtitelů 11, CZ – 786 71 Olomouc – Holice, Czech Republic

Abstract

The presented experiment aimed to evaluate the influence of *Hydrodictyon reticulatum* on diurnal changes in environmental variables of water. Regular measurements of temperature, oxygen concentration and pH were carried out during 26 hours. Remarkable diurnal changes of oxygen concentration and pH values were observed in vessels containing *H. reticulatum*.

Introduction

Hydrodictyon reticulatum (L.) LAGERH. (Chlorophyceae) is a green alga forming characteristic, netlike microscopic or macroscopic cenobia. Cenobia are usually up to 6 dm long or even more. Cenobia consist of a great number of cylindrical cells; commonly, three cells are connected by their edges to form a network of 5-sided meshes. Cells vary considerably in size, sometimes reaching the length of up to 10 mm in large colonies (JOHN et al. eds. 2002). *Hydrodictyon* likes eutrophic water and can sometimes reproduce so fast that it behaves like a pest. *Hydrodictyon* is easy to culture, so its life cycle is known very well. *Hydrodictyon* can propagate in two ways, asexually and sexually. The asexual propagation takes place by biflagellate zoospores that form a daughter cenobium within the mother cell wall. The mother cell disappears and the daughter net comes free. Under favourable conditions, several hundreds of these nets start with the formation of daughter nets in each cell; therefore, this alga can become a real pest in eutrophic water. The sexual reproduction takes place by isogametes (PARMENTIER 1998).

H. reticulatum is known both in northern and southern hemispheres (JOHN et al. eds. 2002). The alga has recently invaded numerous ponds and lakes in the United Kingdom and New Zealand and has become a plague there (JOHN et al. eds. 2002, PARMENTIER 1998). *H. reticulatum* was reported from the Czech Republic as early as in 1889 (HANSGRIG 1889). In spite of strikingness of this species there have not been many records from the following years in the Czech Republic. Its autecology has not been investigated completely yet.

Mass occurrence of *H. reticulatum* can be often found in slow-moving streams, rivers, standing shallow waters, pools, fishponds and irrigation ditches (HANSGRIG 1889, HINDÁK ed. 1978). The influence of such mass development on environmental variables and phytoplankton community can be expected.

H. reticulatum was observed in a shallow floodplain pool Pontonová in Nature reserve Plané loučky in the Protected landscape area Litovelské Pomoraví for the first time in 1998 (SKÁCELOVÁ pers. comm.). KOČÁRKOVÁ & POULÍČKOVÁ 1999 described mass occurrence of *H. reticulatum* in pool Pontonová in June 1999. We observed this species at the same site regularly in the years 2000-2002. *H. reticulatum* occurred in the pool from May to September, although the timing and duration varied from year to year. The changes in phytoplankton community and environmental variables were observed during its occurrence. The laboratory experiment tried to verify the hypothesis that the changes are influenced by dense population of *H. reticulatum*.

Material and methods

Water and biomass of *H. reticulatum* were obtained from pool Pontonová (latitude 49°38´N, longitude 17°15´E, Central Moravia, Czech Republic). The phytoplankton of this site had been studied previously (PALOCHOVÁ 1998, KOČÁRKOVÁ & POULÍČKOVÁ 1999, LELKOVÁ 2003).

The samples were collected to plastic bottles and kept overnight in a refrigerator (4°C). The experiment was carried out in a cultivation room with a 12-hour-photoperiod (light phase from 6:00 a.m. to 18:00 p.m., temperature 15 – 18 °C). Fluorescent lamp (intensity of 70 $\mu mol.m^{-2}.s^{-1}$) was used as a source of light. Shading was simulated with a thin paper.

The experiment was performed from 10:00 a.m. on June 26 to 12:00 a.m. on June 27, 2002. It was carried out in six glass vessels, each vessel contained 800 ml of water from the pool and three of the six vessels were shaded with a thin paper (vessels B, D, and F). Vessels A and B contained only water with nature phytoplankton community (abundance 400 individuals per 1 ml, Phacus triqueter, *Trachelomonas volvocina, Pandorina morum, Scenedesmus* sp. div.*, Asterionella formosa*). Minor biomass of *H. reticulatum* (0,218 g of dry matter) was added to C and D vessels. Major biomass of *H. reticulatum* (1,88 g of dry matter) was added to E and F vessels. Selected environmental variables (pH, oxygen, temperature) were measured every two hours from 10:00 to 22:00 and from 6:00 to 12:00. with 92 WTW oxymeter and MPH 44LN pH-meter.

Results and discussion

Diurnal changes of pH ranged from 6.0 to 11.02. The oxygen concentration ranged from 1.0 to 27.0 $mg.l^{-1}$. Oxygen concentration and pH changed according to the amount of *H. reticulatum* biomass in vessels and the course of photoperiod.

Low fluctuations of pH and oxygen concentration were observed in vessels A and B with no biomass of *H. reticulatum*. The highest fluctuations were observed in vessel E (major biomass, no shading). The oxygen concentration and pH increased during the light phase and decreased during the dark phase in vessels C, D, E and F.

Vessels B, D and F were shaded with a thin paper which reduced the intensity of irradiance by 50 per cent. Diurnal changes of the measured variables were lower in these vessels. Algae were not shaded only by paper, but also by the biomass of *H. reticulatum* in vessel F, where only a small amount of oxygen was produced during the light period and almost depleted during the dark phase. The intensity of irradiance played an important role in the experiment – diurnal changes of pH values and oxygen concentrations in the shaded vessel F were much smaller in comparison with vessel E.

These results are in good agreement with previously published data (KOČÁRKOVÁ & POULÍČKOVÁ 1999).

H. reticulataum was observed in lake Loe Pool (south-west England) since 1989 (JOHN et al. 1998). They reported temperature optima 20 – 25 °C and high fluctuations of its population in the following years. Possible interactions between *Hydrodictyon* and cyanobacteria *Microcystis aeruginosa* were discussed (JOHN et al. 1998). Increasing pH and oxygen saturation were observed at the site Pontonová during the development of *Hydrodictyon* population. Dissolved oxygen saturation ranged from 34% to 195%, and pH reached 9.51 in the pool (unpublished data) or even 11 (KOČÁRKOVÁ pers. comm.) Similar observations were published earlier in England – oxygen saturation 34% - 220 % and pH up to 10 (FLORY & HAWLEY 1994, JOHN et al. 1998).

Our experiment verified that high fluctuations of pH and oxygen concentrations in shallow pools can be influenced by the biomass of algae as well as submerged macrophytes. Their high biomass can even cause oxygen deficit near the bottom (POKORNÝ 1996). Planktonic algae can rarely create such a dense biomass, although extremely high *Planktothrix agardhii* biomass has been reported recently (HAŠLER & POULÍČKOVÁ 2003). On the other hand, macroscopic algae, e.g. *Spirogyra*, *Cladophora* (POKORNÝ 1996) and *Hydrodictyon*, can sometime choke the whole pool.

Conclusion

Mass occurrence of macroscopic alga *Hydrodictyon reticulatum* significantly influences environmental variables (especially pH and oxygen concentration) in the water column due to photosynthesis and respiration. Great biomass of this alga can cause night oxygen deficit in small water bodies, such as pools.

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References

FLORY, J. E. & HAWLEY, G. R. W. (1994): A *Hydrodictyon reticulatum* bloom at Loe–Pool, Cornwall. – European Journal of Phycology 29(1): 17–20.

HANSGRIG, A. (1889): Prodromus českých řas sladkovodních. Díl 1. – 219 pp., Archiv pro přírodovědný výzkum Čech, Praha.

HAŠLEER, P. & POULÍČKOVÁ, A. (2003): Diurnal changes in vertical distribution and morphology of a natural population of *Planktothrix agardhii* (GOM.) ANAGNOSTIDIS et KOMÁREK (Cyanobacteria). – Hydrobiologia, in press.

HINDÁK, F. (ed.) (1978): Sladkovodné riasy. – 724 pp., SPN, Bratislava.

JOHN, D., M., DOUGLAS, G. E., BROOKS, S. J., JONES, G. C., ELLAWAY, J. & RUNDLE, S. (1998): Blooms of water net *Hydrodictyon reticulatum* (Chlorococcales, Chlorophyta) in a coastal lake in the British Isles: their cause, seasonality and impact. – Biologia 53 (4): 537–545.

JOHN, D. M., WHITTON, B. A. & BROOK, A. J. (eds.) (2002): The freshwater algal flora of the British Isles:an identification guide to freshwater and terrestrial algae. – 702 pp., Cambridge University Press, Cambridge.

KOČÁRKOVÁ, A. & POULÍČKOVÁ, A. (1999): Masový výskyt *Hydrodictyon reticulatum* v tůni Litovelského Pomoraví. – In: POULÍČKOVÁ, A. & KOČÁRKOVÁ, A. (eds.): Řasy a prostředí, Sborník referátů 39. pracovní konference Algologické sekce ČSB, Rožmberk nad Vltavou, p. 50–54.

LELKOVÁ, E. (2003): Ekologie fytoplanktonu vybraných tůní Litovelského Pomoraví [Phytoplankton ecology of selected pools in Litovelské Pomoraví]. – Ms.[MSc thesis; depon. in: Dept. Ecol. Palacky University, Olomouc].

PALOCHOVÁ, A. (1998): Biodiverzita řas tůní v okolí Olomouce [Algal diversity of pools in surroundings of Olomouc]. – Ms.[MSc thesis; depon. in: Dept. Zool. Palacky University, Olomouc].

PARMENTIER, J. (1998). Water net. – Micscape Magazine, http://www.microscopy–uk.org.uk/mag/artdec98/net2.html

POKORNÝ, J. (1996): Rozvoj vodních makrofyt v mělkých jezerech a rybnících. – In: EISELTOVÁ, M. (ed.): Obnova jezerních ekosystémů – holistický přístup, 190 pp., Nature Conservation Bureau, Berkshire.

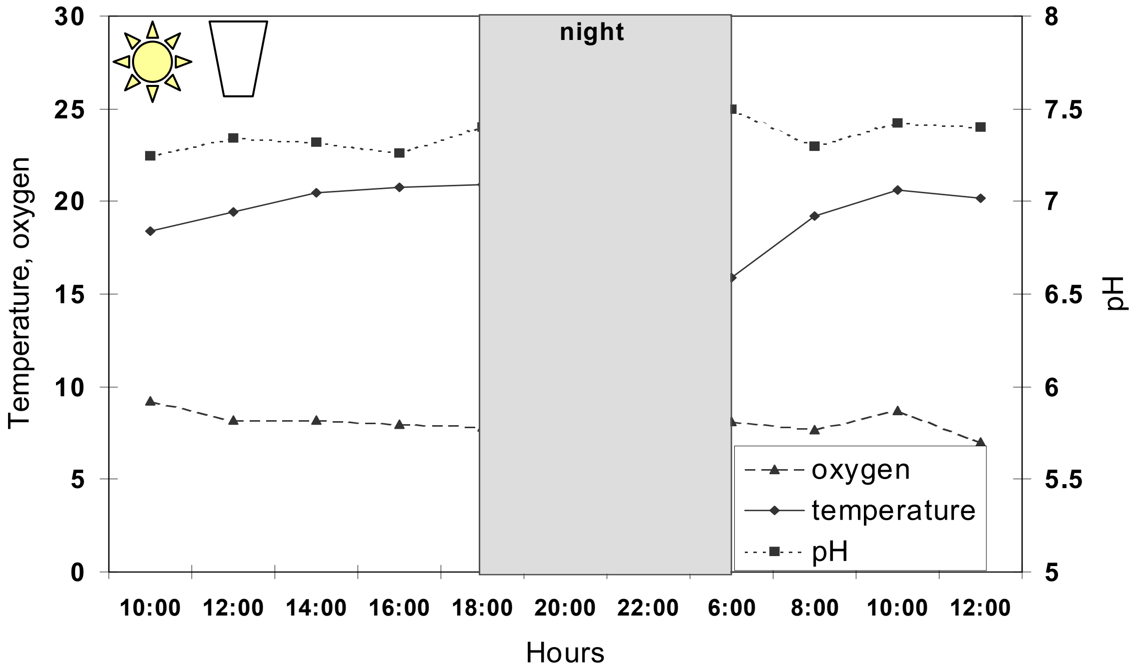

Fig. 1: Diurnal changes of temperature, oxygen concentration and pH in vessel A – no shading, no biomass of *H. reticulatum* (temperature in ^{o}C and oxygen concentration in $mg.l^{-1}$)

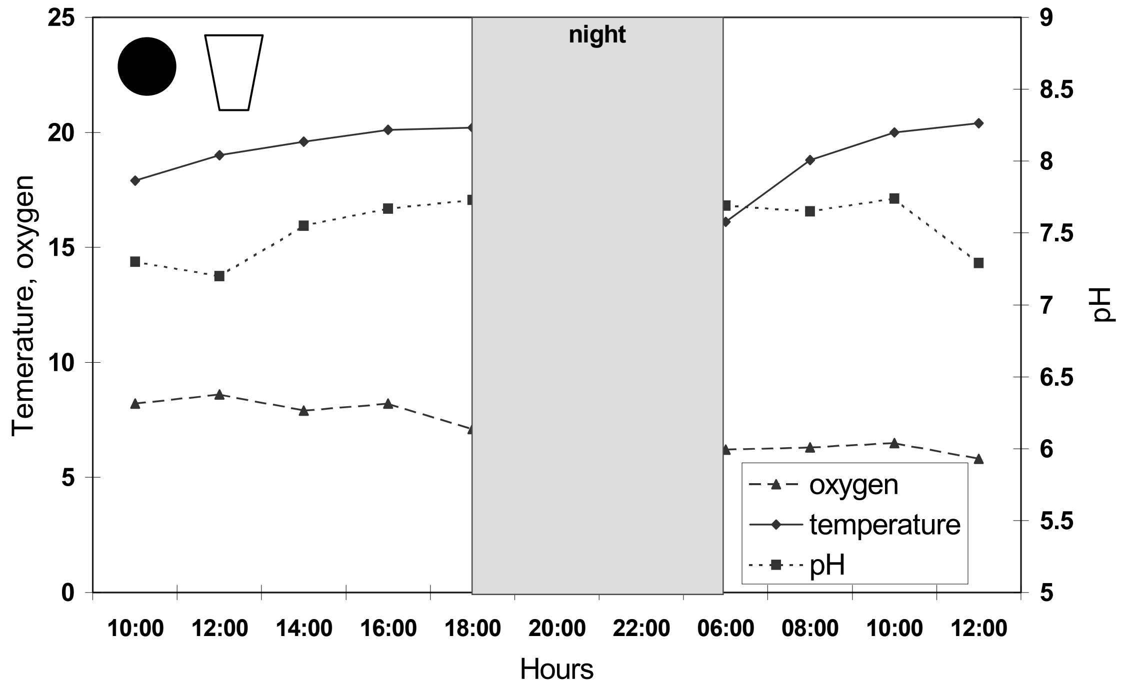

Fig. 2: Diurnal changes of temperature, oxygen concentration and pH in vessel B – shading 50 per cent, no biomass of *H. reticulatum* (temperature in ^{o}C and oxygen concentration in $mg.l^{-1}$)

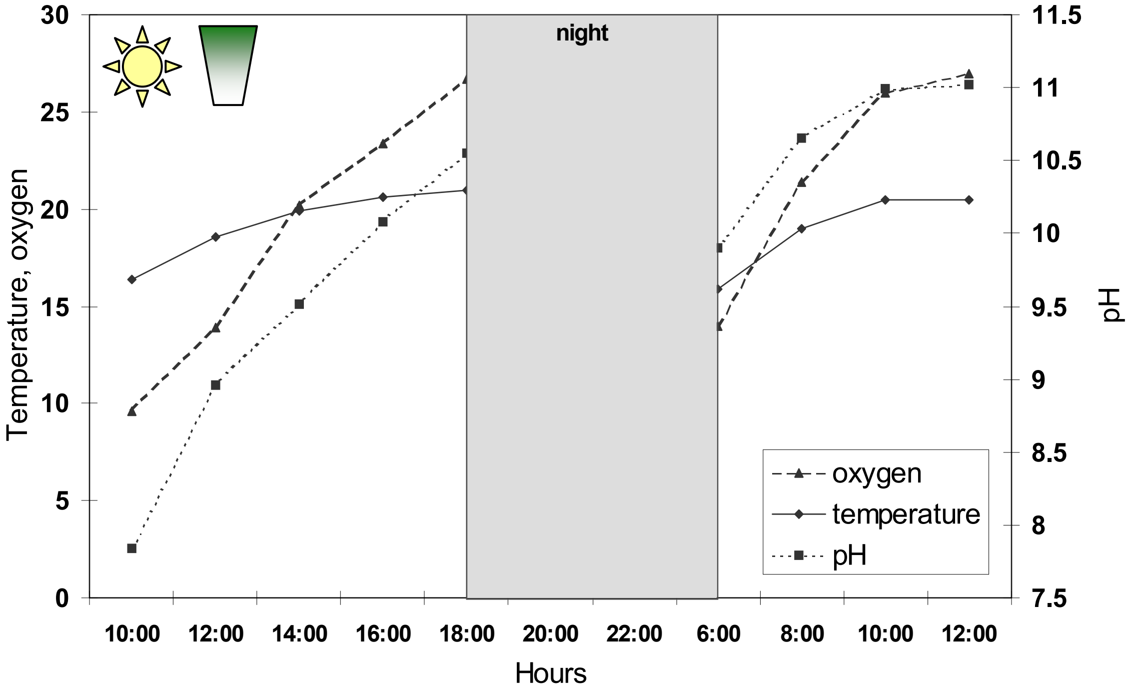

Fig. 3: Diurnal changes of temperature, oxygen concentration and pH in vessel C – no shading, minor biomass of *H. reticulatum* (temperature in ^{o}C and oxygen concentration in $mg.l^{-1}$)

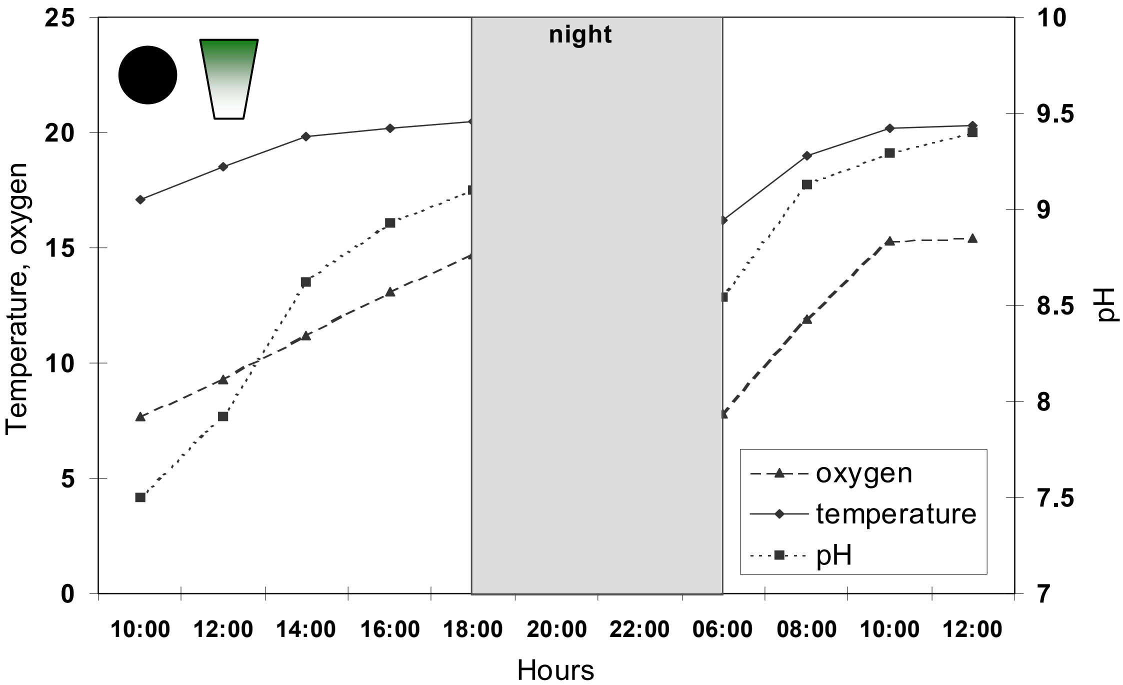

Fig. 4: Diurnal changes of temperature, oxygen concentration and pH in vessel D – shading 50 per cent, minor biomass of *H. reticulatum* (temperature in ^{o}C and oxygen concentration in $mg.l^{-1}$)

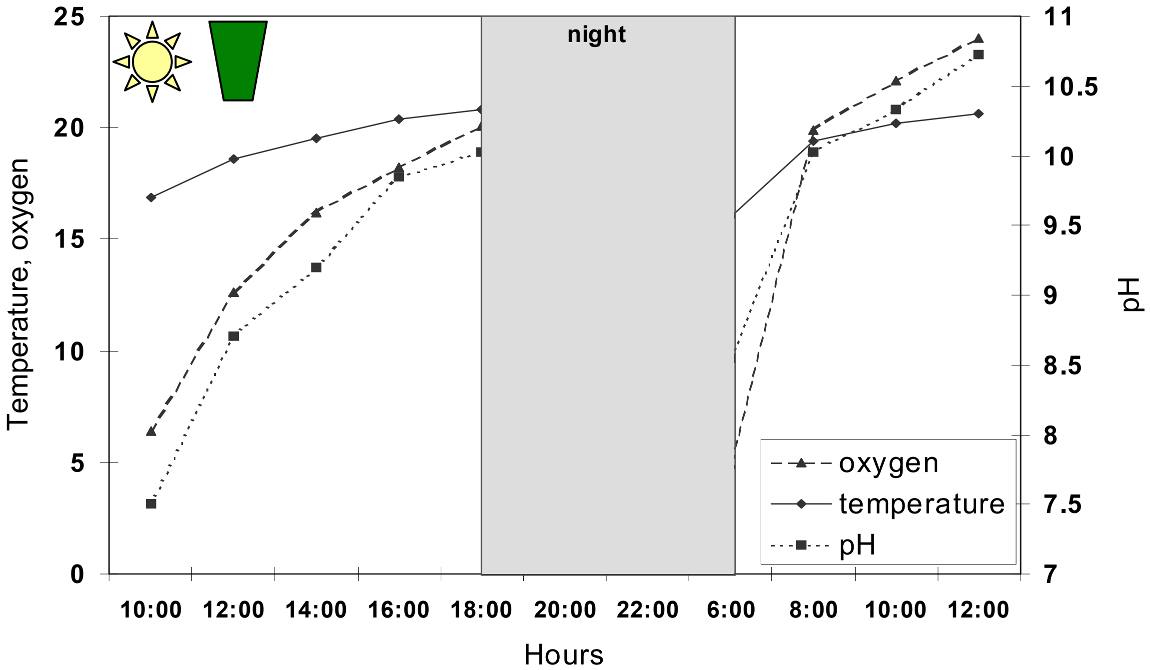

Fig. 5: Diurnal changes of temperature, oxygen concentration and pH in vessel E – no shading, major biomass of *H. reticulatum* (temperature in °C and oxygen concentration in mg.l^{-1})

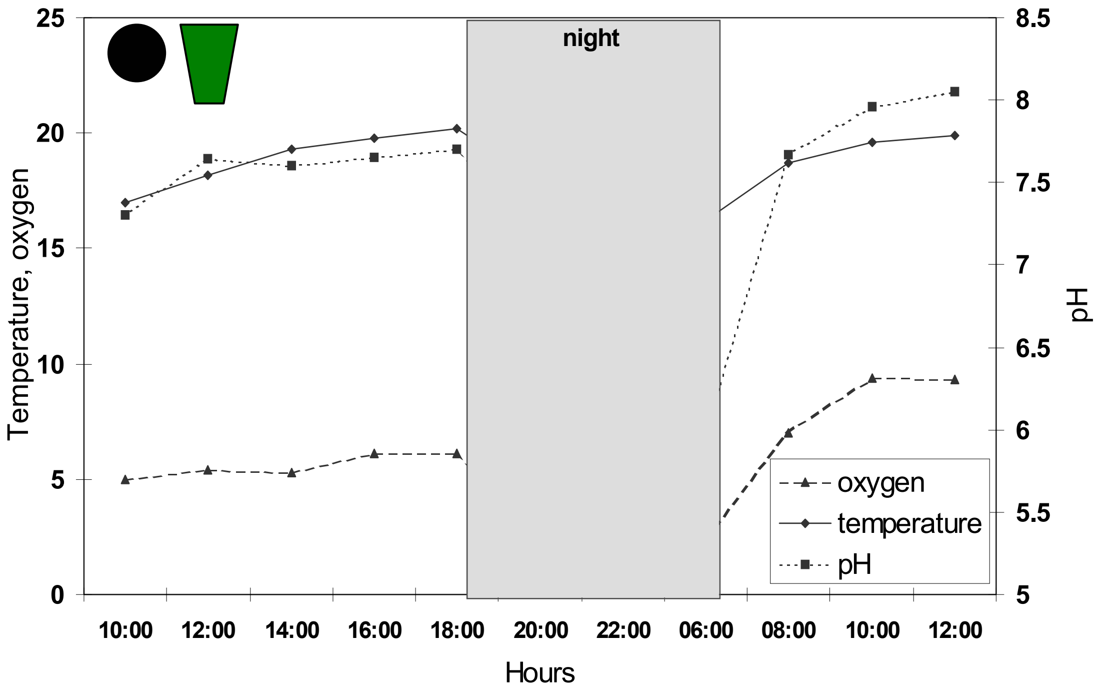

Fig. 6: Diurnal changes of temperature, oxygen concentration and pH in vessel F – shading 50 per cent, major biomass of *H. reticulatum* (temperature in °C and oxygen concentration in mg.l^{-1})