EKOLOGIJA. 2008. Vol. 54. No. 1. P. 32–39
DOI: 10.2478/V10055-008-0007-z

Seasonal succession of epiphyton algal communities on *Phragmites australis* (Cav.) Trin. ex Stend. in a mesoeutrophic lake

Jūratė Karosienė [1],

Jūratė Kasperovičienė [2]

Institute of Botany,
Laboratory of Hydrobotany,
Žaliųjų Ežerų 49, LT-08406 Vilnius,
Lithuania
E-mail: [1] juratek@mail.lt,
[2] jurate.kasperoviciene@gmail.com

The species composition, abundance and biomass of epiphyton algal communities on vegetative *Phragmites australis* stems were studied in two sites of mesoeutrophic Lake Gulbinas in May–October 2002. The highest species diversity, abundance and biomass were observed in June and August–September and the lowest in July. Diatoms formed up to 97.1% of total biomass in June and decreased by 44.3% in August–September. The dominants were typically epiphytic species from the genera *Achnanthidium* and *Cymbella*. Green algae comprised mainly *Coleochaeate scutata, Chaetosphaeridium globosum,* and species from the genera *Oedogonium* and *Cosmarium* reached the biomass maximum in August (up to 33.7%). Cyanobacteria cf. *Cyanobium parvum, Geitleribactron periphyticum* were prevailing at the end of *P. australis* vegetation. The seasonal and spatial development patterns of epiphyton algae on *P. australis* varied in the lake sites.

Key words: epiphyton algae, species composition, abundance, biomass, *Phragmites australis*, mesoeutrophic lake, Lithuania

INTRODUCTION

Epiphyton algal communities are important components of aquatic ecosystems. Their contribution to primary production varies from 0.2% to 41.7% in lakes (Макаревич, 2005). Furthermore, the epiphyton algae with macrophytes are employed as the buffering zone between terrestrial ecosystems and the pelagic zone of lakes (Lakatos et al., 1999). They are important components of food webs (Michael et al., 2006). Also, epiphytic algae are good indicators of water quality and environmental changes due to their sensitivity to external sources of fertilization (Lowe, 1996; Barbour et al., 1999).

Epiphyton algae occurrence in aquatic systems is determined by availability of substrates and the abiotic and biotic environment (Lowe, 1996). Epiphyton seasonal succession in temperate regions mainly depends on climatic conditions as well as on the trophic state of a water body. The algal succession cannot be explained by one model (Meulemans, 1988; Протасов, 1994), its patterns vary in lakes and also in the same lake due to heterogeneous substrates. In some papers, two annual epiphyton biomass maxima are described (Oleksowicz, 1982; Bohr et al., 1983; Шаларь et al., 1994), while in others one peak is indicated (Meulemans, 1988; Müller, 1994; Albay, Akcaalan, 2003; Laugaste, Reunanen, 2005).

The seasonal development attached algae is studied mainly on artificial substrates (Eloranta, 1982; Rodríguez, 1994) and/or, due to a large surface area, on submerged macrophytes (Burkholder, Wetzel, 1989; Lalonde, Downing, 1991; Wetzel, 2001). The emergent macrophytes vegetating all the year round in lakes are also a good substratum for epiphyton algae (Meulemans, Roos, 1987; Meulemans, 1988; Wetzel, 2001). Common reed (*Phragmites australis*) is the best substratum for algal overgrowth in comparison with other helophytes (Шаларь и др., 1994; Mohamad Ali, 2003; Laugaste, Reunanen, 2005). Furthermore, *P. australis* is a cosmopolitan perennial plant growing in different trophy habitats (Meulemans, Roos, 1987; Clevering, 1998). It is common in Lithuanian lakes (Balevičienė, Balevičius, 2006).

In numerous papers on epiphyton algae in European freshwaters, there is little information about attached algae communities in Lithuanian water bodies (Pocienė, Stoškus, 1987; Kasperovičienė, 1994, 1997; Karosienė, 2003; Mohamad Ali, 2003; Касперовичене, Каросене, 2005). The aim of the present research was to study the epiphyton algal species composition, abundance and biomass seasonal variation on the vegetative *P. australis* stems in a mesoeutrophic lake.

MATERIALS AND METHODS

Study area. The research was carried out in the glacial channel Lake Gulbinas situated in the surroundings of Vilnius. The major part of the lake catchment area (8000 ha) is covered by agricultural land (37.6%) and forests (22%) (Taminskas, 2001). The lake area is 36.8 ha, the length of lake bank being 4.4 km, maximum depth 11.8 m and mean depth 4.2 m. Aquatic vegetation covers 8.7 ha (18.6%) of the lake area. The largest areas are occupied by communities of floating-leaved plants *Nupharetum lutei* (W. Koch) Hueck and helophytes *Phragmitetum australis* (Gams) Schmale, reaching respectively 45% and 20.2% of the lake area covered by macrophytes (Balevičius, 2001). Lake Gulbinas is ascribed to mesotrophic water bodies with distinct features of eutrophy (Krevš et al., 2003; Balevičienė et al., 2004).

Physical–chemical variables. Temperature, pH and conductivity were measured *in situ* with a portable universal Multi Line F/Set-3 meter (WTW). Water transparency was measured with a Secchi disk. Dissolved oxygen concentration was estimated by the Winkler method.

Sampling and analysis. Epiphyton algae were sampled monthly during *Phragmites australis* vegetative period (May–October 2002) in two Lake Gulbinas sites (Fig. 1). Epiphyton was taken from submerged *P. australis* stems outside the reed belt. The average number of vegetative stems reached 12–50 per m^2 in sampling sites. Water depth at the sites ranged from 0.5 m to 1.20 m (Table 1). From 1 m^2 3–6 *P. australis* stems were picked. Approximately 30 cm long segments taken 10 cm below water surface were cut. The epiphyton was scraped into distilled water and preserved with 40% formaldehyde (4% concentration in the final sample). Algae species were analysed on a light Biolar microscope at ×600 magnification. At least 600 counting units were counted in a Nagoette chamber (volume 0.05 cm^3). The counting unit of colonial algal species was a colony, of filamentous species – 100 μm, of others – a cell. The biomass was estimated using each taxon abundance and an appropriate geo-

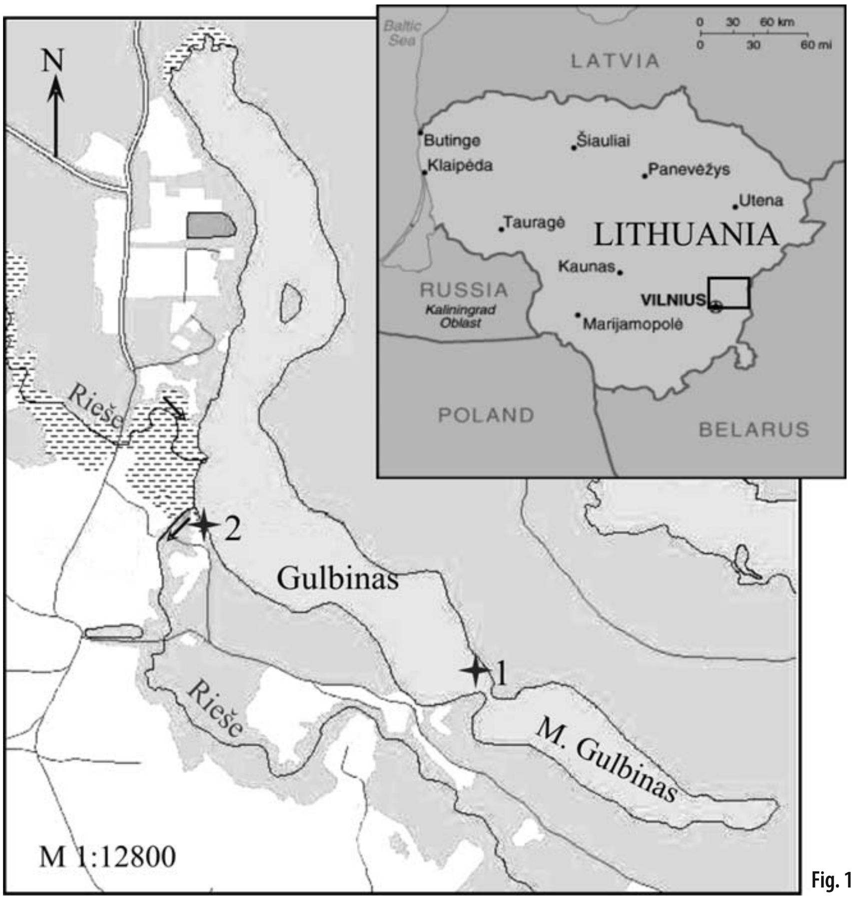


Fig. 1. The situation scheme of Lake Gulbinas and sampling sites

Table 1. **Physical-chemical variables in Lake Gulbinas sampling sites (numerator – site 1, denominator – site 2), May–October 2002**

Data	Sample depth, m	Secchi depth, m	T, °C	pH	O_2, mg/l	Saturation O_2, %	Conductivity, μS/cm
27 May	0.6 / 1.10	tb* / tb	20.6 / 21.2	8.28 / 8.46	9.05 / 12.15	102 / 136	508 / 505
17 June	0.6 / 1.10	tb / tb	18.8 / 17.7	8.23 / 8.10	11.20 / 11.04	121 / 117	508 / 513
16 July	0.5 / 1.20	tb / 0.90	25.6 / 25.4	8.27 / 8.16	10.88 / 11.36	134 / 137	448 / 452
07 August	0.6 / 1.20	tb / 1.10	22.8 / 24.0	8.18 / 8.34	10.40 / 12.08	121 / 143	431 / 432
11 September	0.6 / 0.9	tb / tb	18.6 / 18.6	8.37 / 8.30	15.52 / 14.08	166 / 152	422 / 434
16 October	0.6 / 0.9	tb / tb	6.5 / 6.2	7.68 / 7.94	8.76 / 9.50	70 / 76	504 / 506

* tb – till bottom.

metrical volume (Olrik et al., 1998). The diatoms were identified on permanent microscope slides. After bleaching and destroying the organic matter with H_2O_2, the diatoms were mounted in Naphrax. The Shannon diversity (H') index (Shannon, 1948) was calculated from cell density and total biomass using the natural logarithm (ln). The Sørensen (C) similarity index (Sørensen, 1948) was calculated to assess similarity of communities in different sampling sites.

RESULTS

Environmental characteristic. The physical and chemical parameters of Lake Gulbinas are presented in Table 1. Light penetrated till bottom during all the study period except July–August when the Secchi depth was 0.9–1.10 m. The water was saturated with oxygen (up to 166%) during all the study period. A decrease of saturation to 70% was observed in October during *Phragmites australis* decomposition. Based on A. Krevš et al. (2003), in Lake Gulbinas the annual mean concentrations of total phosphorus and total nitrogen in 2001 were respectively 0.214 mg /l and 2.185 mg /l.

Species composition. More than 150 species and varieties belonging to 8 algal classes were recorded in epiphyton communities. The most numerous were *Chlorophyceae* (37%), *Bacillariophyceae* (34%) and *Cyanophyceae* (21%) species. The highest algal species diversity was observed in autumn (82 ± 6 species) and the lowest in late-spring – early-summer (60 ± 4 species). The Sørensen similarity index varied from 0.58 in May to 0.70 in September (median, 0.62) and showed slight differences of epiphyton communities in both lake sites.

Epiphyton seasonal development. Epiphyton algae abundance and biomass varied significantly during *P. australis* vegetation. Two peaks of algae development were observed in Lake Gulbinas, although these maxima disagreed in sites (Fig. 2). The epiphyton algae species composition (61 ± 5 taxa), abundance (up to 537.08 thous. units/cm^2) and biomass (up to 0.404 mg/cm^2) were low at the beginning of *P. australis* growth in May. The diatoms dominated by abundance (98.2%) and biomass (97.1%). Typically, the epiphytic species *Achnanthidium minutissimum*, *Cymbella microcephala* prevailed (Table 2). Other species from the genus *Cymbella* (43%) and *Eunotia arcus* (14.7%) contributed a significant part to biomass, too. This complex of prevailing species dominated during all the study period with some differences in proportions.

In June, epiphyton algae reached their first abundance (665.8 thous. units/cm^2) and biomass (0.203 mg/cm^2) peaks in site 1. Like in May, diatoms prevailed. Cyanobacteria cf. *Cyanobium parvum* (up to 39.5%) complemented the diatoms in abundance (Table 2).

In July, despite an increase of species epiphyton richness (78 ± 4 species), the quantitative parameters decreased almost three times (Fig. 2). Diatoms were prevailing like in earlier months, but their contribution to abundance and biomass was less and reached 40.2% and 81.2%, respectively. Cyanobacteria became more significant in abundance (up to 57.9%) and green algae in biomass (up to 16.4%) at that period. Cyanobacteria *Geitleribactron periphyticum* accompanied the dominants in abundance (11.1%) in site 1, while their number in site 2 was negligible (Table 2). Green algae *Chaetosphaeridium globosum* (2.7%), species of the genera *Oedogonium* (4.5%) and *Cosmarium* (4.2%) became rich in biomass.

In August–September the epiphyton algae grew up significantly, reaching the highest development (2696.98 thous. units/cm^2, 0.779 mg/cm^2). Diatoms still decreased in abundance (to 14.3%) and biomass (to 44.3%). A substantial contribution to biomass (33.7%) by green algae *Coleochaeate scutata* and species from genera *Cosmarium* and *Oedogonium* was observed. The dinoflagellata *Peridinium cinctum* contributed up to 28.8% of total biomass in site 1 and enlarged the epiphyton peak in September.

In October, epiphyton algae abundance and biomass declined to the values observed in May at the beginning of investigation (443.59 thous. units/cm^2, 0.196 mg/cm^2). Cyanobacteria prevailed in abundance (62.2%) and diatoms in biomass (90.5%).

The Shannon diversity index, based on algae abundance, varied from 1.35 to 2.85 (median, 1.88 ± 0.02) (Fig. 3, A). In the first study period (May–July) it was in inverse ratio in different sampling sites; during the following months it was similar. The diversity index, based on biomass, varied from 2.73 to 3.56 (median, 2.98 ± 0.06) (Fig. 3, B). The most diverse communities were observed in July–August when six taxa (*Coleochaeate scutata*, *Cymbella cistula*, *C. helvetica*, *C. microcephala*, *Achnanthidium minutissimum*, *Eunotia arcus*) contributed 10.7–21.9% of the total epiphyton biomass.

DISCUSSION

The seasonal development of epiphyton algae on *Phragmites australis* in Lake Gulbinas was bimodal, with the abundance and biomass maximum in June and August–September. The recorded peaks were quite similar to those observed in Polish lakes (Oleksowicz, 1982; Bohr et al., 1983) and in a cooling reservoir in Moldova (Шаларь и др., 1994). In other water bodies, one algae biomass peak during *P. australis* vegetation period was observed. In the eutrophic Lake Verevi (Estonia), the epiphyton algae biomass maximum was estimated in autumn (Laugaste, Reunanen, 2005). The spring maximum was indicated in the eutrophic Lake Belau (Germany) (Müller, 1994) and in the oligomesotrophic Lake Maarsseveen (Netherlands) (Meulemans, 1988). The summer maximum was recorded in the eutrophic Lake Manyas (Turkey) (Albay, Akcaalan, 2003).

Diatoms prevailed in the Lake Gulbinas epiphyton. The main factor influencing the intensive growth of diatoms might be their possibility to take silicon (Si) from the host plant when Si concentration decreases in the water (Wetzel, 1996). The contribution of *Cyanophyceae* and *Chlorophyceae* to the greatest biomass in July–August is associated with the water temperature increasing up to 25.6 °C. Müller (1994) and Schalar' et al. (Шаларь и др., 1994) observed similar seasonal variations of different algal groups in epiphyton.

The small diatom species *Achnanthidium minutissimum, Cymbella microcephala* and cyanobacteria cf. *Cyanobium parvum* were most abundant in Lake Gulbinas. Barbour et al. (1999), McCabe and Cyr (2006) have noted that *A. minutissimum*, characterized by an intensive reproduction, are often the first species colonising the substratum in aquatic systems. Data on

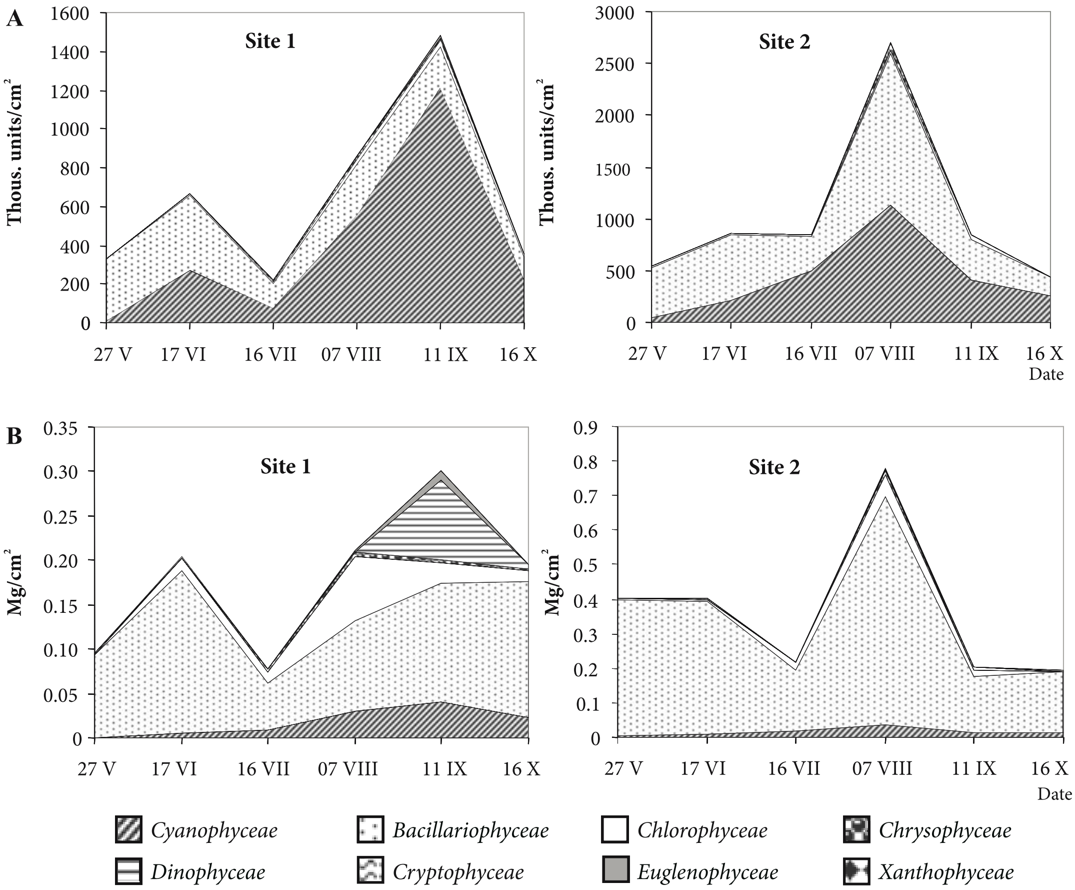
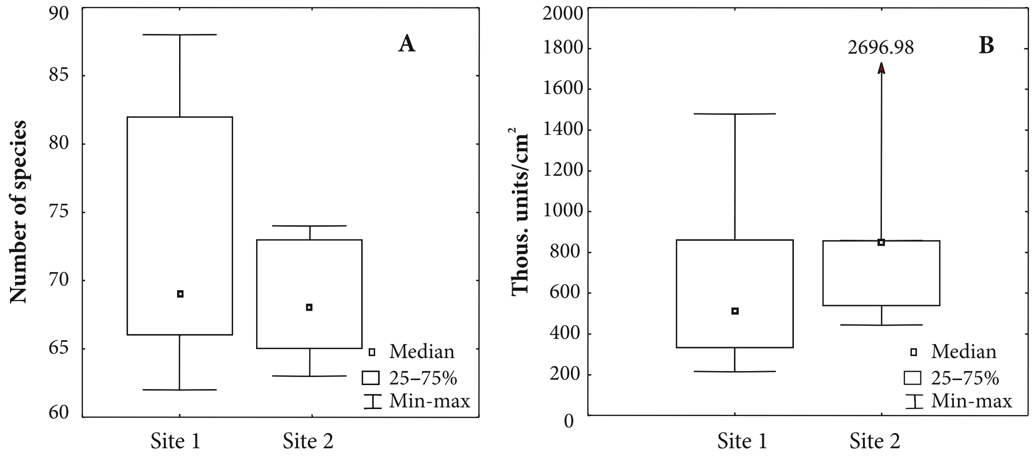


Fig. 2. Variation of epiphyton algae abundance (A) and biomass (B) in Lake Gulbinas, May–October 2002

Table 2. **Dominant epiphyton algae species (>5% of total abundance / biomass) in Lake Gulbinas, May–October 2002**

Data	Site 1	Site 2
27 May	*Achnanthidium minutissimum* Kützing (70.2/27.2%), *Cymbella microcephala* Grunow (12.8/8.4%), *Eunotia arcus* Ehrenberg (0.6/8.2%), *Cymbella cistula* (Ehrenberg) Kirchner (0.2/7.5%), *Encyonema caespitosum* Kützing (0.6/6.5%)	*A. minutissimum* (50.7/7.6%), *C. microcephala* (11.8/3.0%), *C. cistula* (1.7/28.6%), *E. arcus* (3.3/14.7%), *Cymbella helvetica* Kützing (0.5/8.4%), cf. *Cyan arvum* (Migula) Komárek et al. (5.4/0.1%)
17 June	cf. *C. parvum* (39.5/2.1%), *A. minutissimum* (28.5/10.6%), *C. microcephala* (18.0/11.1%), *C. cistula* (0.7/27.7%), *E. caespitosum* (0.5/5.0%)	*A. minutissimum* (45.7/11.1%), cf. *C. parvum* (23.5/0.8 %), *C. microcephala* (13.3/5.3%), *C. cistula* (0.6/14.9%), *E. arcus* (1.8/13.6%), *Gomphonema insigne* Gregory (1.5/12.8%), *Tabellaria flocculosa* (Roth) Kützing (1.0/7.6%), *C. helvetica* (0.2/5.4%)
16 July	*C. microcephala* (20.7/10.7%), *A. minutissimum* (17.2/5.4%), cf. *C. parvum* (13.1/0.6%), *Geitleribactron periphyticum* Komárek (11.1/0.8%), *C. cistula* (0.2/6.7%), *C. helvetica* (0.2/6.8%), *E. caespitosum* (0.7/5.4%), *E. arcus* (0.5/5.2%)	cf. *C. parvum* (54.9/3.4%), *A. minutissimum* (19.1/8.5%), *C. microcephala* (12.1/8.9%), *C. helvetica* (0.3/13.3%), *E. arcus* (0.8/11.8%), *C. cistula* (0.2/8.7%), *G. insigne* (0.3/5.1%)
07 August	cf. *C. parvum* (50.2/3.3%), *C. microcephala* (16.3/12.5%), *A. minutissimum* (8.6/3.9%), *G. periphyticum* (8.0/0.8%), *Coleochaeate scutata* Brébisson (0.1/21.9%)	cf. *C. parvum* (38.6/2.1%), *A. minutissimum* (28.5/11.2%), *C. microcephala* (12.4/8.1%), *C. cistula* (0.3/14.3%), *C. helvetica* (0.1/6.6%), *E. arcus* (0.5/6.2%), *T. flocculosa* (0.03/6.1%), *G. insigne* (0.4/5.9%)
11 September	cf. *C. parvum* (47.0/3.7%), *G. periphyticum* (31.5/3.9%), *C. microcephala* (7.9/7.3%), ***Peridinium cinctum*** (O. F. Müller) Ehrenberg (0.1/28.8%), *C. helvetica* (0.1/7.7%), *C. cistula* (0.1/6.4%)	cf. *C. parvum* (46.7/3.1%), *A. minutissimum* (20.7/9.7%), *C. microcephala* (18.1/14.0%), *E. arcus* (1.1/17.2%), *C. cistula* (0.2/8.9%), *C. helvetica* (0.1/5.6%), ***P. cinctum*** (0.02/5.7%)
16 October	cf. *C. parvum* (35.3/1.0%), *G. periphyticum* (19.2/0.9%), *A. minutissimum* (13.1/2.7%), *C. microcephala* (6.3/2.1%), *C. helvetica* (0.9/20.8%), *E. arcus* (2.8/18.6%), *C. cistula* (0.5/12.0%), *Phormidium terebriforme* (Agardh ex Gomont) Anagnostidis & Komárek (1.6/5.7%)	cf. *C. parvum* (50.0/1.8%), *A. minutissimum* (19.9/5.1%), *C microcephala* (8.5/3.6%), *C. cistula* (0.8/23.2%), *C. helvetica* (0.4/12.4%), *E. arcus* (1.0/8.3%), *Navivula radiosa* Kützing (0.07/5.6%), *Fragilaria biceps* (Kützing) Lange-Bertalot (0.4/5.1%)

Not underlined – *Bacillariophyceae* species; Underlined – *Cyanophyceae* species; Shadowed – *Chlorophyceae* species; **Bold** – *Dinophyceae* species.



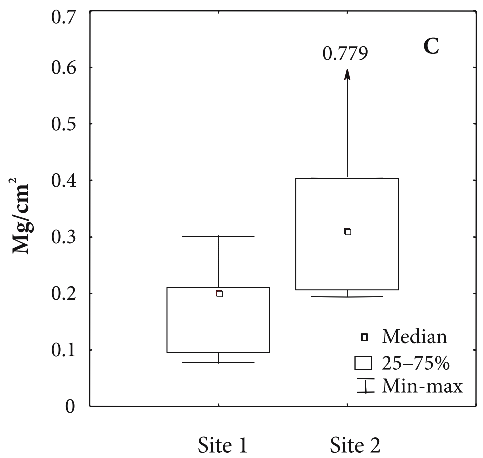


Fig. 3. Shannon diversity values of epiphyton algae communities calculated by abundance (A) and biomass (B) in Lake Gulbinas, May–October 2002

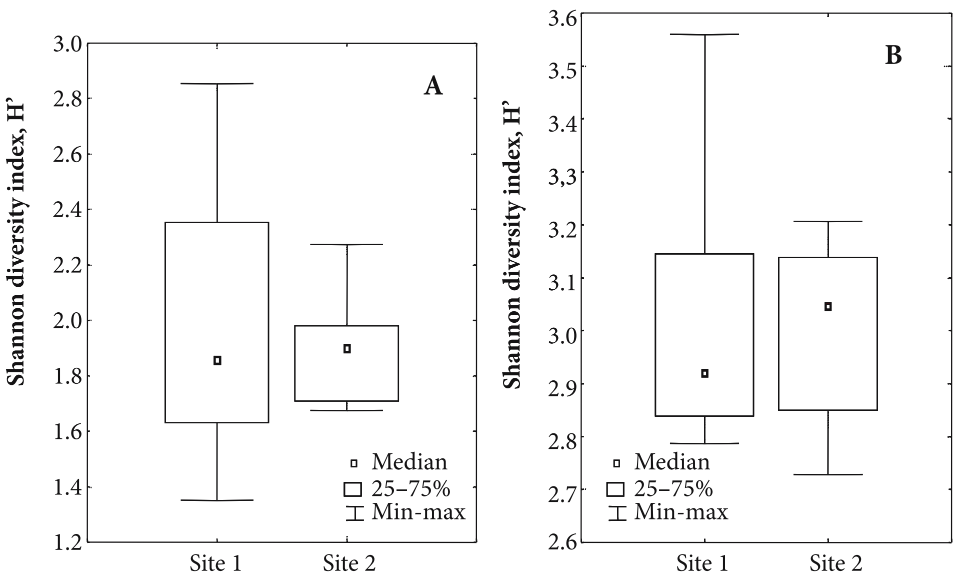


Fig. 4. Variation of epiphyton algae species number (A), abundance (B) and biomass (C) in Lake Gulbinas, May–October 2002

A. minutissimum relative abundance are used in bioassessment as an indicator of lake disturbance. According to the classification recommended by Barbour et al. (1999), *A. minutissimum* relative abundance less than 25% is characteristic of undisturbed lakes. In Lake Gulbinas, *A. minutissimum,* possibly a pioneer species, was the most abundant only during the first reed colonization months (May–June) and comprised 45.7–70.2% of total abundance (Table 2). Later, their abundance decreased to 17%. Thus, lake disturbance could not be a limiting factor for epiphyton algal development in our study. In comparison with Lake Gulbinas epiphyton data, in the eutrophic Lake Spėra (Lithuania) *A. minutissimum* was also common on *Phragmites australis.* However, their dominant species complexes differed (Касперовичене, Каросене, 2005). In Lake Spėra, the most abundant were diatoms from the genera *Cymbella*, *Gomphonema*, *Epithemia* and filament cyanobacteria *Leptolyngbya* spp.

In addition to temporal variation, the epiphyton algal communities also exhibited spatial variation. Changes in epiphyton structure in the lake sites were most distinct in August–September (Fig. 2). The abundance (median, 848.9 thous. units/cm^2) and biomass (median, 0.309 mg/cm^2) were almost two times higher in site 2 situated near the inflow of the Riešė stream, while the species number (median, 68 species) was lower (Fig. 4). In this site, more diverse epiphyton algal communities, based on the Shannon index values (median, 1.9 and 3.04), were observed as compared with communities in site 1. (Fig. 3). The differences should be determined by different the depth of sampling sites. In the sampling sites, the correlation among algal biomass and depth was positive ($r^2 = 0.45$, $p < 0.02$, $n = 12$). According to Lalonde and Downing (1991), epiphytes on the macrophytes in deeper waters were less influenced by surface turbulence, therefore, algae were more abundant than on shallower macrophytes.

Light is one of the most important factors influencing epiphyton seasonal development (Eloranta, 1982; Meulemans, 1988; Wetzel, 2001). However, the epiphyton algal communities were not abundant in spring in Lake Gulbinas, despite the fact that *Phragmites australis* stems were partially emergent and light penetrated till bottom. The reason could be epiphyte growth inhibited by reeds releasing allelophatic substances during their active growth period (Шаларь et al., 1994). The epiphyton algae decline observed in July was possibly influenced by light decrease. Maier (1979) (cit. Asaeda et al., 2002) found that during reed maximal development in July, only 3% of photosynthetic active radiation (PAR) reached the water surface. Followed by Müller (1994), 7.5% of PAR reached the water surface at 60 reed stems per m^2 in a site. Our results showed a negative correlation ($r^2 = 0.55$, $p < 0.09$, $n = 8$) between epiphyton biomass and reed stem density. Furthermore, it is known that an intensive phytoplankton development may depress epiphyton algae growth because of shading (Hansson, 1992; Lowe, 1996). The phytoplankton biomass peak which could influence epiphyton growth in July, was characteristic in this month in 2002 in Lake Gulbinas (Krevš et al., 2003). Similar phytoplankton development patterns based on transparency values (Secchi depth 0.9 m) were found also during the epiphyton investigation in 2002. Obviously, after algae development peak they could be easily washed by waves (Протасов, 1994; Lowe, 1996). Many authors reported a decrease of epiphyton development in middle summer (Eloranta, 1982; Oleksowicz, 1982; Meulemans, 1988; Müller, 1994; Шаларь, 1994).

The highest epiphyton algae development in August–September in Lake Gulbinas corresponded to the end of *P. australis* vegetation. This peak is a result of some factors, mainly of an increased light intensity within the reed belt and nutrients released to water during host plant decomposition. Asaeda et al. (2002), Meulemans and Roos (1987) have noted that reeds start decomposing at this time, transferring 5–50% of nutrients to rooting tissues. The release of residue nutrients to the water could be effectively fixed into the new algal biomass (Burkholder, 1996; Wetzel, 2001). Besides, light transparency after the beginning of the reed senescence phase increases to 70% in autumn (Müller, 1994).

Nutrients in water bodies influence epiphyton growth also (Wetzel, 1996, 2001). According to Burkholder (1996) and Wetzel (1996), the algae loosely attached with the help of gelatinous pads or stalks elevate from macrophyte surface into water and develop intensively in nutrient-rich aquatic systems. However, adnate algae growing flat on substrata in immediate contact with the macrophytes develop in nutrient-lacking waters. In Lake Gulbinas, loosely attached algae (*Cymbella* spp., *Gomphonema* spp., *Oedogonium* spp., *Geitleribactron periphyticum*, etc.) comprised a more diverse group and made 53.6–74.0% of the total biomass. Therefore, a presumption based on the data mentioned above was made that the lake water was rich in the nutrients during the study.

In conclusion, the seasonal investigation of epiphyton algae on *Phragmites australis* showed a high variability of their productivity in two study sites during the reed vegetation period. No significant changes were observed in the prevailing species complex. In the epiphyton, species from *Bacillariophyceae*, *Cyanophyceae* and *Chlorophyceae* dominated. Diatoms grew intensively in spring and autumn. Cyanobacteria were abundant in late summer–autumn and grenn algae in summer. The temporal and spatial differences among epiphyton algae communities were determined by various environmental conditions such as light, nutrients, host plant, the depth of sampling sites.

ACKNOWLEDGEMENTS

We are grateful to Dr. R. Paškauskas and Dr. J. Koreivienė for comments on the manuscript. Mrs. V. Ptašekienė kindly revised the English of the manuscript. Special thanks go to anonymous reviewers who improved the manuscript significantly.

Received 8 May 2007
Accepted 20 December 2007

References

1. Albay M., Akcaalan R. 2003. Comparative study of periphyton colonization on common reed (*Phragmites australis*) and artificial substrate in a shallow lake Manyas, Turkey. *Hydrobiologia*. Vol. 506–509. S. 531–540.
2. Asaeda T., Hung Nam L., Hietz P., Tanaka N., Karunaratne S. 2002. Seasonal fluctuations in live and dead biomass of *Phragmites australis* as described by a growth and decomposition model: implications of duration of aerobic conditions for litter mineralization and sedimentation. *Aquatic Botany.* Vol. 73. S. 223–239.
3. Balevičienė J., Balevičius A. 2006. A. Qualitative and quantitative parameters of phytocenoses in Lithuanian lakes of different trophic state. *Ekologija*. Nr. 2. P. 33–43.
4. Balevičienė J., Balevičius A., Jodinskaitė-Šimanauskienė R. 2004. Fitocenozių struktūra ir kasmetinis biomasės įnašas įvairaus produktyvumo ežeruose. *Ekologija*. Nr. 2. P. 37–49.
5. Balevičius A. 2001. *Vandens augalijos struktūra ir produktyvumas Riešės baseino įvairaus trofiškumo ežeruose*. Daktaro disertacija. P. 178.
6. Barbour M. T., Gerritsen J., Snyder D. B., Stribling J. B. 1999. *Rapid bioassessment protocols for use in streams and wadeable*

rivers: periphyton, benthic macroinvertebrates and fish. United States Environmental Protection Agency; Washington.

7. Bohr R., Luścińska M., Oleksowicz A. S. 1983. Phytosociological associations of algal periphyton. In: Wetzel R. G. (ed.). *Periphyton of Freshwater Ecosystems*. S. 23–30.
8. Burkholder J. M. 1996. Interactions of benthic algae with their substrata. In: Stevenson R. J., Bothwell M. L., Lowe R. L. (eds.). *Algal Ecology: Freshwater Benthic Ecosystems*. S. 253–297.
9. Burkholder J. M., Wetzel R. G. 1989. Microbial colonization on natural and artificial macrophytes in a phosphorus-limited, hardwater lake. *Journal of Phycology*. Vol. 25. S. 55–65.
10. Clevering O. A. 1998. An investigation into the effects of nitrogen on growth and morphology of stable and die-back populations of *Phragmites australis*. *Aquatic Botany*. Vol. 60. S. 11–25.
11. Eloranta P. V. 1982. Periphyton growth and diatom community structure in a cooling water pond. *Hydrobiologia*. Vol. 96. S. 253–265.
12. Hansson L. A. 1992. Factors regulating periphytic algal biomass. *Limnology Oceanography.* Vol. 37(2). S. 322–328.
13. Karosienė J. 2003. New for Lithuania species of epiphytic cyanobacteria. *Botanica Lithuanica*. Vol. 9(4). S. 363–370.
14. Kasperovičienė J. 1994. *Fitoapaugimų tyrimai Drūkšių ežere – AE baseine-aušintuve*. 1993 m. mokslinės veiklos ataskaita. Botanikos institutas. P. 82–83.
15. Kasperovičienė J. 1997. Litoralės perifitinių ir bentosinių dumblių struktūra ir formavimosi tendencijos. In: *Atominė energetika ir aplinka.* Mokslinių ataskaitų rinkinys 1993–1997. P. 93–101.
16. Krevš A., Paškauskas R., Šulijienė R. 2003. Fitoplanktono susintetintos organinės anglies išskyrimo ir heterotrofinės utilizacijos sezoniniai ypatumai skirtingose mezotrofinio ežero (Gulbinas) zonose. *Ekologija*. Nr. 3. P. 17–22.
17. Lakatos G., Kiss M., Mészáros I. 1999. Heavy metal content of common reed (*Phragmites australis*/Cav./Trin. Ex Steudel) and its periphyton in Hungarian shallow standing waters. *Hydrobiologi*a. Vol. 415. S. 47–53.
18. Lalonde S., Downing J. A. 1991. Epiphyton biomass is related to lake trophic status, depth, and macrophyte architecture. *Canadian Journal of Fisheries and Aquatic Sciences*. Vol. 48. S. 2285–2291.
19. Laugaste R., Reunanen M. 2005. The composition and density of epiphyton on some macrophyte species in the partly meromictic Lake Verevi. *Hydrobiologia*. Vol. 547. S. 137–150.
20. Lowe R. L. 1996. Periphyton patterns in lakes. In: Stevenson R. J., Bothwell M. L., Lowe R. L. (eds.). *Algal Ecology: Freshwater Benthic Ecosystems*. S. 57–76.
21. McCabe S. K., Cyr H. 2006. Environmental variability influences the structure of Benthic algal communities in an oligotrophic lake. *Oikos*. Vol. 115. S. 197–206.
22. Meulemans J. T. 1988. Seasonal changes in biomass and production of periphyton growing upon reed in Lake Maarsseveen I. *Archiv für Hydrobiologie*. Vol. 112. S. 21–42.
23. Meulemans J. T., Roos P. J. 1987. Production and decomposition in the emergent littoral zone of Lake Maarsseveen I, an overview. *Hydrobiological Bulletin*. Vol. 21(1). S. 61–69.
24. Michael E. S., Michael E. M., Douglas A. J. 2006. Benthos as the basis for arctic lake food webs. *Aquatic Ecology*. Vol. 37(4). S. 437–445.
25. Mohamad Ali S. 2003. The influence of macrophytes on the structure of phytoepiphyton communities in Lake Baluoshas littoral. *Süleyman Demirel Üniversitesi*. Vol. 2(10). S. 1–6.
26. Müller U. 1994. Seasonal development of epiphytic algae on *Phragmites australis* (Cav.) Trin. ex Sten. in a eutrohic lake. *Archiv für Hydrobiologie*. Vol. 129(3). S. 273–292.
27. Oleksowicz A. S. 1982. Interactions among algal communities in three lakes of the Tuchola Forests area (Northern Poland). *Archiv Hydrobiology Supply*. Vol. 63. S. 77–90.
28. Olrik K., Blomquist P., Brettum P., Cronberg G., Eloranta P. 1998. *Naturvårdsverket förlag*. Stockholm.
29. Pocienė Č., Stoškus A. 1987. Skroblaus upelio dumblių ekologinių grupuočių bendrijos. *Lietuvos TSR aukštųjų mokyklų mokslo darbai*. *Biologija*. T. 25. P. 16–21.
30. Rodríguez M. A. 1994. Succession, environmental fluctuations, and stability in experimentally manipulated microalgal communities. *Oikos*. Vol. 70. S. 107–120.
31. Shannon C. E. 1948. A mathematical theory of communication. *The Bell System Technical Journal*. Vol. 27. S. 379–423.
32. Sørensen T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. *Det Kong Danske Videnskabernes Selskab Biologiske Skrifter*. Vol. 5. S. 1–34.
33. Taminskas J. 2001. *Ežerų kranto zonos žemėnaudos įtaka organogeninio atabrado formavimuisi*. Ataskaita Lietuvos valstybiniam mokslo ir studijų fondui. Vilnius. 114 p.
34. Wetzel R. G. 1996. Benthic algae and nutrient cycling in lentic freshwater ecosystems. In: Stevenson R. J., Bothwell M. L., Lowe R. L. (eds.). *Algal Ecology: Freshwater Benthic Ecosystems*. S. 641–667.
35. Wetzel R. G. 2001. Land–water interfaces: attached microorganisms, littoral algae and zooplankton. In: Wetzel R. G. (ed.). *Limnology, Lake and River Ecosystems*. S. 577–135.
36. Касперовичене Ю., Каросене Ю. 2005. Структурно-функциональная характеристика эпифитона и фитопланктона литоральной зоны оз. Спера (Литва). *Вестник Тюменского государственного университета*. № 5. С. 70–77.
37. Макаревич Т. А. 2005. Вклад перифитона в суммарную продукцию пресноводных экосистем (обзор). *Вестник Тюменского государственного университета*. № 5. С. 77–85.
38. Протасов А. А. 1994. *Пресноводный перифитон*. Киев.
39. Шаларь В. М., Недбалюк Б. И., Обух П. А. 1994. Состав и динамика развития эпифитных водорослей в Кучурганском водохранилище-охладителе Молдавской ГРЭС. *Альгология*. № 4(2). С. 27–33.

Jūratė Karosienė, Jūratė Kasperovičienė

SEZONINĖ EPIFITONO DUMBLIŲ BENDRIJŲ ANT *PHRAGMITES AUSTRALIS* (CAV.) TRIN EX STEND. KAITA MEZOEUTROFINIAME EŽERE

S a n t r a u k a

Straipsnyje pateikti epifitono dumblių ant *Phragmites australis* panirusių stiebų rūšių sudėties, gausumo ir biomasės sezoninės kaitos tyrimų rezultatai. Tyrimai atlikti 2002 m. gegužę–spalį skirtingose Gulbino ežero litoralės vietose. Išanalizuoti veiksniai, nulėmę epifitono dumblių vystymąsi. Tyrimų metu nustatyti du epifitono dumblių vystymosi maksimumai birželį ir rugpjūtį–rugsėjį. Titnagdumbliai gausiai vystėsi visą tyrimų laikotarpį. Vyraujančių rūšių kompleksą sudarė *Achnanthidium*, *Cymbella* genčių titnagdumbliai. Žaliadumbliai, daugiausia *Coleochaeate scutata*, *Chaetosphaeridium globosum, Oedogonium* ir *Cosmarium* genčių rūšys, intensyviausiai vystėsi rugpjūtį. Melsvabakterės, dažniausiai cf. *Cyanobium parvum*, *Geitleribactron periphyticum*, svarbiausios buvo nendrės vegetacijos pabaigoje (rugpjūtį–rugsėjį).

Raktažodžiai: epifitono dumbliai, rūšių įvairovė, gausumas, biomasė, Phragmites australis, mezoeutrofinis ežeras, Lietuva