

## PECULIARITIES OF EPIPHYTON ALGAL COMMUNITIES FORMATION ON DIFFERENT MACROPHYTE SPECIES

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### Abstract

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The epiphyton on different aquatic vegetation represented by emerged macrophytes (*Phragmites australis*, *Equisetum fluviatile*, *Schoenoplectus lacustris*), floating-leaved plants (*Nuphar luteum*) and submerged macrophytes (*Potamogeton perfoliatus*, *Chara rudis*) was studied in two meso- and mesoeutrophic lakes. The morphological characteristics, physiological and synecological peculiarities of plant host had more effect on epiphyton algae abundance and biomass than species richness. The highest densities of algae were associated with helophytes *Phragmites australis*, *Equisetum fluviatile*, the lowest was recorded on *Schoenoplectus lacustris* and laminae of *Nuphar luteum*. Loosely attached diatoms prevailed on helophytes, adnate species on *Nuphar luteum* laminae. Cyanobacteria and green algae were more abundant on *Nuphar luteum* laminae and *Potamogeton perfoliatus*.

**Keywords:** epiphyton, algae, cyanobacteria, macrophyte, lakes, Lithuania.

### INTRODUCTION

In aquatic ecosystems more than 90 % of algae species grow attached to the various submerged substrates or are associated with them (WETZEL, 2001). However, traditionally most hydrobiological studies have focused on phytoplankton and less attention is paid to the attached communities regardless of their growth in the most productive littoral zone of aquatic ecosystems (WETZEL, 2001; O'REILLY, 2006).

In the littoral zone, aquatic macrophytes with associated algae have been shown to be important component influencing on lakes productivity and the water quality, especially in small, shallow lakes (LAKATOS et al., 1999; WETZEL, 2001; KISS et al., 2003; MAKAREVIČ, 2005). Macrophyte-epiphyton complex serve as a buffer system that protects water ecosystem from inflow of nutrients forcing eu-

trophication (KOSJATOVA et al., 1990; LAKATOS et al., 1999; WETZEL, 2001). In addition, epiphyton algae utilize from overlying water organic compounds, heavy metals, radionuclides (AFANAS'EV et al., 1990; ŠEVČENKO, 1994; ŠEVČENKO & KLENUS, 1997). On the other hand, intensive development of algae may cause secondary water pollution. Detached from substrates they form large floating mats and reduce recreational value of water bodies (HORNER et al., 1983).

Macrophytes serve as a substrate for algae settlement. The variability of morphological configurations and surface microtopography within and among macrophytes provides diverse habitats for epiphyton algae (WETZEL, 1996). Also, macrophytes can be used as a source of nutrients. On the other hand, algae may successfully compete with the host plant for similar resources such as light and particularly nutrients (SAND-JENSEN & BORUM, 1991). A thick layer of epi-

phyton may inhibit growth of macrophytes reducing light availability and limiting the diffusion of some nutrients from the water column because of algae capable to assimilate nutrients not only from the water but also released from macrophytes. Rooted macrophytes are able to take up nutrient pools in the water and in the sediment (SAND-JENSEN & BORUM, 1991; WETZEL, 1996). Therefore, epiphyton algae inspire scientific interest due to their interaction with the host plant.

Although a large number of studies have attempted to identify relationships between macrophyte and their associated organisms, the contradictory data exists about their interaction. Several authors (KUZ'KO, 1988; PIIRSOO et al., 2007) revealed similar epiphyte communities among different macrophytes and the data were used as evidence that macrophytes represent an inert surface for algal colonization. Conversely, distinct algal assemblages among macrophyte substrata were interpreted as argument indicated that host plant is more important in the life of epiphyton (PIP & ROBINSON, 1985; MAKAREVIČ et al., 1986; CATTANEO et al., 1998; MESSYASZ & KUCZYŃSKA-KIPPEN, 2006). Thus, overall, the knowledge of algal diversity variations among epiphytic communities on different macrophytes and factors controlling it is still insufficient. The aim of the study was to investigate the epiphyton algal communities on different macrophyte species of ecological groups and assess their impact on epiphyton formation.

## THE STUDY AREA

The study was carried out in the glacial stratified lakes Balsys and Gulbinas situated in the surroundings of Vilnius, Lithuania (Fig. 1). The lakes differ in morphometric parameters, land use of the catchment area (Table 1). Both lakes are characterized as mesotrophic water bodies, some features of eutrophy are observed in Lake Gulbinas (KREVŠ et al., 2002, 2003; BALEVIČIENĖ et al., 2004). The lakes littoral zone has become overgrown by helophytes (*Phragmites australis*, *Schoenoplectus lacustris*), communities of floating-leaved plants (*Nuphar luteum*) (BALEVIČIENĖ et al., 2004). Also, stoneworts (*Chara tomentosa*, *C. rudis*) dominate in Lake Balsys.

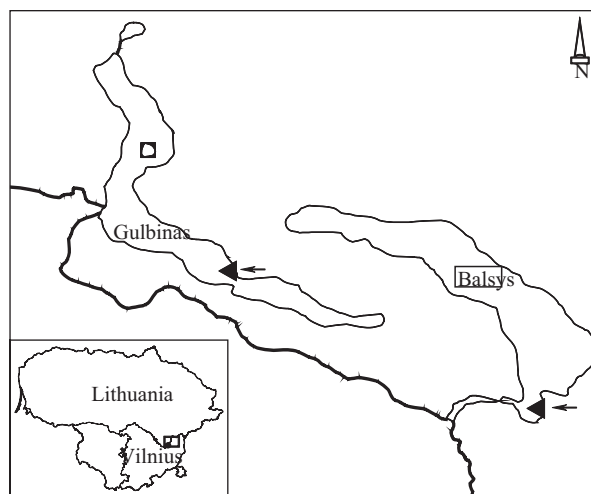


Fig. 1. Location of the investigated lakes and epiphyton sampling sites

Table 1. Some morphometric characteristics of studied lakes (KILKUS & BERNATONIS, 2003; LINKEVIČIENĖ et al., 2004)

Parameters	Balsys	Gulbinas
Shoreline length, km	5.2	4.4
Catchment area, ha	327	8000
Lake surface area, ha	55.0	36.8
Littoral area, ha	6.0	7.3
Max depth, m	38.8	11.8
Mean depth, m	15.2	4.2
Forest land in catchment area, ha	56.8	22.0
Agricultural land in catchment area, ha	21.8	37.6

## MATERIALS AND METHODS

Sampling was performed throughout July and August over the period 2001 and 2006. Four different morphological-ecological types of aquatic vegetation represented by helophytes *Phragmites australis* (Cav.) Trin. Ex Steud, *Equisetum fluviatile* L., *Schoenoplectus lacustris* (L.) Palla, nymphaeids *Nuphar luteum* (L.) Sm., potamoideids *Potamogeton perfoliatus* L. and limnoids *Chara rudis* (A. Braun) Leonh. were selected for study. Algae were taken from macrophytes growing in one restricted area of each lake (54°47'33N, 25°18'31E in Lake Gulbinas, 54°47'03N, 25°20'00E in Lake Balsys) to avoid the impact of some environmental variables such as nutrients alteration on epiphyton formation. Macrophytes density, total coverage was evaluated in triplicates of 1 m<sup>2</sup> size area.

Epiphyton was collected from 3 to 6 individuals of different plants randomly selected at the study sites according to MÜLLER (1995), ALBAY & AKCAALAN (2003). Approximately 20–30 cm long helophyte segments were cut 10 cm below water surface. Epiphyton from *Nuphar luteum* was taken from laminae and 20–40 cm long petiole segments cutting 10 cm below water surface. Samples from the stems and leaves of *Potamogeton perfoliatus* and *Chara rudis* were collected from 10–20 cm long middle part of the plant. Epiphyton from *C. rudis* was taken just for species composition due to counting complication on algal abundance and biomass per *Chara* surface area. Algae were scraped into distilled water and preserved with 40 % formaldehyde (4 % concentration in the final sample).

Algae were analysed using a light Biolar microscope at  $\times 150$ – $1500$  magnification. The diatoms were identified on permanent microscope slides after bleaching and destroying the organic matter with  $H_2O_2$ . The abundance was determined by counting the number of taxa units: a colony or cenobium, 100  $\mu m$  long filament, and a cell for the rest species (HELCOM, 2006). At least 600 units were counted in a Nageotte chambers. The biomass was estimated using taxa abundance data and an appropriate geometrical volume (OLRIK et al., 1998; OLENINA et al., 2004). Dominating species were selected according to DAVYDOVA (1989). Ecological groups of algae were distinguished after KAIRESALO (1984), BURKHOLDER & WETZEL (1989), ABE et al. (2000), BARIANOVA et al. (2006).

Some water physical and chemical characteristics (Table 2) were measured *in situ* at each sampling site according to GRASSHOFF et al. (1983). Dissolved oxygen concentration was estimated by the Winkler method (MURAVE'EV, 1999). Nutrients (phosphorus and nitrogen) analyses were performed based on MERKIENĖ & ČEPONYTĖ, 1994.

The Sørensen index (SØRENSEN, 1948) was used to compare similarities in the epiphyton species composition. The Shannon index ( $H'$ ) (SHANNON, 1948) was calculated to evaluate algal communities diversity. Statistical data analysis was completed using STATISTICA '99 software package. The correlation between environmental variables and epiphyton algal communities was evaluated applying the non-parametric Pearson's correlation coefficient (at  $p <$

0.05). Cluster analysis based on algae species relative abundance was applied for the comparison of communities.

Table 2. Physico-chemical water characteristics of lakes Gulbinas (2001) and Balsys (2006) in the sampling sites

Parameters	Gulbinas	Balsys
Temperature, °C	19.8	20.7
pH	8.38	8.19
Conductivity, $\mu S\ cm^{-1}$	463	323
$O_2$ , $mg\ L^{-1}$	10.24	8.69
TN, $mg\ L^{-1}$	1.64	0.43
TP, $mg\ L^{-1}$	0.13	0.02
Secchi depth, m	t.b.	t.b.*
Depth of the sampling sites, m	1.20	1.00

\*\* t.b. – till bottom

## RESULTS AND DISCUSSION

The total number of algal species in epiphyton on different macrophytes ranged from 74 to 100 in Lake Gulbinas and 90–125 in Lake Balsys (Fig. 2). The highest taxa diversity induced by relatively large number of planktonic species (45.2 % of all species) was found on potameids *Potamogeton perfoliatus*, the lowest on nymphheids laminae of *Nuphar luteum* (74 and 90 species in Lakes Gulbinas and Balsys, accordingly) and limneids *Chara rudis* (90 species) (Fig. 2). Epiphyton on floating-leaved plants is often associated with low algal taxa numbers and densities (MAKAREVIČ et al., 1986; CATTANEO et al., 1998; KOPYRINA, 1999). Small number of species on *C. rudis* possibly was caused by the allelopathic substances that inhibit algal growth (VAN DONK & VAN DE BUND, 2002; BERGER & SCHAGERL, 2004). In addition, allelopathic effect indicates remarkably clear water surrounded stands of *Chara* species (BLINDOW, 1987). Algal taxonomic composition was rather similar on different macrophytes in each lake (Table 3). According to CATTANEO et al. (1998), species composition is more closely related to the chemical characteristics of the lake water than the macrophyte type.

The Sørensen index ranging from 0.55 to 0.77 (median 0.71) revealed no significant differences in epiphyton flora. The most similar algal communities were found on helophytes *Equisetum fluviatile* and *Schoenoplectus lacustris* (index value 0.77). The evident differences were observed on macrophytes

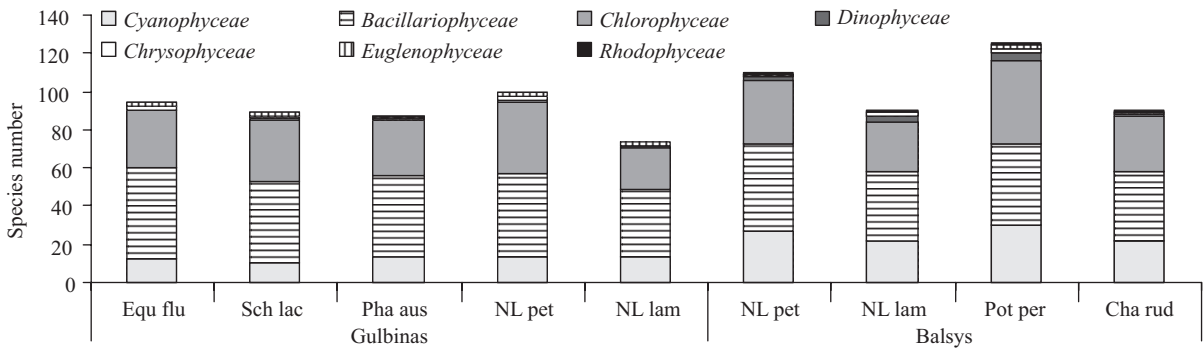


Fig. 2. Epiphyton algae diversity on different macrophytes in lakes Gulbinas and Balsys. Abreviation: Equ flu – *Equisetum fluviatile*, Sch lac – *Schoenoplectus lacustris*, Pha aus – *Phragmites australis*, NL pet – *Nuphar luteum* petiole, NL lam – *Nuphar luteum* lamina, Pot per – *Potamogeton perfoliatus*, Cha rud – *Chara rudis*

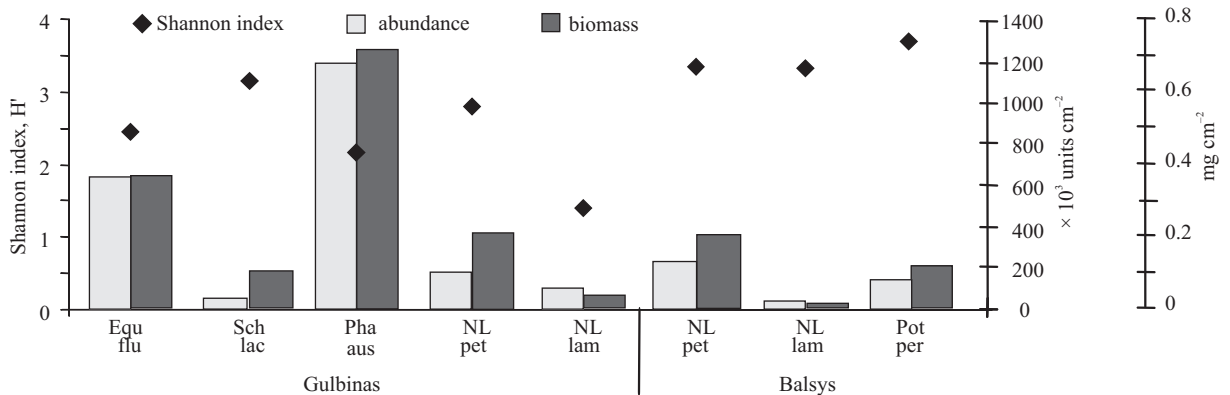


Fig. 3. The Shannon diversity index ( $H'$ ), abundance (units  $\text{cm}^{-2}$ ) and biomass ( $\text{mg cm}^{-2}$ ) of epiphyton algae on different macrophytes in lakes Gulbinas and Balsys (abbreviations as in Fig. 2)

belonging to different ecological groups: nymphs *Nuphar luteum* and helophytes *Phragmites australis* (index value 0.57) as well as potameids *Potamogeton perfoliatus* (index value 0.55).

The Shannon diversity index varied from 1.60 to 3.65 and showed heterogeneity of epiphyton algal communities (Fig. 3). The most diverse assemblages, resulting from a more equitable distribution among species, were found on *Potamogeton perfoliatus* and *Schoenoplectus lacustris*. The lowest index values were determined for epiphyton of *Nuphar luteum* laminae in Lake Gulbinas, where single species cf. *Cyanobium parvum* reached up to 57 % of the total abundance (Fig. 3, Table 3).

Cluster analysis revealed the similarity of algal communities on coarse stem surface of macrophytes *Equisetum fluviatile*, *Phragmites australis* and petioles of *Nuphar luteum* (Fig. 4). These species sup-

ported also the highest abundance and biomass of algae (Fig. 3). Structurally different communities due to low algal amount were assessed on *Schoenoplectus lacustris* and laminae of *Nuphar luteum*. Similar results were determined by McCORMICK & STEVENSON (1998) and SYSOVA (2004). LAUGASTE & REUNANEN (2005) showed three times higher algal biomass on *Phragmites australis* than on petioles of *Nuphar luteum* in Estonian lake also.

Particularly, morphological, anatomical and biochemical features of host plant represents a positive or negative feedback on algae abundance and biomass. GOLDSBOROUGH & HICKMAN (1991) experimentally showed that coarse substrate of macrophytes was densely overgrown with epiphyton. On the contrary, on macrophytes possessing smooth surface algal densities were low (ROOS, 1983; ANTOINE & BENSON-EVANS, 1985). It is in agreement with our results

Table 3. Dominant species (&gt; 5 % of total abundance, biomass) in the epiphyton on different macrophyte species

Lake	Macrophyte	Dominant species	
		% of total abundance	% of total biomass
Gulbinas	<i>Equisetum fluviatile</i>	cf. <i>Cyanobium parvum</i> (Migula) Komárek et al. (36.7 %), <i>Achnanthydium minutissimum</i> (Kützing) Czarnecki (15.3 %), <i>Cymbella microcephala</i> Grunow (8.4 %), <i>Encyonema caespitosum</i> Kützing (6.9 %), <i>Cymbella cistula</i> (6.5 %)	<i>Cymbella cistula</i> (Hemprish & Ehrenberg) Kirchner (41.1 %), <i>C. helvetica</i> Kützing (11.6 %), <i>Tabellaria flocculosa</i> (Roth) Kützing (10.7 %), <i>Encyonema caespitosum</i> (10.7 %)
	<i>Phragmites australis</i>	cf. <i>Cyanobium parvum</i> (36.3 %), <i>Achnanthydium minutissimum</i> (29.3 %), <i>Cymbella microcephala</i> (5.0 %)	<i>Cymbella cistula</i> (25.1 %), <i>C. helvetica</i> (14.2 %), <i>Fragilaria intermedia</i> Grunow (6.8 %), <i>Achnanthydium minutissimum</i> (5.8 %), <i>Tabellaria flocculosa</i> (5.8 %), <i>Encyonema caespitosum</i> (5.5 %)
	<i>Schoenoplectus lacustris</i>	<i>Achnanthydium minutissimum</i> (21.3 %), <i>Cymbella microcephala</i> (11.7 %), <i>C. cistula</i> (8.5 %)	<i>Cymbella cistula</i> (29.2 %), <i>Gomphonema truncatum</i> Ehrenberg (15.8 %), <i>Cymbella helvetica</i> (9.3 %), <i>Tabellaria flocculosa</i> (7.9 %)
	<i>Nuphar luteum petiole</i>	cf. <i>Cyanobium parvum</i> (15.0 %), <i>Achnanthydium minutissimum</i> (27.5 %), <i>Cymbella cistula</i> (7.3 %), <i>C. microcephala</i> (7.1 %)	<i>Cymbella cistula</i> (37.2 %), <i>C. helvetica</i> (15.2 %)
	<i>Nuphar luteum lamina</i>	cf. <i>Cyanobium parvum</i> (57.0 %), <i>Achnanthydium minutissimum</i> (25.8 %), <i>Cymbella microcephala</i> (7.4 %)	<i>Eunotia arcus</i> Ehrenberg (23.9 %), <i>C. cistula</i> (11.7 %), <i>Oedogonium</i> spp. (9.2 %), <i>Achnanthydium minutissimum</i> (7.7 %), <i>Cymbella helvetica</i> (6.0 %), <i>Gomphonema truncatum</i> (6.0 %), <i>Tabellaria flocculosa</i> (5.1 %)
Balsys	<i>Nuphar luteum petiole</i>	<i>Achnanthydium minutissimum</i> (18.1 %), <i>Cymbella microcephala</i> (17.5 %), <i>Leptolyngbya</i> sp. (9.5 %)	<i>Rhopalodia gibba</i> (Ehrenberg) O.F. Müller (11.7 %), <i>Epithemia adnata</i> (Kützing) Brébisson (10.0 %), <i>Mastogloia smithii</i> Thwaites (9.5 %), <i>Eunotia praeurupta</i> Ehrenberg (6.7 %), <i>Cymbella helvetica</i> (5.4 %)
	<i>Nuphar luteum lamina</i>	<i>Achnanthydium minutissimum</i> (18.3 %), <i>Leptolyngbya</i> sp. (8.2 %), <i>Gomphonema subtile</i> Ehrenberg (9.1 %), <i>Cymbella microcephala</i> (6.1 %)	<i>Oedogonium</i> spp. (9.2 %), <i>Cymbella cistula</i> (8.2 %), <i>Rhopalodia gibba</i> (7.0 %), <i>Eunotia praeurupta</i> (6.0 %)
	<i>Potamogeton perfoliatus</i>	<i>Microcystis</i> sp. (13.8 %), <i>Chlorella</i> spp. (13.2 %)	<i>Spirogyra</i> spp. (23.3 %), <i>Cymbella cistula</i> (7.5 %), <i>Zygnema</i> spp. (7.0 %), <i>Rhopalodia gibba</i> (6.8 %), <i>Epithemia adnata</i> (6.7 %)

showing the highest algae abundance and biomass on *Phragmites australis*, *Equisetum fluviatilis* and the lowest on *Schoenoplectus lacustris*. High amount of algae on the helophytes likely was affected by nutrient compounds secretion by host plant also. It was shown that emergent species have a high nutritional value for algal growth (AUCLAIR, 1979; DYKYJOVA, 1979). According to BURKHOLDER (1996) and WETZEL (1996), epiphyton algae can take 25–60 % of phosphorus from their plant hosts depending on species attachment type. All phosphorus amount released by host can be incorporate into new algal biomass (KAIRISALO & UUSI-RAUVA 1983). Low abundance and biomass of epiphyton on *N. luteum* probably related to shading effect of large leaves of nymphs.

Diatoms dominated over other algal groups in epiphyton, especially on helophytes (Fig. 5, Table 3). They were abundant on *Schoenoplectus lacustris* (86.4 % total abundance). In terms of biomass, they prevailed on *Equisetum fluviatile* (95.9 % total biomass) and *Phragmites australis* (95.9 %). High diatom biomass could favour the large amount of dissolved silica in the tissues of reeds (KAIRISALO, 1984; WETZEL, 1996). KOMARKOVA et al. (1983), MESSYASZ & KUCZYŃSKA-KIPPEN (2006) also noted that diatoms easily adaptable to changing light conditions dominated in dense helophyte belts. Mainly loosely attached *Cymbella*, *Gomphonema* species as well as *Achnanthydium minutissimum* prevailed on all types of the investigated aquatic plants (Table 3). Adnate

species *Epitemia adnata*, *Eunotia* spp., *Mastogloia smithii* were more characteristic of epiphyton of *Nuphar luteum* laminae.

Rather high amounts of cyanobacteria and green algae were found on *Potamogeton perfoliatus* and laminae of *Nuphar luteum* (Fig. 5). Filamentous green algae (35.0 % of total biomass), mainly *Spirogyra*, *Zygnema* and *Mougeotia* were characteristic of

epiphyton on pondweed, whereas *Oedogonium* spp. dominated on laminae of *Nuphar luteum* (Table 3). Similarly to our data, LAUGASTE & REUNANEN (2005) found that cyanobacteria prevailed in epiphyton of nymphs and *Potamogeton* species, conjugate green algae were important on the latter also. Other studies (MAKAREVIČ et al., 1986; LALONDE & DOWNING, 1991) showed domination of adnate *Cocconeis* diatoms on pondweed. However, during these studies, it was found that epiphyton of *Potamogeton* largely consisted of planktonic species (61.4 % of total abundance) (Fig. 6). Adnate algae formed very small part of relative abundance (3.1 % of total abundance). Since *Potamogeton* is often encrusted by thick layer of calcium carbonate, it as a substrate is less suitable for algal colonization. Also, CATTANEO & KALFF (1978) found that planktonic species prevailed during the initial colonization by epiphyton, later they were replaced by epiphytic ones.

Overall, dominant epiphyton algal species slightly differed on macrophytes within the studied lakes (Table 3). The differences indicating macrophyte species

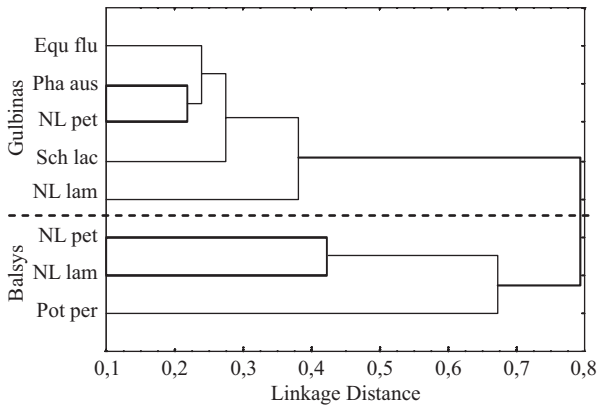


Fig. 4. Similarity of epiphyton algal communities based on algae abundance (abbreviations as in Fig. 2)

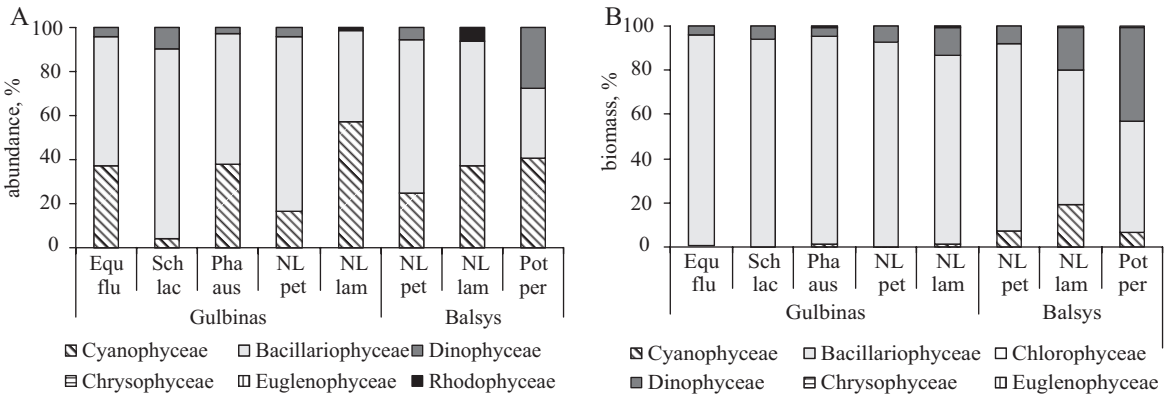


Fig. 5. Variations of algae and cyanobacteria relative abundance (A) and biomass (B) in epiphyton on different macrophytes in lakes Gulbinas and Balsys (abbreviations as in Fig. 2)

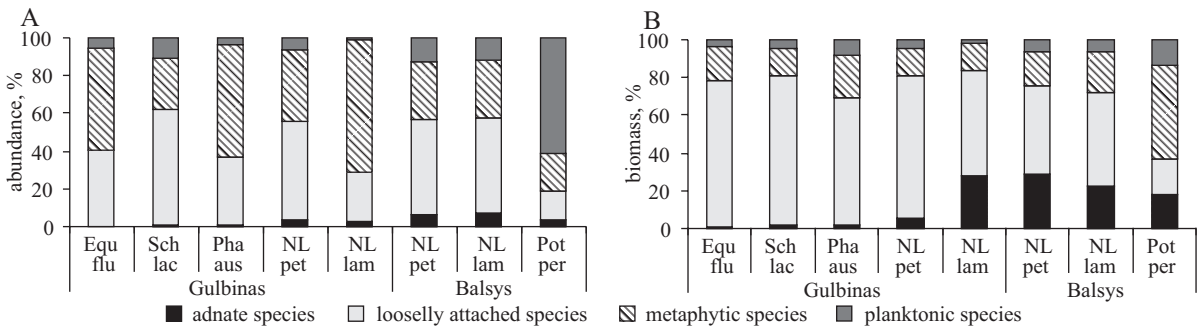


Fig. 6. Species abundance (A) and biomass (B) of different ecological algal groups in epiphyton on the macrophytes in lakes Gulbinas and Balsys (abbreviations as in Fig. 2)

importance for the formation of algal communities were observed in mesotrophic Lake Balsys. WETZEL (2001) indicated that the plant host type has higher effect on epiphyton community formation in infertile lakes, external environmental factors become more important in eutrophic conditions. Furthermore, importance of adnate algae, which are in intimate contact with the host, decreases with the increasing of trophic state in the lakes (BURHOLDER, 1996). The dominance of adnate species (up to 30.9 % of total biomass) in mesotrophic Lake Balsys vs. mesoeutrophic Lake Gulbinas was observed (Fig. 6). In Lake Gulbinas, mainly loosely attached species prevailed on all macrophytes. Adnate species high biomass (up to 28.4 % of total biomass) was found only on laminae of *Nuphar luteum*.

Macrophytes form a specific habitat for epiphyton algae. Morphological peculiarities of stems and leaves, macrophyte density determine penetration of light that is one of the main factors affecting the development of attached algae (KAIRISALO, 1984; MÜLLER, 1995). According to KUZK'ŲO (1988), dense helophytes belts limit epiphyton algae growth ( $r = -0.4$ ;  $p < 0.05$ ). Our results confirmed that macrophyte density (plant number per square metre, macrophyte coverage) influenced epiphyton algae biomass. Two significant relationships between algae biomass on *Phragmites australis* and reed densities ( $r = -0.74$ ;  $p < 0.05$ ) as well as between algae abundance on petioles of *Nuphar luteum* and macrophytes coverage ( $r = -0.53$ ;  $p < 0.05$ ) were ascertained.

In general, morphological, physiological and synecological peculiarities of host plants significantly influenced epiphyton algae abundance and biomass and slightly altered species diversity. Taxonomic composition of algae was rather similar, whereas abundance and biomass differed substantially. Helophytes possessing coarse stem surface (*Phragmites australis*, *Equisetum fluviatile*) were more suitable for dense algal colonization. *Schoenoplectus lacustris*, floating-leaved laminae of *Nuphar luteum* had less marked preference for algae growth. Epiphyton on helophytes was characterized by dominance of diatoms, mainly loosely attached species. Cyanobacteria and green algae were abundant on floating-leaved plants (*N. luteum*) and submerged macrophytes (*Potamogeton potamogeton*). Adnate species were characteristic of epiphyton of *Nuphar luteum* laminae and planktonic ones of pondweed. Differences

in algal ecological groups distribution concerned likely with lakes trophic state than macrophyte species. Epiphyton in mesoeutrophic lake associated with loosely attached species that dominated on all investigated macrophytes. Macrophyte as substrate specificity was more expressed in mesotrophic lake, where adnate algae amount was higher.

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## SKIRTINGŲ MAKROFITŲ RŪŠIŲ EPIFITONO DUMBLIŲ BENDRIJŲ FORMAVIMOSI YPATUMAI

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### Santrauka

Epifitono dumblių struktūros tyrimai ant šešių skirtingų ekologinių grupių makrofitų rūšių, helofitų (*Phragmites australis*, *Schoenoplectus lacustris*, *Equisetum fluviatile*), nimfeidų (*Nuphar luteum*), potameidų (*Potamogeton perfoliatus*), limneidų (*Chara rudis*), surinktų Gulbino ir Balsio ežeruose, atlikti 2001–2006 m. liepos–rugpjūčio mėn. Makrofitų rūšių biologiniai savitumai nulėmė epifitono dumblių produktyvumo rodiklius ir nežymiai rūšių įvairovę. Didžiausios dumblių gausumo (iki 1,2 mln. vnt./cm<sup>2</sup>) ir biomasės (iki 0,60 mg/cm<sup>2</sup>) vertės nustatytos helofitų *P. australis*, *E. fluviatile* epifitone, mažiausiu produktyvumu išsi-

skyrė epifitonas ant *S. lacustris* ir *N. luteum* lapalakščių. Ženklius dumblių gausumo ir biomasės skirtumus ant įvairių makrofitų rūšių manoma sąlygojo augalų anatominės, morfologinės bei biocheminės savybės. Titnagdumbliai vyravo ant helofitų, melsvabakterės ir žaliadumbliai, dažniausiai siūlinės rūšys, – ant *N. luteum* lapalakščių ir *P. perfoliatus*. Makrofitų formuojamų bendrijų savitumai, lemiantys šviesos praskverbimą į vandens sluoksnius, taip pat sąlygojo dumblių vystymąsi. Nimfeidų projekcinis padengimas ir nendrių stiebų tankumas turėjo neigiamą įtaką epifitono dumblių produktyvumui.