7. VASCULAR PLANTS, PERIPHYTON AND FILAMENTOUS ALGAE

(Teresa Ozimek)

Littoral vegetation of Lake Flosek forms a 0.2–0.5 m wide belt spread out along 60% of the shoreline and bordering on the water table (Phot. 1). The belt is overgrown by *Caricetum limosae* Br.-Bl. 1921 consisting of *Sphagnum cuspidatum* Schimp., *Carex limosa* and *C. lasiocarpa* Ehrh. Beyond the belt, patches of *Rhynchosporetum albae* Koch. 1926 occur. These also are formed by mats of *S. cuspidatum* overgrown by *Drosera rotundifolia* L., *Rhynchospora alba* L. (Vahl.), *Menyanthes trifoliata* L. and *Comarum palustre* L. In the furthest distance from the water table (in the northern part), phytocenoses of *Sphagnetum mediorubelli* Schwick. 1933 occur consisting of the mat of *Sphagnum magellanicum* Bird. and *S. rubellum* Wils. as well as *Oxycoccus quadripetalus* Gilib., *Andromeda polifolia* L., *Ledum palustre* L. and *Eriophorum vaginatum* L. There are also single dwarf pines (*Pinus silvestris* L.). Observations made during 3 years of the studies have shown that the above phytocenoses occurred in the same places. No increment was found in the moss mat surface area, nor its spreading over the water table. Water conductivity inside the peatmoss mat has been maintained at the level of 30 μS cm^{-2}, and pH at 4.5–5.0.

Vascular plants of Lake Flosek littoral are very scarce. Among emerged macrophytes, *Phragmites australis* (Cav.) Trin ex Steudel occurs sporadically, and one patch of *Schoenoplectus lacustris* (L.) Palla of an area of about 10 m^2 is present. Macrophytes with floating leaves are represented by small patches of *Nymphaea alba* L. covering about 2% of the lake area. Submerged macrophytes do not occur.

Characteristic component of littoral vegetation of Lake Flosek are periphyton algae growing on submerged tree branches and occurring wherever the branches are present. This community is mainly formed by *Tolypothrix tenuis* Kütz. constituting over 95% of periphyton biomass (Fig. 13). Sporadically, the species is accompanied by algae of the genera *Eunotia, Closterium, Cosmarium, Staurastrum* and *Mougeotia*. The community occurs throughout the year (also under ice) with unchanged composition. Biomass of *Tolypothrix tenuis* attained maximum in summer in both years of the studies (Fig. 13).

As *Tolypothrix tenuis* belongs to nitrogen-fixing species (Kawecka and Eloranta 1994), periphyton algae dominated by this species may enrich waters of Lake Flosek in nitrogen. There are no data available concerning occurrence of this species in acidic lakes. It is known to occur in periphyton of oligotrophic lakes (e.g. Tahoe lake, according to Reuter *et al.* 1983). Some experimental data (Ozimek, unpublished data) have suggested that the species may utilise simple organic compounds released from the colonised substrate, i.e. tree branches, as a source of carbon.

Community of filamentous algae suspended in the water mass, so called metaphyton (Turner *et al.* 1995), is widely distributed along the shoreline of Lake Flosek, and forms a belt 2–10 m wide and 1.5 m deep. In April and June 1992, it covered 5% and 30% of the lake surface area, respectively. It is noteworthy that the community is almost entirely composed of the genus *Mougeotia*. Small-sized planktonic *Desmidiaceae* occurred sporadically. The community is not so stabile as the previously described periphyton. In 1992, algae of the genus *Mougeotia* were abundant and reached from 0.5 to 2.5 g of biomass dry weight l^{-1} (Fig. 14). In 1993 the algae were scarce (below 0.01 g l^{-1}) and occurred in few places on less than 0.01% of the lake surface area, whereas in spring 1994 they again occurred in large numbers (Fig. 14).

Filamentous algae of the genus *Mougeotia* have been regarded as indica-

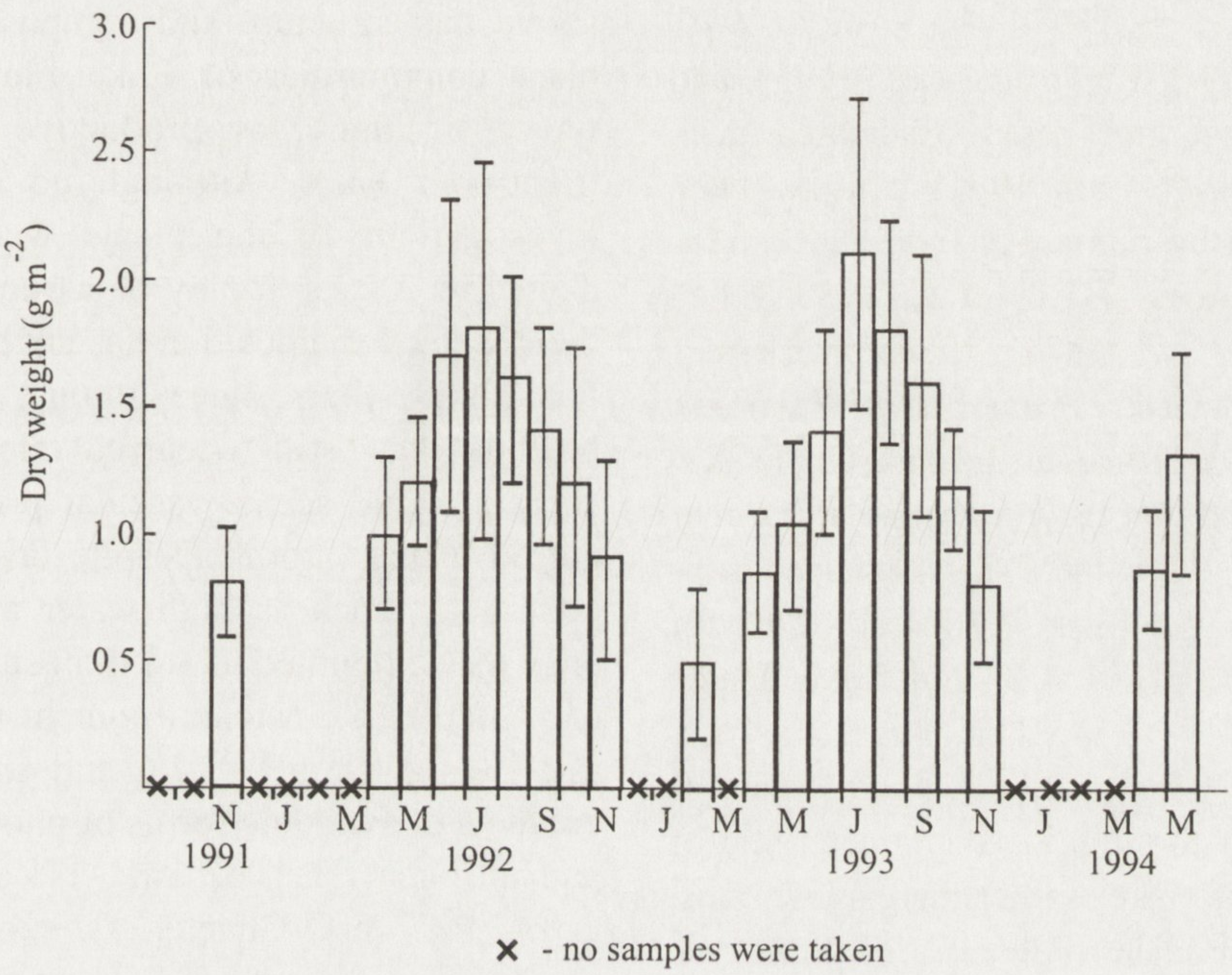

Fig. 13. Biomass dynamics of periphyton algae *Tolypothrix tenuis* (mean ± SD, n = 20) attached to submerged branches in Lake Flosek

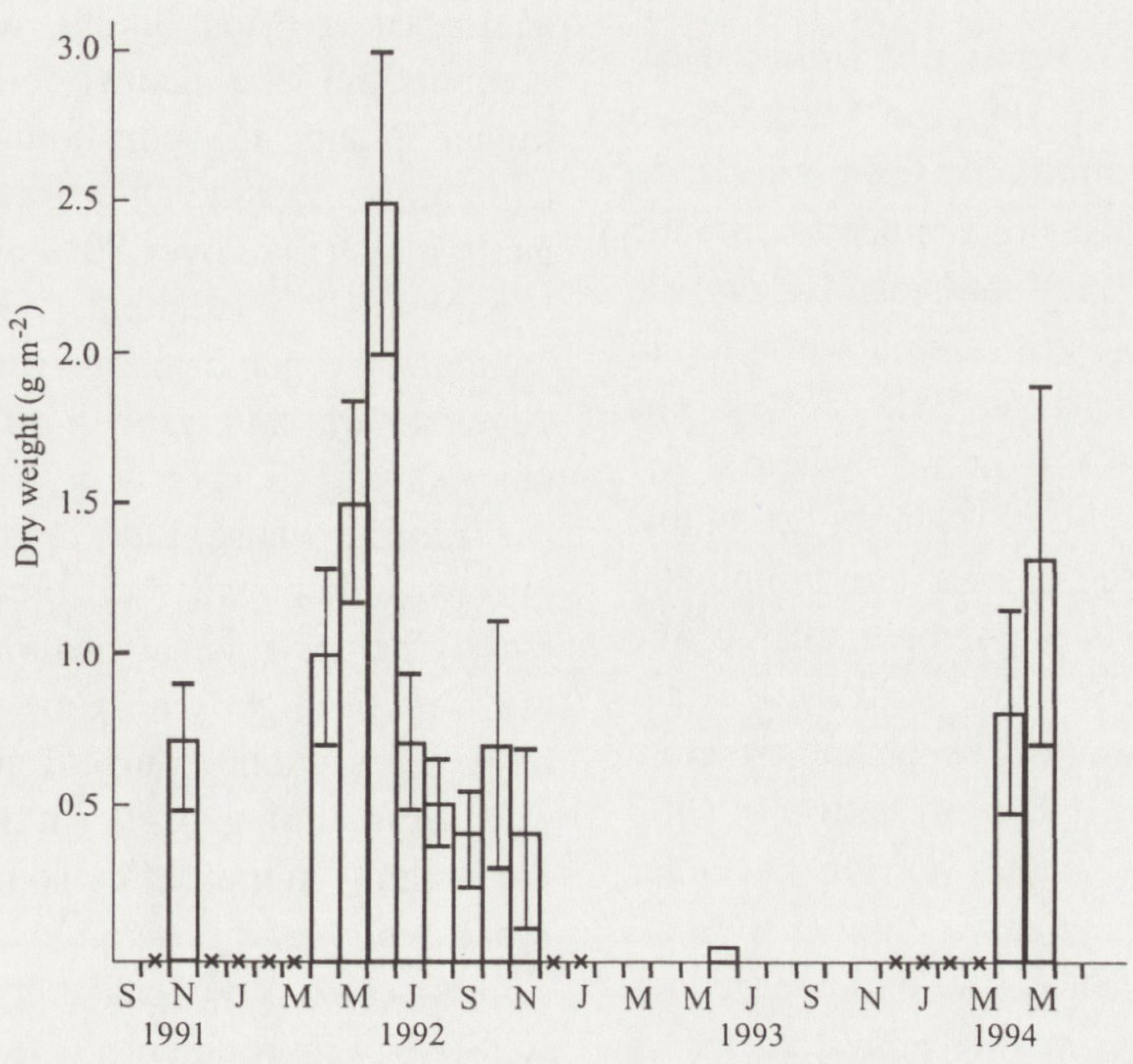

Fig. 14. Biomass dynamics of filamentous algae *Mougeotia* (mean ± SD, n = 20) in Lake Flosek. Crosses – months in which no samples were taken; remaining months with no bars denote lack of the algae.

tory species for waters of 5–6 pH (Grahn *et al.* 1974, Lazarek 1979, Olem 1991, Turner *et al.* 1995), and hence these are often associated with acidic lakes (Olem 1991). This has been confirmed by numerous field and experimental studies (Hall *et al.* 1980, Brezonik *et al.* 1984, 1986, Jackson 1985, Schindler *et al.* 1985, Stokes *et al.* 1989). However, Eloranta (1982) has claimed that the genus may also occur at higher pH value. This has been supported by unpublished Ozimek's data for Lake Kuc (pH = 8.6) and Lake Majcz Wielki (pH = 8.3) where this genus predominates among filamentous algae. It seems that the algae are characteristic of oligotrophic lakes rather than acidic ones, because of fairly high ratio of photosynthesis to respiration at higher temperatures and oxygen concentration (therefore found in shallow sites) and DIC concentrations (Turner *et al.* 1995). Moreover, the high production to respiration rate is maintained at lowered pH (*ibid.*). Seasonal variation in *Mougeotia* biomass in Lake Flosek exhibits a pattern similar to those in other lakes of temperate climatic zone (e.g. in Lake Gardsjön, Lazarek 1985). However, year-to-year variation in *Mougeotia* biomass in Lake Flosek was very high. It is not known whether the changes are cyclic or random. Attempts to relate these changes to environmental factors, such as spring temperatures of the water (decisive for new growth) or water chemistry have failed, because the factors exhibited no differences between 1992 and 1993 (cf.: Chapter 4). On the other hand, *Mougeotia* mats is known to alkalise the site. It cannot be excluded that a rapid drop in pH in July 1992 (cf.: Fig. 4 and Chapter 4) following a rise in preceding months relates to a decrease in biomass of these algae (Fig. 14).

Conclusion may be drawn from the above that structure and composition of plant communities of Lake Flosek are typical of humic, low-productive and nutrient-poor lakes. Although no detailed investigations of the plants were conducted in 70-ties, it may be assumed that their species composition has not changed for 22–23 years since liming. Raised peatbog has still occurred along the shoreline, and scarce vascular plants occurred in the littoral. Despite favourable conditions, such as high water transparency (SD amounted to 3.5 m in summer – cf.: Chapter 4), calcium content exceeding 10 mg l^{-1}, pH = 7.6 and sufficient contents of available forms of phosphorus and nitrogen (Hillbricht-Ilkowska *et al.* 1977 and Chapter 4), submerged plants have not occurred. There were no pond-weeds (*Potamogeton*), the genus that invaded limed lakes in Adirondack in USA (Weiher *et al.* 1994), nor *Utricularia* genus typical of humic, weakly acidic lakes. Most likely, a factor that prevents the lake against colonisation by higher plants is semi-liquid sediments containing considerable fraction of organic matter, i.e. over 80% of dry weight (Chapter 10). Sediments of such high content of organic matter usually inhibit development and growth of submerged macrophytes (Balls *et al.* 1989).

Liming cause Lake Flosek to split into two "chemically" different zones: the clearly acidic zone of peatmoss mat and the zone of slightly alkaline waters. This has been maintained up till now. This results from liming itself (in 1970) and is presumably supported by some biological processes. Hydrogen ion excretion with simultaneous Ca^{2+} uptake by *Sphagnum* acidifies environment (Craige and Maas 1966), whereas intensive assimilation of carbon dioxide by planktonic and filamentous algae alkalises water

(Kawecka and Eloranta 1994). Furthermore, Nyman (1990) has found that the low pH of *Sphagnum* habitat causes peatmoss to trap phosphorus released through organic matter decomposition. Thereby, constant occurrence of the peatmoss mat would be a factor separating the two habitats and maintaining oligotrophic nature of the lake.

According to Podbielkowski and Tomaszewicz (1979), peatmoss mats may expand over water table very fast, at a rate up to 10 cm per year (Grahn *et al*. 1974). Meanwhile, the mat has not spread over Lake Flosek nor surface area of the water table decreased significantly since 1974. This indicates that the process, if any, is very slow. *Sphagnum* is known to have disappeared from many acidic lakes and their drainage basins after liming (Eriksson *et al.* 1980, Stenson 1985, Kelly 1991, Hagley *et al*. 1996), and the process is usually very rapid. This occurred, for example, in the Loch Fleat in Scotland already after 18 months since the treatment (Brown *et al*. 1988).

Peatmosses of Lake Flosek belong to oligotrophic species, such as calciphobes or acidophytes (Kornaś and Medwecka-Kornaś 1986). According to Clymo (1973) after Kelly (1991), a combination of pH above 6 and calcium content over 10 mg l^{-1} is lethal for majority of *Sphagnum* species. In Lake Flosek, the values are even higher. In the case of Lake Flosek, liming slowed down or even inhibited peatmoss spreading over the lake surface and, at the same time, did not influence adjacent habitats to a degree as to degenerate raised peatbogs, with their valuable biodiversity.