MONITORING SUCCESSIONAL AND OTHER CHANGES IN WETLAND PLANT COMMUNITIES

Štěpán Husák & František Krahulec

Abstract

The paper recommends long-term monitoring with regular documentation of all events that may influence the living ecosystem compartments of the wetlands studied. This enables: (1) detection of undesirable changes caused by human activities, (2) detection of cyclic changes with different frequencies, (3) determination of successional trends, and (4) detection of unpredictable rare events which may be of enormous ecological importance. This holds for rivers, river alluvia and reservoirs as well as fishponds, bogs and fens.

Husák, Š. & F. Krahulec: **Monitoring von sukzessionsbedingten und anderen Änderungen in den Pflanzengesellschaften von Feuchtgebieten**

Der Artikel empfiehlt Langzeit-Monitoring mit regelmäßigen Dokumentationen aller Ereignisse, die Bereiche von untersuchten Feuchtgebietsökosystemen beeinflussen. Das ermöglicht: (1) das Erkennen unerwünschter Veränderungen, die durch menschliche Aktivität verursacht werden, (2) das Erkennen zyklischer Veränderungen mit unterschiedlichen Frequenzen, (3) die Bestimmung von Trends in Sukzessionen, und (4) das Erkennen unvorhersehbarer seltener Ereignisse, die von großer ökologischer Bedeutung sein können. Das gilt für Flüsse, Überschwemmungsgebiete und Staue ebenso wie für Fischteiche, Moore und Feuchtwiesen.

Husák, Š. & F. Krahulec: **Monitoring sukcesních a jiných změn u mokřadních rostlinných společenstev**

Práce doporučuje dlouhodobý monitoring s pravidelnou dokumentací všech jevů, které by mohly mít vliv na živou složku sledovných mokřadů. Tím lze: (1) postihnout nežádoucí změny způsobené činností člověka, (2) zjistit cykly změn a jejich frekvenci, (3) stanovit směry sukcese a (4) zjistit nepředvídatelné události se zvlášť významným vlivem. Platí to jak pro řeky a říční nivy, tak pro přehradní nádrže, rybníky, rašeliniště a slatiniště.

INTRODUCTION

Long-term monitoring of ecological systems can result in: (1) detection of undesirable changes caused by human activities, (2) detection of cycles with different frequency, (3) determination of successional trends and (4) detection of unpredictable rare events which may be of enormous ecological importance.
All these possibilities should be considered at the beginning of ecological monitoring and mainly during the interpretation phase.
The determination of these phenomena is possible provided the monitoring is based on a careful and systematic (regular) sampling scheme. It should not be biased in favour of any present paradigms - any bias limits the possibilities of interpretation of data collected in ways other than within the framework of the accepted paradigm. Unfortunately, in the past, most of the data were not collected systematically: preferences were usually given to some (often small) taxonomic groups or environmental factors, collection was repeated irregularly, often without precise geographic determination, etc.. These facts limit the possibility of using earlier data for the detection of rather inconspicuous phenomena. On the other hand, the data collection should be sufficiently flexible to react to unpredictable events, such as the invasions of new organisms.
In our contribution we intend to describe the present status of monitoring of selected wetland habitats in the Czech Republic, and demonstrate our experience from long-term successional studies.

RIVERS AND RIVER ALLUVIA

It is generally accepted that in most rivers water quality, and often also quantity, has greatly changed. However, the changes in water plant communities are hardly documented (only irregularly collected floristic data are available). This situation changed in the late 1970s and during the 1980s when J. Rydlo with his colleagues published a series of papers carefully describing the distribution of macrophytes along the following rivers of the Czech Republic:
Labe (NOVÁKOVÁ & RYDLO 1978, 1981a,b, RYDLO 1987, RYDLO & JOHANISOVÁ 1983); **Loučná** (RYDLO 1983); **Sázava** (RYDLO 1993); **Berounka** (RYDLO 1986, RYDLO 1994a); **Pšovka** (RYDLO 1988); **Lužnice** (HUSÁK & RYDLO 1992); **Cidlina** (RYDLO 1990); **Mdlina** (RYDLO 1991); **Ohře** (PIVOŇKOVÁ & RYDLO 1992); **Lower Vltava** (RYDLO 1989); **Morava** to Lanžhot (RYDLO 1992); **Otava** (RYDLO 1994b).
This dataset provides an excellent opportunity to compare different river systems, and also a good basis for repeated observations and detection of changes. We consider this contribution important because it describes the whole river course with the resolution scale of 0.5 km (Figs. 1-4).
Perhaps the most negative changes have been to streams and their floodplains. We were not always able to record the actual state prior to the straightening and canalization of streams, and scarcely ever could we monitor the development of living nature both in the new river bed and the separated backwaters. Most streams in the Czech Republic have been regulated. The oxbows, backwaters as well as dikes (levées) are along the main stream of the Morava river, see Fig. 5.

For monitoring the changes, the following is needed:
1) If possible, to study at the shortest possible intervals all abiotic and abiotic components of the ecosystems.
2) To assess what are appropriate intervals for monitoring. This depends on several factors such as:
 a) timeliness, the relevance of natural changes (e.g. flooding, alluvial sediment deposition, damage to river banks); or man-made changes (e.g. classical engineering with canalization, straightening of streams, and other waterworks)

b) careful definition of both the number and quality of criteria applied under normal conditions (without conspicuous changes); monitoring of changes in river beds and banks can be done only once per season, possibly every 5 or 10 years.

In inundated river areas it is important to observe dynamic changes of the vegetation every year and, if possible, several times during each season.
Single-term studies on vegetation of alluvial waterbodies are not rare (ADAMEC et al. 1993, ČERNOHOUS & HUSÁK 1986, OTAHELOVÁ & HUSÁK 1986, and many others).

RESERVOIRS

Various aspects of succession in artificial reservoirs were reviewed by BAXTER (1977, 1985), BAXTER & GLAUDE (1980), and GODSCHALK & BARKO (1987). Most attention was paid to classical limnological problems (for former Czechoslovakia see e.g. HRBÁČEK 1981), while the few studies devoted to macrophytes were only descriptive. The reviews mentioned above and our own experience illustrate that new reservoirs are quickly developing systems which differ in many respects from old stabilized water bodies (lakes and fishponds) particularly by their rapidly changing trophic conditions (leaching of nutrients from flooded vegetation and soil) and by species-unsaturated communities.
In this century, a number of large shallow reservoirs has been built in Central and Eastern Europe. They have served as suitable areas for successional studies. Succession of macrophytes was studied mainly in the former USSR, in reservoirs on the Volga river (BELAVSKAJA & KUTOVA 1966, EKZERCEV 1961, 1966, KABANOV 1959, etc.) and on the Dniepr river (ZEROV 1976). In Central Europe, the most complex study was done on the reservoir at Goczalkowice (Vistula river, Poland) - see the complex survey in KRZYŽANEK et al. 1986, and the special issue of Ekologia Polska (34/3, 1986). Some reservoirs with macrophytes were also studied in our country, mainly in Moravia (ŠEDA 1963, 1967, 1976, 1987, HETEŠA & MARVAN 1984, HUSÁK 1984a,b, HETEŠA & HUSÁK 1986). Only partial studies were made in Germany (RICHTER 1974, WESTHUS 1987). Detailed studies on the influence of fluctuating water level were made in Sweden (NILSSON 1981, DANELL & SJÖBERG 1982, GRELSSON 1987).
The Rozkoš reservoir is unique in several respects when compared with other reservoirs in Central and Eastern Europe. A detailed study of flora and vegetation had been made in it before it was filled (KRAHULEC 1975, 1981) and the vegetational succession has been studied since its filling (KRAHULEC, LEPŠ & RAUCH 1980, 1984, 1986). The colonization of a new reservoir by plant species absent in the area before the flooding showed that some plant species move relatively easily through Central Europe, but an important factor is "filtering" by existing communities (KRAHULEC, LEPŠ & RAUCH 1987, KRAHULEC & LEPŠ 1993). A recent review on case studies of plant migration (SAUER 1989) does not mention any comparable study on the colonization of a new reservoir.
During more than 20 years study of succession we have observed several phenomena that have been, according to our opinion, underestimated or incorrectly interpreted in short term studies. In the present paper we briefly mention the following phenomena:

(1) in the period following the filling, the change of the dominant species was rapid; the sequence of individual dominants seems to be regular when we compare our data with observations from a number of reservoirs, especially from those of the upper Volga and Dniepr rivers and with the reservoir at Goczalkowice (KRAHULEC et al. 1980);

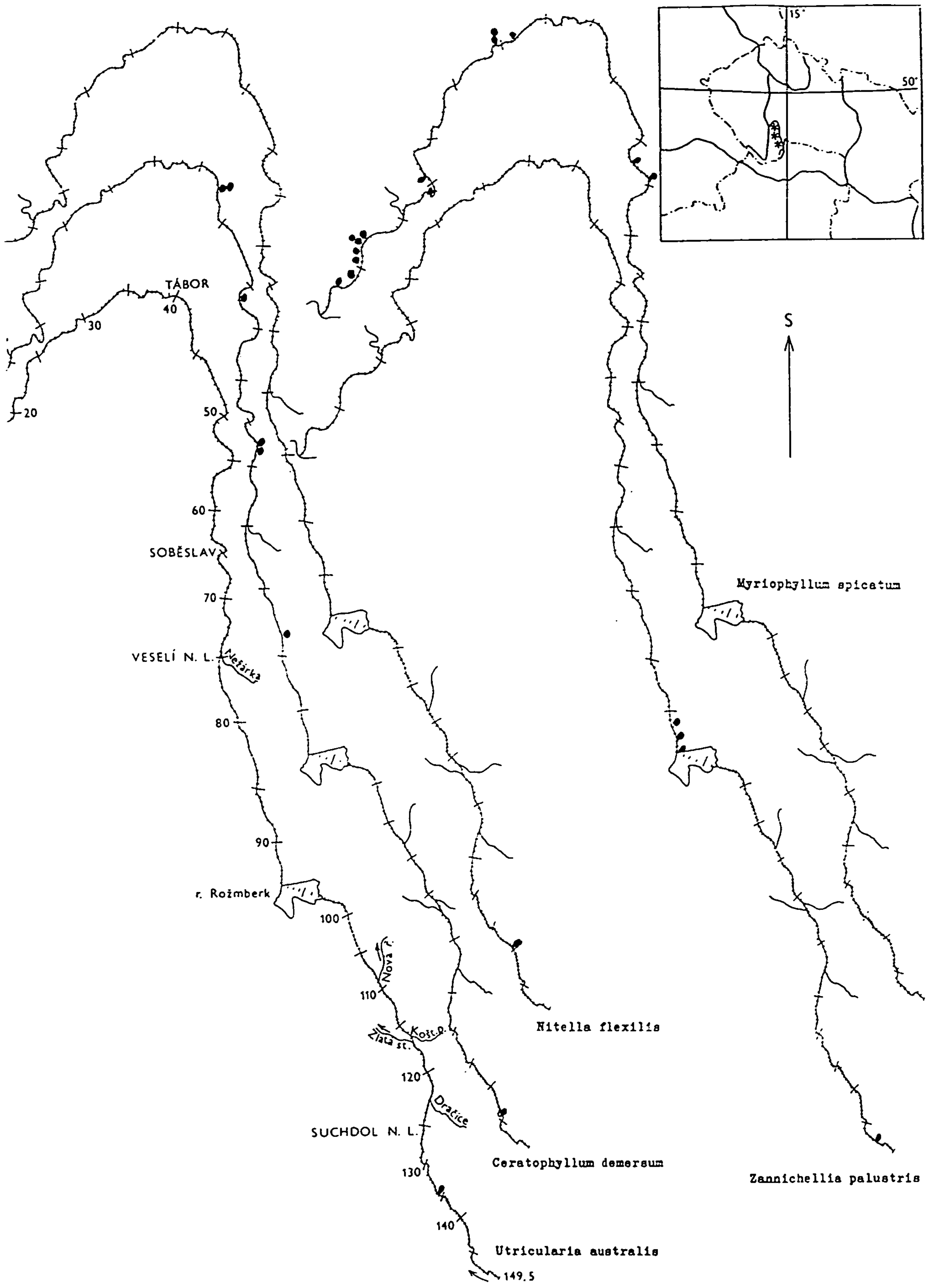

Fig. 1. Distribution of aquatic macrophytes in the Lužnice river (after HUSÁK & RYDLO 1992).

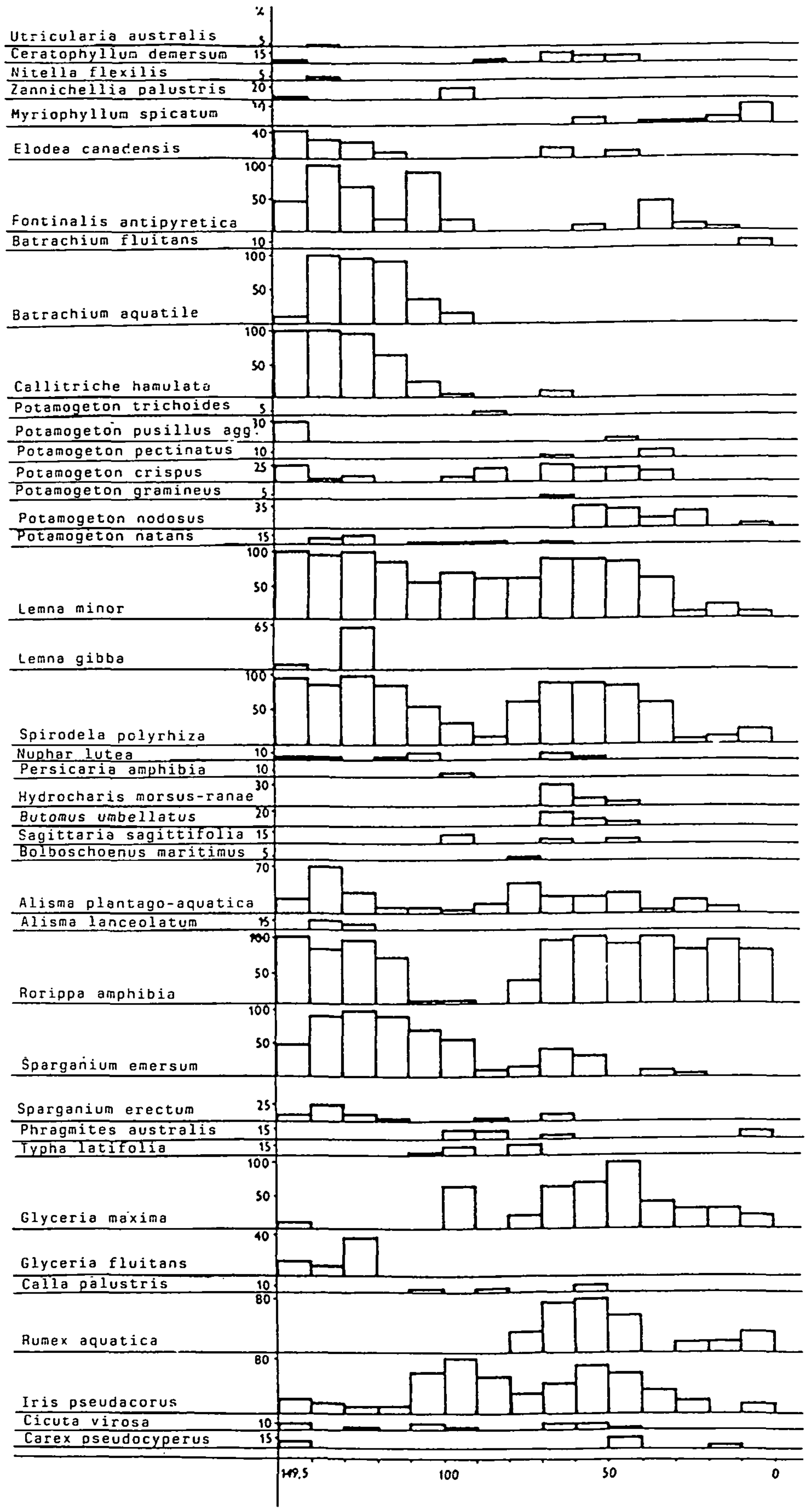

Fig. 2. Incidence of species in ten kilometer segments of the Lužnice river (from Czech-Austrian border, 149.5 km, to the confluence with Vltava river) (after HUSÁK & RYDLO 1992).

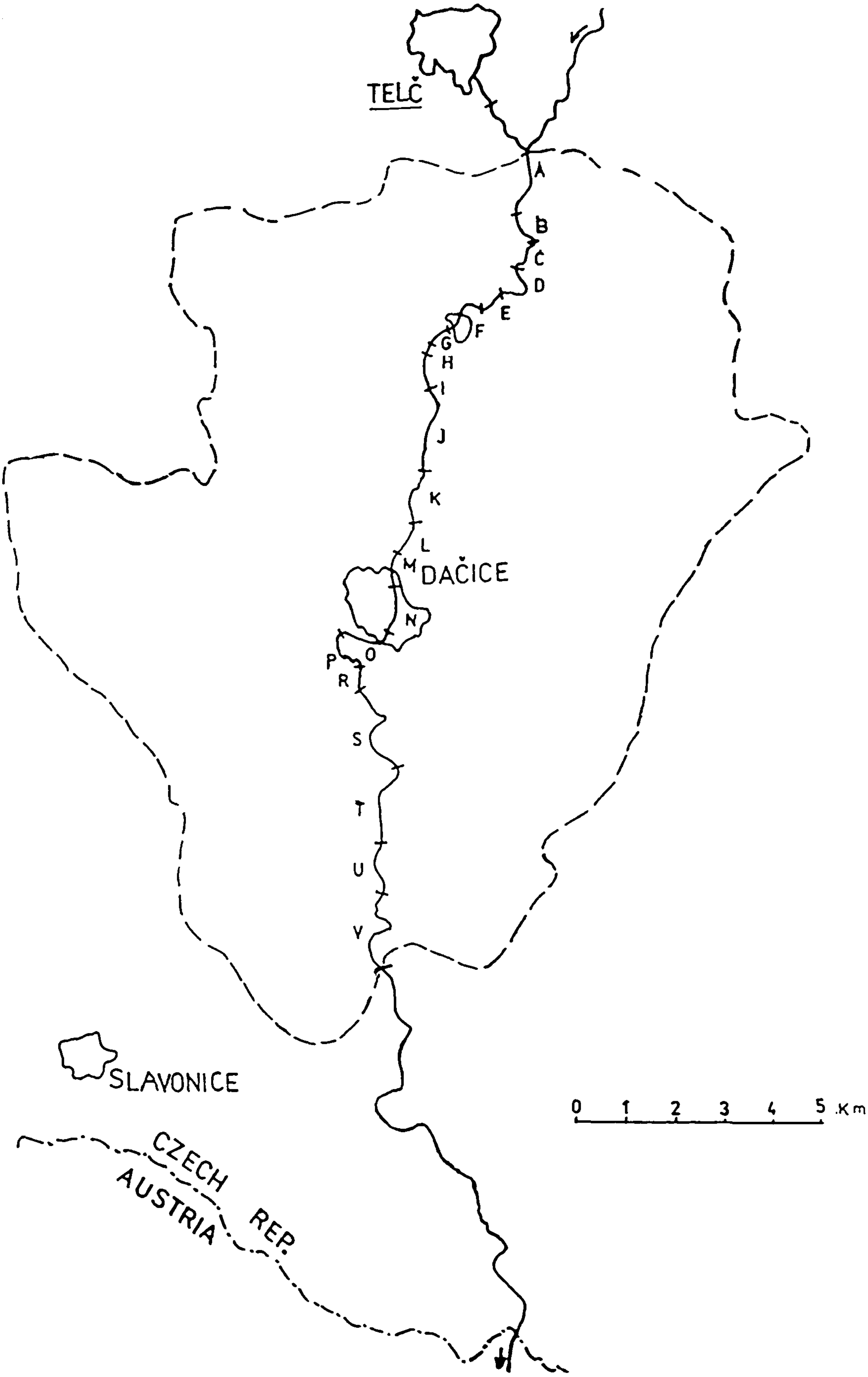

Fig. 3. Catchment area of Moravská Dyje river in the region of Dačice. River segments from A to V had a similar length, as in the case of Lužnice river.

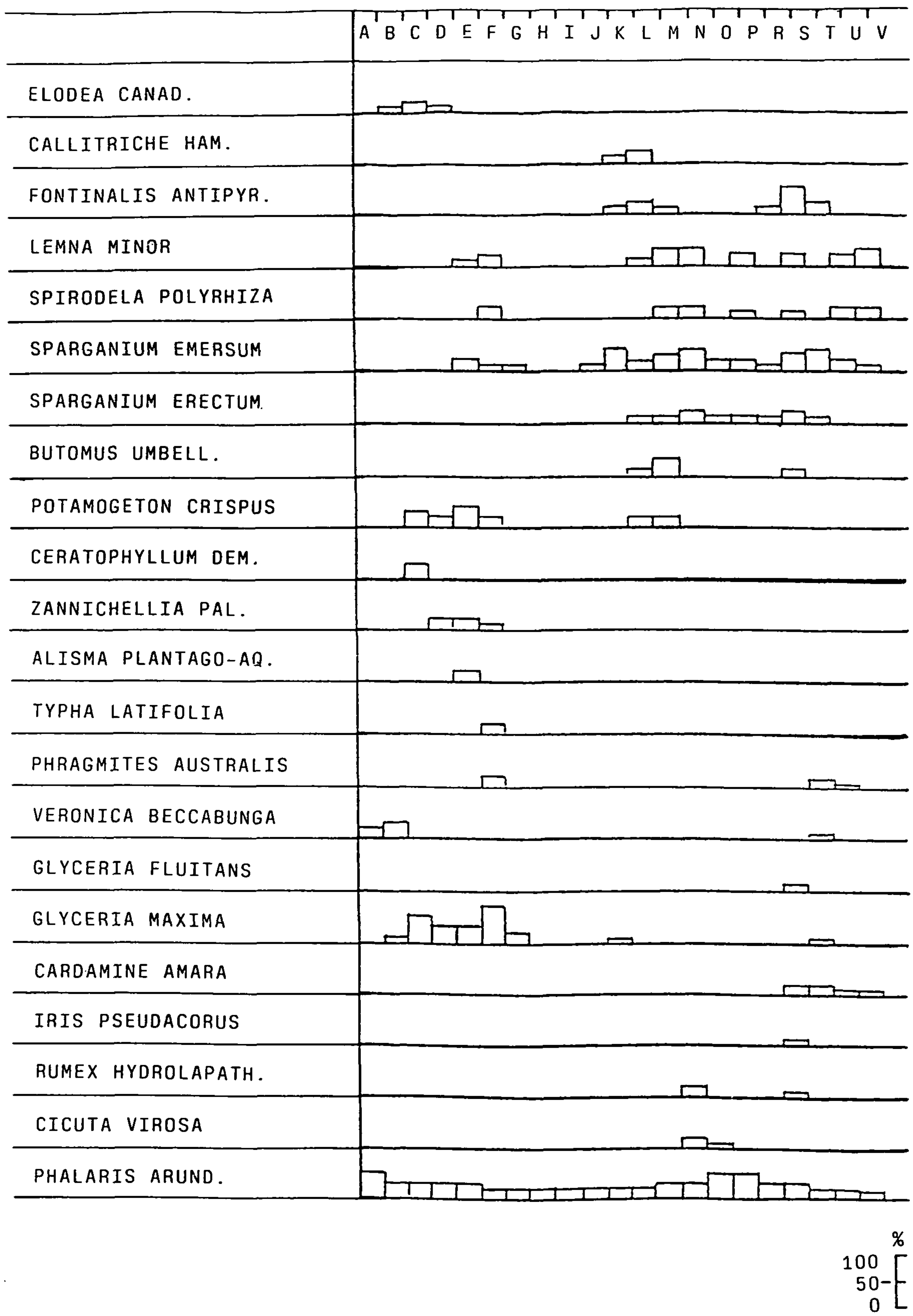

Fig. 4. Estimated representation of plant species in selected river segments (A-V) in terms of percentage cover of the bottom or banks of the Moravská Dyje river (in collaboration with V. Vořechovská, Morava river Authority, Brno).

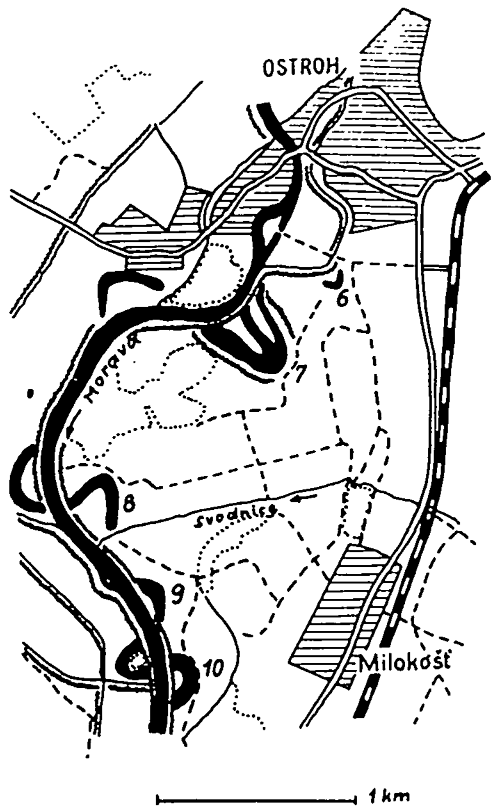

Fig. 5. Channelised Morava river between Ostroh and Milokošť villages (oxbows: 6 Ostrožská tůň, 7 Okasovo rameno, 8 Strnadlova šlajza, 9 Vítovské rameno, 10 Vláky).

(2) in the period after the filling, different macrophytes regularly grow at unusual depths - this phenomenon is related to the high water transparency (to several meters) caused by a low density of fish population. The macrophyte production is extremely high and not fully comparable with stabilized old water bodies;

(3) in the first years following the filling, there was a pronounced effect of selective grazing by waterfowl on the establishment of different shoreline species, especially *Phragmites*;

(4) during 21 years after the flooding, we observed 25 species which migrated into the reservoir, several times we observed cases that the nearest localities of these species were more than 50 km distant. Most of these occurrences were not successful, but several species formed viable populations (KRAHULEC & LEPŠ 1993). These observations suggest that mobility of species at the landscape level is much higher than it is usually thought;

(5) we observed different responses of individual species of trees and shrubs to long-lasting flooding (different lengths of the periods of survival and differences in adventitious root formation - see KRAHULEC et al. 1980); two specimens of *Salix purpurea* and *Salix cinerea* had living leaves and branches above water in 1982, i.e., they survived 10 years of continuous flooding at the depth of more than 2m! Similar resistance was described only once, for *Salix nigra* in the USA (GILL 1970);

(6) the observation of the dynamics of individual species led us to the re-interpretation of different species grouping in the process of synthesis of phytosociological data obtained in the communities of emerged shores (KRAHULEC et al. 1984).

FISHPONDS

Analyses on the bottom surface in periodically discharged fishponds during their summer-drainage period, or when the fishponds are only partially filled and their margins are emerged have been made by PRACH et al. 1987, LEPŠ et al. 1990, etc.. From a long-term point of view there is a need to study different succession series in the vegetation of fishponds which are

(a) subject to intensive management, especially to periodic mechanical cleaning which blocks the succession and prevents overgrowing and filling of the ponds;

(b) subject to extensive management or are abandoned or are "sky-fed", i.e., supplied irregularly or insufficiently mainly with rain and snow water.

In the latter case, the course of succession corresponds more or less to the changes in natural conditions. Long-term monitoring of fishpond vegetational succession in the water and littoral zones of fishponds in the

Czech Republic has yielded explicit information on the uniformity and on the increasing tendency towards uniformity of the fishpond vegetation. S. HEJNÝ has made a nearly continuous description of the vegetation for 120 fishponds in Southern Bohemia from 1949 up to recent times. Unfortunately, his data are still awaiting a thorough evaluation. Only the most important changes in the occurrence of various community types in the fishpond system have been published (HEJNÝ 1990).
One of the parameters that are important for macrophytes in oligotrophic water is water transparency. Intensification of fishpond management (especially enormous fertilization) has resulted in the extinction of submersed macrophyte vegetation in many fishponds of Třeboň region (Fig. 6) during the last 20 years.

PEATLANDS

For monitoring succession in peatlands the most important parametres are the fluctuations of moisture content and groundwater table in the soil, the impact of nutrients from arable land or meadows, and other disturbances such as peat extraction or bog fires (during dry periods) (PODBIELKOWSKI 1960, HALD & PETERSEN 1988, ZOBEL 1988).

DISCUSSION

Long-term studies were identified as necessary for a good understanding of ecological systems (see a number of contributions in the book by LIKENS 1989). Especially, four categories of phenomena and subjects requiring these studies were identified: processes involving gradual change, long-term life history phenomena, ecological phenomena affected by rare or intermittent events, and interannual variability in ecological systems (PACE & COLE 1989). However, to distinguish between gradual change and cyclic changes

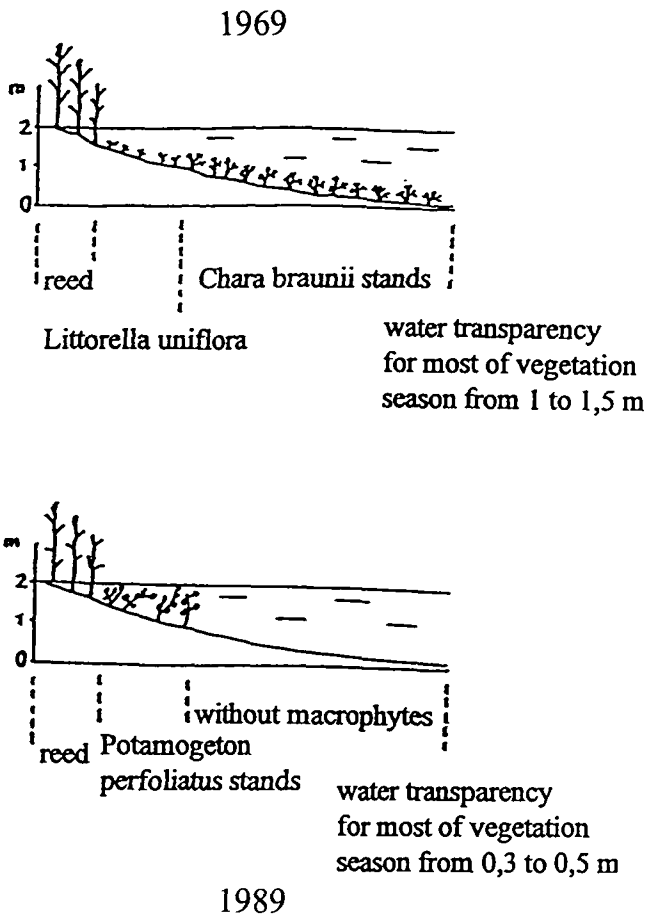

Fig. 6. Disappearance of the vegetation typical of oligo-mesotrophic fishponds (*Littorella uniflora* stands) in the period 1969-1989. Svêt fishpond at the edge of Třeboň is a typical example of subsequent changes of previous vegetation.

with different lengths of cycle is not easy. In this respect, we feel that we need some long-term studies of different systems to have a firm basis for comparisons of short-term data and their correct evaluation. The present knowledge of succession is based more on deductions from short-term observations than on direct long-term observations. Fortunately, succession in wetlands can often be reconstructed, because of different sediments (e.g. peatbogs, lake sediments). However, it is not known if there is a limited number of successional pathways or just one. However, the firmly known successional series started at least under different climatic conditions. For this reason, it is questionable to use them for making predictions. All successional and cyclic processes should be considered when evaluating observed ecological change.

A special problem, which has not been sufficiently monitored, is the invasion and penetration of new plant species (neophytes) such as *Impatiens* spec. div., *Solidago* spec. div., *Aster* spec. div., *Reynoutria japonica* and *R. sachalinensis*, *Rudbeckia laciniata*, and *Acer negundo*.

Monitoring of rivers and river alluvia in Central Europe shows a gradual retreat from excessive technical demands on the drainage of water from the landscape and in flood protection. Maps from the last century or from the beginning of this century are now often used as a basis for revitalization of rivers or their segments, where it is possible (e.g., the Rhine in Germany and France, CARBIENER & ORTSCHEIT 1987, DISTER et al. 1990). Also the rivulets and streams which have been straightened and canalized rather recently will need to be brought back to their near-natural state and exposure to the effect of natural water flow.

REFERENCES

ADAMEC, L., Š. HUSÁK, G.A. JANAUER & H. OTAHELOVÁ (1993): Phytosociological and ecophysiological study of macrophytes in backwaters in the Danube river inundation area near Palkovičovo (Slovakia). Ekológia **12**: 69-79.

BAXTER, R.M. (1977): Environmental effects of dams and impoundments. Ann. Rev. Ecol. Syst. **8**: 255-283.

BAXTER, R.M. (1985): Environmental effects of reservoirs. In: GUNNISON, D. [ed.], Microbial processes in reservoirs. Dr. W. Junk Publishers, Dordrecht. Pp. 1-26.

BAXTER, R.M. & P. GLAUDE (1980): Environmental effects of dams and impoundments in Canada: Experience and prospects. Canad. Bull. Fisheries and Aquatic Sciences, Bull. **205**: I-VI, 1-34.

BELAVSKAJA, A.T. & T.N. KUTOVA (1966): [Vegetation of temporarily flooded parts of the Rybinsk reservoir]. In: Rastitelnost Volžskich vodochranilišč. Tr. Inst. Vnutr. Vod **11**(14): 162-189.

CARBIENER, R. & A. ORTSCHEIT (1987): Wasserpflanzengesellschaften eines der größten Grundwasservorkommen Europas (Oberrheinebene). In: MIYAWAKI, A. et al. (eds.), Vegetation ecology and creation of new environments. Proceed. Int. Symp. Tokyo, Japan, 283-312.

ČERNOHOUS, F. & Š. HUSÁK (1986): Macrophyte vegetation of Eastern and North-eastern Bohemia. Folia Geobot. Phytotax. **21**: 113-161.

DANELL, K. & K. SJÖBERG (1982): Successional pattern of plants, invertebrates and ducks in a man-made lake. J. Appl. Ecol. **19**: 395-409.

DISTER, E. et al. (1990): Water management and ecological perspectives of the upper Rhine's floodplains. Regulated Rivers **5**: 1-15.

EKZERCEV, V.A. (1961): [First stages of the overgrowing of shallows of the Volga reservoirs]. Bjull. Inst. Vodochran. **11** (14): 104-142.

EKZERCEV, V.A. (1966): [Flora of the Ivanikovsk reservoir]. In: Rastitelnost Volžskich vodochranilišč. Bjull. Inst. Biol. Vodochran. **11**(14): 11-13.

GILL, C.J. (1970): The flooding tolerance of woody species - a review. Forest Abstr. **31**/4: 671-688.

GODSCHALK, G.L. & J.W. BARKO (1985): Vegetative succession and decomposition in reservoirs. In: GUNNISON, D. [ed.], Microbial processes in reservoirs. Dr. W. Jung Publ., Dordrecht. Pp. 59-77.

GRELSSON, G. (1987): Vegetation changes in terrestrial habitats following hydroelectric exploitation. Dissertation, Umea.

HALD, A.B. & P.M. PETERSEN (1988): Effects on mire vegetation of drainage (6 years) and subsequent flooding during winter time (2 years), case study. Proc. Third Int. Wetland Conf., Rennes, 301-302.

HEJNÝ, S. (1990): Dynamic changes in the macrophyte vegetation of South Bohemia fishponds after 35 years. Folia Geobot. Phytotax. **25**: 245-255.

HETEŠA, J. & P. MARVAN [eds.] (1984): [Biology of newly flooded reservoir]. Studie ČSAV 1984/3: 1-58, Praha.

HETEŠA, J. & Š. HUSÁK (1986): Changes in the vegetation after construction of the Nové Mlýny reservoirs (South Moravia). In: HEJNÝ, S., I.M. RASPOPOV & J. KVĚT (eds.), Studies on shallow lakes and ponds. Academia, Praha, pp. 252-256.

HRBÁČEK, J. (1981): Produkční vztahy, výchozí struktura pro posuzování faktoru eutrofizace údolních nádrží. Studie ČSAV 1981/24: 1-58.

HUSÁK, Š . (1984a): The vegetation cover in the studied area before the reservoir filling. In: HETEŠA, J. & P. MARVAN [eds.], [Biology of newly flooded reservoir]. Studie ČSAV 1984/3: 85-93.

HUSÁK, Š. (1984b): Development of macrophytes in the upper impoundment. In: HETEŠA, J. & P. MARVAN [eds.], [Biology of newly flooded reservoir]. Studie ČSAV 1984/3: 94-98.

HUSÁK, Š. & V.P. GORBIK (1990): Macrophyte biomass in the Kiev reservoir (Ucraine). Folia Geobot. Phytotax. **25**: 265-273.

HUSÁK, Š . & J. RYDLO (1992): Water macrophytes of Lužnice river. Muzeum a Současnost, ser. natur., Roztoky, **6**: 67-108.

KABANOV, N. M. (1959): [Questions about overgrowing of the Klazminskoje reservoir]. Tr. Vsesojuz. gidrobiol Obsc. **9**: 175-182.

KRAHULEC, F. (1975): [Vegetationsverhältnisse im Überschwemmungsgebiet Rozkoš bei Česká Skalice, Ostböhmen]. Acta Mus. Reginaehradec., S.A. **13**: 45-69.

KRAHULEC, F. (1981): [Vegetationsverhältnisse im Überschwemmungsgebiet Rozkoš bei Česká Skalice (Ostböhmen) II]. Acta Mus. Reginaehradec., S.A. **16**: 155-161.

KRAHULEC, F. & J. LEPŠ (1993): The migration of vascular plants to a new water reservoir: geographic relationships. Preslia, Praha, **65**: 147-162.

KRAHULEC F., J. LEPŠ & O. RAUCH (1980): Vegetation of the Rozkoš reservoir near Česká Skalice (East Bohemia). 1. The vegetation development during the first five years after its filling. Folia Geobot. Phytotax. **15**: 321-362.

KRAHULEC F., J. LEPŠ & O. RAUCH (1984): Vegetation of the Rozkoš reservoir near Česká Skalice. II. The formation and differentiation of communities of flooded soils (Agropyro-Rumicion crispi). Folia Geobot. Phytotax. **19**: 227-254.

KRAHULEC F., J. LEPŠ & O. RAUCH (1986): Vegetation succession on a new lowland reservoir. Arch. Hydrobiol., Beih. Ergebnisse Limnol., **27**: 83-93.

KRAHULEC F., J. LEPŠ & O. RAUCH (1987): [Long distance dispersal as a factor influencing the present-day pattern of plant distribution]. Zpr. Cs. Bot. Spolec. **22**, Mater. 7: 71-76.

KRZYŽANEK , E. et al. (1986): Succession of communities in the Goczalkowice dam reservoir in the period 1955-1982. Arch. Hydrobiol. **83**: 21-43.

LEPŠ, J. et al. (1990): Classification of sequences in community ecology -three case studies. Coenoses **5**: 69-77.

LIKENS, G.E. (1989) (ed.): Long-term studies in ecology. Approaches and alternatives. Springer Verlag, Berlin.

NILSSON, CH. (1981): Dynamics of the shore vegetation of a North Swedish hydroelectric reservoir during a 5-year period. Acta Phytogeogr. Suecica, Uppsala, **69**: 1-94.

NOVÁKOVÁ, H. & J. RYDLO (1978): Rozšíření vodních a pobřežních rostlin v korytě Labe mezi Pardubicemi a Mělníkem. Práce a Studie Krajského stř. st. pam. péče a ochrany přírody, Pardubice, **9**: 63-89.

NOVÁKOVÁ, H. & J. RYDLO (1981a): Květena Opatovického kanálu. Práce a Studie Krajského stř. st. pam péče a ochrany přírody, Pardubice, **12**:35-44.

NOVÁKOVÁ, H. & J. RYDLO (1981b): Rozšíření vodních a některých pobřežních cévnatých rostlin v korytě Labe mezi Jaroměří a Pardubicemi. Práce a Studie Krajského stř. st. pam péče a ochrany přírody, Pardubice, **11**: 53-62.

OTAHELOVÁ, H. & Š. HUSÁK (1986): Types of higher aquatic and wetland vegetation of the East Slovakian lowland plain (Czechoslovakia). In: HEJNÝ, S., I.M. RASPOPOV & J. KVÊT (eds.), Studies on shallow lakes and ponds. Academia, Praha, pp. 243-252.

PACE, M.L. & J.J. COLE (1989): What questions, systems, phenomena warrant long-term ecological study? In: LIKENS, G.E. (ed.), Long term studies in ecology. Approaches and alternatives, pp. 183-185. Springer Verlag, Berlin.

PIVOŇKOVÁ, L. & J. RYDLO (1992): Water macrophytes of Ohře river. Muzeum a Současnost, ser. natur., Roztoky, **6**: 11-38.

PODBIELKOWSKI, Z. (1960): The development of vegetation in peat pits. Monographiae Bot. **10**: 1-144.

PRACH, K., J. KVĚT & I. OSTRÝ (1987): Ecological analysis of the vegetation in a summer-drained fishpond. Folia Geobot. Phytotax. **22**: 43-70.

RICHTER, W. (1974): Die Vegetationsdynamik der Talsperre Spremberg. Herzynia, N.F. **11**: 352-393.

RYDLO, J. (1986): Aquatic flora and vegetation of the Berounka river (Bohemia). Muzeum a Současnost, ser. natur., Roztoky, **1**: 49-77.

RYDLO, J. (1983): Příspěvek k poznání vodní a pobřežní květeny dolní Loučné a Haldy. Práce a Studie Krajského stř. st. pam péče a ochrany přírody, Pardubice, **13-14**: 73-81.

RYDLO, J. (1987): Water macrophytes of Elbe river 1974-1986. Muzeum a Současnost, ser. natur., Roztoky, **2**: 67-122.

RYDLO, J. (1988): Vodní flóra a vodní vegetace Pšovky. Sborník Severočes. Muz., Přír. Vědy, Liberec, **16**: 97-125.

RYDLO, J. (1989): A contribution to the knowledge of aquatic macrophytes of the lower Vltava river. Muzeum a Současnost, ser. natur., Roztoky, **3**: 51-73.

RYDLO, J. (1990): Water macrophytes of Cidlina river and Sánský canal (Eastern and Central Bohemia). Muzeum a Současnost, ser. natur., Roztoky, **4**: 107-128.

RYDLO, J. (1991): Water macrophytes of Mdlina river (East and Central Bohemia). Muzeum a Současnost, ser. natur., Roztoky, **5**: 55-100.

RYDLO, J. (1992): Water macrophytes of the Morava river. Muzeum a Současnost, ser. natur., Roztoky, **6**: 39-66.

RYDLO, J. (1993): Water macrophytes of Sázava river. Muzeum a Současnost, ser. natur., Roztoky, **7**: 3-34.

RYDLO, J. (1994a): Vodní makrofyta Berounky v letech 1982-1992. Muzeum a Současnost, ser. natur., Roztoky, **8**: 67-87.

RYDLO, J. (1994b): Vodní makrofyta Otavy. Muzeum a Současnost, ser. natur., Roztoky, **8**: 79-96.

RYDLO, J. & N. JOHANISOVÁ (1987): Příspěvek k poznání vodní a pobřežní květeny dolního Labe. Stipa, ùstí nad Labem.

SAUER, J.D. (1989): Plant migration. Univ. of California Press, Berkeley.

ŠEDA, Z. (1963): Bemerkungen über die Ufervegetation der Korycany-Talsperre.

Spisy Přírod. Fak. Univ. J.E. Purkyně, Řada L 20, Brno, No. 445, 1963/7: 293-352.

ŠEDA, Z. (1967): Die Vegetation der Litoral-Zone einiger mährischer Talsperren. I., II. Folia Fac. Sci. Natur. Univ. Purkynianae Brunensis, Biol. **8**(7): 1-67.

ŠEDA, Z. (1975): Vegetace litorálu v povodí Moravy. Manuscript, Library of the Masaryk University, Brno.

ŠEDA, Z. (1976): Die Vegetation der Litoral-Zone einiger mährischer Talsperren. Teil III. Das Verwachsen der Ufer der Talsperre bei Vír. Folia Fac. Sci. Natur. Univ. Purkynianae Brunensis, Biol. **17**(9)): 1-47.

ŠEDA, Z. (1987): [Die Entwicklung und gegenwärtige Zusammensetzung der Vegetation des Staubeckens bei Korycany]. Scripta Fac. Sci. Nat. Univ. Purk. Brun. **17**/8: 469-484.

WESTHUS, W. (1987): Zur Vegetation landwirtschaftlicher Wasserspeicher im Thüringer Becken. Limnologica **18**/2: 381-403.

ZEROV, K.K. [Vegetation formation and overgrowing of reservoirs on the Dniepr river]. Kiev.

ZOBEL, M. (1988): Autogenic succession in boreal mires - a review. Folia Geobot. Phytotax. **23**: 417-445.

Addresses of the authors:

Štêpán Husák

Institute of Botany, Academy of Sciences of Czech Republic
Dukelská 145
379 01 Třeboň
CZECH REPUBLIC

František Krahulec

Institute of Botany
Academy of Sciences of Czech Republic
2 252 43 Průhonice
CZECH REPUBLIC