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Differentiation of summer temperatures in fishpond vegetation

Diferenciace letních teplot v rybniční vegetaci

Jan Květ

Dedicated to S. Hejný, Corresponding Member of the Czechoslovak Academy of Sciences, on his 60th birthday

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A comparison is made between the gradients of the air (at 2 m and near the water or ground level), water (at −0.01 or −0.05 and −0.1 m) and soil (at −0.05 or −0.1 m) temperature occurring along the environmental and vegetational gradients in an undisturbed and in a cleaned fishpond in Central Europe under typical summer conditions. The gradient of plant communities of the undisturbed pond corresponded to the classical land-filling hydrosere, the cleaned pond was distinguished by a steep transition from the open water to the freshly vegetated shore deposits about 3 m high. The amplitude between the recorded temperature minima and maxima was smallest in the wooded upper links of the hydrosere, i.e., in the willow and alder carrs, and also in the purely aquatic links of both gradients. The widest temperature amplitudes occurred in the naturally developed outer pond littoral colonized by either tall or short sedge communities. Next followed the amplitudes at the insolated sites of the shore deposits at the cleaned pond.

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INTRODUCTION

The effects of fishpond management on the vegetation of Central European fishponds have long been studied by S. Hejný and his collaborators; see, e.g., HEJNÝ et HUSÁK (1978) or HEJNÝ et al. (1982). In the sixties, large-scale pond amelioration represented the most striking impact of modern technology on the fishpond ecosystems. In order to increase the open water area of the ponds, heavy machines (bulldozers) started to be used for deepening the pond edges and removal of the littoral vegetational belts formed by largely monodominant stands of various helophytes. During this operation, known as "pond cleaning", the scraped-off bottom and littoral material is piled up in deposits which are up to several meters high. These deposits are overgrown quite rapidly. Their plant cover partly originates from the already present propagules and hence it consists of some of the original littoral plant species and/or of those typical of emerged pond bottoms, partly some new species establish themselves on the deposits. HEJNÝ et HUSÁK (1978) present a general picture of the vegetation succession on the deposits. In any case, the plant cover of the deposits strikingly differs from that in more or less undisturbed ponds and on their shores. This paper reports on the results of microclimatological measurements which were initiated and supervised by S. Hejný. The aim was to compare the differentiation of high-summer temperatures along the environmental and vegetational gradient in a hydrosere (and zonation) of plant communities in an undisturbed pond, with the corresponding temperatures in a newly cleaned pond and on its freshly vegetated shore deposits.

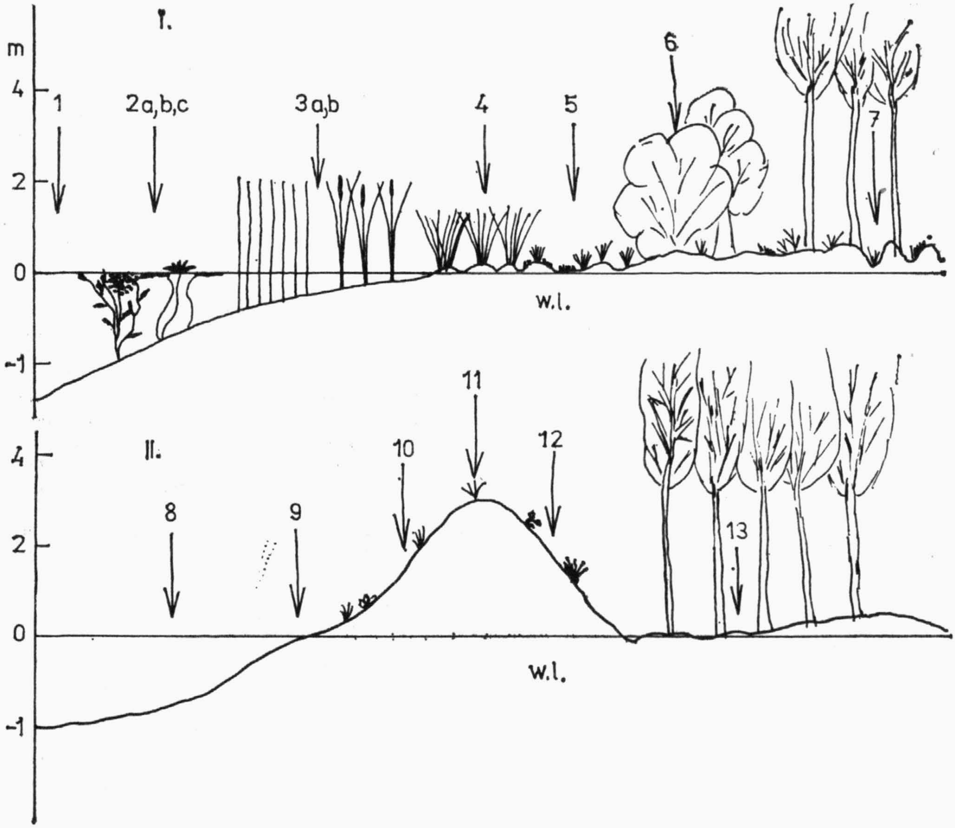

Fig. 1. — Schematic drawings of the surface configuration and vegetational zonation in the undisturbed Záhorský pond (I.) and in the cleaned Kačírek pond (II.) with their littoral zones. The positions of the sites 1 to 13 with stations for temperature measurements are indicated. The horizontal lines labelled w.l. indicate the position of water level. For further details see text.

METHOD AND SITES OF MEASUREMENT

The temperature measurements were taken with mercury-in-glass thermometers along two line transects leading from the open water to the outer littoral zones of two adjacent small ponds. The thermometer bulbs were screened from direct solar radiation with small shields made of white perspex and attached to them. The shields did not hinder the ventilation of the bulbs. When measuring the water temperature, the thermometers were immersed in the water as much as possible. Correction of the thermometer readings for errors due to differences between air and water temperature thus became redundant. The two ponds are situated at 49°09′ North and 14°16′ East, altitude 405 m: I. Záhorský pond, cadastral area 24 ha, water area 12.5 ha, with an undisturbed zonation of plant communities; II. Kačírek pond, cadastral area 4.3 ha, water area 3.5 ha, cleaned with bulldozers one to two years prior to the microclimatological measurements. Both ponds belong to the "Vodňanská soustava" system of ponds which receives water from the Blanice river. Figure 1 shows schematically the differences in the shore configuration and vegetation cover between the two ponds; the sites of the stations for temperature measurement are also indicated. The sites may be briefly characterized as follows (names of the communities after MORAVEC et al. 1983).

I. In the Záhorský pond:

1. Open water of the pond with no macrophytes, depth about 1.2 m.
2. Inner littoral zone with prevailing floating macrophyte communities of the alliance *Nymphaeion albae* OBERDORFER 1957, depth 1.0 to 0.6 m. Measurements were taken in pure stands of: (a) *Potamogeton natans* L. (dense); (b) *Nymphaea candida* PRESL (dense); (c) *Trapa natans* L. (very loose).
3. Central littoral zone of helophyte communities of the alliance *Phragmition communis* KOCH 1926, depth 0.5 to 0.3 m. Measurements were taken in monodominant stands of: (a) *Schoenoplectus lacustris* PALLA; (b) *Typha latifolia* L., both emerging about 2 m above the water surface.
4. Outer littoral zone of tall sedge communities of the alliances *Magnocaricion elatae* KOCH 1926 and *Caricion gracilis* NEUHÄUSL 1959 em. BALÁTOVÁ-TULÁČKOVÁ 1963, with water level mostly about 0.1 m above the ground level.
5. Outer littoral zone of short sedge communities of the alliance *Caricion fuscae* KOCH 1926 em. KLIKA 1934, with *Sphagnum* spp. undergrowth and with water level at about −0.1 m below ground level.
6. Willow carr of the alliance *Salicion cinereae* TH. MÜLLER et GÖRS ex PASSARGE 1961, with water level at about −0.15 m below ground level on the average. The willows were up to 4 m high.
7. Alder carr of the alliance *Alnion glutinosae* MALCUIT 1929, with water level at various depths below the ground level (at ± 0 m in depressions). The alder (*Alnus glutinosa* L.) trees were about 15 m high on the average.

II. In the Kačírek pond:

8. In the open water with no macrophytes, some 6 m from the shoreline, depth about 0.8 m.
9. In shallow water, not more than 0.1 m deep, at the shoreline at the base of a shore deposit with very sparse vegetation of various tenagophytes sensu HEJNÝ (1960).
10. On the pond-facing "inner" slope of the deposit, exposed to the S.E., some 1.8 m above the water level in the pond.
11. At the top of the deposit, some 3 m above the water level.
12. On the land-facing "outer" slope of the deposit, exposed to the N.W. and partly shaded by the alder carr, elevation the same as at site 10.
    The sites 10 to 12 were vegetated sparsely in 1964 and more densely in 1965, by various successional stages from which a stage with dominant *Agropyron repens* L. was gradually developing.
13. Alder carr, much the same as at site 7.

Vegetation records from the two ponds are available with S. Hejný, Institute of Botany, Czechoslovak Academy of Sciences, CS-25243 Průhonice u Prahy. The measurements were taken in two successive summers on July 7 to 9, 1964 and on June 24 to 25, 1965. In either case there was clear sky during both day and night with little wind, and only occasional clouds in the afternoon.

Numerous persons were involved in taking and recording the measurements. They were the young participants of the two nature history expeditions organized by the J. Fučík House of Youth in Prague in 1964 and 1965, and their supervisors — the collaborators of the Institute of Botany, Czechoslovak Academy of Sciences, at Průhonice and Brno. All of them deserve thanks for their keen cooperation.

RESULTS

Tables 1 and 2 summarize the results of the temperature measurements taken in both years. The weather was warmer on the two days of measurement in 1965 but the amplitudes between the respective daily temperature

Table 1. — Maximum (max.) and minimum (min.) temperatures of the air, water and soil recorded at different levels at 16 sites of the undisturbed Záhorský pond (I.) and of the cleaned Kačírek pond (II.) on July 8 to 9, 1964. All data in °C

Site no.		Community type	Air temperature 2 m max.	Air temperature 2 m min.	Air temperature 0.1 m max.	Air temperature 0.1 m min.	Water temperature −0.01 m max.	Water temperature −0.01 m min.	Water temperature −0.05 m max.	Water temperature −0.05 m min.	Soil temper. −0.1 m max.	Soil temper. −0.1 m min.
I.	1	Open water	25.6	10.7	25.5	12.2	21.7	19.6	21.6	19.6	—	—
	2a	*Potamogeton natans*	23.5	9.8	25.2	10.9	22.1	18.3	21.8	18.5	—	—
	2b	*Nymphaea candida*	24.6	10.7	26.3	11.9	22.1	18.9	21.5	18.9	—	—
	2c	*Trapa natans*	24.8	11.7	24.3	12.2	22.7	19.5	22.3	19.6	—	—
	3a	*Schoenoplectus lacustris*	24.5	10.6	22.7	11.9	21.7	19.5	21.7	19.5	—	—
	3b	*Typha latifolia*	26.5	9.9	25.1	11.7	22.2	18.5	21.7	18.7	—	—
	4	Tall sedge commun.	27.3	10.2	26.9	9.3	24.7	12.9	18.8	12.6	—	—
	5	Short sedge commun.	26.9	9.9	26.8	8.1	26.7	12.2	17.8	12.8	18.1	11.2
	6	Willow carr	25.6	10.0	25.6	9.9	—	—	—	—	14.7	12.1
	7	Alder carr	25.3	10.3	26.4	10.2	—	—	—	—	14.7	12.1
II.	8	Open water	25.1	9.7	24.7	12.0	23.8	20.2	23.8	20.2	—	—
	9	Shoreline	26.5	10.1	25.7	9.9	25.6	19.5	—	—	22.8	17.0
	10	Deposit "inner" slope	27.7	10.3	27.1	10.2	—	—	—	—	25.1	13.9
	11	Deposit top	28.2	10.5	28.8	10.5	—	—	—	—	26.0	13.4
	12	Deposit "outer" slope	27.7	10.5	27.8	10.4	—	—	—	—	21.0	13.6
	13	Alder carr	25.9	10.5	24.9	10.5	—	—	—	—	14.3	12.7

maxima and minima were approximately the same in both years. The air temperature maxima recorded at 2 m above ground or water level were only little differentiated over the seminatural vegetational gradient of the Záhorský pond. The greater temperature differentiation across the artificial shore deposit at the Kačírek pond was due to the elevation of the deposit and to the orientation of its slopes (S.E. and N.W.). The lowest minimum air temperatures recorded at 2 m occurred in both the tall and the short sedge communities (sites 4 and 5) in which the nightly radiant heat loss towards the clear sky was apparently greatest. These two sites also exhibited both the lowest minimum and the highest maximum air temperatures near the ground or water surface. Their microclimate is thus the most extreme of all the sites, and the aerial plant parts are exposed to the widest amplitudes between the day and night temperatures. Much the same amplitudes of the near-ground air temperatures were recorded on the "inner" slope and at the top of the shore deposit (sites 10 and 11) in 1964, when its plant cover was still loose. It became denser in 1965; hence the temperature amplitudes became relatively smaller at these two sites than in the undisturbed outer littoral hosting the sedge communities (sites 4 and 5). In absolute terms, however, all the respective temperature amplitudes were somewhat wider on the two days of measurement in 1965.

The water temperatures, also shown in Tables 1 and 2, were higher, on the whole, during the 1965 measurements which had been preceded by a longer warm period than in 1964. The daily amplitudes of the near-surface water temperature were naturally narrowest over the relatively deep open water of the Záhorský pond (site 1), and in the fairly dense stand of *Schoenoplectus lacustris* (site 3a). A slight daily overheating and nightly cooling of the water was observed amidst the strongly irradiated floating foliage of *Potamogeton natans*, *Nymphaea candida* and *Trapa natans* (sites 2a, b, c). Below the relatively loose canopy (in 1964, not in 1965) of *Typha latifolia*, the water temperature increased somewhat more than in the denser stand of *Schoeno-*

Table 2. — Maximum (max.) and minimum (min.) temperatures of the air, water and soil recorded at different levels at 14 sites of the undisturbed Záhorský pond (I.) and of the cleaned Kačírek pond (II.) on June 24 to 25, 1965. All data in °C

Site no.		Community type	Air temperature 2 m max.	min.	Air temperature 0.2 m max.	min.	Water temperature −0.05 m max.	min.	Water temperature −0.1 m max.	min.	Soil temper. −0.1 m max.	min.
I.	1	Open water	32.6	14.8	33.5	14.6	26.5	22.1	26.7	22.1	—	—
	2a	*Potamogeton natans*	32.4	14.6	32.8	14.5	33.0	21.6	33.8	21.8	—	—
	3a	*Schoenoplectus lacustris*	33.9	14.2	33.8	14.7	31.0	21.9	30.5	22.1	—	—
	3b	*Typha latifolia*	31.7	13.4	31.7	13.9	28.4	20.3	27.8	20.0	—	—
	4	Tall sedge commun.	30.9	12.0	37.2	9.4	23.4	14.7	—	—	14.1	13.8
	5	Short sedge commun.	—	—	—	—	—	—	—	—	14.5	12.7
	6	Willow carr	28.2	12.6	26.2	11.8	—	—	—	—	15.1	13.9
	7	Alder carr	27.8	13.0	27.6	13.2	—	—	—	—	16.5	15.1
II.	8	Open water	28.4	13.8	28.3	14.1	30.6	21.5	29.9	20.8	—	—
	9	Shoreline	27.5	13.2	28.6	13.2	31.2	19.4	—	—	25.5	18.4
	10	Deposit "inner" slope	29.0	12.4	29.8	12.8	—	—	—	—	25.5	16.7
	11	Deposit top	28.8	12.4	31.0	12.6	—	—	—	—	20.3	16.5
	12	Deposit "outer" slope	27.4	13.0	25.4	13.0	—	—	—	—	18.2	15.8
	13	Alder carr	27.4	13.0	29.0	13.0	—	—	—	—	16.9	15.0

plectus lacustris. The daily increase in the near-surface water temperature was relatively great in the open water of the cleaned Kačírek pond, and it was extremely high in the very shallow and strongly irradiated water near the shoreline of that pond (sites 8, 9). The water temperature was noticeably lower and stable in both types of sedge communities in the outer littoral (sites 4 and 5) at the deph of −0.1 m. Near the surface (at −0.01 m) of the water in small pools occurring in hollows between the sedge tussocks, the water temperature increased markedly at daytime: the resulting difference between the daily minimum and maximum water temperature was thus greatest here of all the sites. This observation also testifies to the steep vertical temperature gradients which develop in the pools on sunny days.

The soil temperature (at −0.05 m and −0.1 m in 1964 and 1965, respectively) varied, quite understandably, within the narrowest limits in both the willow and the alder carr (sites 6, 7 and 13) white its daily amplitude was appreciable, like that of the water temperature, near the surface (at −0.05 m) of the *Sphagnum* carpet covering the ground in the short sedge community (site 5). Quite wide amplitudes of soil temperature were recorded on the "inner" slope and at the top of the artificial deposit (sites 10 and 11). The soil temperatures were less extreme on the "outer" slope of the deposit, facing the North-West and partly shaded (site 12). On the whole, however, the plant populations participating in the secondary succession on newly created shore deposits must be adapted to rather harsh microclimatic conditions. The microclimate may act here as a selective stress factor complicating or preventing the ecesis of some species on the deposits. One fact is still to be noted, namely that all the soil temperatures recorded varied within narrower limits in 1965 because they were taken at a greater depth (−0.1 m) than in 1964 (−0.05 m).

The water and, especially, the soil temperatures represent rather conservative characteristics of the thermal régime in various biotopes and biocenoses. For the plant communities, they characterize the environment in which the roots and other belowground (or aquatic) plant organs live. Figure 2a, b shows the daily course of the soil temperatures recorded at —0.1 m depth at the various terrestrial and wetland sites in 1965. The already given temperature characteristics of the individual sites are thus confirmed and stand out even more clearly. The artificial shore deposit (sites 9 to 12) clearly provides warmer biotopes with wider daily temperature fluctuations than does the natural outer pond littoral (sites 4 to 7 and 13), also including the willow and alder carrs. The soil is, however, somewhat warmer in the

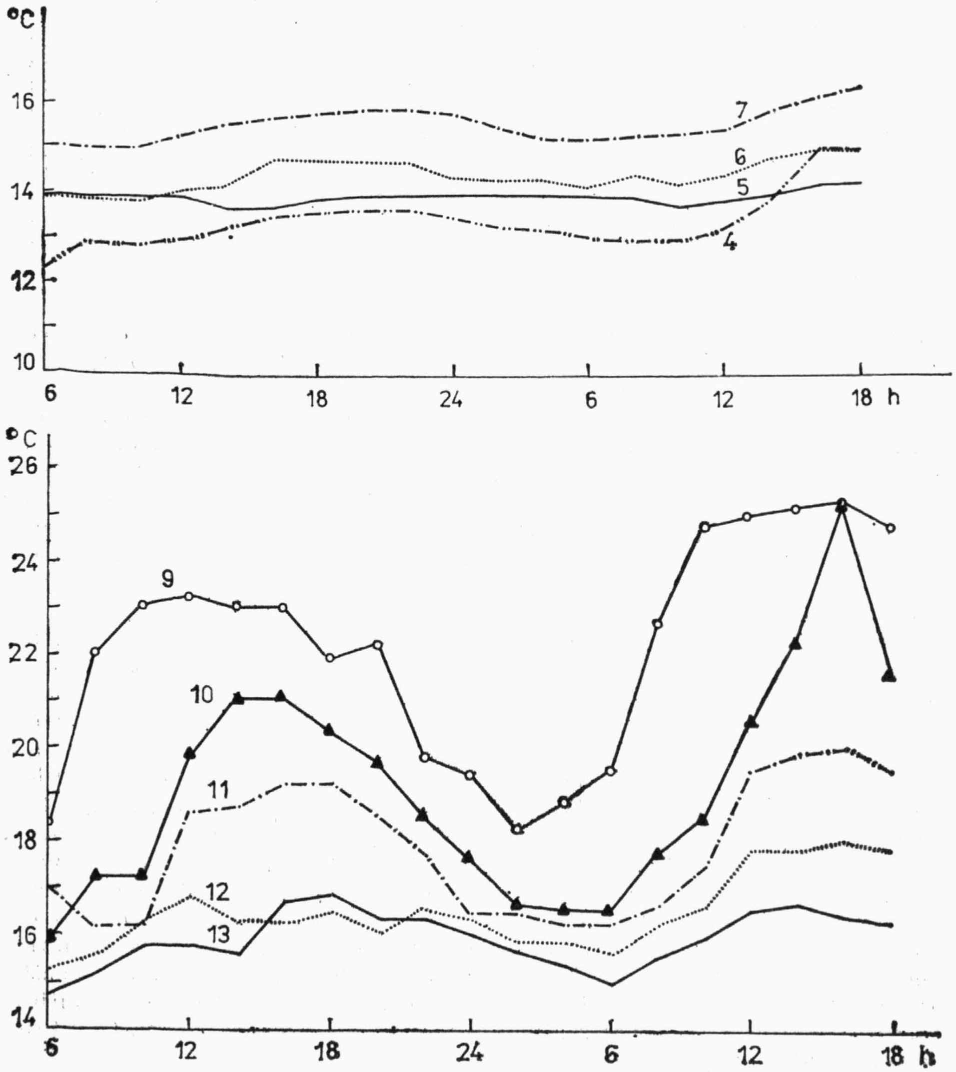

Fig. 2. — Daily course of soil temperatures (°C) at —0.1 m depth on June 24 to 25, 1965: (a) in the undisturbed littoral of the Záhorský pond at the sites 4 to 7; (b) across the shore deposit at sites 9 to 12 and in the adjacent alder carr (site 13) at the cleaned Kačírek pond.

alder carr (sites 7 and 13) than in the rest of the outer littoral. Conspicuous is the rapid increase in temperature that occurred in the *Sphagnum* carpet at site 5 in the hot afternoon of June 25, 1965. The replacement of water by warm air can explain the wide fluctuations of temperature taking place in the upper layer of the *Sphagnum* undergrowth.

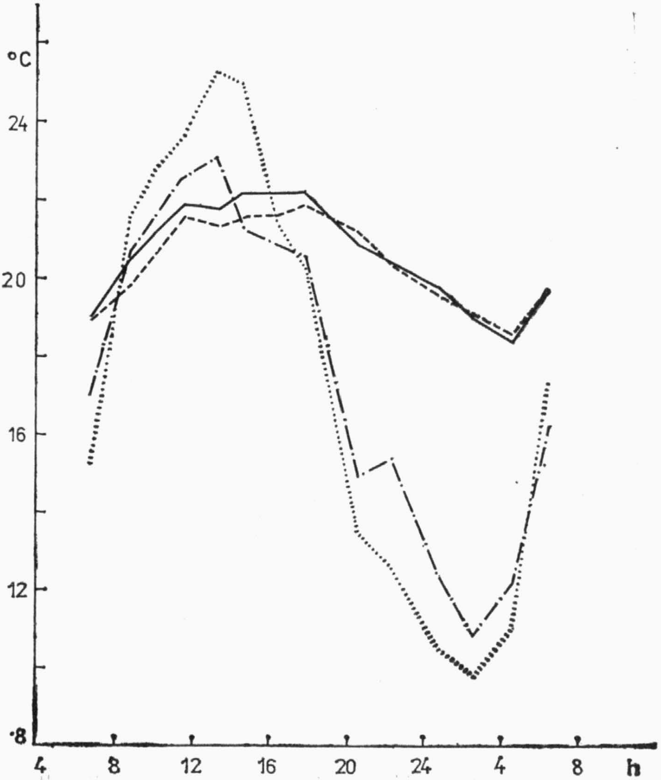

Fig. 3. — Daily course of temperatures (°C) at site 2a with *Potamogeton natans* on July 8 to 9, 1964. The lines indicate the following temperatures: :..... at 2 m above water surface; —.—.—.—. at 0.1 m above water surface; ———— at —0.01 m below water surface; — — — — — — at —0.1 m below water surface.

Examples of the daily courses of temperatures recorded at selected stations on July 8 to 9, 1964, are given in Figures 3 to 9. Figure 3 demonstrates particularly the buffering effect of the large volume of water in the pond on the air temperature near the water surface: the temperature extremes are both higher and lower at 2 m than at 0.1 m above the water level. Figure 4 illustrates the rather even temperature conditions developing within helophyte stands and, especially, the shading effect of the aerial plant parts at daytime. Figure 5, on the other hand, demonstrates the great temperature heterogeneity, both spatial and temporal, in the aquatic and aerial environment of the outer littoral tall sedge community (site 4). Similar temperature patterns are also characteristic of the short sedge community (site 5). Figure 6 shows a typical "woodland" course of the air and soil temperatures as it develops below the canopy of either the willow or the alder carr. The irregularities in the course of the air temperatures are due to the irregular penetration of direct solar radiation through gaps in the canopy. Figure 7 illustrates the warm conditions developing in the water and bottom at the shoreline of cleaned ponds in warm weather. Such conditions apparently

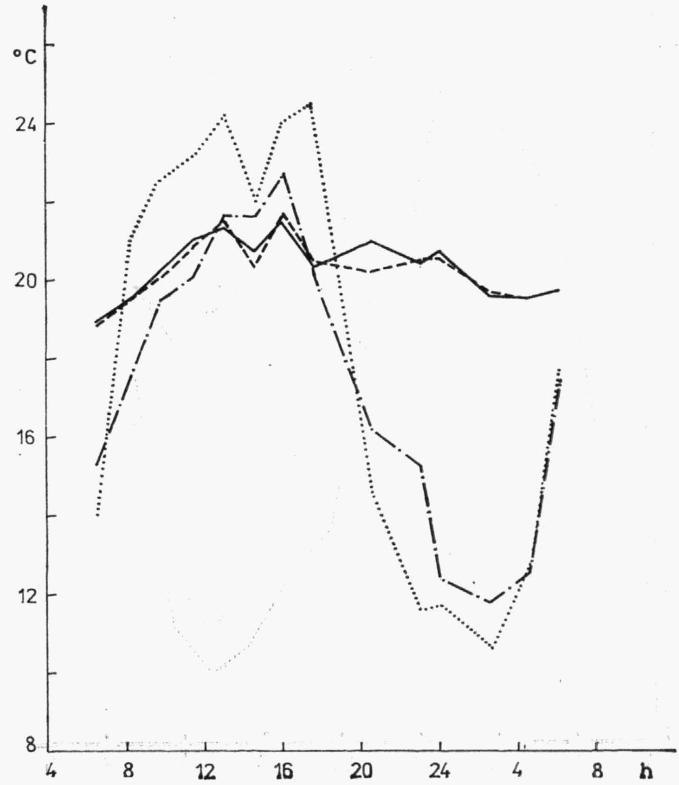

Fig. 4. — Daily course of temperatures (°C) at site 3a in the stand of *Schoenoplectus lacustris* on July 8 to 9, 1964. For symbols see Fig. 3.

favour the germination or sprouting of plant propagules and facilitate the recolonization of the cleaned littoral by plants — though mostly belonging to other species than originally, prior to the pond cleaning. Figures 8 and 9 show the great daily variation in both soil and air temperatures occurring on and over the shore deposits, The most extreme conditions develop at the deposit top (site 11) where the soil temperature varies quite widely and follows closely the air temperatures. Site 12 on the "outer" slope of the deposit exhibits a similar but less extreme temperature pattern as site 10.

DISCUSSION

The rules governing the microclimate in ponds and their littorals have been described, e.g., by PŘIBÁŇ, ŠMÍD et KVĚT (1977). The observations presented in this paper have confirmed the validity of these rules with respect to the temperature differentiation in an undisturbed pond littoral and macrophyte-overgrown water surface under typical summer conditions.

Several authors have performed temperature and other microclimatological measurements in fishponds (e.g., SEDLMEYER 1931, SZUMIEC 1966, 1973, MARTIN 1972) but few authors have paid attention to the zonation of

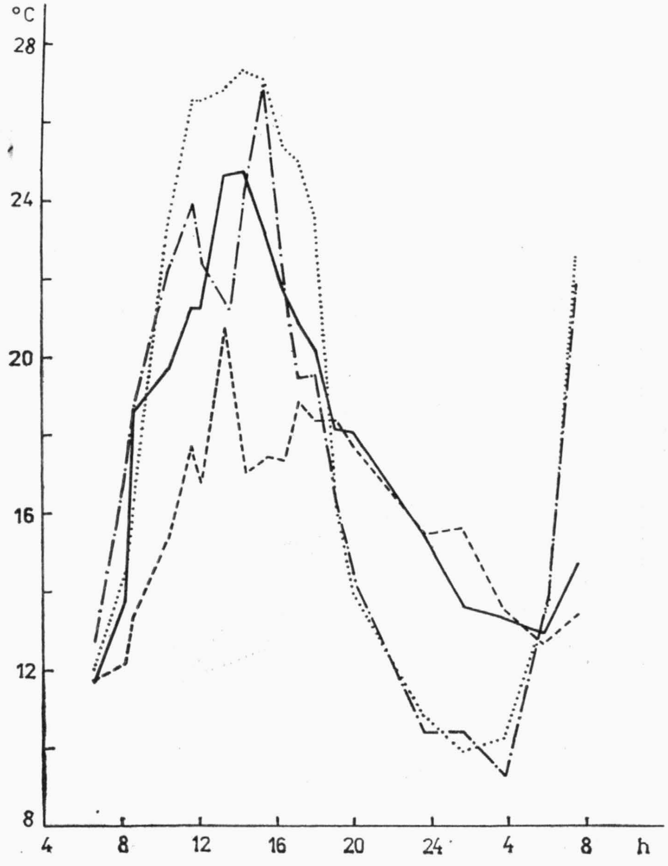

Fig. 5. — Daily course of temperatures (°C) at site 4 in the tall sedge community on July 8 to 9, 1964. For symbols see Fig. 3.

microclimatic conditions in pond littorals (e.g., PŘIBÁŇ 1973, ŠMÍD 1973, 1977, ŠMÍD et PŘIBÁŇ 1978). Simultaneous microclimatological measurements taken in the individual vegetational zones of the ponds are still scarce (ŠMÍD 1973, 1977). For this reason, the measurements reported here, simple as they were, contribute to our understanding of the ecology of the Central European fishpond vegetation. Like other measurements taken on selected days, they demonstrate the salient features of the microclimate more clearly than any average values can do. For example, the integrative sucrose-inversion method, which is the most sensitive to the highest temperatures occurring at any one site, failed to detect any substantial temperature differences between the central and outer littoral of the Nesyt fishpond in southern Moravia (Šmíd 1977). But these differences stood out clearly from the diurnal temperature courses recorded in the two zones (Šmíd 1973).

Ondok et Přibáň (1982) evaluated the feedback between the aquatic vegetation and its physical environment. Their statement on the temperature

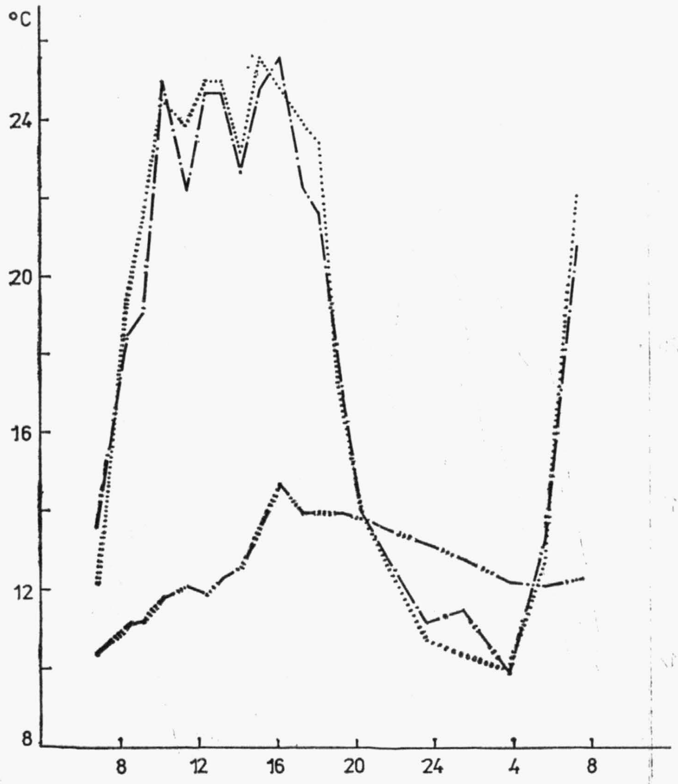

Fig. 6. — Daily course of temperatures (°C) at site 6 in the willow carr on July 8 to 9, 1964. The lines indicate the following temperatures: ...... at 2 m above ground level; —.—.—. at 0.1 m above ground level; — ... — ... — air at ground level.

patterns developing in floating macrophyte communities has been confirmed by the measurements performed at the sites 2a, b, c. The observation made in the *Potamogeton natans* stand (site 2a) in June 1965, of the water being slightly warmer at —0.1 m than at —0.05 m at mid-day, appears strange at first glance. Yet, it may be explained by a higher stand biomass density and stronger absorption of incoming radiation at the deeper level. Pokorný et al. (1984) made a similar observation in a dense stand of *Elodea canadensis* Rich. The buffering effect of the helophyte vegetation on both air and water temperatures is well known in the central pond littoral (Přibáň 1973, Šmíd 1973, Šmíd et Přibáň 1978). The measurements reported in this paper have also proved this effect. The stand of *Typha latifolia* (site 3b) was rather loose in 1964 and became denser in 1965 (initial and invasion stages of stand development, respectively, *sensu* Hejný 1960). Hence the conditions were warmer in this stand than in that of *Schoenoplectus lacustris* (site 3a) only in 1964, but not in 1965.

A marked both spatial and temporal temperature differentiation was typical of the outer littoral sedge communities (sites 4 and 5). Similarly

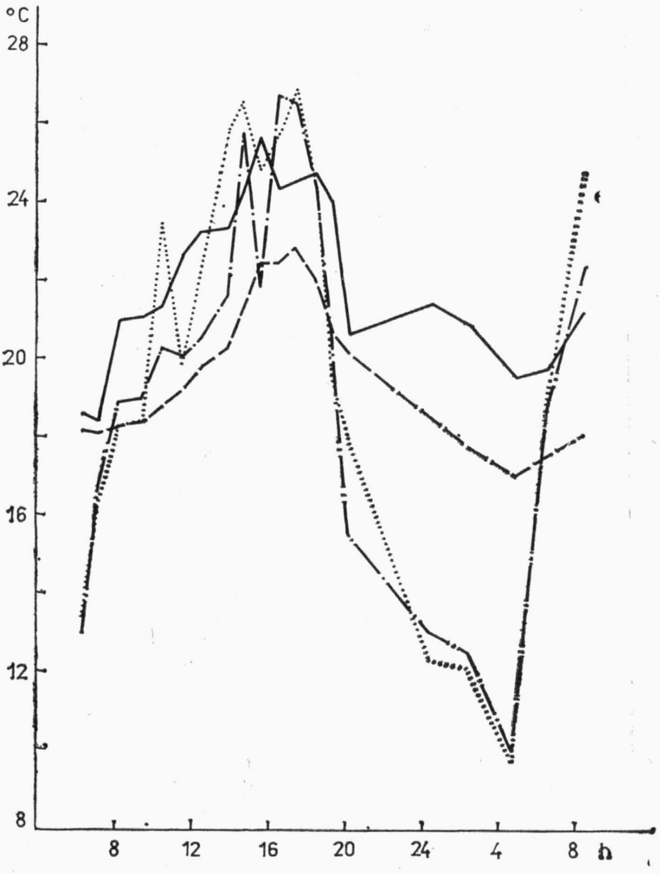

Fig. 7. — Daily course of temperatures (°C) at site 9 at the shoreline of the cleaned Kačírek pond on July 8 to 9, 1964. The lines indicate the following temperatures: ...... at 2 m above water surface; ———— at −0.01 m below water surface; — — — — — — in mud about −0.05 m below water surface.

extreme temperature conditions have been reported from other outer littoral herbaceous communities (Šmíd 1973, Přibáň et Ondok 1978, Přibáň 1983) and are apparently one of the factors limiting their primary production (Hejný, Květ et Dykyjová 1981, Květ et Jeník 1983).

Cleaning of the ponds and the formation of relatively high shore deposits alter the littoral microclimate drastically. Terrestrial biotopes are thus created in an immediate vicinity of the ponds. Sharp microclimatic differences arise between the wetland of the unmodified pond littoral and the dry land of the deposits. These differences may acquire the same magnitude as those between a wet grassland dominated by *Glyceria maxima* HOLMB. and a steppe-like dry grassland (RYCHNOVSKÁ et al. 1972).

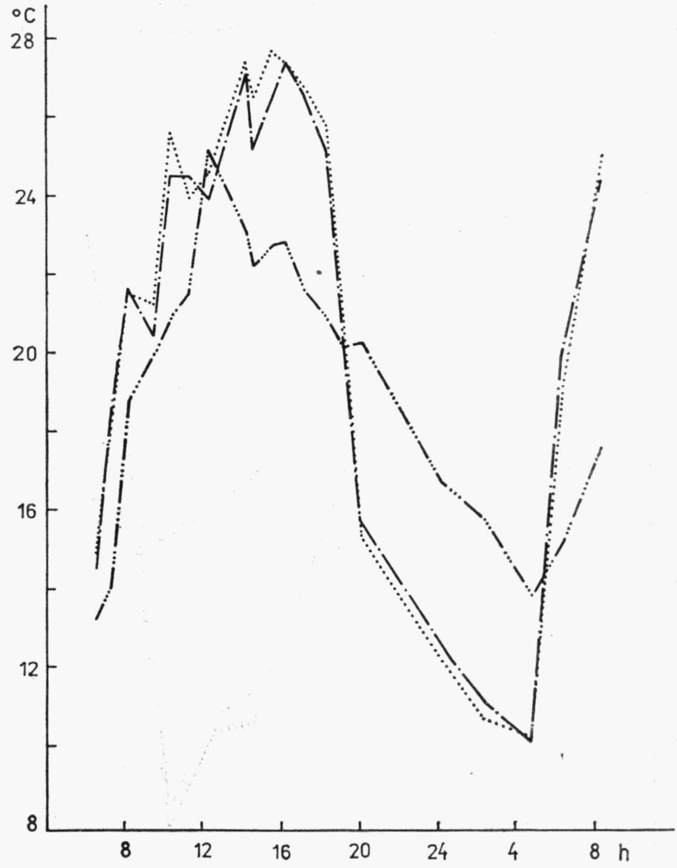

Fig. 8. — Daily course of temperatures (°C) at site 10 on the "inner" (= pond-facing) S.E.-oriented slope of the shore deposit on July 8 to 9, 1964. The lines indicate the following temperatures: ...... at 2 m above ground level; —.—.—. at 0.1 m above ground level; at −0.05 m below ground level in soil.

The differences in the air temperatures near the ground or water surface are usually only partly correlated with differences in water-vapour saturation deficit of the air. In the two ponds compared, this deficit was estimated only indirectly, from water losses of Piché-type evaporimeters exposed at 0.2 m above ground or water level. In the undisturbed Záhorský pond, the gradient of total evaporation from morning of June 24 to evening of June 25, 1965, followed the zonation of the plant communities. With the evaporation a site 2a as 100 %, that at sites 3a, b, 4, 6, 7 and 13 amounted to 66, 62, 33, 23.5 and 25 %, respectively. In the cleaned Kačírek pond littoral, the same measurement was made on June 29, 1965, from morning to evening. With the evaporation at site 9 as 100 %, that at sites 10, 12 and 13 amounted to 97, 76 and 36 %, respectively. The differences recorded across the deposit thus reflected the distribution of air and soil temperatures.

Conclusions

Quite pronounced temperature differentiation develops in undisturbed plant communities of Central European ponds in typical summer weather with high both irradiance at daytime and eradiance in the night. Most

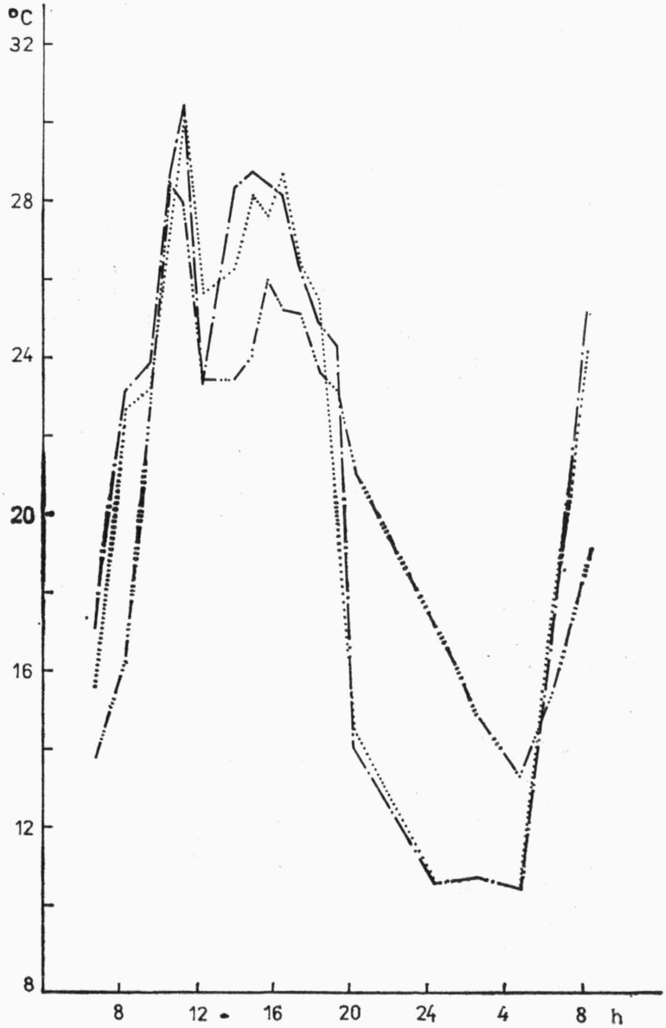

Fig. 9. — Daily course of temperatures (°C) at site 11 at the top of the shore deposit on July 8 to 9, 1964. For symbols see Fig. 8.

extreme temperatures occur in the sedge communities of the outer pond littoral whereas the open water of the pond, the helophyte stands in its central littoral and the shrub and/or tree communities of the outer littoral tend to smooth down the temperature amplitude. Dense stands of macrophytes with floating leaves are characterized by a slight overheating of both the water and the immediately overlying air at daytime and by their slight cooling in the night (both compared with an open water surface). This pattern of temperatures is disrupted when relatively high and massive shore deposits are piled up during the pond-cleaning operations. A steep microclimatic gradient thus develops, which is equivalent to that between a water body or wetland and dry land. All these conclusions, based on empirical data, are in full agreement with the general rules of microclimatology as outlined, e.g., by Geiger (1961).

SOUHRN

V mechanicky nerozrušené zonační a sukcesní řadě společenstev vyšších rostlin ve středoevropských rybnících a na jejich pobřežích vzniká za letního radiačního počasí výrazná teplotní diferenciace jak prostorová, tak časová (v denním průběhu teplot vzduchu, vody a půdy). Největší teplotní výchylky od středních hodnot, kladné i záporné, nastávají v ostřicových společenstvech vnějšího rybničního litorálu. Naproti tomu ve volné vodě rybníka, v helofytních porostech středního litorálu a v dřevinných porostech vnějšího litorálu jsou teplotní výkyvy tlumeny a denní chod i prostorové rozdělení teplot jsou vyrovnanější. V hustých porostech hydrofyt se vzplývavými listy se voda při hladině a vzduchová vrstva těsně nad ní mírně přehřívají ve dne a mírně podchlazují v noci (obojí ve srovnání s volnou vodou bez porostů). Popsané rozdělení teplot podél přirozeně vzniklé zonace rybničních rostlinných společenstev se zcela rozruší navršením poměrně vysokých a mohutných pobřežních deponií při vyhrnování rybničního dna a okrajků. Vznikne tak strmý mikroklimatický gradient mezi vodní nádrží nebo mokřadem (při částečném napuštění rybníka) a suchou zemí. Všechny tyto empirické poznatky odpovídají základním mikroklimatologickým principům, jak je shrnul např. Geiger (1961). Mikroklima jednotlivých pásem rybniční vegetace, přirozeně vyvinutých i uměle vzniklých při vyhrnování, má zřejmý vliv na primární produkci této vegetace i na ecesi rostlinných populací v průběhu druhotné sukcese při zarůstání deponií. Základní rysy této sukcese popsali Hejný et Husák (1978).

REFERENCES

Geiger R. (1961): Das Klima der bodennahen Luftschicht. — Braunschweig.

Hejný S. (1960): Ökologische Charakteristik der Wasser- und Sumpfpflanzen in den slowakischen Tiefebenen Donau- und Theissgebiet. — Bratislava.

Hejný S. et Husák Š. (1978): Ecological effects of fishpond amelioration. — In: Dykyjová D. et Květ J. [red.]: Pond Littoral Ecosystems. Structure and Functioning. — Ecol. Stud., Berlin, Heidelberg et New York, 28 : 409—415.

Hejný S., Husák Š., Jeřábková O., Ostrý I. et Zákravský P. (1982): Anthropogenic impact on fishpond flora and vegetation. — In: Gopal B., Turner R. E., Wetzel R. G. et Whigham D. F. [red.]: Wetlands Ecology and Management. — New Delhi, p. 425—433.

Hejný S., Květ J. et Dykyjová D. (1981): Survey of biomass and net production of higher plant communities in fishponds. — Folia Geobot. Phytotax., Praha, 16 : 73—94.

Květ J. et Jeník J. (1983): Perspektivy ekologického výzkumu Mokrých Luk u Třeboně. (Further ecological investigation of the "Wet Meadows" near Třeboň.) — In: Jeník J. et Květ J. [red.]: Studie zaplavovaných ekosystémů u Třeboně. — Studie ČSAV, Praha, 4/83 - 137—144.

Martin N. A. (1972): Temperature fluctuations within English lowland ponds. — Hydrobiologia, den Haag, 40 : 455—469.

Moravec J. et al. (1983): Přehled vyšších vegetačních jednotek České socialistické republiky. [Survey of the higher vegetation units of the Czech Socialist Republic.] — Preslia, Praha, 55 : 97—122.

Ondok J. P. et Přibáň K. (1982): Vliv vodní vegetace na fyzikální faktory ve vodním prostředí. [Impact of the aquatic vegetation on physical factors in the aquatic environment.] —

In: Význam makrofyt ve vodním hospodářství, hygieně vody a rybářství. — Dům techniky ČSVTS České Budějovice, p. 56—64.
POKORNÝ J., KVĚT J., ONDOK J. P., TOUL Z. et OSTRÝ I. (1984): Production-ecological analysis of a community dominated by *Elodea canadensis* (L. C. Richard). — Aquatic Botany, Amsterdam, XX : 000—000.
PŘIBÁŇ K. (1973): Microclimatic measurements of temperatures in pure reed stand. — In: HEJNÝ S. [red.]: Ecosystem Study on Wetland Biome in Czechoslovakia. — Czechosl. IBP/PT-PP Rep., Třeboň, No. 3 : 65—70.
— (1983): Mezoklimatická měření Mokrých Luk v roce 1978. (Mesoclimatic measurements in the "Wet Meadows" in 1978.) — In: JENÍK J. et KVĚT J. [red.]: Studie zaplavovaných ekosystémů u Třeboně. — Studie ČSAV, Praha, 4/83 : 25—32.
PŘIBÁŇ K. et ONDOK J. P. (1978): Microclimate and evapotranspiration in two wet grassland communities. — Folia Geobot. Phytotax., Praha, 13 : 113—128.
PŘIBÁŇ K., ŠMÍD P. et KVĚT J. (1977): Microclimatic differentiation in fishpond vegetation. — In: UNGER K. [red.]: Biophysikalische Analyse pflanzlicher Systeme. — Jena, p. 283—289.
RYCHNOVSKÁ M., KVĚT J., GLOSER J. et JAKRLOVÁ J. (1972): Plant water relations in three zones of grassland. — Acta Sc. Nat. Brno, Praha, 6 (5) : 1—38.
SEDLMEYER K. A. (1931): XV. Ein Beitrag zur Klimatologie des Teiches. — Zeitschrift f. Fischerei, Berlin, 29 : 305—315.
ŠMÍD P. (1973): Microclimatological characteristics of reedswamps at the Nesyt fishpond. — In: KVĚT J. et al. [red.]: Littoral of the Nesyt Fishpond. — Studie ČSAV, Praha, 15/1973 : 29—38.
— (1977): Sucrose-inversion temperature measurements in fishpond littoral vegetation. — Aquatic Botany, Amsterdam, 3 : 257—265.
ŠMÍD P. et PŘIBÁŇ K. (1978): Microclimate in fishpond littoral ecosystems. — In: DYKYJOVÁ D. et KVĚT J. [red.]: Pond Littoral Ecosystems. Structure and Functioning. — Ecol. Stud., Berlin, Heidelberg et New York, 28 : 104—112.
SZUMIEC M. (1966): Zeiträumige Temperaturänderungen über Laichteichen und über dem Boden in den niedrigsten Luftschichten. — Verh. Int. Ver. Limnol., Stuttgart, 16 : 1311—1317.
— (1973): Określanie temperatury wody w płytkich zbiornikach wodnych. (Determination of water temperature in shallow water bodies.) — Acta Hydrobiol., Kraków, 15 : 247—257.

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Flóra Slovenska 3

Veda, Bratislava 1982, 596 str., 61 tabulí pérovek, 108 map, cena 88,— Kčs. (Kniha je v knihovně ČSBS.)

Po téměř 16 letech vyšel botanickou veřejností dlouho očekávaný 3. svazek Flóry Slovenska. Jeho vydání se již bohužel nedočkal doc. Futák, první editor a vůdčí osobnost celého projektu slovenské květeny. Kniha je z větší části dílem autorského kolektivu bratislavských taxonomů (L. Bertová, A. Hlavaček, M. Jasičová, E. Kmeťová, K. Zahradníková), některé skupiny zpracovali čeští autoři, kteří se jejich studiem již v minulosti zabývali: M. Hostička (*Polygalaceae*), J. Chrtek (*Euphorbiaceae*), B. Křísa (*Pyrolaceae, Monotropaceae, Euphorbiaceae*), V. Zelený (*Hypericaceae*), V. Osvačilová (*Thalictrum*), B. Slavík a Š. Husák (*Batrachium*).

Ve 3. díle Flóry je zpracováno 26 čeledí dvouděložných v pořadí Novákova systému (*Magnoliaceae* až *Polygalaceae*) uvedeného v 1. díle Flóry Slovenska (1965); zahrnuty jsou autochtonní, zavlečené a běžně pěstované druhy. U každého druhu jsou uvedena nejčastější synonyma, popis, počet chromosomů, údaje o variabilitě, biologii, ekologii a fytocenologii taxonu, jeho rozšíření na Slovensku (většinou s výčtem lokalit) a případně i zmínky o užitkovosti. Vesměs jde o originální