THE CHANGES OF pH IN THE WATER OF A TRANSITION SPHAGNUM MOOR

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In the formation of aquatic ecosystems the hydrogen ion concentration of the water has a decisive rôle. Among the factors of aquatic climate — through the changes and interactions of the components most intricate and complex in themselves — pH appears as a resultant.

As well-known, pH primarily determines the character of the water of the *Sphagnum* moors taking a distinguished place among special-type waters, these natural resources of Hungary. Some of the authors engaged in research on the Hungarian *Sphagnum* moors publish data also about pH, however as a rule they characterize the whole of the moor studied by them by one single numerical value or interval (Ábrahám — Bende — Horváth — Megyeri 1952, Megyeri 1965, Megyeri 1970, Soós 1941, Varga 1956). In certain instances they also separately indicate the pH values for the water of the moor and for that pressed out of the Sphagnum clusters (Juhász 1963, Megyeri 1958, Zólyomi 1939). In other publications the results of the measurements are presented broken down to plant associations (Máthé — Kovács 1958, Zólyomi 1931), moreover, even to *Sphagnum* species (Jaczó 1941). From the great number and diversity of data it is not easy to draw general conclusions, since subsequently it cannot be exactly found out from what site and with what method the samples were taken. Only the time of sampling is kown. Even a comparison of the data obtained by measurings in different years and in different seasons (Zólyomi 1939) or in moors at various stages of development can only be of informative character.

So that the Hungarian *Sphagnum* moors and/or occurences of *Sphagnum* can be compared by exact hydrochemical methods and classified, the aspects likely to serve as a basis for this should be examined. Considering the possibilities open for him, in the course of hydrobiological examinations, the author also conducted hydrochemical analysis in a site relatively more researched and easier to access: the *Sphagnum* moor of Egerbakta. In the present paper he sets forth the data about the hydrogen ion concentration of the water of the moor; these may serve with information on the values and tendency of the changes in pH in a highly acid type of water like the one under discussion.

Material and method

The sedgy transition *Sphagnum* moor of Egerbakta is situated at a height of 280 m. above sea level on the side of the Tó-hegy (Lake Hill). The basin including it is surrounded by dry oak-forests. It is a topogenous moor, the formation and survival of which was made possible by local geomorphological and climatic factors: a basin without outlet produced by a landslide; impermeable clay layer; groundwater; a lower temperature and a micro- and/or "meso"-climatically higher relative humidity of the basin than those of its environment. The central part of the oval-shaped moor is formed by a *Carex rostrata* – *Sphagnum recurvum* association. This one is ringwise surrounded by the lagg zone densely overgrown with *Salix cinerea* shrubbery.

In the course of a detailed hydrochemical analysis, the author measured the

a) seasonal values and changes of pH on seven occasions in 1971 and 1972 (Table I),

b) its diel values and changes on August 14–15, 1971, out of samples taken every six hours (Table II),

c) its horizontal – "spatial" – values and changes, from five and/or six sample areas at the time of the seasonal as well as diel examinations.

As to their character and 1–1.5 m² environment, the six sample areas represent six different mosaics. Proceeding from the Sphagnetum towards the lagg zone, the areas were marked out roughly along a straight line in a way that they should touch each of the plant associations of the moor.

Table I.

Sample area		1971 IV. 24.	VIII. 14.	X. 31.	1972 I. 23.	IV. 9.	VII. 9.	IX. 23.
Sphagnetum	1.	5,85	4,54	4,96	– – –	5,68	4,27	4,00
	2.	6,07	4,93	6,43	– – –	5,97	5,00	4,60
	3.	5,75	5,47	6,33	– – –	5,84	5,78	4,76
	4.	5,97	5,10	5,63	– – –	5,69	5,22	4,65
Lagg-zone	5.	6,35	6,11	6,36	– – –	6,15	6,15	5,05
	6.	– – –	– – –	– – –	5,65	5,90	5,75	5,95

Table II.

Sample are		14/18	14/24	15/6	15/12	15/18
Sphagnetum	1	4.40	4.25	4.50	4.84	4.70
	2	5.10	5.10	–	4.58	4.95
	3	5.40	5.37	5.60	5.50	5.47
	4	5.10	–	–	–	–
Lagg-zone	5	6.10	6.28	6.07	6.08	6.04

Table III

O_2 CONSUMPTION (unfiltered water samples) mg O_2/1

Sample area		1974 IV. 24.	VIII. 14.	X. 31.	1972 I. 23.	IV. 9.	VII. 9.	IX. 23.
Sphagnetum	1.	– – –	217,0	1113,0	– – –	136,0	345,0	915,0
	2.	– – –	166.0	1125,0	– – –	368,0	680,0	1305,0
	3.	– – –	144,5	913,0	– – –	113,0	672,0	632,0
	4.	– – –	88,8	780,0	– – –	101,0	356,0	848,0
Lagg-zone	5.	– – –	81,5	902,0	– – –	151,0	368,0	580,0
	6.	– – –	– – –	– – –	537,0	98,4	161,6	570,0

O_2 CONSUMPTION (filtered water samples) mg O_2/1

Sample area		1971 IV. 24.	VIII. 14.	X. 31.	1972 I. 23.	IV. 9.	VII. 9.	IX. 23.
Sphagnetum	1.	– – –	90.5	417,4	– – –	120,0	240,0	232,0
	2.	– – –	92.0	365,0	– – –	108,0	226,0	169,0
	3.	– – –	86,5	366,0	– – –	84,8	204,0	192,0
	4.	– – –	64,4	360,0	– – –	93,0	210,0	208,0
Lagg-zone	5.	90,5	58,4	241,0	– – –	61,0	178,0	130,0
	6.	– – –	– – –	– – –	446,0	99,4	157,0	142,0

Sample areas:

Sphagnetum. *Sphagnum recurvum*, *S. squarrosum* and *S. obtusum* occur in great quantities in each sample area. (The author makes use of this opportunity to thank dr. László Vajda for determining the *Sphagnum* species.)

1. Bound tussocks of *Sphagnum* with sedge species *Carex rostrata* and *Juncus effusus*,
2. Bound tussocks of *Sphagnum* with *Juncus effusus*,
3. Open-water fen window with stand of *Carex pseudocyperus*

4. Open-water fen window. Sedges are represented by *Carex rostrata* and *Juncus effusus*.

Lagg-zone.

5–6. Water densely overgrown with *Salix cinerea* shrubbery and covered with Lemna; it is filled up nearly to the full depth by rotting plant and animal remains.

On each occasion the examinations were performed in a laboratory by means of an OP–107 type pX meter with OP–8071–1/A type glass electrode, on scooped, unfiltered water. The samples taken home in black bottles were kept in a refrigerator till the next day when measuring took place. From preliminary measurements on the spot and from laboratory controls the author could ascertain that the pH of the water did not change during transport and storage.

Results

As known from the literature, the highly acid reaction is in close connection with the origin and development of the *Sphagnum* moors. The acidophilous *Sphagnum* species settle on the meadow being formed on acid rocks and becoming more and more oligotrophic, and then, having become predominant in the moor, with their peat moss forming activity they shift over the pH value of the water to an even more acid direction.

Taking into consideration the averages of the values measured at the sample spots during two years, the pH of the water of the Sphagnetum was 5.58 in 1971 and 5.12 in 1972, with extreme values of 4.00 and 6.43 within the full series of data of the two years. The average pH of the lagg-zone was 6.27 in 1971, 5.78 in 1972, with extreme values of 5.05 and 6.36 (Table I). The data indicate that the pH value changes with time and place. The seasonal change can even reach pH values between 1 and 1.5. The data of the sample areas differing in absolute value, however identical as to their tendency – such were the areas 1., 2., 3., 4. in the Sphagnetum and those marked with 5. and 6. in the lagg-zone – had to be averaged so that the general features and changes could be demonstrated. Fig. 1. presents how the value of pH changes seasonally in the Sphagnetum and in the lagg-zone. (Standard deviation is marked by perpendicular lines.)

The change in pH was of different character in the years 1971 and 1972. Both in the Sphagnetum and in the lagg-zone, in 1971 pH decreased in summer, at identical springtime and autumn values and gradually decreased from spring to autumn in 1972. In that year the author could measure pH also in the winter season, however, only in the lagg-zone. Accordingly, the value of pH is lower in winter than in spring, followed by a decrease lasting till autumn. Since the course and tendency of the curves representing the values of the Sphagnetum and the lagg-zone are identical in both years – although in a different

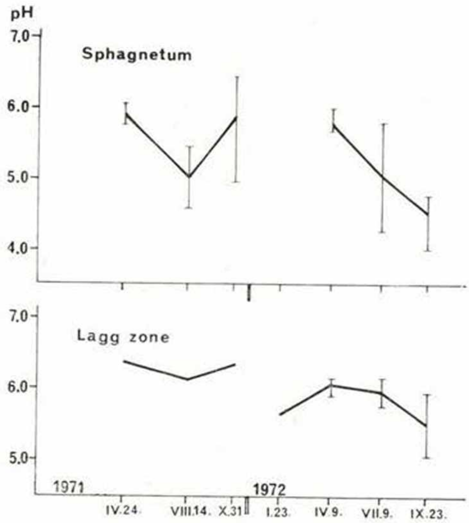

Fig. 1. Seasonal changes of pH in 1971 and 1972

way in each year — one can presume that, as to its character, the winter measurement also refers to the Sphagnetum. Between the lagg-zone and the Sphagnetum there is a difference in the slope of the curves: the interseasonal changes are at all times more decided in the latter than in the former.

The results obtained by way of the measurements clearly indicate that the water of the *Sphagnum* moor cannot be characterized by a single figure of pH, neither that of the Sphagnetum or lagg-zone alone.

Relying upon a comparison to the measured values of HCO_3^- one can state that there is a certain correlation between the seasonal changes of pH and HCO_3^-. The trend of pH is a result of the complex effect of several factors. Evidently, out of these peat formation is the decisive one. Thus it is possible that highly acid, however well-"buffered" water is formed in the moor and in this water the seasonal change of HCO_3^- brings about a certain fluctuation. The phenomenon of being buffered is also proved by the circumstance that to the diel changes of HCO_3^- — which, as to order of magnitude are near to the seasonal changes — belongs only a minimum change in pH.

The dissimilar character of the changes in pH during the years 1971 and 1972 is due to the fact that the conditions of the water of the moor (which influence hydrogen-ion concentration) as regards temperature, HCO_3^- consumption and, at last the production of living organisms showed different trends in both years. Similarly, it is the difference in the intensity of production, in the proportion of the building and decomposing processes which calls forth the differences in absolute value between the Sphagnetum and the lagg-zone, as well as the varying slope of the curves representing the seasonal changes.

The diel data are presented in Table II and Fig. 2. It is easy to see that there are only small changes in the Sphagnetum and in the lagg-zone. There is, however, a difference among the single mosaics as to the absolute values of the pH data. The smallness of diel changes finds its explanation in the circumstance that "on the short run" the HCO_3^- consumption and production of the phytoplankton of small mass are unable to bring about significant changes in the highly acid and well buffered water of the moor.

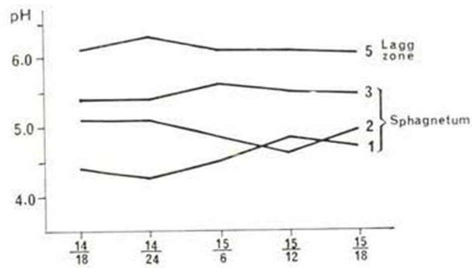

Fig. 2. Diel changes of pH

Representing the pH values measured in the seasons of the year by the sample areas, one obtains a figure which shows that pH is lowest in the centre of the Sphagnetum and, proceeding from there towards the lagg-zone, its value increases (Fig. 3.). (See also Fig. 2., presenting the diel changes.) In Fig. 3. the average of all data measured in each sample area within two years is encircled black. (Standard deviation is marked by perpendicular lines.)

Proceeding from the centre of the Sphagnetum towards the lagg-zone, the increase of pH is unambiguously connected with the differences between the successive sampling areas. The centre of the Sphagnetum are sample areas 1/ and/or 2/ with dense tussocks of the dominant *Sphagnum* species. Proceeding outwards – in the direction of the lagg-zone – the open water surface and the quantity of sedges are increasing among the tussocks (area 4/). The next stage within the Sphagnetum is the large free-surface fen window where peat-moss is almost fully thrust back by *Carex pseudocyperus* (area 3/). The area marked 6/, meaning a transition, follows next, then the lagg-zone taken in the strictest sense (area 5/).

The thickness of the peat layer and the measure of peat formation decrease towards the same direction as well. Also the quantity of the organic matter solved and formed is indicative of this (Table III). The Table presents the data of O_2 consumption (measured in an acid medium with $KMnO_4$), of unfiltered and filtered water samples. From

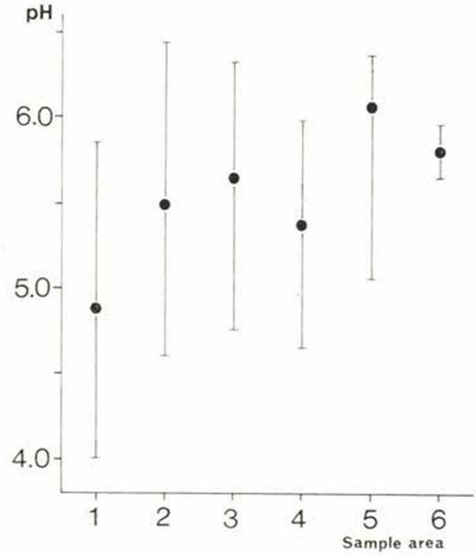

Fig. 3. Changes of pH values by the sample areas

this one can see that the process of peat formation is a significant factor in calling forth an acid pH; more exactly: the proportion of the *Sphagnum* species to the peat-moss formed of them and/or that of sedge to the sedge-peat formed of it.

Summary of the results

1. In the sedgy transition *Sphagnum* moor of Egerbakta, the acid base-rock (quarzite) and peat-moss formation have a decisive and primary part in the trend of the absolute value of pH. At the time of the examinations discussed here the water showed extreme acidity, however, at the same time also a buffered quality.

2. The pH of the water of the moor shows a seasonal change which follows that of HCO_3^- connected with the production of living organisms and with the temperature as well as conductivity.

3. The author observed only small diel differences in the value of pH.

4. Within a given transition *Sphagnum* moor the value of pH is condsiderably influenced by the proprotion of *Sphagnum* and sedge in the actually present association and/or in the process of peat formation, as well as by other ecological differences among the sampling areas.

REFERENCES

Á b r a h á m, A. – B e n d e, S. – H o r v á t h, A. – M e g y e r i, J. 1952. Adatok Putnok környékének hidrobiológiai viszonyaihoz. Beträge zur Kenntnis der hydrobiologischen Verhältnisse der Umgebung von Putnok. Ann. Biol. Univ. Hung. **1:** 341–350.

J a c z ó, I. 1941. Néhány dunántúli átmeneti tőzegmohás láp és Sphagnum előfordulás Rhizopodáiról. Über die Rhizopoda testacea-Fauna einiger Übergangsmoore und Sphagnum-Vorkommen in Westungarn. Állat. Közlem. **38:** 18–34.

J u h á s z, L. 1963. Az egerbaktai tőzegmohás láp. (Sphagnum moor of Egerbakta.) Természettud. Közl. **7:** 519–520.

M á t h é, I. – K o v á c s, M. 1958. A Mátra tőzegmohás lápja. Das Sphagnummoor des Mátra-Gebirges. Bot. Közlem. **47:** 323–331.

M e g y e r i, J. 1958. Hidrobiológiai vizsgálatok két tőzegmohalápon (Bábtava, Nyírjestó). Hidrobiologische Untersuchungen an zwei Sphagnum-Mooren, Bábtava – Nyírjestó. Szegedi Ped. Főisk. Évk. 103–119.

M e g y e r i, J. 1965. Összehasonlító hidrobiológiai vizsgálatok a keleméri és az egerbaktai Sphagnum-lápokon. Vergleichende hydrobiologische Untersuchungen an den Sphagnum-mooren von Kelemér und Egerbakta. Szegedi Tanárképző Főisk. Tud. Közlem. 115–123.

M e g y e r i, J. 1970. Tólak vízi mikrofaunájáról. Über die Wasser-mikrofauna des Tólak Szegedi Tanárképz. Főisk. Tud. Közlem. 131–138.

S c h r é t e r, Z. 1948. A Mátrától ÉK-re eső dombvidék földtani viszonyai. Conditions Géologiques de la Région de Collines ne de la Montagne Mátra. Magy. Áll. Földt. Int. Évi Jelentése 1948. 111–119.

S o ó s, Á. 1938. A magyarországi tőzegmoha-lápok fonálférgeiről I. Die Nematoden der ungarischen Sphagnummoore. Állatt. Közlem. **35:** 61–83.

S o ó s, Á. 1940. A magyarországi tőzegmoha-lápok fonálférgeiről II. Die Nematoden der ungarischen Sphagnummore. II. Állatt. Közlem. **37:** 71–91.

S o ó s, Á. 1941. A magyarországi tőzegmoha-lápok fonálférgeiről III. Az északkeleti Kárpátok lápjai. Die Nematoden der ungarischen Sphagnummoore. III. Állatt. Közlem. **38:** 35–48.

V a r g a, L. 1956. Adatok a hazai Sphagnum-lápok vízi mikrofaunájának ismeretéhez. Contributions to the aquatic microfauna of the Sphagnum marshes in Hungary. Állatt. Közlem. **45:** 149–158.

Z ó l y o m i, B. 1931. A Bükk-hegység környékének Sphagnum-lápjai. Vegetationsstudien an den Sphagnummooren am das Bükkgebirge in Mittelungarn. Bot. Közlem. **28:** 89–121.

Z ó l y o m i, B. 1939. A kőszegi Sphagnumos láp. Das Kőszeger Sphagnumreiche Moor. Vasi Szemle, **6:** 254–259.