ANNAL. BIOL. TIHANY	35	203—226	HUNGARIA 1968

REMAINS OF PEDIASTRUM KAWRAISKYI SCHMIDLE (CHLOROPHYTA, PROTOCOCCALES) IN THE SEDIMENTS OF LAKE BALATON.

A paleolimnological study.

OLGA SEBESTYÉN

Biological Research Institute of the Hungarian Academy of Sciences, Tihany, Hungary

Received: 12 February, 1968

B. ZÓLYOMI called attention on the frequent occurrence of both *Pediastrum* and diatom remains in the sediments of Lake Balaton (ZÓLYOMI 1952, 527, 1953, 405). In the course of initial studies on cladoceran remains in the Balaton sediments it became evident, that with some additional effort both *Pediastrum* and Cladocera remains could be counted on the same quantitative slides and the data might be used as a basis for paleolimnological interpretation.

Preliminary investigations were made on cores III (Szigliget—Balatonfenyves) and, on A I (off Akali [SEBESTYÉN 1965]). Later on a representative core, B 28 (Boglár—Révfülöp in the middle of the profile, 1964) was recommended by Prof. ZÓLYOMI because no trace of transgression could be established in the course of his palynological studies when comparing the pollenspectra of a series of cores. *(Fig. 1)*

The organic matter of the samples was recovered by the following methods: ZÓLYOMI 1952, 493—494, 1953, 370—371 (samples 1—11, 25, 36 of core III), FREY 1951, 1955 (one sample of core I A), FREY 1961 and personal communication (3—4 samples, of core I A, 9 samples of core B 28, and one sample, of core B 24). To eliminate minute particles the sediment was rinsed through a stainless steel screen of a 400 mesh (37 μ/mesh) fitted in a Clarke—Bumpus Bucket (FREY 1961 and personal communication, GOULDEN, personal communication). Because the sample No 140, B 28 included quite an amount of coarse plant debris, a sieve of coarser mesh was also applied.

For the mounting of the slides polyvinil lactophenol lignin pink, chlorazole, and glycerinegelatine-gentiana violet was used with good success. Glycerine-picric acid (VAN DOUWE 1925) proved convenient also, being, however, less satisfactory for permanent slides. Material of both plant and animal origin stained well with lignin pink. Chlorazole makes also fine preparates. Gentiana violet* stains plant fragments, in general, distinctly. However, all these methods proved to be convenient for quantitative investigation.

* Most of the remains of the *P.* species found in the samples of core B 28 assumed a bright blue color with gentiana-violet, with the exception of *P. duplex*. Remains of this species assumed a faded blue shade sometimes with a pale brownish tint. There were specimens the presence of which could only be established by the distinct refraction at the contact of the inner cells and at the tips of the processes of the marginal cells. In the material recovered by ZÓLYOMI's $ZnCl_2$ method (core III) *P. duplex* also assumed an intensive blue shade.

70 years ago from Lake Balaton proper the following *Pediastrum* species were mentioned: *P. simplex* (MEYEN) LEMMERMANN and few varieties of *P. duplex* MEYEN (ISTVÁNFFI 1897, 1898). The same author noted *P. boryanum* (TURPIN) MENEGHINI, *P. angulosum* (EHRENBERG) MENEGHINI and *P. tetras* (EHRENBERG) RALFS in ancient bays of Lake Balaton *(berek*, pl. *berkek)* and from Kis-Balaton, formerly a part of the lake. Three decades later *P. clathratum* (SCHROETER), *P. boryanum* LEMMERMANN and some of its varieties were noted (SCHERFFEL 1930). Both *P. biradiatum* MEYEN and *P. tetras* were found in the lake off Boglár respectively off Fonyód (HORTOBÁGYI 1952, 1953), *P. tetras* was found recently also in the Keszthelyi-öböl at the SW corner of the lake in the neighborhood of the inflow of the river Zala (TAMÁS, personal communication). In the meantime other varieties of the species mentioned were noted (KOL 1938, TAMÁS 1959).

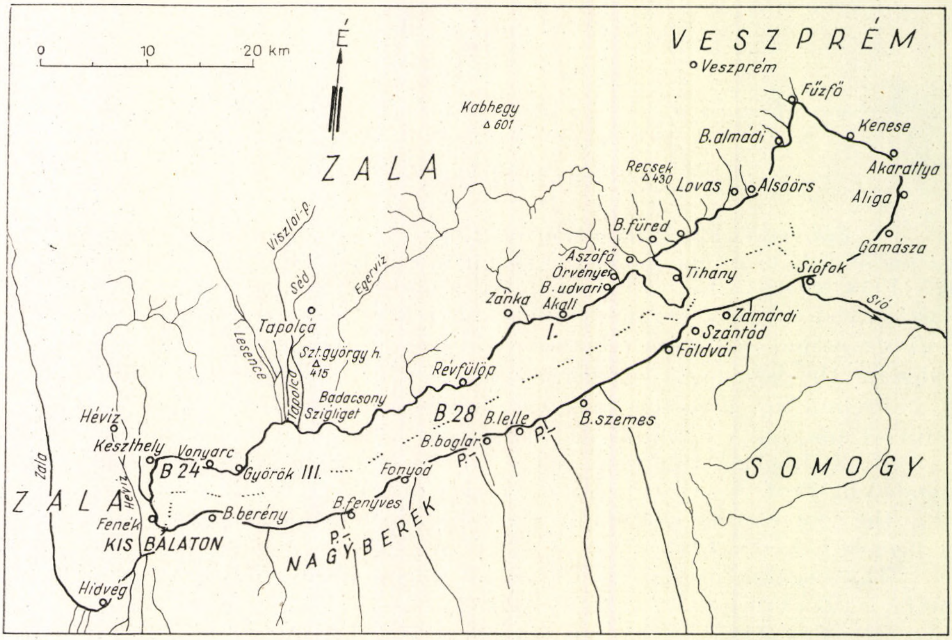


Figure 1. Sketch of Lake Balaton showing the sites of the borings mentioned in the text

1. ábra. A Balaton vízrajzának vázlata, a szövegben említett furatok helyének megjelölésével

From BIGEARD's 8 *Pediastrum* species-groups enumerated from Europe (BIGEARD 1933) 5 occur in Lake Balaton: *Pediastrum simplex* MEYEN, *Pediastrum duplex* MEYEN, *P. boryanum* (TURPIN) MENEGHINI, *P. biradiatum* MEYEN and *P. tetras* (EHRENBERG) RALFS. In the subfossil material with the exception of *P. biradiatum* and *P. tetras* the other three species-groups were recovered (see p. 207). (*M. ph.* 8—13.)

In addition remains of *P. kawraiskyi* SCHMIDLE were also found (identified by G. UHERKOVICH) (*M.ph.* 1—7.) This species is noted from Hungary rather recently in the upper reaches of the river Tisza, and in the Keleti-Főcsatorna (Eastern-Main-canal) connecting the rivers Tisza and Berettyó (UHERKOVICH 1966, 1966a). It is considered in these habitats as a cenoxene element of the plankton. The biota of both these waters are enriched by specimens of species from northern habitats (UHERKOVICH, personal communication).

*

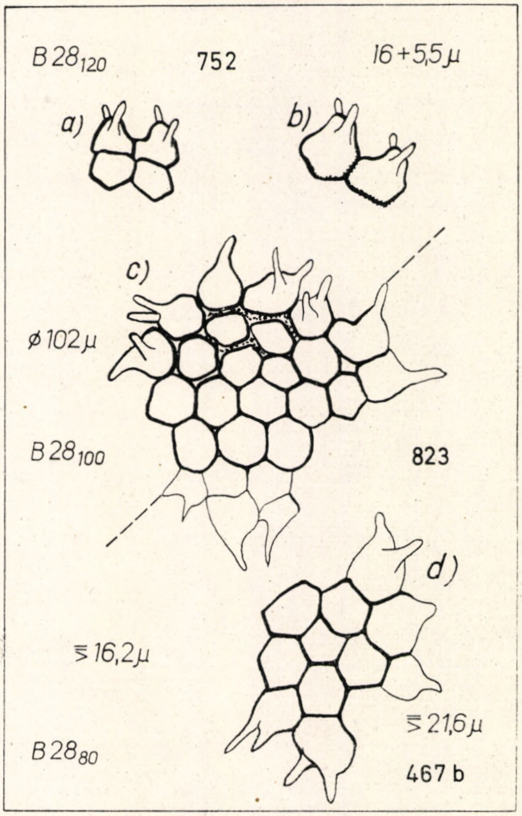


Figure 2. Sketches of *Pediastrum kawraiskyi* remains
a—b = marginal cells of cenobium No. 752. (See microphoto No. 1.); *c* = Cenobium No. 823, sample B 28, 100. Cell wall granulated. Diameter of the cenobium (---) 102 μ. — Picric acid — glycerine; *d* = Detail of the cenobium 467b (see microphoto No. 2.)

2. ábra. Vázlatok a *Pediastrum kawraiskyi*ról
a—b = a 752. sz. példány peremsejtjei (vö. 1. sz. mikrofelvétellel); *c* = 823. sz. példány a B 28, 100. sz. mintából. Granulált sejtfal. A cenobium átmérője (--) 102 μ. — Pikrinsav—glicerin. *d* = 467b sz. példány részlete (vö. 2. sz. mikrofelvétellel)
Camera lucida sketches (comp. oc. 6, obj. 7a) with the exception of Fig. 2b, which is drawn by free hand. For further details see explanation of the microphotos
Rajzolókészülék-vázlatok (comp. oc. 6, obj. 7a) a 2b sz. ábra kivételével, mely szabadkézi vázlat. További adatok a megfelelő mikrofelvételek magyarázatában

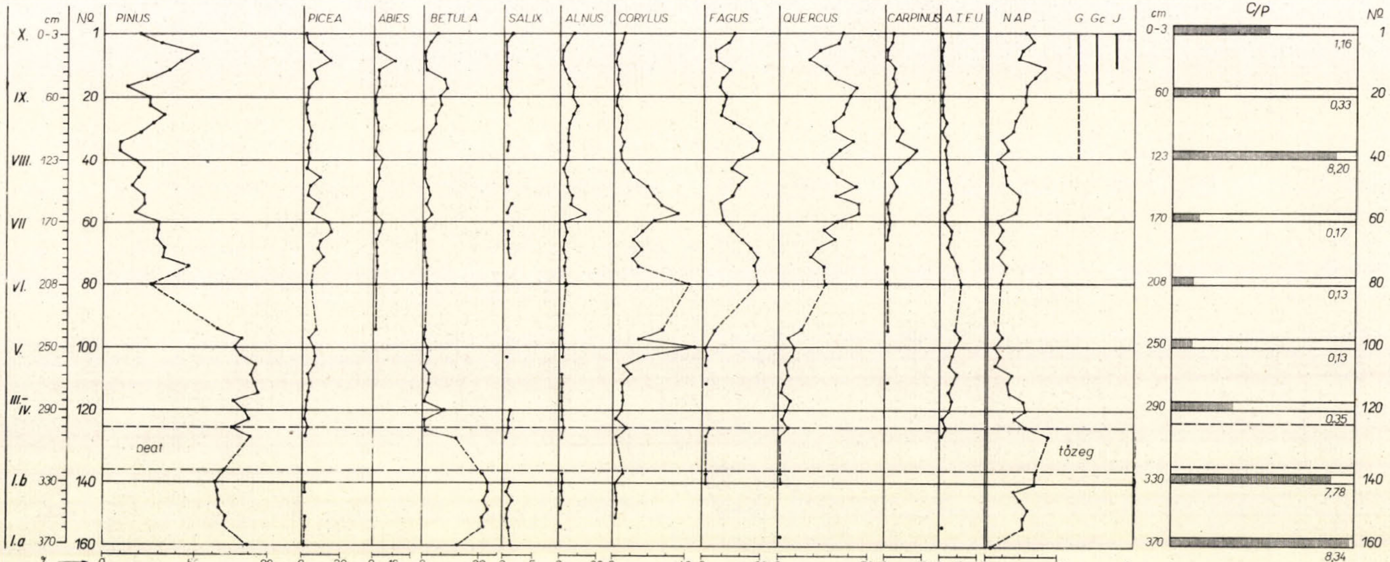


Figure 3. B 28. Pollenspectrum. AP (%), NAP (in % of AP. From Zólyomi's data, 1964, 1965, 2—3 items being united. C/P = Percentage distribution of Cladocera (cross-hatched) and *Pediastrum* (solid white) remains. 1, 20, 40 . . . 160. = No. of sample; ATFU = *Acer*, *Tilia*, *Fraxinus*, *Ulmus;* G = graminea, Gc = graminea cult., J = *Juglans*

3. ábra. B 28. furat pollenspektruma. AP = fapollen, %; NAP = nemfapollen, a fapollen %-ában. Zólyomi 1964, 1965 adataiból 3, néhány esetben 2 adat összevonásával. C/P = Cladocera (vonalkázott) és *Pediastrum* (üres) maradványok aránya, %; 1, 20, 40 . . . 160 = minta száma

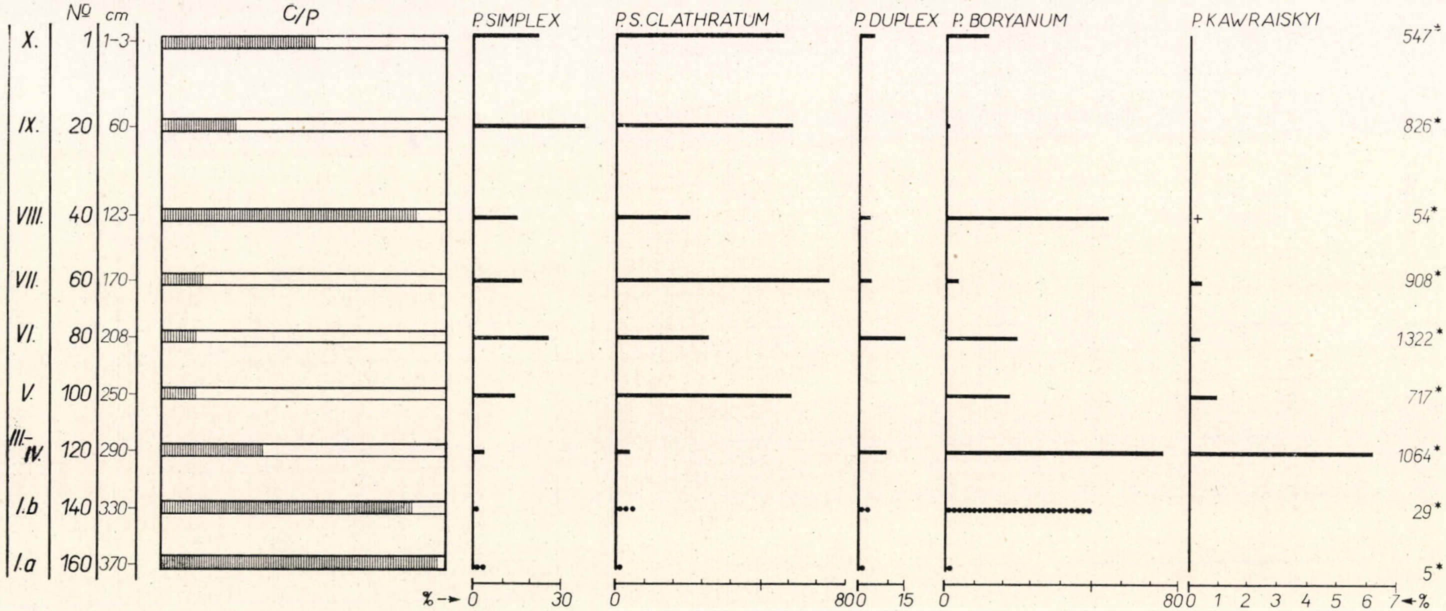


Figure 4. Core B 28. Percentage distribution of *Pediastrum* remains in samples 1—120. For samples 140. and 160. numbers of specimens given. . = * = number of specimens. For other signs see Fig. 3

4. ábra. *Pediastrum* maradványok előfordulásának százalékos gyakorisága. A 140. és 160. sz. mintákban példányszámok . = * = példányszám. Egyéb jelzés jelentését l. 3. ábra

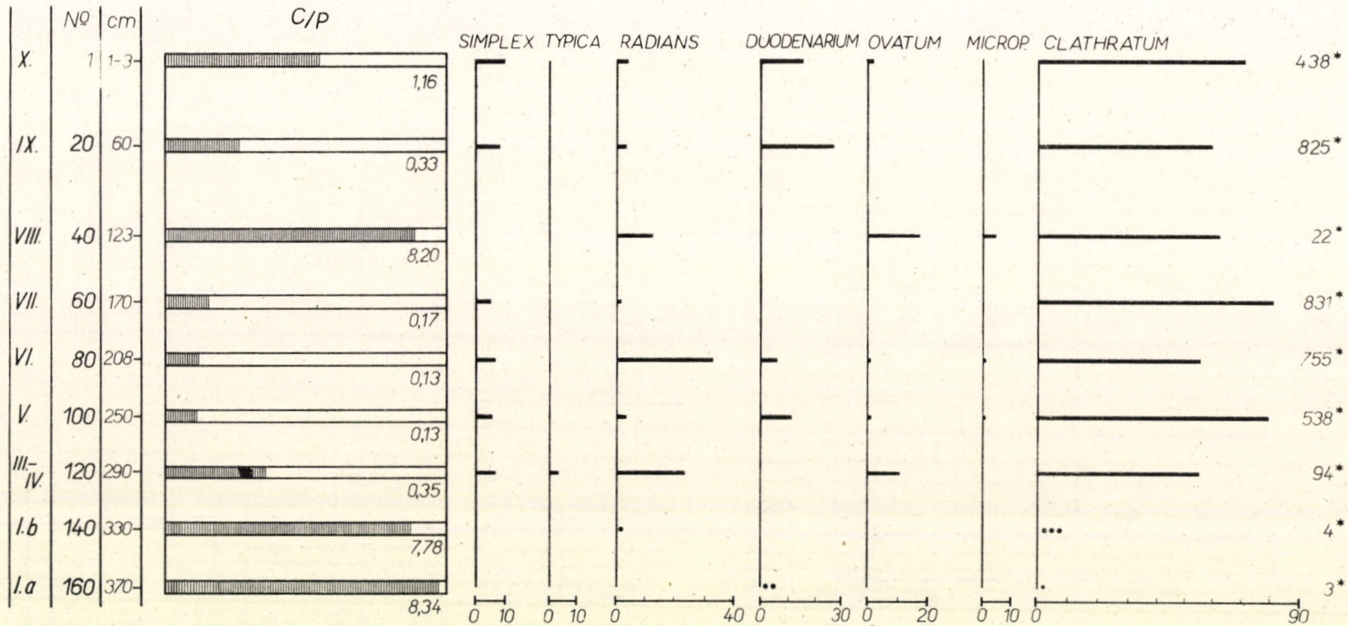


Figure 5. Percentage distribution of *Pediastrum simplex* and varieties. B 28., samples 1—120. For samples 140. and 160. numbers of specimens given. For other signs see Fig. 4

5. ábra. B 28. *Pediastrum simplex* és varietásainak százalékos előfordulása. A 140. és 160. minták adatai példányszámok. Egyéb jelzés jelentést l. 4. ábrában

The rate of sedimentation in Lake Balaton amounts to 0.4 mm/year (ZÓLYOMI, p. c.) and not to more than 0.5—1.0 mm/year (SZESZTAY 1965). At the location of core B 28 the thickness of the lacustrine sediments amounts to 410 cm: 300 cm silt + 90 cm sand + 20 cm peat (ZÓLYOMI 1965).

In *Fig. 4—5* data of the percentage distribution of remains of *Pediastrum* species found in nine samples of core B 28 are given. *P. kawraiskyi* remains were found in five samples in a section of 290—123 cm depth. (±8000—± 1000 year b. p., ZÓLYOMI.) Data of both earlier and later samples are negative (see p. 207). *Fig. 4* and *Table 1* show further that *P. kawraiskyi* is associated with *P. simplex, duplex* and *boryanum* in the Balaton sediments.

The occurrence of the remains of *P. kawraiskyi* only in one section of the core investigated as well as the fact that at present it does not belong to the biota of our lake, call our attention toward this species.

Pediastrum kawraiskyi Schmidle 1897

(Fig. 2a—d, microphotos (M. ph.) 1—7)

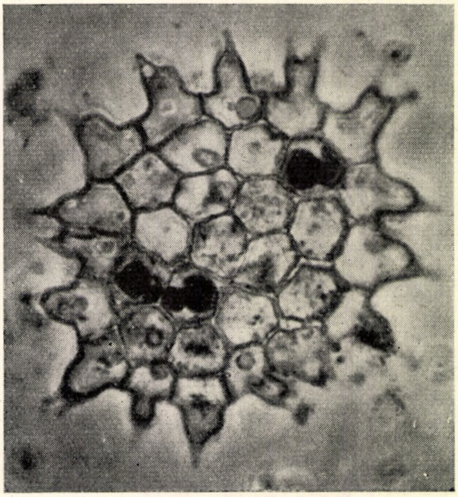
The species was found first by W. SCHMIDLE (1897) in material from a Caucasian lake at high altitude. In the system he placed it between *P. simplex* and *P. braunii* (WARTMANN). BIGEARD in his thorough study on the *P.* species in Europe (1933) enlisted it between *P. simplex* and *P. boryanum* (p. 102.). This species resembles somewhat *P. boryanum* by having solid (not clathrate) colonies. The inner cells are 5—6 sided. Granules in the cell wall are either present or absent, depending on the age of the cenobium (BIGEARD, 171.). Its most significant characteristic is that the processes of the marginal cells are not situated in the same level *(Fig. 2a—b)*. Neither the compactness of the inner cells and the irregular margin nor the uneven surface of the cenobia suggest adaptation to the pelagic mode of life (BIGEARD 1933, 155) (*M. ph.* 2.). PRESCOTT's note that this species is eu- and tychoplanktonic supports this idea (PRESCOTT 1962, 225). In BIGEARD's material most of the cenobia consist of 16 cells, those having 8 or 32 cells are rather infrequent. In the subfossil Balaton material the marginal cells in most of the specimens resembles to Fig. 30 in BIGEARD's work (p. 10), and have 16 or 32 cells. There occur however few specimens resembling *P. kawraiskyi* v. *brevicorne* LEMMERMANN, which, in BIGEARD's opinion, are benthic or aged specimens (1933, 103).

The distribution of this species is limited like that of both *P. angolusom* and *P. braunii* (BIGEARD p. 153). Main centers of its distribution in Eurasia are the Baltic region and Middle-Asia. BIGEARD gives a detailed list of its occurrence (p. 150—151). Three lakes are mentioned in Sweden by SKUJA (1948, 129 and 1956, 167) and another one by FLORIN (1957). *(Table 2)* It is common in lakes of both Michigan and Wisconsin, USA (PRESCOTT 1962, 225). It inhabits two lakes in the Baikal region: Lake Kotokel and Sor Possolsky (KORDE 1966, 24—31). *(Table 2)* It seems that with the exception of the habitats in North America, most of the sites mentioned from Eurasia are situated north from the Lake Balaton.* In Prof. B. FOTT's (p. c.) consideration

* In this paper data in the list of the Polish PAN Biological algotheca have not been taken into consideration.

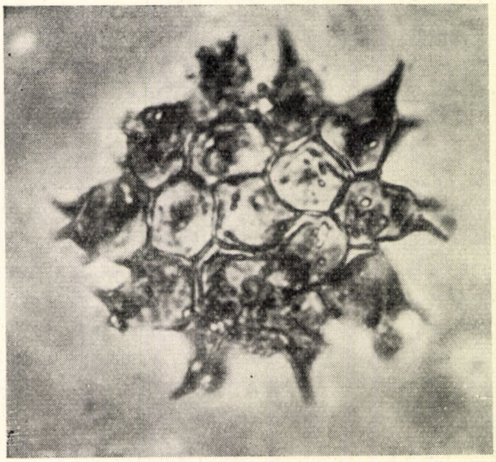
Remains of *Pediastrum kawraiskyi* SCHMIDLE from the sediments of Lake Balaton

Pediastrum kawraiskyi maradványok balatoni üledékekből



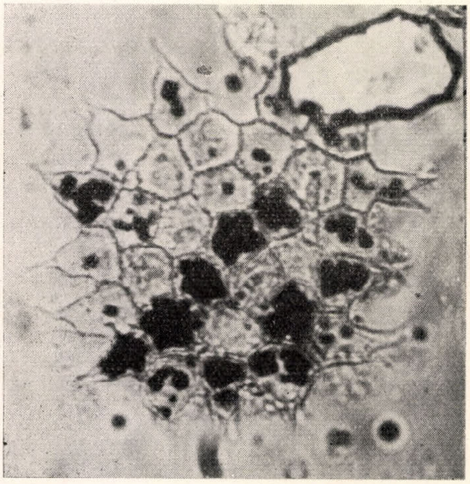
M. ph. 1. — Specimen 752. from sample B 28, 120. Cell wall with granules. Some cells with pyrite (?) crystalls. Size, inner cells 11—13 μ, marginal cells ± 16 + 5.5 μ. The specimen is flattened under the cover slip. Polyvinil lactophenol-lignin pink. (See Fig. 2.a—b.)

1. B 28, 120. minta, 752. sz. példány. Granulált sejtfal, egyes sejtekben pirit (?) kristályok. Belső sejtek mérete = 11—13 μ, peremsejtek ± 16 + 5.5 μ. A példányt a fedőlemez ellapította. Vö. 2a, b ábrával



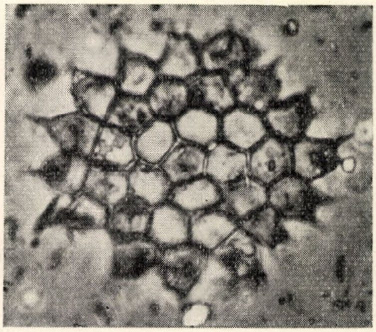
M. ph 2. — Specimen 467b from sample, B 28, 80. Cell wall not granulated. Size, inner cells ± 16.2 μ, marginal cells with processes ≧ 21.6 μ. The specimen is not flattened under the cover slip. Glycerine gelatine-gentiana violet. (See Fig. 1d.)

2. B 28, 80. sz. minta 467b példányszám. Sejtfal nem granulált. Belső sejtek = ± 16.2 μ, peremsejtek, nyúlvánnyal ≧ 21.6 μ. A cenobium nincs ellapítva. Vö. 1d ábrával



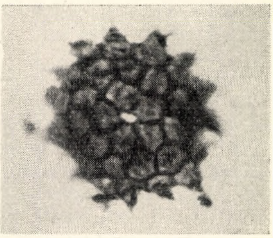
M. ph. 3. — Specimen from sample B 28, 120. Diameter 124 μ. Some cells with pyrite (?) crystals and granules. Granulated cell wall. Polyvinil lactophenol-lignin pink

3. B 28, 120. minta. Átmérő 124 μ. Egyes sejtekben pirit (?). Granulált sejtfal



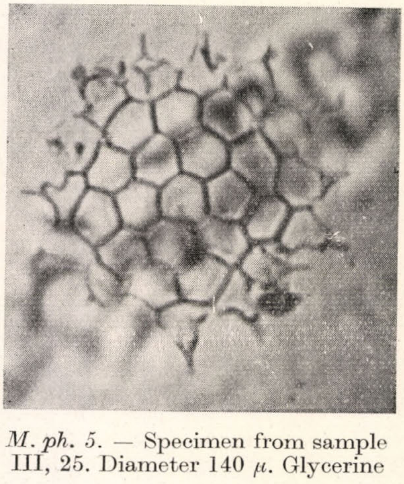
M. ph. 4.—Specimen from sample B 28, 120. Diameter 102 μ. Polyvinil lactophenol-lignin pink

4. B 28, 120. μ minta. Átmérő 102 μ



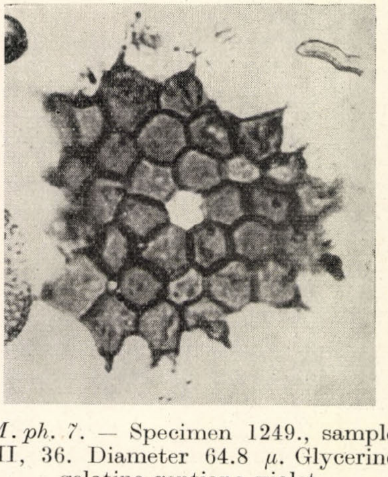
M. ph. 6.—Specimen 1260, sample III 6. Diameter 43.7 μ. Size, inner cells 5.5 μ. Glycerine gelatine-gentiana violet

6. III 36. minta, 1260. példány. Átmérő 43.7 μ. Belső sejtek = 5.5 μ



M. ph. 5. — Specimen from sample III, 25. Diameter 140 μ. Glycerine

5. III, 25. minta. Átmérő 140 μ



M. ph. 7. — Specimen 1249., sample III, 36. Diameter 64.8 μ. Glycerine gelatine-gentiana violet

7. III, 36. sz. minta. Átmérő 67.8 μ

it is a northern form. In KOLKWITZ's systeme (1950) *P. k.* is considered as an oligosaprobic form together with *P. duplex*, *P. tetras* and *P. rotula* (EHRENBERG) A. BRAUN.

Let us call in mind the part of KORDE's paper (1966) mentioned above, with reference to Lake Kotokel and Sor Possolsky. Both the recent and subfossil occurrences of *P. k.* in the Baikal region might give aid for the interpretation of the subfossil occurrence of *P. k.* in the sediments of Lake Balaton.

Recent and subfossil occurrences of P. kawraiskyi in Lake Kotokel and Sor Possolsky (Korde 1966, 24—31)

The altitude of Lake Kotokel is 12 m higher than that of Lake Baikal (453 + 12 m) from which it was separated by the change of the water-level. The temperature of its soft water may attain 25.8 °C in summer. Its algal community, differing from that of L. Baikal exhibits affinities to the littoral plankton communities of both the Baikal's shallow bays and that of the ,,Sor"-s (shallow bays of L. Baikal running more or less far into the adjacent land and being separated from the main lake by sand banks). Such communities *(,,Sibirische Artenkomplexe")* are characteristic of shallow rivers and standing water-bodies in the Asian part of the Soviet Union.

In an August sample of Lake Kotokel blue-greens, Protococcales — including *P. kawraiskyi* — and, diatoms were noted. *P. k.* is mentioned also from Sor Possolsky with many blue-greens, Protococcales, including several *Pediastrum* species and, diatoms. Such community develops abundantly in its shallow water which warms up well in summer.

In the sediments of L. Kotokel two main parts could be distinguished. The border between them is situated in ± 500 cm depth. The deepest layer represents the initial age of the lake, a warm phase with blue-greens in the dominancy, Protococcales, including *P. kawraiskyi* and other members of the *Pediastrum* genus. Some Chrysomonads and diatoms are also associated. All the species the remains of which were found here are members of the recent littoral plankton community of this lake as well as the bays and Sor-s of Lake Baikal.

Layer rich in algae, mentioned but especially in Desmids and Chrysomonads are found immediately underneath the border (at ± 500 cm), with *Drepanocladus aduncus* f. *capillifolia* in abundance. Such assembly indicates rather cold climate and shallow water situation.

In the section between the border and the layer situated about 60 cm below the surface of the sediments blue-greens, Protococcales, Chrysomonads and diatoms are constantly present, with the varying dominance of various species. The Protococcales group attains dominancy only in the layer near to the upmost part of the sediment.

Changes in the percentage distribution of these algal-assemblies correspond the changes taking place in both the climate and the water level, as they are interpreted by the pollenspectra. Within such major changes finer details may also be established, reflecting, very likely, the repeatedly occurring seasonal variations in the structure of the plankton community.

With reference to the reconstruction of the limnological past of Lake Balaton the following facts may have a special value:

1. Following the transitory IV. phase, initiated at the 317 cm deep layer of Lake Kotokel the *Pinus* age (V. phase) is continuously prevailing in the Baikal region (KORDE 1966, 30).

2. The development of a dense algal flora in the well warmed up littoral waters during a supposedly short summer is reflected in the sediments.

A seasonal rise of the temperature in water bodies situated in the region of cold climate or high altitude, very likely, takes place in our time as well.

Discussion

In the literature we find indications that the microfossil-assemblies recovered from the various layers of the sediments, do not reflect completely the structure of the biota-series corresponding to the age of the sedimentation. Beside the various elements of lacustrine origin allochthonous forms may also be present (FREY 1958, 210, 1964, 1). From the various factors affecting the structure of the microfossil-assemblies the followings are mentioned:

a) the nature of the various substances of the morphological remains,

b) the environmental conditions offered by the lake as an ecosysteme, including some individual properties of the habitat in question,

c) the effects of the various techniques applied in the preparation of the material for microscopical analysis, and

d) the ,,ease of the recognition'' of the remains (FREY 1958, 210).

1. In the recovery of the organic parts of the samples various methods were used (see p. 203), all resulting in the case of *Pediastrum* remains a condition suitable for identification at the species level. Hence the rate of percentage distribution of the few *P.* species found may mirror fairly well the true situation. In most cases the remains were present in quantities sufficient for percentage evaluation. *(Table 1, Fig. 4)*

2. There are three kinds of data, relating to the occurrence of *Pediastrum k.:*

a) only recent occurrence (see p. 209, *Table 2),*

b) both recent and subfossil occurrence (Lake Kotokel, KORDE),

c) only fossil occurrence (Lake Balaton, in this study). *(Table 2)*

It seems that all the positive data either recent or subfossil, relate to the active phase of the life cycle. No data were found in the literature on the cyst (aplanospore) of *P. k.* with the exception of the possibility of cyst formation concluded from the distinct morphology of some cells in the cenobium (BIGEARD 1933, 99, 102).

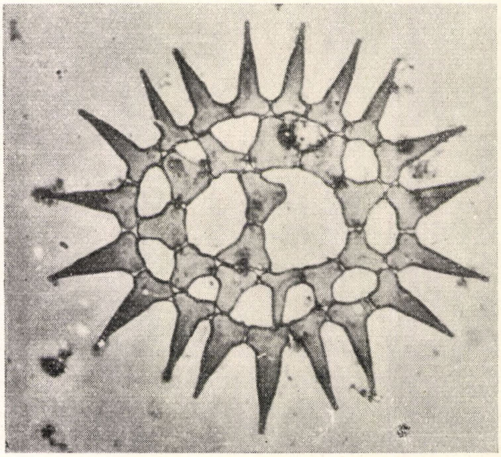
Data on recent occurrences suitable to our aim should include time of sampling, length of the period of occurrences in both the active and resting states.

The section of core B 28, containing remains of *P. k.* relates to the vegetation phases (FIRBAS) III—IV, V, VI, VII, VIII. This is the period from the border of the Pleistocene and Holocene (younger tundre age and early postglacial *Pinus-Betula* phase, ± 8000 b. p.) until the subboreal (the beginning of the New Holocene *Fagus* phase, ± 1000 b. p.). In this period changes in the climate and the water level took place: the Holocen maximal water level, and brief periods of low water levels (SEBESTYÉN 1968b).

No remains could be recovered in the two Pleistocene samples (Nos 160, and 140, in core B 28), representing partly high water situations partly low water level. However the extremely scarce occurrence of *Pediastrum* remains in these samples leaves the possibility for the presence of *P. k.* still open. The analysis of two samples from layers of two other cores corresponding the samples 140, B 28 brought positive data for *Pediastrum kawraiskyi*. These samples as suggested by Prof. ZÓLYOMI (in litt.) are samples 145, core B 24 (N part of the Keszthelyi-öböl, in 300 m distance off the littoral *Phragmitetum* at Gyenesdiás) from the same series of borings (1965) as core B 28 and sample 36 of core III (in the middle of the profile Szigligeti-öböl bay—Balatonfenyves), an earlier set of borings (1948). *(Fig. 1)*

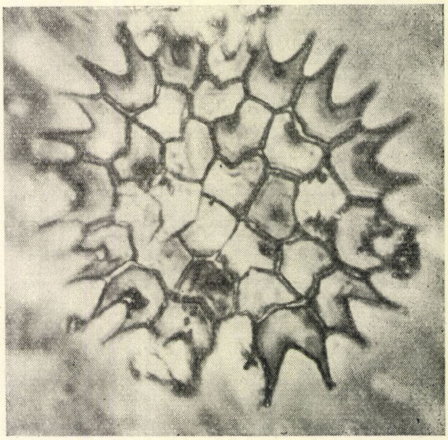
Pediastrum remains from the sediments of Lake Balaton

Pediastrum maradványok balatoni üledékekből



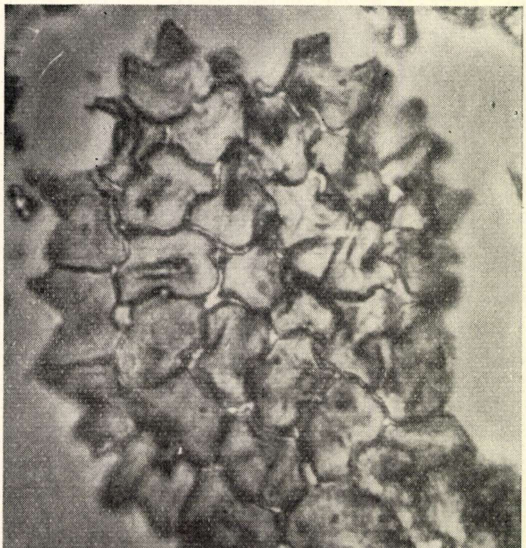
M. ph. 8. — Pediastrum simplex clathratum. Specimen 493, from sample B 28, 80. Size of the cenobium 153.45 × 133.6 μ. Polivinil lactophenol—lignin pink

8. P. simplex clathratum. B 28, 80. sz. minta, 493. sz. példány, cenobium = 153.45 × 133.6 μ



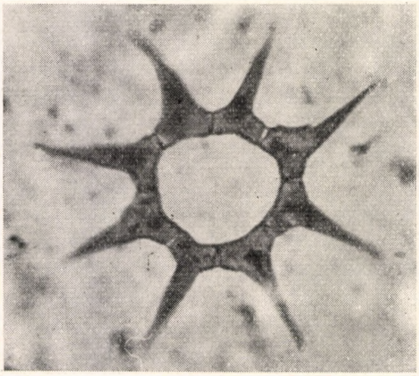
M. ph. 9. — Pediastrum boryanum from sample IA, 4. Diameter 118.9 μ. Glycerine gelatine-gentiana violet

9. P. boryanum, IA, 4. minta. Átmérő 118.9 μ



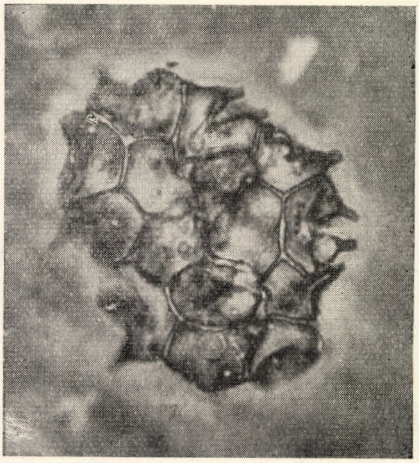
M. ph. 10. Pediastrum duplex? Specimen 1142. from sample B 28, 140. length 140 μ. Polyvinil lactophenol-lignin pink

10. P. duplex (?) B 28, 140. minta, hosszméret 140 μ. 1142.pl.



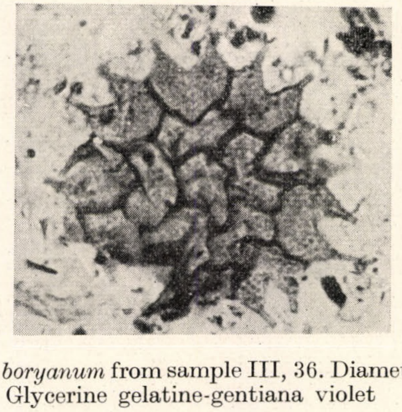
M. ph. 11.—Pediastrum simplex radians from sample B 28, 80. Diameter of cenobium 75 μ. Glycerine gelatine-gentiana violet

11. P. simplex radians B 28, 80. minta, átmérő 75 μ



M. ph. 12.—Pediastrum bidentulum AL. BRAUN v. *ornatum* NORDSTEDT (in BIGEARD's consideration it is a variety of *P. boryanum)*. Length of cenobium 92 μ. Size of the marginal cell with pyrite (?) crystal, 21.6 × 16.7 μ. Polyvinil lactophenol-lignin pink

12. Pediastrum bidentulum AL. BRAUN v. *ornatum* NORDSTEDT (BIGEARD szerint a *P. boryanum* varietása). Hosszméret 92.



M. ph. 13. — Pediastrum boryanum from sample III, 36. Diameter of cenobium, 70.26 μ. Glycerine gelatine-gentiana violet

13. P. boryanum III 36. sz. minta. Átmérő 70.26 μ

The presence of the remains of *Pediastrum k.* in the sediment of Lake Kotokel from the Subatlantic b (phase Ib, KORDE 1966, Table IX) supports the possibility of the existence of *P. k.* in the biota of Lake Balaton in the Pleistocene *(Table 1,* microphoto *6—7)*.

,,There is a peat layer above the layer represented by the sample 36. in core III. similarly to the situation of 140. B 28. The palynological investigations extended to 560 cm below the peat (315—350 cm). The layer represented by sample 140 B 28 here, regrettably, is thinner and more sandy, however it is without doubt identical with that of 140. B 28." (ZÓLYOMI, in litt. 2. XII. 1966.)

Yet their microfossil assemblies others than pollen exhibit interesting differences. We have to keep in mind, that in the recovery of the organic part of the samples of these two cores different methods were applied (p. 203).

a) In the course of quantitative investigations of sample 36. of core III. no cladoceran remains were found. Samples 1—11, 25. of the same core were also reduced in such remains (SEBESTYÉN 1965, 218). In sample 140, B28 Cladocera remains were frequent (SEBESTYÉN 1968b).

b) The organic part of III. 36. shows a fine concentration of both pollens and *Pediastrum* remains. *Pediastrum* remains in B 28, 140. were very scarce *(Table 1, Fig. 4)*.

c) The *Pediastrum* assembly in its systematic construction is different, although the scarce occurrence of these algae in B 28, 140 has also to be considered.

d) Cenobia of *P. k.* having 32 cells are more frequent in III. 36. than in B 28, 120, where this species was frequent also *(Table 1)*. Cenobia (32 cells) with very small size of cells were also found (microphoto *6—7)*.

e) In III 36 spicules of Spongillidae, among them that of *Trochospongilla horrida* were frequent, diatoms present. In B 28, 140 both spicules and diatoms were found scarce.

On the ground of these differences we are attempted to draw the conclusion that at the late Pleistocene the limnological characteristics in the SW part of the lake, situated S from the Tihany peninsula, were not uniform in that sense that the profile Révfülöp—Boglár differed considerably from the profile Szigliget—Balatonfenyves and that these two parts represented by the profiles mentioned were probably separated from each other. (See LÓCZY 1916, p. 585, Fig. 274.)

The first datum of the occurrence of *P. k.* in core B 28 (sample 120) marks at the same time the maximal value of its percentage distribution. With the appearance of thermophylous deciduous tree a gradual decrease (?) seems to be taking place in the population of this species, lasting — probably — for $\pm$ 7000 or more years. Its ecological requirements could be somewhat satisfied as yet at the beginning of the New Holocene *Fagus* phase (sample No 40).

No traces of its presence could however be established in the subatlantic present (No 20). This sample was the only one in which *P. duplex* was also absent. The palynological data suggest a sudden decrease of the water level and, following fluctuations on a smaller scale, a stabilization. From the Cladocera *Pediastrum* ratio and the dominance of the clathrate varieties of *P. simplex* (v. *radians*, v. *duodenarium* and v. *clathratum*, 99%]*)* open water situations (high water level?) might be concluded *(Fig. 4—5)*.

The problem arose what could the reason be for the absence of this species in the biota of this lake for the last ± 2500 years? Could it be that because of the ageing of the lake, through the accumulation of the sediments the thickness of the water column decreased, resulting in the elongation of the warm water season? Such situation may effect the development of the population of this species unfavourably (see p. 213).

If we attempt to interpret the occurrence of *P. k.* remains only in one portion of this core we need informations on the followings:

a—b) ecology of both *P. k.* and the concurrent *P.* species,

c) nature of the related algal assemblies,

d) geographical position, morphometry and environmental conditions of the habitat, including the water climate etc,

e) ecology of the watershed (climate, pollenspectra, hydrography),

f) ecology of concurrent species others than *Pediastrum*, the remains of which were simultaneously present.

a) There is hardly any direct information in the literature on the ecology of *P. k.* However, the fact that it is the only *P.* taxon enlisted in ,,*stenotopic species indicative of eutrophic conditions*'', in a thorough study on ten lakes in Sweden, of which only Lake Måsnaren inhabits the ,,*rather demanding*'' *P. k.* (FLORIN 1957, 48, 67) seems to have the meaning that it is the rarest taxon in the *P.* genus and its distribution is sporadic (BIGEARD 1933, 99, 147, 151). It has been reported from three other lakes in Sweden (SKUJA 1948, 1956). Only one lake is mentioned from that part of France where BIGEARD's material for his monographic study originated from (99, 150). All these data suggest stenotopy, and are valuable from both ecological and paleolimnological standpoints.

b) It has been established that remains of *P. k.* in Lake Balaton are associated with the remains of all the three *P.* species which inhabit our lake at the present. (Both *P. biradiatum* and *P. tetras*, as small water forms, could hardly be considered as members of the typical algal flora of Lake Balaton. They are, very likely, carried into the territory of the lake by waters of the draining canals from the adjacent swamps [*berek*, *berkek*], former shallow bays of the lake and become planktoxene elements here).

Lake Måsnaren inhabits 16 taxa of the *Pediastrum* genus, including *P. k.* (FLORIN 1957, 110). *(Table 2)*

It could be established that *P. boryanum* is always present in the habitats where *P. k.* is noted from. This is true of both recent and subfossil condition. The maxima of the percentage distribution of the remains of these two taxa were found in the same sample (No 120) in this study (see *Fig. 4, Table 1)*.

Nevertheless, because the very resistant, plastic and polymorphic *P. boryanum* has an eurytopic and eurythermic nature (BIGEARD, 149), such concurrency may come about by coincidence, hence it does not give any clue for the ecological valence of *P. k.*

We are, however, in the position to say as much that the ecological valence of *P. k.* is restricted in comparison with the other three species-groups: *P. simplex*, *P. duplex* and *P. boryanum*, the remains of which were recovered multaneously from the sediments of lake Balaton and which belong to our lake's biota continuously from the late Pleistocene till present. These findings seem to be in consent with the Swedish authors' view that *P. kawraiskyi* is a *stenotopic* form.

Table I.

Percentage distribution of the remains of *Pediastrum* species (—groups) in samples of cores B 28, III, B 24. and in quantitative plankton samples from four dephts, off Tihany in 1944. XII — 1945 — 1947 — 1949 — 1951 — 1952 I.) 41 months, 136 l water)

From TAMÁS' data, 1954, Tables 1—4

+ = present in qualitative samples
— = not present
figures in brackets are included in the figures above

core		B 28					
Pediastrum	N° of sample depth cm Firbas	1 0—3 X	20 60 IX	40 123 VIII	60 170 VII	80 208 VII	100 250 V
kawraiskyi		—	—	+	0.33	0.22	0.97
simplex (v. *clathratum)*		80.94 (58.03)	99.78 (61.13)	40.73 (25.92)	91.61 (74.86)	59.37 (32.98)	75.03 (60.39)
duplex		4.99	—	3.71	3.85	15.28	0.97
boryanum (biduntulum ornatum)		14.04	0.12	55.54	4.18	25.12 (1)	23.01
N° of specimens		547	826	54	907	1322	717

* Total of mean values per sample

c) The algal communities of the two lakes in the Baikal region (Extent of L. Kotokel 15×6 km×6 m, altitude 465 m) having positive data for the occurrence of *P. k.* resemble to the ,,*Sibirische Artenkomplexe*'' (KORDE 24—25). The phytoplankton of Lake Måsnaren (extent ±110 ha, depth ±3 m, altitude 27,5 m, FLORIN, 46) includes Chlorococcales with *P. k.*, Chrysophyts and diatoms, the dominant and subdominant members being usually blue-greens. ,,*Consequently Måsnaren resembles eutrophic lakes containing a 'Baltic plankton formation' characterised by Cyanophyceae water-blooms*'' (TEILING 1918, quoted by M. B.—FLORIN, p. 67). It seems that both views suggest *Northern* affinities.

d) Most part of Lake Balaton in situated N of 47° N. Lat. Lake Baikal in the neighborhood of which Lake Kotokel is situated lays in its entire extent N from the 50° Lat. The *Pinus* age is prevalent there continuously since the transitory IV. phase. *P. k.* was sampled here in August, in the shallow littoral warm water. Lake Måsnaren is situated N of the 60° N Lat. *P. k.* was collected there in V—IX. (M. B.—FLORIN 1957, 52, 67). Both these details and the distribution of *P. k.* in general (see p. 209), suggest that *P. k.* is a northern form. We may add that it has, perhaps, rather a demand for high temperature in a brief (?) period of time, than a tolerance against it.

I. táblázat

Pediastrum fajok maradványainak százalékos megoszlása a B 28., III. és B. 24. furatok mintáiban, valamint *Pediastrum* fajok százalékos gyakorisága Tihany előtti vizekben gyűjtött mennyiségi planktonmintákban (4 m mélység, összesen 136 l. víz, 1944. XII.— 1945 — 1947 — 1949 — 1951 — 1952. I. évek 41 hónapjában). TAMÁS 1954. 1—4. táblázat adataiból számítva

+ = minőségi mintákból

— = negatív adat

A zárójelben előforduló számok az e számadatok fölöttiekben bennfoglaltaknak.

			III		B24	plankton
120 290 III—IV	140 330 1b	160 370 1a	25 290—295 III—IV	36 350—370 I b	145 318—320 I b	Tihany 4 depth
6,29	—	—	11.08	10.72%	+	—
8.82 (4.88)	4 (3)	3 (1)	9.91	All other *P.* species etc.	—	30.51 (30.51)
9.49	2	1	31.13	89.27%	—	(v. *ret)* 45.28
75.37	(22) (1)	1	47.87	(+)	—	24,19
1064	29	5	424	452		4827*

However temperature itself hardly could be responsible for the changes in the environmental conditions in a particular water-body. Along with it, very likely, changes are taking place in the intensity and quality of other ecological factors (see KORDE 1966, 27).

There are valuable records on the physical and chemical properties of the water of some of the habitats which have positve data on the recent occurrences of *P. k.* (BIGEARD, 161, KORDE 1964, 24, M. B. FLORIN, 46). The comparison of such data might also give a clue on the limnological nature of the environment which is in favour for the development of the population of *P. k.* From the results of this the criterion of its stenotopy might be outlined. From culture experiments valuable informations in this effect may be expected.

e) Morphometry of the waterbody with positive data as well as a study on the resemblance (?) of the ancient bays of Lake Balaton to Lake Kotokel and to the Sor-s of Lake Baikal may support also fruitful material for the enlightening of the ecological demand of this species.

f) Since in the course of the analysis of the samples both *Pediastrum* and Cladocera remains were taken into consideration, it lays at hand to make a comparison of the occurrence of *P. k.* with that of some species of the chydo-

Table II.

Occurrence of *Pediastrum kawraiskyi* and other concurrent members of the *Pediastrum* genus in some water-bodies in Europe and Asia

\+ = recent
● = subfossil
— = no data

Geogr. position		Name of lake	*Pediastrum*				
			kawraiskyi	*simplex*	*duplex*	*biradiatum*	*boryanum*
Europe	Hungary	Balaton	—	+	+	+	+
			●	●	●	—	●
	France	l'etang de Serrant	+	+	+	—	+
	Sweden	Sä Säbysjön Uppland	+	+ *clath.*	+ v. *araneusum*	+	+ v. *brevicorne*
		Tämnaren	+				
		Skedviken	+				
		Masnaren	×	+	+	+	+
U.S.S.R. Asia	Baikal region	Lake Kotokel	+	—	—	+	+
			●	●	—	—	●
		Sor Possolsky	+			+	
	Altaj mt.	Lake Zaisan	+	+	+ v. *aspera* v. *clath.* v. *retic.*	—	+

rid cladocerans with both active and resting phases in their life-cycle, within the populations. *Leydigia acanthocercoides* FISCHER seems to be a suitable object for this purpose.

L. a. inhabits our lake at present. Remains of it were recovered from all samples, analysed, with the exception of samples No 140. and No 160. in the Pleistocene (SEBESTYÉN 1968b). Its population, in comparison with other benthic chydorid cladocerans, is distinct by having the shortest active phase in the life-cycle. *L. a.* appears later in the warm water season (early July) than any other stenothermic benthic chydorids and, following a sudden increase of the population, the males appear in the same month, ephippia are formed to preserve life in form of a resting state which is the longest among any other

II. Táblázat

*A Pediastrum kawraiskyi*nak és a vele egyidejüleg előforduló más *Pediastrum* fajoknak előfordulása néhány európai és ázsiai vízben.
+ = recens adat
● = szubfossilis adat
— = negatív adat

angulosum	*tetras*	*braunii*	Source	Remarks
—	+	—	TAMÁS, 1959	
—	—	—	this study	
+	—	—	BIGEARD, 1933	
—	+	—	SKUJA, 1948	only in this lake in Uppland
			SKUJA, 1965	168: „regelmässig und zu verschiedenen Jahreszeiten, doch mehr vereinzelt unter verschiedenen anderen Pediastren, Blaualgen, etc."
				168: „vereinzelt unter zahlreichen anderen Phytoplanktern. 12, 7, 34"
+	+	—	M. B.-FLORIN, 1957	and others, alltogether 16 taxa see p. 110 General table
—	—	—	KORDE, 1966	
—	—	—		
	+			
+	+	+ *tricornutum*	SKVORTZOV, 1928	

benthic Chydorids in our lake. Its sporadic occurrence in Europe (SEBESTYÉN 1965, 205) and especially the result of DE COSTA's investigations on a series of lakes in the Mississippi valley indicate that it is a „southern form" (DE COSTA 1964, 81—83, SEBESTYÉN 1965, 206, 219—220). The ability of this species — within the population — to accomodate to the thermic conditions etc. of the environment may explain its existence in our lake both in the border of the Pleistocene and Holocene and in the Holocene, including the present. We are inclined to conclude that the period of the active stage of its life, within the population, must have been shorter in period of rigid climates in the geoogical past in Lake Balaton than it is at present (in our time).

Resumé

In nine samples of a core from sediments of Lake Balaton which is representative in palynological view, remains were found of those *Pediastrum* species which inhabit our lake at present *(P. simplex, P. duplex* and *P. boryanum)*. Remains both of *P. biradiatum* and *P. tetras* noted in our time as planktoxene elements carried by draining canals from adjacent marshy meadows (ancient bays of the lake) and by the river Zala were absent in the analysis of quantitative slides.

In the sections, 290–123 cm depth, corresponding the age ±8000–±1000 b. p., of the 410 cm long core B 28, remains of *Pediastrum kawraiskyi* were found in decreasing percentage frequency. Such remains were recovered from other cores from deeper (earlier) layers.

There are several data on the recent occurrence of *P. k.* in the literature. It occurs in both recent and subfossil conditions in one lake in the Baikal region and, only the remains were found in the sediments of Lake Balaton. All data refer to the active state of the life-cycle of this species.

From the subfossil Balaton data we might conclude that its ecological valence is more restricted than that of the other three *Pediastrum* species which inhabit our lake at present. It seems that the environmental conditions, offered by our lake, could satisfy the ecological demands of *P. k.* only in a section of its past history: Late Pleistocene + part of the Holocene. This means, that the period when *P. k.* was a member of the biota of the lake marks a distinct portion in the history of Lake Balaton.

From the literature we learn that *P. k.* is a northern form with stenotopic nature and perhaps has a demand for higher temperature for a brief period for both the development and the maintenance of the population.

From the differences of the results of the analysation for cladoceran and *Pediastrum* remains in Pleistocene samples originated from two different cores but from the same layer – as could be established on palynological ground – the conclusion might be drawn that the limnological situations in that part of the lake which situated south from the Tihany-peninsula were not uniform in the Late Pleistocene or at least a part of that age. This would also suggest that in the Late Pleistocene perhaps there were no connections between the water-bodies represented by the profiles Boglár–Révfülöp and Balatonfenyves–Szigliget. (Pre-Balaton condition?, SEBESTYÉN 1968b See LÓCZY 1916, p. 585, Fig. 274.)

No more could be concluded from the analysis of the microfossils recovered in the course of this study and from the pertinent literature which, however, the author was not in the position to consider in its full extent.

Results of the investigations of more samples both of the core B 28 and other cores of the sediments of the present Lake Balaton and the same of the „*berkek*", chemical analysis of the samples, and more knowledge on the ecology of *P. k.* (literature, culture experiments) are needed in order to approach the goal: to gain an insight into the environmental situations in a particular part of the past history of Lake Balaton.

ACKNOWLEDGEMENT

Many persons were kind enough to give various aids which made my investigations possible:

Director DR. JÁNOS SALÁNKI provided working place, laboratory and library facilities in the Biological Research Institute, Tihany. — Academician BÁLINT ZÓLYOMI offered the samples from his borings, placed many of his unpublished data at my disposal, made helpful suggestions and comments in the course of my study — DRS. GIZELLA TAMÁS and GÁBOR UHERKOVICH gave aid in the line of algology whenever it was needed. — MR. TIBOR FARKAS and his assistant, MISS ETHEL SZABÓ prepared the samples for the microscopical analysis. — IMRE ZS.-NAGY M. D. and MR. IMRE KEMENESI were kind enough to provide for the microphotos.

Accept, please, my very best thanks for the aids given.

I would like to express my sincere appreciation to Professor D. G. FREY (Zoology Department, Indiana University) and DR. C. E. GOULDEN (then at the Biology Department, Yale University) for all the help kindly given in my lake-history studies.

REFERENCES

BEHRE, K. 1964: Zur Algensociologie des Süsswassers (unter besonderer Berücksichtigung der Littoralalgen) — *Arch. Hydrobiol.* **62,** 125—164.

BIGEARD, E. 1933: Les *Pediastrum* d'Europe. — Trav. du Laboratoire de Botanique de l'Université Catholique d'Angers. **5,** *Revue Algologique,* 1—175.

BRUNNTHALER, J. et A. PASCHER 1915: Chlorophyceae II. in PASCHER's *Süsswasserflora* etc.

DE COSTA, J. J. 1964: Latitudinal Distribution of Chydorid Cladocera in the Mississippi Valley, Based on Their Remains in Surficial Lake Sediments. — *Investigations of Indiana Lakes and Streams* **6,** 65—101.

VAN DOUWE, C. 1925: Chitinfärbemittel für Entomostraken-präparate. — *Zool. Anz.* **64,** 294.

FLORIN, MAJ-BRITT 1957: Plankton of fresh and brakish waters in the Södertälje area. — *Acta Phytogeographica Suecia* **37,** 1—144.

FOTT, B. Algenkunde. — VEB G. Fischer Verlag pp. 282, 245.

FREY, D. G. 1951: Pollensuccession in the sediments of Singletary Lake, North Caroline. — *Ecology* **32,** 518—533.

— 1955: A differential flotation technique for recovering microfossils from inorganic sediments. — *New Phytologist.* **54,** 257—258.

— 1958: The late-glacial cladoceran fauna of a small lake. — *Arch. Hydrobiol.* — **54,** 209—275.

— 1961: Developmental history of Schleinsee. — *Verhandl. internat. Verein. Limnol.* **14,** 271—278.

— 1964: Remains of animals in Quaternary lake und bog sediments and their interpretations. — *Arch. Hydrobiol. Beih. Ergebn. Limnol.* **2,** 1—114.

FRITSCH, F. E. 1935: The Structures and Reproduction of the Algae. I. *Cambridge.* The Univ. Press. XVII + 789, 169.

HORTOBÁGYI T. 1942: Adatok a Balaton fonyódi júliusi mikrovegetációjához. — Beiträge zur July-Mikrovegetation des Balaton-Sees bei Fonyód. — *Bot. Közl.* Budapest, **39,** 57—85.

— 1943: Adatok a Balaton boglári sestonjában, psammonjában és lasionjában élő moszatok ismeretéhez. — Beiträge zur Kenntnis der im Boglárer Seston, Psammon and Lasion lebenden Algen des Balaton-Sees. — *Magyar Biol. Kut. Munk.* **15,** 75—127.

ISTVÁNFFI, GY. 1897: A Balaton moszatflorája. — *Balat. Tud. Tanulm. Eredm.* II. 2. **1,** 1—140.

— 1898: The Kryptogamen Flora des Balaton-Sees und seiner Nebengewässer. — *Res. wiss. Erforsch. Balatonsees.* II. 2, I, 1—148.

KOL, E. 1938: Die Algenvegetation des Balaton-Sees. — A nagy Balaton algavegetációja. — *Magyar Biol. Kut. Munk.* **10,** 154—160.

KOLKWITZ, R. 1950: Oekologie der Saprobien 18, 29. Piscator Verlag, Stuttgart.

KORDE, N. V. 1966: Algenreste in Seensedimenten. Zur Entwicklungsgeschichte der Seen und umliegenden Landschaften. — *Arch. Hydrobiol. Beih. Ergebn. Limnol.* **3,** 1—38, **3—4,** 24—25.

LÓCZY L. 1913: A Balaton környékének geológiai képződményei stb. — *A Balaton Tudom. Tanul. Eredm.* Budapest. **I.** 1. 1. VII + 617, 515 o. 274. ábra.

— 1916: Die geologischen Formationen der Balatongegend und ihre regionale Tektonik. — *Res. wiss. Erforsch. d. Balaton-sees.* Wien. **I.** 1.1. pp. 716, p, 585, Fig. 724.

PRESCOTT, G. W. 1962: Algae of the Western Great Lakes area. — BRAUN *Co. Publ. Dubuque, Iowa.* XIII + 977.

SCHMIDLE, W. 1897: Algen aus dem Hochseen der Kaukasus. — *Arch. Bot. Gart. Tiflis,* 2. (AFFER BIGEARD, 1833. p. 6.)

SEBESTYÉN O. 1965: Kladocera tanulmányok a Balatonon. III. Tótörténeti előtanulmányok. — Cladocera studies in Lake Balaton III. Preliminary studies for lake history investigations. — *Annal. Biol. Tihany.* **32,** 187—228.

— 1968a: *Pediastrum kawraiskyi* SCHMIDLE maradványok balatoni üledékekben. — Tótörténeti tanulmány. — Remains of *Pediastrum kawraiskyi* SCHMIDLE in sediments of Lake Balaton. — *Hidr. Közl.* Budapest. **48,** 1—6.

— 1968 b: Studies on *Pediastrum* and Cladocera remains in the sediments of Lake Balaton with reference to lake history. (in press.)

— 1968c: A balatoni szivacsfauna néhány problémája tótörténeti vizsgálatok tükrében. — On some problems of fresh-water sponges occurring in Lake Balaton with reference to lake-history investigations. — *Annal. Biol. Tihany.* **35,** (191 — 201)

SKUJA, H. 1948: Taxonomie des Phytoplanktons einiger Seen in Uppland, Schweden. — *Sym. Bot. Ups.* IX, **3,** 1—399. mit Tafel I—XXXIX.

— 1956: Taxonomische und biologische Studien über des Phytoplankton schwedischer Binnengewässer. — *Nova Acta Regiea Soc., Sci. Upsaliensis* Ser. IV. V. 16.

SKVORTZOF, B. 1928: Über das Phytoplankton des Zaisansees Südsiberien. — *Arch. Hydrobiol.* **19,** 165—171.

SZESZTAY K. 1965: A Balaton feliszapolódásával kapcsolatos kutatások néhány kérdésével foglalkozó munkaközösség titkári jelentése. *Kézirat.* — Secretary's report on the investigations of a research collectiva on few problems regarding to the filling of Lake Balaton with mud. *Manuscript.*

TAMÁS G. 1954: Mennyiségi planktontanulmányok a Balatonon IV. A negyvenes évek fitoplanktonjáról. — Quantitativ planktonstudies in Lake Balaton IV. — *Annal. Biol. Tihany.* **22,** 199—225.

— 1959: Algenflora des Balatonsees. 1938—1958. — *Annal. Biol. Tihany.* **26,** 349—392.

UHERKOVICH, G. 1966: Übersicht über das Phytoplankton der Tisza (Theiss) in Ungarn. — *Hydrobiologia* **28,** 252—280.

— 1966 a: Adatok a Tisza potamofitoplanktonja ismeretéhez. V. Additional Data on the Phytoplankton in the Eastern Main Canal. — *Hidr. Közl.* 46, 368—372.

ZÓLYOMI B. 1952: Magyarország növénytakarójának fejlődéstörténete az utolsó jégkorszaktól. — *MTA Biol. Oszt. Közl.* **1,** 491—530.

— 1953: Die Entwicklungsgeschichte der Vegetation Ungarns seit dem letzten Interglacial. — *Acta Biol.* **4,** 307—430.

— 1964., 1965., 1966.: VITUKI jelentés Budapest, *Kézirat.* VITUKI reports. *Manuscript.*

PEDIASTRUM KAWRAISKYI SCHMIDLE MARADVÁNYOK BALATONI ÜLEDÉKEKBEN

Paleolimnológiai tanulmány

Összefoglalás

Sebestyén Olga

Egy palynológiai szempontból reprezentatív balatoni furat 9 mintájából előkerültek a tavat ma benépesítő *Pediastrum* fajok szubfosszilis maradványai. Azon két *P.* faj maradványainak jelenlétét, melyek balatoni vonatkozásban planktoxen elemeknek tekinthetők (*P. biradiatum, P. tetras*), s melyek minden valószínűséggel a berekvizeket levezető csatornák útján és a Zalával jutnak tavi területre, a minták mennyiségi elemzése során nem lehetett megállapítani.

A 410 cm hosszú B 28 furat egy szakaszának (290—123 cm ± 8000— ± 1000 i.e.) öt mintájából előkerültek *P. k.* SCH. maradványok, az idők folyamán csökkenő mennyiségben (relatív quantitatív adatok). Hasonló maradványokat más balatoni furatokból is feljegyeztünk, részben mélyebb (korábbi) rétegekből.

Az irodalomban háromféle adatot találunk e faj előfordulására: récens adatok (209. o.), récens és szubfosszilis adatok egyaránt (Lake Kotokel, KORDE) csupán fosszilis adatok (Balaton, 213). Valamennyi adat e faj életkörének aktív szakaszára vonatkozik.

A balatoni szubfosszilis adatokból arra következtethetünk, hogy e faj ekológiai valenciája szűkebb, mint a vele együtt szubfosszilisan előforduló s tavunkban ma is élő fajokéi. Úgy látszik, hogy tavunk történetében csak egy bizonyos szakaszon voltak olyan környezeti körülmények, melyek kielégíthették e faj ekológiai igényét. Ez azt is jelenti, hogy tavunk történetében egy sajátos fejezetet képvisel az az időszak. amikor a *P. k.* tagja volt biotájának (késő Pleisztocén + első része a Holocénnek). Irodalmi adatok alapján úgy látszik, hogy a sztenotopikus *P. k.* északi forma, mely életének egy rövid (?) szakaszán valószínűleg magasabb hőmérsékletet igényel.

Két balatoni furat pollenanalitikai szempontból megfelelő rétegéből származó mintájának cladocerákra és *Pediastrum*okra való elemzése alapján arra a következtetésre lehet jutni, hogy tavunknak a Tihanyi-félszigettől délre fekvő részében a limnológiai körülmények a késő Pleistocénban nem voltak egységesek: a Boglár—Révfülöp és B. fenyves—Szigliget profiloknak megfelelő vízterületek egymástól el lehettek különülve (vö. LÓCZY, 1913, 515 o., 274. ábra).

E tanulmány során sem a számba vett mikrofossziliák értelmezéséből, sem a vonatkozó irodalomból nem tudtunk több következtetést levonni abból a célból, hogy tótörténeti szempontból értelmezzük egy palynológiailag reprezentatív balatoni furat egy szakaszának néhány mintájából feltárt *P. k.* maradványokat.

Több üledékminta elemzése volna szükséges a B 28 furatból, más balatoni furatokból és a berkek üledékéből is. Szükséges volna az üledékek vegyi viszonyainak mérlegelése a maradványok előfordulásával kapcsolatban, több ismeret a *P. k.* ekológiájára vonatkozóan (irodalom, tenyésztési kísérletek eredményei), hogy megközelítsük a célt, felidézni a Balaton múltja egy szakaszában uralkodó környezeti körülményeket.

ОСТАТКИ PEDIASTRUM KAWRAISKYI В ОСАДКАХ БАЛАТОНА. ОЧЕРК ПО ИСТОРИИ ОЗЕРА

Ольга Шебештен

Вертикальный анализ осадков Балатона использовали как метод изучения истории озера, имея в виду, что количественные и качественные изменения биосферы получают отражение в составе животного мира озера. С этой целью анализировали остатки Cladocera и *Pediastrum* в материале, полученном из 9 шурфов дна. Теоретическое обоснование метода дается в работах (ZÓLYOMI, 1952 и 1953).

Во свех проанализированных образцах, кроме одного, обнаруживаются остатки тех же видов Pediastrum, которые обитают в озере и ныне, разница отмечается только в частоте их встречаемости. В одном из слоев найдены остатки *P. kawraiskyi* — вода, который в настояшее время в озере отсутствует.

Экологию этого вида можно понять на основе данных о современном распространении. *P. kawraiskyi* и других видов рода *Pediastrum*, а также данных по изучению остатков современных и ископаемых губок в озере Кокотель в районе Байкала.

Создается впечатление, что этот вид обладает более узкими экологическими потенциями, в отношении теплоустойчивости, чем остальные представители рода *Pediastrum* (*Табл.* II). *P. kawraiskyi* переносит только кратковременное нагревание воды. Отсюда можно понять особенности распространения этого вида в прошлом и его отсутствие в современном озере. Изменение климатических условий повлекло за собой удлинение периода летного нагревания воды, что привело к исчезновению этого вида из Балатона. Однако в некоторых озерах района Байкала и поныне имеются условия, подходящие для его существования, и там этот вид встречается как в ископаемой, так и в современной форме.

На основании данных, относящихся к *Pediastrum*, можно заключить, что условия в озере Валатон за несколько тысяч лет не претерпевали резких изменений, и исчезновение *P. kawraiskyi* можно понимать, как результат естественного развития озера.

Экологическим исследованием остатков *P. kawraiskyi* и других организмов биосферы мы можем более реально реконструировать процессы, происходившие в прошлом, и понять явления, протекающие в настоящее время.

Помимо остатков *Pediastrum*, в этом плане привлекают внимание и ископаемые остатки *Cladocera*. Создается впечатление, что экология обитающего в иле вида *Leydigia acanthocercoides* может быть объяснена таким же путем, как приуроченность *P. kawraiskyi* к определенным периодам истории озера.