

A MAGYAR TUDOMÁNYOS AKADÉMIA
TIHANYI BIOLÓGIAI KUTATÓINTÉZETÉNEK ÉVKÖNYVE
(1968)
(VOL. XXXV.)

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Szerkesztő:

S.-Rózsa Katalin

PAPER CHROMATOGRAPHIC AND FLUOROMETRIC EXAMINATION OF THE SEROTONIN CONTENT IN THE NERVOUS SYSTEM AND OTHER TISSUES OF THREE FRESHWATER MOLLUSCS

(*Anodonta*, *Unio*, *Lymnaea*)

LÁSZLÓ HIRIPI

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

Received: 4th March, 1968

Extensive studies were performed concerning the role of serotonin (5HT) in vertebrates and invertebrates (GARATTINI 1965, ERSPAMER 1966). In the latter group of animals it may function as a stimulating transmitter (WELSH 1957, KOSHTOYANTS 1957). The effect of serotonin has been examined and described in various organs and representants of Molluscs (HILL 1958, KOSHTOYANTS and RÓZSA 1961, AIELLO 1957, 1960, GERSCHENFELD and STEFANI 1962, 1962, SALÁNKI 1963, TWAROG 1964, 1966).

That 5HT might have the role of a transmitter was indicated not only by its occurrence only (WELSH and MOORHEAD 1960, DAHL et al. 1966), but also by the fact that the 5HTP decarboxylase enzyme which is involved in synthesis was also demonstrated (WELSH and MOORHEAD 1959, KERKUT and COTTRELL 1963, CARDOT 1966). The monoamino oxidase enzyme, however, which is responsible for the decomposition of 5HT was not demonstrable in the nerve, but only in the other tissues (BLASCHKO and HOPE 1957, KERKUT and COTTRELL 1963).

Examinations were performed concerning the 5HT content of the nervous system and other tissues in a number of molluscan species by chromatographic, fluorometric and histochemical methods (WELSH and MOORHEAD 1960, DAHL et al. 1966, Zs.-NAGY 1967, SAKHAROV and Zs.-NAGY 1967). The results show that in the stage of development of the two classes of Molluscs the serotonin content of the tissues was higher in Lamellibranchs than in Gastropods. Only little data are available concerning the 5HT content of the tissues in freshwater molluscan species. The present investigations were made with the objective to compare the serotonin content of the various tissues in three species.

Method

In the present study the cerebral, visceral and pedal ganglia, the cerebrovisceral connective (CVC), the adductors, the tissue of the mantle, gill and the Heart in the *Anodonta cygnea* L.; the cerebral, visceral and pedal ganglia, the CVC, adductors further the tissues of the mantle and the gill in *Unio pictorum* and the pharyngeal ganglia of *Lymnaea stagnalis* were examined. Tissue samples were prepared immediately before the experiment and were stored at ice

temperature for a period not longer than 1 hour before use. The measurements were conducted in the period between October and January.

Paper chromatographic examination

The ganglia of *Anodonta* and *Lymnaea* were examined paper chromatographically. The ganglia were homogenized in 70 percent acetone and centrifuged (10 000 r. p. m.). The supernatant was decanted and the residue was extracted again and centrifuged. The two supernatants were collected and concentrated by evaporation at room temperature to a small volume and dipped onto WHATMAN No 1 paper and developed by ascendent technique at room temperature for 4–12 hours. Solvents of the following composition were used: butanol-acetic acid-water (4 : 1 : 5); 20 percent KCl in water; N-butanol-30 percent methylamine solution (8 : 3). The ganglion extract was developed parallel with the mixture of the extract and authentic substances and with the authentic substances themselves. To develop the spots EHRlich-reagent and ninhydrin-acetic acid fluorescent reagent was used (ERSPAMER 1966).

Fluorometric examination

Two extraction methods were used. The reagents were prepared according to the method applied by BOGDANSKI (1956).

1. In the case of ganglia and CVC the micro analytical method applied by KUNTZMANN (1961) was used with a few modifications: 5–50 mg tissue was homogenized in 1 ml 0.1 N HCl solution and the homogenizate was transferred into glass-stoppered shaking tube. Thereafter the homogenizator was washed with 0.5 ml water and the wash was added to the homogenase. The pH was adjusted approximately to 10 with anhydrous Na_2CO_3 , and 0.5 ml borate buffer (pH 10) was added. Next, 1 g NaCl and 4 ml butanol were added and the tube was shaken for 30 min. After centrifuging 3 ml of the butanol phase was transferred into another test tube containing 6 ml heptane and 1 ml 0.1 N HCl. The tube was shaken. Centrifugation followed and 0.9 ml of the acid phase was transferred into a test tube containing 0.27 ml cc HCl. Excited in quartz cuvette at 300 m μ , fluorescence was measured at 540 m μ (uncorrected instrument values). Blank reagent (in which the tissue aliquot was replaced by water), standard (i.e. serotonin) and „internal standard” (tissue aliquot + serotonin) were taken through the same procedure. A recovery of 85–102 percent was obtained by adding serotonin to the tissue aliquot.

2. In the case of muscle, mantle, gill and the Heart the method described by BOGDANSKI (1956) was used. In the case of the muscle and the mantle butanol extraction was preceded by protein precipitation with ZnSO_4 (ERSPAMER 1966).

Reagent blank, standard and „internal standard” were simultaneously also taken through the same procedure as the sample. Measurement was performed at 540 m μ with excitation at 300 m μ (uncorrected instrument readings). A recovery of 86–105 percent was obtained.

The measurements were performed in Aminco–Bowman spectrophotofluorometer. Excitation and emission spectra were taken with Cimagraphie (Type 30/40 GZ) recorder. When taking the emission spectra GG14 colour filter was used for filtering out reflection which presented itself at 360 m μ maximum.

Results

Examination by paper chromatography

When examining the ganglion extract of *Anodonta* two spots could be discerned on the chromatographic paper, whereas in case of *Lymnaea* one spot only (*Fig. 1*). Rf values of the ganglion extracts and of the authentic substances

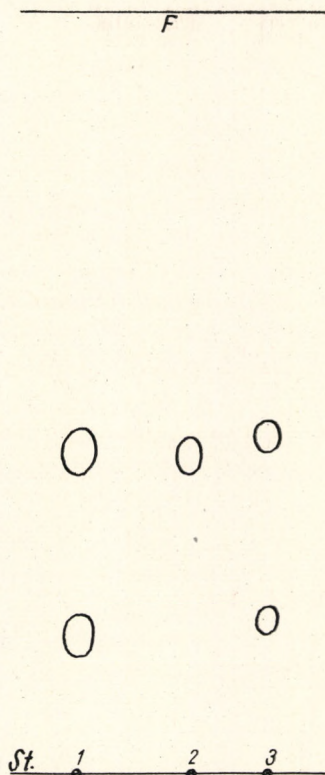


Fig. 1. 1. Ganglion extract of *Anodonta*, 2. Ganglion extract of *Lymnaea*. 3. 5HT and 5HTP chromatograms. Developing by ascending technique. The solvent used: *n*-butanol: acetic acid: water (4 : 1 : 5). Development with EHRlich reagent

1. ábra. 1. *Anodonta* ggl, 2. *Lymnaea* ggl. extraktum, 3. 5HT és 5HTP kromatogramja
Futtatás felszálló kromatogramként *n*-butanol : ecetsav : víz (4 : 1 : 5), futtatószerben.
Előhívás EHRlich reagenssel

developed simultaneously are illustrated in *Table 1*. The Rf values of the ganglion extract were somewhat lower as compared to the authentic substances, nevertheless it was possible to identify them as 5HT and 5HTP in case of *Anodonta* and as 5HT in case of *Lymnaea*. If, namely, 5HT and 5HTP was added to the extracts the intensity of the corresponding spots increased, and the Rf values were in that case too smaller than those of 5HT and 5HTP.

Table 1.
Rf values of 5HT and 5HTP of the ganglion extracts in *Anodonta*,
Lymnaea and control

Solvents	<i>Anodonta</i> RF ₁	ggl. RF ₂	<i>Lymnaea</i> ggl. Rf	Authentic 5HT Rf	Authentic 5HTP Rf
Butanol: acetic acid: water (4 : 1 : 5)	0.39—0.47	0.17—0.21	0.39—0.46	0.45—0.47	0.20—0.22
20 percent KCl in water	0.33—0.38	0.38—0.42	0.32—0.37	0.36—0.38	0.40—0.44
Butanol: 30 percent methylamine (8 : 3)	0.57—0.60	—	0.56—0.60	0.59—0.61	—

Examination by fluorometry

Besides identifying serotonin by paperchromatography it has been identified also on basis of its excitation and emission spectrum. In a 3 N HCl solution serotonin has maximum fluorescence at 550 m μ when excited at 295 m μ (UDENFRIEND, BOGDANSKI and WEISSBACH 1955).

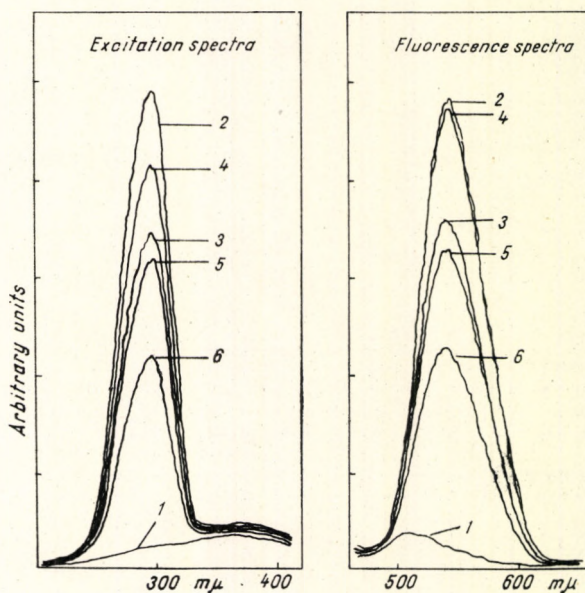


Fig. 2. Spectra of the extracts of the ganglia and the CVc of *Unio*:
1. blank reagent, 2. standard 5HT, 3. cerebral ganglia, 4. pedal ganglia, 5. visceral ganglia,
6. CVc

2. ábra. *Unio* ggl. és CVc extraktumok spektrumai:
1. reagens blank, 2. standard 5HT, 3. cerebrális ggl., 4. pedális ggl., 5. viscerális ggl.,
6. CVc

The maxima of both excitation and emission spectra of the tissues examined by us well corresponded to the maxima of authentic serotonin, and they were at 298–300 $m\mu$ and 538–540 $m\mu$ respectively (all values are uncorrected instrument readings). Such a spectrum is presented in Figs. 2 and 3.

Table 2 summarizes concentration values of serotonin in the various tissues, expressed in μg 5HT/g fresh weight unit. In the case of ganglia and the CVc the 5HT content of a pair of ganglia and CVc are also given. The values are the averages of 5–20 measurements.

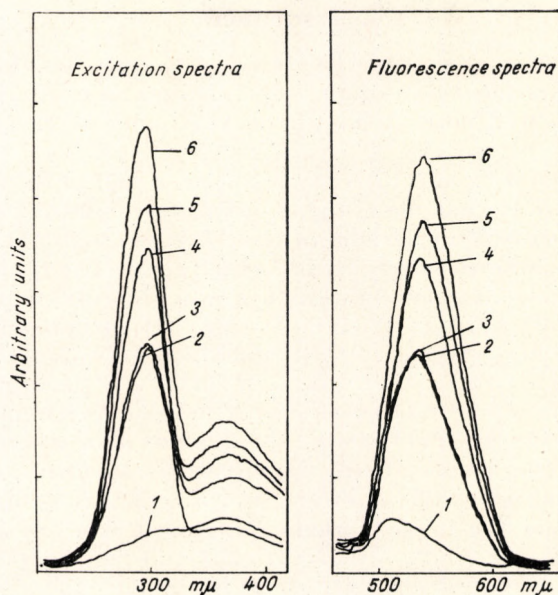


Fig. 3. Spectra of mantle and muscle extracts of *Anodonta*:

1. blank reagent, 2. muscle, 3. mantle, 4. muscle + 5HT, 5. standard 5HT, 6. mantle + 5HT

3. ábra. *Anodonta* köpeny és izom extraktumok spektrumai: 1. reagens blank, 2. izom, 3. köpeny, 4. izom + 5HT, 5. standard 5HT, 6. köpeny + 5HT

Table 2.

Serotonin concentration in the various tissues (fluorimetric measurement)

	ANODONTA		UNIO		LYMNAEA
	μg 5HT/g wet weight	μg 5HT/ specimen	μg 5HT/g wet weight	μg 5HT/ specimen	ggl. $\mu\text{g/g}$ wet weight
Cerebral ganglion	72.5	0.19	112	0.19	14
Visceral ganglion	43.5	0.23	66	0.20	
Pedal ganglion	66.5	0.30	108	0.31	
CVc	38.0	0.34	53.5	0.096	
Muscle	0.33		0.22		not examined
Mantle	0.37		0.33		
Gills	0.25		0.90		
Heart	0.0		not examined	not examined	

As the results show the 5HT-content of the ganglia of *Unio* is the highest. As regards ganglion tissue the values were higher in the case of *Unio* than in case of *Anodonta*. 5HT-content of the muscle and the mantle was nearly the same in both species, whereas in the gill of *Unio* almost four times as much 5HT was demonstrable than in the gill of *Anodonta*.

In the *Lymnaea* only the ganglia were examined concerning their 5HT content. The value obtained was considerably lower than in the case of *Anodonta* or *Unio*. In the heart serotonin was not demonstrable.

Discussion

The paperchromatographic Rf values of the ganglion extracts well conform to those of authentic serotonin. The maxima of excitation and emission spectra similarly well correspond to the maximum of the spectrum of the authentic serotonin.

As evidenced by quantitative data obtained, out of the species examined the 5HT content of the ganglia of the *Unio* was the highest, it was in somewhat less amount present in the ganglia of *Anodonta*, whereas the 5HT content of the *Lymnaea* was approximately by one order lower. The results obtained well conform to previous literary data (WELSH and MOORHEAD 1960, DAHL et al. 1966, KERKUT and COTTRELL 1966) indicating that serotonin is of more general occurrence in the nerve tissues of the mussel, than in those of the snail. 30–60 $\mu\text{g/g}$ 5HT was demonstrated by DAHL (1966) in the ganglia of *Anodonta piscinalis*, whereas in those of *Helix pomatia* only 4 $\mu\text{g/g}$. As examined by KERKUT and COTTRELL (1963) the 5HT content in *Helix aspersa* was of the same value (0.5–4 $\mu\text{g/g}$). Also histochemical examinations confirm this observation. A fluorescence indicative of the presence of serotonin was observed in nearly every nerve cell of the mussel, whereas in the nervous system of the snail only in a few cells (ZS.-NAGY 1967, SAKHAROV and ZS.-NAGY 1967). Out of the ganglia of the Lamellibranchs highest 5HT content expressed in wet weight unit was demonstrable in the cerebral ganglia, lower values were obtained in case of pedal ganglia, whereas in the visceral ganglia the 5HT concentration values amounted only to about 60 percent of that of the cerebral ganglia. As evidenced by DAHL (1966) 5HT content (62 μg) was the highest in the pedal ganglia of *Anodonta piscinalis*, in comparison to the other ganglia of the same species, i.e. it was less in the cerebral ganglia (58 μg) and in conformity to our results by about 50 percent less in the visceral ones (30 μg).

5HT content of CVc is relatively high. Nearly the same 5HT concentration was measured in the CVc and in the ganglia. This is in contradiction to histochemical data evidencing that the neuropil of the ganglia and the axons themselves do not contain 5HT (ZS.-NAGY 1967). This suggested, therefore, that the high 5HT content of the CVc is the result of the transport of 5HT originating from the ganglia.

The concentration of serotonin is low in the adductors, nevertheless, it is easily demonstrable. With regard to this it is assumable, that it is involved in the neuromuscular transport as it has been suggested previously on basis of physiological examinations (TWAROG 1954, 1966).

In the mantle and the muscle the concentration of 5HT was the same. The low 5HT content of the latter tissue is ascribed to the presence of nerve elements, by which it is thought the low concentration might be explained.

Considerable difference in the serotonin content of the gill was found between *Anodonta* and *Unio*. The concentration of serotonin in the gill of the former was 0.25 μg , while in the latter 0.9 μg . Serotonin concentration of the same order (0.1–1.0 $\mu\text{g/g}$) was demonstrated by AIELLO (1962) in the gill of MYTILUS. This agent appears to be involved in the regulation of the movement of the cilia.

It is only the tissue of the heart, out of the tissues examined in which serotonin was not demonstrable. Were serotonin present in the heart its concentration would possibly fall below 0.02 $\mu\text{g/g}$. In one instance about 8 g heart tissue obtained from 120 animals was extracted by the method described. Had serotonin been present in a concentration of 0.02 $\mu\text{g/g}$ this would have presented itself in a final concentration of 0.10–0.16 $\mu\text{g/1.5 ml}$; serotonin is in such concentration namely demonstrable by the applied method. Also the high activity of monoaminooxidase might explain the absence of serotonin. With regard to this, however, we have no data at our disposal.

Summary

Examinations on the concentration of serotonin by paper chromatography and fluorometric method in the central nervous system and other tissues of *Anodonta cygnea* L., *Unio pictorum* and *Lymnaea stagnalis* L. have led to the following conclusions:

1. 5HT was demonstrable in the ganglia, the cerebrovisceral connective (CVc) of the gill, the adductors and the mantle of *Anodonta* and *Unio*. In the heart, however, its presence could not be demonstrated.

The order of 5HT concentration in the case of *Anodonta*: cerebral ggl. (72.5 $\mu\text{g/g}$), pedal ggl. (66.5 $\mu\text{g/g}$); visceral ggl. (43.5 $\mu\text{g/g}$); CVc 38 $\mu\text{g/g}$; mantle (0.37 $\mu\text{g/g}$); muscle (0.33 $\mu\text{g/g}$); gill (0.25 $\mu\text{g/g}$), in the case of *Unio*: cerebral ggl. (112 $\mu\text{g/g}$); pedal ggl. (108 $\mu\text{g/g}$); visceral ggl. (66 $\mu\text{g/g}$); CVc (53.5 $\mu\text{g/g}$); gill (0.9 $\mu\text{g/g}$); mantle (0.33 $\mu\text{g/g}$); muscle (0.22 $\mu\text{g/g}$).

2. The ganglia of the *Lymnaea* contain less 5HT than those of the Lamelli-branches.

3. The high serotonin content of the CVc speaks in favour of the possibility of serotonin transport.

4. The low serotonin-content of the adductor indicates that the presence of this compound is connected to the nerve elements, and it is suggested that it might be related to its functioning as a neuromuscular transmitter.

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Összefoglalás

SZEROTONIN PAPIRKROMATOGRÁFIÁS ÉS FLUORIMETRIÁS
VIZSGÁLATA HÁROM ÉDES-VIZI MOLLUSCA (*ANODONTA*, *UNIO*, *LYMNAEA*)
IDEGRENDSZERÉBEN ÉS MÁS SZÖVETEIBEN

Hiripi László

Papírkromatográfiásan és fluorimetrián vizsgálva a szerotoninmegoszlást *Anodonta cygnea* L., *Unio pictorum* és *Lymnaea stagnalis* L. központi idegrendszerében és egyéb szöveteiben azt találtuk, hogy

1. *Anodonta* és *Unio* ganglionjai a cerebro-viscerális connectivum (CVc), a kopoltyú, záróizmok és köpeny tartalmazzak 5HT-t, a szívben azonban nem sikerült kimutatni.

Az 5HT koncentráció sorrendje: *Anodonta* esetében: cerebrális ggl. (72,5 µg/g); pedális ggl. (66,5 µg/g); viscerális ggl. (43,5 µg/g) CVc (38 µg/g); köpeny (0,37 µg/g); izom (0,33 µg/g); kopoltyú (0,25 µg/g).

Unio esetében: cerebrális ggl. (112 µg/g); pedális ggl. (108 µg/g); viscerális ggl. (66 µg/g); CVc (53,5 µg/g); kopoltyú (0,9 µg/g); köpeny (0,33 µg/g); izom (0,22 µg/g).

2. *Lymnaea* ganglion kevesebb 5HT-t tartalmaz, mint a Lamellibranchiatáké.

3. A CVc magas szerotonin-tartalma szerotonin transzport lehetőségét támasztja alá.

4. A záróizom alacsony szerotonin-tartalma a szerotonin idegelemekhez kötött jelenlétére utal, ami feltételezett neuromuscularis transmitter szerepével függhet össze.

ИССЛЕДОВАНИЕ СЕРОТОНИНА ПРИ ПОМОЩИ БУМАЖНОЙ ХРОМАТОГРАФИИ И ФЛУОРИМЕТРИИ В НЕРВНОЙ СИСТЕМЕ И ДРУГИХ ТКАНЯХ ТРЕХ ВИДОВ ПРЭСНОВОДНЫХ МОЛЛЮСКОВ (*ANODONTA*, *UNIO*, и *LYMNAEA*).

Л. Хирпи

При исследовании распределения серотонина методами бумажной хроматографии и флуориметрии в нервной системе и других тканях беззубки, перловицы и большого прудовика установлено, что:

1. Ганглии, cerebro-висцеральные коннективы (ЦВК), жабы, запирающие мышцы и мантия беззубки и перловицы содержат серотонин, однако в сердце его выявить не удалось. По содержанию серотонина в мг/г ткани беззубки распределены следующим образом: церебральные ганглии 72,5; педальные ганглии 66,5; висцеральные ганглии 43,5; ЦВК 38; мантия 0,37; мышцы 0,33; жабы 0,25. Содержание в тканях перловицы: церебральные ганглии 112; педальные ганглии 108; висцеральные ганглии 66; ЦВК 53,5; жабы 0,9; мантия 0,33; мышцы 0,22.

2. Ганглии большого прудовика содержат меньше серотонина, чем ганглии исследованных пластинчатожабных.

3. Высокое содержание серотонина в ЦВК указывает на возможный транспорт серотонина в ЦНС.

4. Низкое содержание серотонина в запирающей мышце указывает на то, что он локализован здесь в нервных элементах. Обсуждается предполагаемая роль серотонина в нервно-мышечной передаче.

THE ROLE OF ENVIRONMENTAL TEMPERATURE AND pH ON THE VARIATIONS IN K^+ - AND TRYPTAMINE- SENSITIVITY OF GLOCHIDIA OF *ANODONTA CYGNEA* L.

ELEMÉR LÁBOS and FERENC LUKACSOVICS

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

Received: 1st March, 1968

Having investigated for several years the K^+ - and tryptamine-sensitivity of adductor-response of glochidia (LÁBOS and SALÁNKI 1963, LÁBOS et al. 1964, LÁBOS 1966, 1967) we could state that the intensity of responses show considerable variations. These variations exist under apparently identical circumstances, thus necessitating a more thorough study of some laboratory conditions (temperature, properties of the solvent, as pH, ion composition etc.).

The degree of rhythmic-tonic adductor-response is of importance also from the point of view of the development of individuals. For instance the responding capacity of a glochidium and its changes—getting from the gills of the parent animal into the water—may be of decisive importance as regards the possibility to get into a parasite-state on the gills and fins of fishes (HARMS 1908, 1909, AREY 1921, HEARD and HENDRIX 1964, LUKACSOVICS and LÁBOS 1965). Furthermore it is open to question whether there exist any endogenous sensitivity variations connected with seasonal changes or with the ontogenesis, independent from the non-specific seasonal changes of the environment, e.g. Balaton-water.

Methods

We have investigated under different circumstances rhythmic and tonic muscular responses triggered by KCl and tryptamine in glochidia of *Anodonta*-species.

The animals were observed in groups consisting of 25—100 individuals in the presence of the given agent and the number of rhythmic contractions performed in a minute (a/min) respectively the ratio of the larvae in closed state (c%) was noted.

In the course of investigations lasting for several years (1960—1967) we used ordinary tap-water, Balaton-water as well as distilled water as solvent for the KCl and tryptamine. The use of Balaton-water is justified because it is the natural medium of the animal during the time when getting out of the gills and reaching the parasitic state. Nevertheless in this case we have to deal with a substance which is very variable from physico-chemical viewpoint thus being difficult to be characterized satisfactorily. The use of distilled

water is reasonable owing to its rather stable character; nevertheless it is no "physiological" medium.

The agents used were: tryptamine HCl (Fluka), serotonin-creatinine sulphate (5-HT) and KCl of high purity.

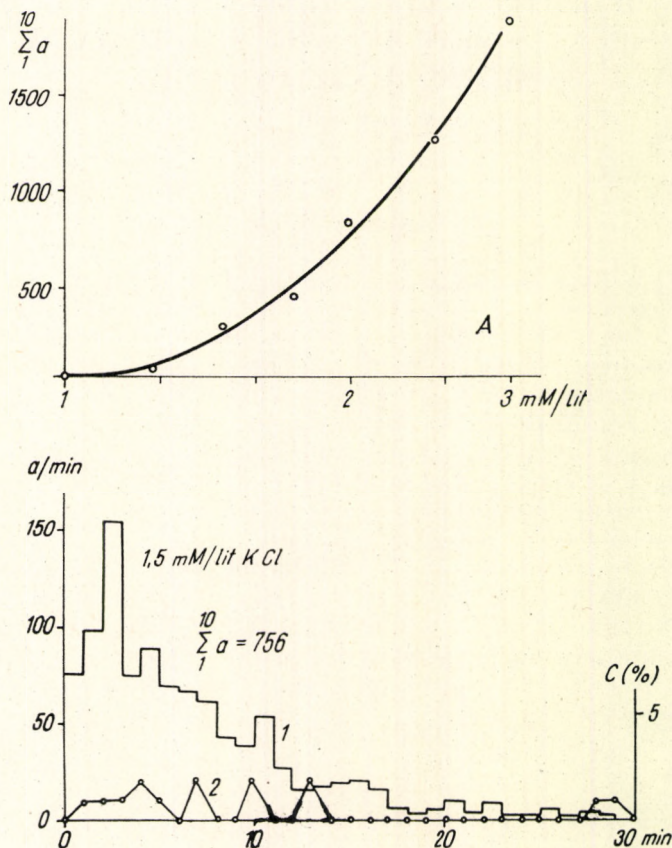


Fig. 1A. — Dosage-effect curve of a population unsensitive against K^{+} . Balaton-water, April, 24–27 °C. Abscissa: KCl – concentration in mM; Ordinate: Number of contractions of 100 glochidia in 10 min

B — Frequency- (1) and time course of tone ratio (2) of a less sensitive population. Distillated water – 100 animals, Mid-October, 25 °C

(With this and all further figures we give mean values of 100 animals, except for Fig. 7)

1. ábra. K^{+} -érzékeny feltételek, illetve populációk

A — KCl-érzékeny populáció dózishatás-görbéje

Balatonvíz, áprilisi populáció, 24–27 °C; Abscissa: KCl-koncentráció mM-ben; Ordinata: 10 perc alatt 100 glochidium által teljesített kontrakciók száma

B — Érzékenyebb októberi populáció frekvencia (1) és tónusarány időgörbéje (2).

Desztillált víz — 100 állat, október közepe, 25 °C

(Ennek és a további ábráknak minden egyes pontja 100 db glochidiumon végzett mérés átlagértéke. Ez alól csak a 7. ábra kivétel. Lásd ott.)

Results

1. Variations of the K^+ -sensitivity

The maximum of KCl-sensitivity is represented by a concentration of about $100 \mu\text{M}$, while its minimum is around $2.5\text{--}3 \text{ mM}$, anyway without an artificial complement (r.g. ion-addition; LÁBOS 1967). Thus if we use the various solutions randomly in different seasons, we may reckon 25–30 fold variations in the sensitivity.

In Balaton-water (see *Fig. 1/A* resp. Curve 2., *Fig. 2*) the concentration needed for a few hundred contractions and that for a tone of 50% in 10 min.

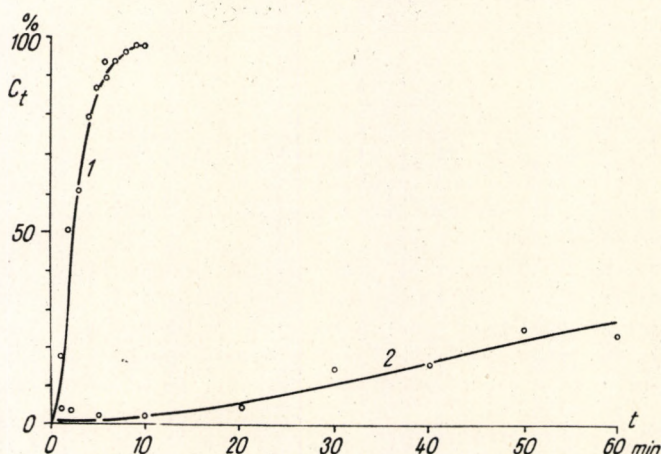


Fig. 2. KCl-response and tone-ratio — time diagrams

Abscissa: time, ordinate: ratio of individuals in tonic contraction at the given time for 100 animals (in %)

1. = 1 mM KCl, distillated water, December,
2. = 1 mM KCl, Balaton-water, April

2. ábra. KCl-válasz és tónusarány-idő diagramok

Abscissa: idő; ordinata: 100 db állat közül az adott időpontban tónusos kontrakcióban levő egyedek aránya (%)

1. = 1 mM KCl; oldószer: desztillált víz, hónap: december,
2. = 1 mM KCl; oldószer: Balatonvíz, hónap: április

may vary between 1–3 mM. In distillated water (*Fig. 2* Curve 1 resp. *Fig. 1/B*) during the whole glochidium-season — except the beginning (October) — a nearly constant sensitivity could be observed. At the beginning of October a small degree of sensitivity can be met both in Balaton water and in distillated water (*Fig. 1/B*). Solution and seasonal dependences are shown in *Table I*.

2. Dependence of K^+ -response on the temperature of environment

In the course of the experiments we collected the glochidia — as a rule — from source-animal living in Balaton-water which was generally cooler than the room temperature. Observations were made in a medium of room tempera-

Table I
Dependence of the sensitivity of glochidia on the solution and the season

Month	Balaton-water	Distillated water	Suppositions	
			Balaton water	Distillated water
Mid-October	Low sensi- tivity	Low sensi- tivity*	osmotic immaturity	
November- March	Moderate sensitivity	High sensi- tivity**	Balaton water undergoes changes	No antagonistic ions are present
March-May	Decreased sensitivity	High sensi- tivity		

* = Fig. 1/3

** = Fig. 2/1

ture. Some times the populations were kept a day or more — with a small density of animals — at room temperature or at 4–10 °C in refrigerator. Thus it is obvious that temperature changes might play a part among the causes of sensitivity variations.

To clear this problem we divided the glochidia coming from the same mother-animal in two groups. One group was kept at 20–26 °C for some days, while the other remained in Balaton water at 6–10 °C. On both groups we observed daily the effect of a KCl concentration of 1–1.5 and 2 mM. The above temperatures were kept unchanged during the observations.

In the warmer medium K⁺-response was observed for 4 days, while in the cooler — one for 11 days, till the animals died.

We observed the rate of the tone in the case of animals kept in warmth to increase from day to day when using the same concentration of KCl. That was characteristic for all three concentrations (*Fig. 3*, upper row of graphs, curves marked 1). The response of animals kept in cold appeared for 1–4–5 days practically without tone so that the responses of the two groups kept at different temperatures deviated more and more. But later—beginning from the 4th–5th days — we found a gradually increasing tone even in the group adapted to low temperature (*Fig. 3*, upper row, curves marked 2).

The frequency of rhythmic activity shows also characteristic variations in the two groups. At all three concentrations in the warm-group the frequency was increasing on the 2nd day, then it decreased (*Fig. 3*, lower curves). The response of the group with cold adaptation, on the other hand, became less frequent from day to day and the variations were larger. When applying the 2 mM KCl concentration we got a frequency-maximum parallel to the tone-minimum (*Fig. 3*, lower row, last graph, curve 2). Parameters characterizing

the rhythm and tone ($\sum^{10}$ = number of contractions performed by 100 animals in 10 min and, c(%) is the percentual ratio of animals found in tonic state at the 10th min) are not independent. *Fig. 3* shows that the cases of higher frequency in the cold-adapted group are connected in general with a lower level of tone. On the other hand, we can observe a deviation in the correlation of the frequency-tone ratio of the two groups, so that at low temperature a higher frequency is to be expected together with the same lower tone-ratio.

The effects of sudden and significant temperature changes are shown in the experiments where groups consisting of 5×100 larvae were used:

1. group: the mother animal was collected from Balaton-water and the glochidia were put in distilled water of 22°C (control),
2. group: stored for 1 hour at 6°C ,
3. group: stored for 1 hour at 37°C ,
4. group: stored for 1 hour at 37°C , then immediately after it for 1 hour at 6°C ,
5. group: stored for 1 hour at 6°C , then immediately after it for 1 hour at 37°C .

The tone ratios observed at 1.5 mM KCl concentration after 120 min in the five groups were (Fig. 5): 94 — 76 — 92 — 34 — 34%.

We can state that the sudden temperature change of significant value decreases the duration of tone, i.e. increases the degree of the so-called late-relaxation. The latter follows the tone and not a phasic contraction (LÁBOS 1967).

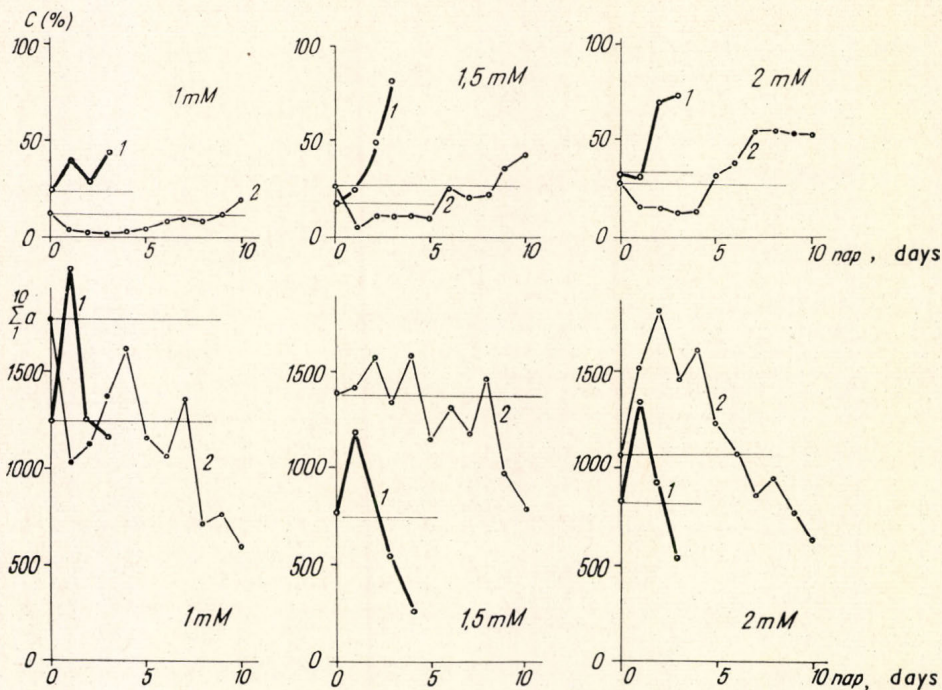


Fig. 3. Effect of 1, 1.5 and 2 mM KCl on the same population, at $20-25^\circ\text{C}$ during 4 days (1) and at $6-10^\circ\text{C}$ during 11 days (2) respectively. The upper diagrams show the $C_{10}(\%)$ -values, the lower ones the number of contractions performed by 100 animals in 10 min. Horizontal lines show the values the first day.

3. ábra. 1, 1.5 és 2 mM KCl hatása ugyanazon glochidium-populáción $20-25^\circ\text{C}$ -on 4 napig (1), illetve $6-10^\circ\text{C}$ -on 11 napig (2). A felső diagramok a $C_{10}(\%)$ értékeket, az alsók pedig a 100 állat által 10 perc alatt teljesített kontrakciók számát mutatják. A vízszintes vonalak az első napi értékeket jelölik.

3. K^+ -response and pH of the medium

The pH-dependence of the K^+ -response was investigated by observing the tone ratio at the 5th, 10th and 20th min with pH-values between 5–9. The investigation was carried out in November, with distilled water as solution. Temperature of the medium was 22–25 °C and only freshly collected animals were used. On *Fig. 6* we can see the pH-dependence of responses against a concentration of 2 mM KCl (curves A-2 and B-1-2-3). We can state in general that the tonicity increases towards the direction of alkalinity. So the

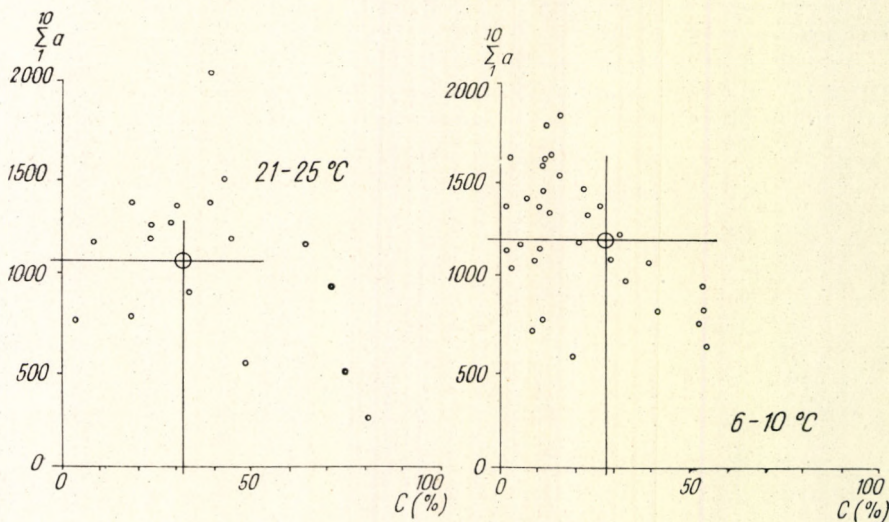


Fig. 4. Connection between corresponding values of tone-ratio (C%) and number of contractions performed by 100 animals in 10 min at two different temperature levels

4. ábra. Az összetartozó tónusarány (C%) és 100 állat által 10 perc alatt teljesített kontrakciószám értékek összefüggése két különböző hőmérsékleten

Table II
Dependence of sensitivity against tryptamine and solvent in glochidia

Season	Balaton-water	Distillated water	Tap-water
Beginning of October	low activity		
Winter	High activity	low activity or lack of activity	High activity
Spring	Decreased activity		Decreased activity

tone ratio values of 5 min follow the regression: $c_5(\%) \sim 7.1 (\text{pH}) - 27$ with a correlation coefficient of $r > 0.9$. It is characteristic that the values of 10–20 min show a decrease in the case of $\text{pH} < 7$ (acidic solutions) up to the pH-value of about 5.5, while they increase again with the decrease of pH about $\text{pH} \sim 5$.

In one of our experiments with a KCl concentration of 1 mM at the 10th min (*Fig. 6/A*, curve marked 1) we could observe a tone decrease when progressing towards the alkalinity instead of the decrease as mentioned above.

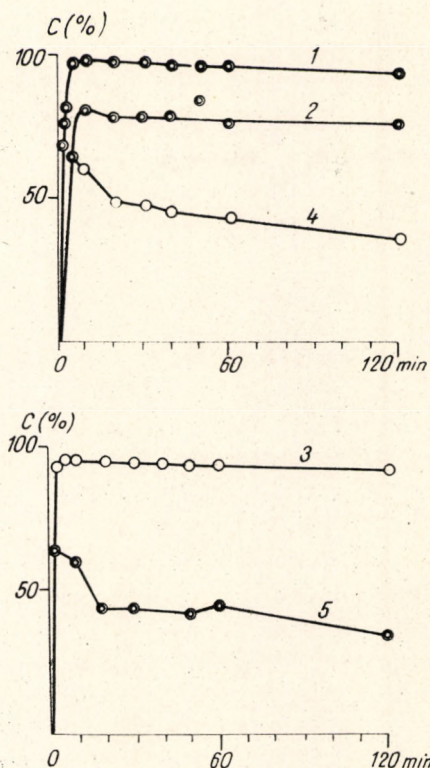


Fig. 5. Effect of a temperature jump on the K^+ -tone
Tone-ratio-time diagrams (explanation in the text)

5. ábra. A hőmérsékletugrás hatása a K^+ -tónusra
Tónusarány—idő diagramok (Magyarázat a szövegben)

4. Examination on tryptamine sensitivity

Very early populations (October) show, as a rule, hardly any sensitivity (see *Table II*). In winter we find a high sensitivity in Balaton-water and a low one in distilled water. In spring sensitivity decreases in general (LÁBOS et al. 1964, LÁBOS 1965). Tryptamine solved in distilled water has little or no effect at all, but when alkalinizing the medium we obtained a considerable tryptamine response (see under 5).

5. Relation between tryptamine-response and pH of the medium

Fig. 7 shows the dependence of the number of rhythmic contractions on the pH. We can see that the effect is considerable mainly in the alka-

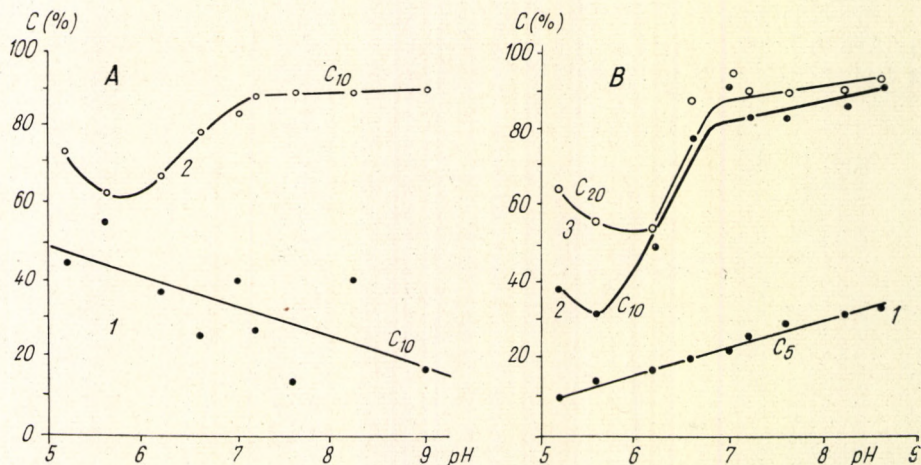


Fig. 6. Dependence of KCl-response on pH
The values of C_5 , C_{10} and C_{20} represent the tone-ratio-values in % found at the 5th, 10th and 20th min; November; distilled water; tris-maleate buffer of 3 mM concentration; temperature 22–25 °C

6. ábra. A KCl-válasz pH-függése

A C_5 , C_{10} és C_{20} értékek az 5., 10., illetve a 20. percben talált tónusarány-értékeket jelentik %-ban. Novemberi populációk; oldószer: desztillált víz; 3 mM trisz-maleát puffer; hőmérséklet: 22–25 °C

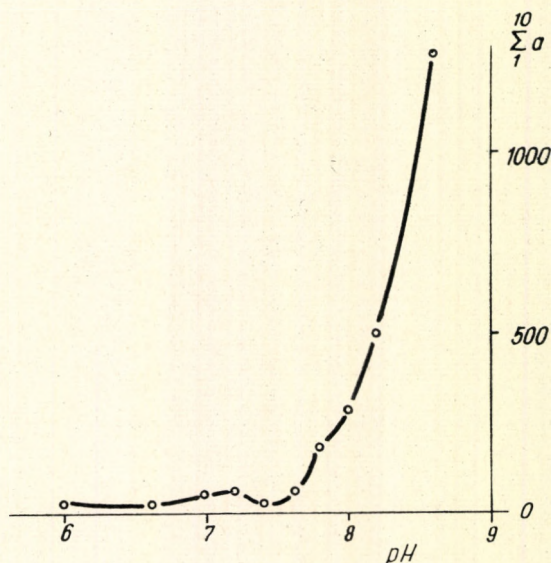


Fig. 7. Dependence of tryptamine effect on pH; distilled water; 10 $\mu\text{g/ml}$ tryptamine, winter; temperature: 22–25 °C, number of glochidia: 25

7. ábra. A triptaminhatás pH-függése

Oldószer: desztillált víz; 100 $\mu\text{g/ml}$ triptamin; téli populáció; 25 °C hőmérséklet; 25 glochidium

linic domain $8 < \text{pH} < 9$ and at a neutral pH we get practically no response at all. The investigations were carried out in a tris-maleate buffer of 3 mM. Because of the presence of a given amount of organic material, even

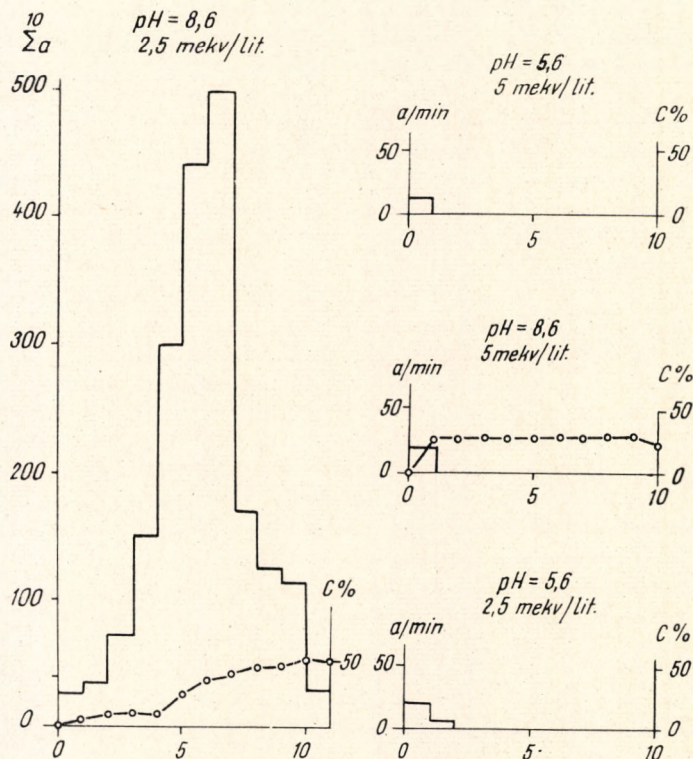


Fig. 8. Rhythmic and tonic muscular response produced by 100 $\mu\text{g/ml}$ tryptamine, in a 2.5 and 5 mekv./lit. tris-maleate buffer. Distillated water, spring, room temperature

8. ábra. 100 $\mu\text{g/ml}$ triptaminnal kiváltott ritmikus és tónusos izomválasz, 2, illetve 5 mekv/lit. triszmaleát pufferben. Oldószer: desztillált víz, tavaszi populáció, szoba-hőmérsékleten

with a use of buffers at low concentration, it is rather difficult to carry out an isolated study of H^+ -ion effect. In the following we used tris-maleate buffers of 5 mM and 2.5 concentration at pH 8.6 and 5.6. It is obvious from the figure (Fig. 8) that an alkaline pH value is only a necessary condition of the high sensitivity, since a too high buffer-concentration may cover this effect, i.e. the effect necessitates the absence of different inhibitory factors. Nevertheless this can not be realized by the application of buffers alone. As in earlier experiments the response of the glochidia against 5-HT (LÁBOS et al. 1964, LÁBOS 1966) could not be observed either in this case even by alkalizing the medium.

Discussion

The explanation of high K^+ -sensitivity perhaps requires the supposition of an unusual mechanism. Without dealing the problem in detail we note that above all the potentials of electrokinetic nature of colloidal systems (see e.g. BUZÁGH 1958) are sensitive against an ion-concentration of 10^{-4} M. The Nernst-mechanism furnishes a satisfactory explanation only in the case when the critical threshold of K^+ -depolarisation is very low.

The intensive variations of the latter can be caused by the presence or absence of K^+ -antagonistic ions. Observation of *Table 1* may lead to the hypothesis that the higher sensitivity observed in distilled water could originate in the lack of K^+ antagonistic ions (Na^+ , Mg^{2+} , Ca^{2+}) of the other solution i.e. of the Balaton-water. Data on ion-antagonism (LÁBOS 1967) and on the composition of Lake Balaton-water (ENTZ, 1953, 1959) make this explanation obvious. But the explanation does not hold for the low sensitivity in October (*Table I.*, *Fig. 1/B*), found with both solutions. The explanation may be brought in connection with the immaturity of early glochidia. It seems probable, namely, that the larvae more adapted to the maternal lymph and ready for the life in fresh water must pass through certain ripening stages to be able to get adapted to osmotic variations. A further question is the change of sensitivity presenting itself in winter and spring and observable only in Balaton-water. Therefore these variations may originate in the alteration of chemism of the Balaton-water, e.g. the increase of activity and of Ca^{2+} ionization (ENTZ 1953, 1959).

Thus variations in K^+ sensitivity can not be explained by one reason alone. Among the reasons changes in the animal and those of the „natural medium” are equally probable. Only the early change might be of ontogenetic origin.

For the interpretation for variations of nonseasonal character the thermic past of the larvae seems to be sufficient. On the one hand: the intensity of metabolic activity of oyster-mantle decreases with the change of temperature of any direction (PEDERSEN 1947), but on the other hand: the cold-adaptation may induce a K^+ -lost in other species, e.g. in *Loligo*-nerve (SHANES 1954), or in erythrocytes (SOLOMON 1952). In the case of glochidia the steadily hypo-osmotic environment (fresh-water or Balaton water) may easily lead to ion-loss serving as explanation for the phenomena under consideration.

The variations of tryptamine sensitivity are of a different character. One of them is that the sensitivity decrease of spring could be observed both in tap-water (LÁBOS et al. 1964) and in Balaton water. Thus this variation can not be explained by the changes of the environment. However it should be noted that the pH of the Balaton-water is 7.9–8.8, therefore a high tryptamine response could sooner be expected here than in neutral or acidic distilled water. Thus the pH-variation would be sufficient to explain the inhibiting effect of distilled water, since we have no activity with a neutral pH, but with a corresponding buffer we may still produce a high rhythm even at spring and in distilled water. The alkaline pH, of course, may bring about an effective acceleration of both permeation and alkaline hydrolysis.

We have to point out the fact that the change of solvent: Balaton-water $\rightleftharpoons$ distilled water cause opposite changes in K^+ - and tryptamine-responses arguing for a different mechanism.

The dependence of K^+ -effect on the pH shows a surprisingly good linearity when measuring at the 5th min which itself could be explained in a

satisfying manner by simple kinetic conceptions. Nevertheless, the pH-dependence is connected with K^+ -concentration, furthermore the toneincrease observable in an extremely acidic environment (see Fig. 6 at pH ~ 5) points also to an activation of a further reactive system.

Summary

An experimental analysis on K^+ - and tryptamine-sensitivities of rhythmic and tonic adductor-response in *Anodonta*-larvae was made and their dependence from temperature, osmotic and pH-changes was investigated.

The low value of K^+ -sensitivity in October is supposed to be in connection with the osmotic immaturity of the larvae; the higher sensitivity found in distilled water was attributed to the absence of antagonistic ions while the sensitivity-decrease in spring to the changes of Balaton-water.

The possibility of a change of ontogenetic character can not be excluded in the decrease of tryptamine response in spring. In distilled water no tryptamine response was found while there is a high K^+ response.

For the pH-dependence of the responses it is characteristic that

1. the K^+ — tone increases in general with pH between 6 and 9; a pH < 6 again — decreases the tone,

2. the tryptamine-rhythm — in case of a corresponding buffer — is pronounced with an alkaline value of pH, but it is very low with a neutral pH.

In the case of K^+ -response the importance of temperature adaptation was demonstrated. The cold-adapted animals give a less tonic response with a rhythm of higher frequency. The animals are capable to response for 11 days at temperatures of 6–10 °C, and for 4 days at temperatures of 20–25 °C. The jumps in temperature are of a sensitivity-decreasing effect.

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A KÖZEG HŐMÉRSÉKLETÉNEK ÉS pH-JÁNAK SZEREPE AZ *ANODONTA CYGNEA* L. GLOCHIDIUMOK K⁺- ÉS TRIPTAMIN-ÉRZÉKENYSÉGÉNEK ELTÉRÉSEIBEN

Lábos Elemér és Lukacsovics Ferenc

Összefoglalás

Anodonta-lárvák ritmikus és tónusos záróizomválaszának K⁺- és triptaminérzékenységet és ezeknek külsőleg szezonális és egyéb jellegű változásait elemeztük kísérletesen. Az alacsony októberi K-érzékenységet a lárvák ozmotikus éretlenségével, a desztillált vízben tapasztalt magas érzékenységet az antagonistá-ionok hiányával, a tavaszi érzékenységesökkenést a Balatonvíz változásával hozzuk összefüggésbe.

A ritmikus triptamin-válasz nagyságának tavaszi csökkenésében az ontogenetikus jellegű változás nem zárható ki. Desztillált vízben nincs triptaminválasz, de nagy a K⁺-érzékenység.

A válaszok pH-függésére az alábbiak jellemzőek:

1. a K⁺-tónus általában nő a pH-val 6–9 között; pH 6 újra tónusnövelő;
2. a triptaminritmus — megfelelő pufferválasztás mellett — lúgos pH-n kifejezett. Neutrális pH-n igen alacsony.

A K-válasz esetében a hőadaptáció fokozott jelentőségét mutattuk ki. A hidegadaptált állatok kevésbé tónusos és nagyfrekvenciájú ritmussal válaszolnak. 6–10 °C-on 11, 20–25 °C-on 4 napig válasz (élet)képesek. A hőmérsékletugrások érzékenységesökkenőek.

РОЛЬ ТЕМПЕРАТУРЫ И pH СРЕДЫ В РАЗЛИЧНОЙ ЧУВСТВИТЕЛЬНОСТИ ГЛОХИДИЕВ БЕЗЗУБКИ К ТРИПТАМИНУ И ИОНАМ КАЛИЯ

Э. Лабос и Ф. Лукачевич

Были проанализированы причины наблюдающихся сезонных и иных изменений чувствительности ритмических и тонических реакций запирающей мышцы глохидиев беззубки к калию и триптамину.

Результаты исследования показывают, что низкая чувствительность к ионам калия в октябре связана с осмотическим недоразвитием личинок, а высокая чувствительность к дистиллированной воде с отсутствием ионов антагонистического действия. Весенние изменения чувствительности ставятся в связь с изменением состава воды Балатона, но в весеннем снижении чувствительности к триптамину могут играть роль и онтогенетические изменения самих личинок. Ответ на триптамин не наблюдается в дистиллированной воде.

Зависимость ответа личинок от pH такова:

1. Калиевый тонус глохидиев увеличивается между pH 6–9.
2. Триптаминовый ритм более выражен при щелочных значениях pH, в нейтральной же среде он очень низок.

Для реакции на калий имеет значение тепловая адаптация: личинки, адаптированные к холоду, реагируют на калий менее тонично и ритмом высокой амплитуды. Они переносят температуры 6–10° в течение 11 дней, а 20–25° в течение 4 дней. Резкие изменения температуры снижают чувствительность личинок.

DATA TO THE CHEMICAL SENSITIVITY OF FRESHWATER MUSSEL (*ANODONTA CYGNEA* L.)

FERENC LUKACSOVICS and JÁNOS SALÁNKI

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

Received: 4th March, 1968

As demonstrated in course of previous investigations considerable changes occur in both rhythmic and periodic activity of freshwater mussel exposed to the lasting effect of KCl, CdCl₂ and other inorganic salts, which manifests itself partly in an increased frequency of the rhythmic activity and partly in a specific rearrangement of the periodicity of activity (KOSHTOYANTS and SALÁNKI 1958, SALÁNKI 1960a, b). Denervation studies suggest that the special ciliated formation of the caudal part of the mantle and the area of the out- and inflow syphons are most important points of attack for these agents (SALÁNKI 1961a, b). Earlier anatomical data suggest that there are chemoreceptor areas beside the outflow syphon on both sides of the visceral ganglia (HERBERS, 1914). Beyond these, however, we know of no data concerning the actual existence and role of a chemoreceptor organ in the *Anodonta*, that might confirm the above theories.

HOPKINS conducted studies (1932) on the effect of different cations and anions on syphon reflex in *Ostrea virginica* and on basis of differences observed he set up a gradient of effectiveness. Simultaneously he also confirmed the chemical sensitivity of syphons in the oyster. Studies of similar nature are not known on freshwater mussel. In view of this, it appeared most desirable to decide firstly, whether the syphon of the freshwater mussel, which is different in construction from that of the oyster might be considered as a chemoreceptor area or not, i.e. whether it is sensitive, in case of a short effect, to such chemical agents which influence activity. Another objective of the present study was the cognition and comparison of the effects produced by various chlorides, because when studying the responsiveness of periodic activity differences were observed between the cations.

Method

One valve of *Anodonta cygnea* specimens with an average valve length of 15 cm was fixed in vertical position, and to the other valve (1. in *Fig. 1*) a cord (6) leading to the lever of a kymograph was attached, and the animal was placed into a glass container. A stream of Balaton-water was led through the glass container (8, 9). By opening the tap of a burette (5) 1 ml water was

allowed to pour on the area of the syphon of the mussel (2) in a time unit of 15 sec, and by opening the water tap (4) Balaton-lake water was pouring on the same area in 4 jets from plastic tubes located at 1 cm distance. As it is known that the mussel, and particularly the area of the syphon is most susceptible to mechanical effects, this area has been exposed to the mechanical

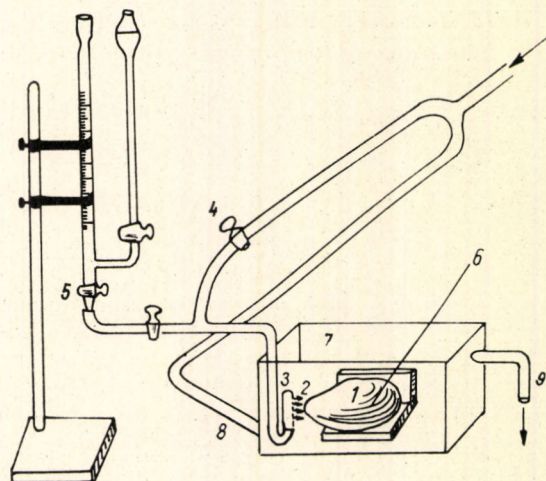


Fig. 1. Apparatus for testing chemical sensitivity (explanation in the text)

1. ábra. A kémiai érzékenység vizsgálatára szolgáló berendezés (magyarázat a szövegben)

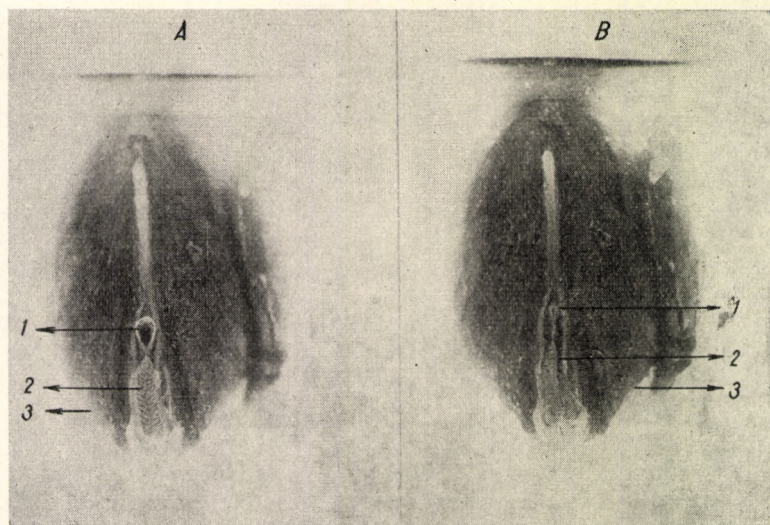


Fig. 2. Position of the syphons: a) open, b) closed
1. outflow syphon; 2. inflow syphon; 3. valve

2. ábra. Szifók pozíciója: a) nyitva, b) zárva
1. kiáramló szifó; 2. beáramló szifó; 3. kagylóhéj

effect of streaming Balaton-water also in the non experimental periods for ensuring identical conditions. Accordingly, during the control experiment no response was produced by opening or closing the Balaton-water tap.

When the valves were in open position and the light conditions were suitable the out- and inflow syphons were well observable. It was possible to decide even by the naked eye whether these were responding to the chemical agent or not (*Fig. 2*). The closure of the out- and inflow syphons was judged visually, and the closure of the valves recorded on a kymograph.

The effect of the drugs was always examined at first at a low concentration, and in case effectiveness was lacking or if it was only a partial one, the concentration was increased until closure of the valves was produced in about 100 percent of cases.

The examinations were repeated at intervals of 5 min, when during this period the initial condition was restored. At least 20 tests were performed at every concentration examined.

On the abscissa the concentrations of the agent in M, on the ordinate the percentages of responses of the syphon and adductors are illustrated.

The experiments were conducted at the actual temperature (12–16 °C) of Balaton-lake water. The test solution was also adjusted to the same temperature as the distal part of the leading tube itself was also placed in the container. The experiments were run in spring and early summer 1967.

Results

The animals placed into the experimental container were performing the usual periodic activity. The several hours long open condition (active period) of the valves was followed now and again by the tightly closed condition of the valves (resting period) which lasted similarly for hours. During the active period the adductors were in the condition of relaxation and irregularly occurring rapid contractions were succeeded by relaxation, whereas, in the period of rest the adductors were in the condition of tonic contraction („catch”).

In these studies only animals being in the condition of activity were used because only this enabled the agent administered from outside and in diluted form to find a quick access to the syphon.

In the course of testing the animals responded differently. At the lowest concentrations the closure of the outflow syphon was registered in general. The closure of the inflow syphon was more seldom observed at the same concentrations, or it was observed only at increased concentrations. Closure of the valves was produced at even higher concentrations of the agents. Accordingly, the closure of the outflow syphon and the occurrence of the reaction of the adductors (closure of valves) were registered in every single instance, and also these were illustrated in the figures.

Occasionally there was only a small difference between the least effective concentration and the concentration necessary for producing maximum response. In other instances response of the syphon was observed already at relatively low concentrations, whereas the response manifesting itself in the movement of the valves presented itself at concentrations several times greater.

Effect of KCl

This is one of the agents that in the course of previous examinations (KOSHTOYANTS and SALÁNKI 1958) proved to be most effective in influencing periodic activity. In a considerable percentage of cases the syphon responded even at relatively low (10^{-3} M) concentrations of this agent, whereas response of similar measure of adductors was obtained only at considerably higher (higher than 10^{-2} M) concentrations (*Fig. 3a*). The frequency of response of the syphon increased only gradually with increase in concentration. On the contrary, the percentage of closures of the valves increased considerably within a narrow range of concentration, i.e. only a 20 percent increase was registered at 10^{-2} M concentration, whereas an 80 percent one at $4 \cdot 10^{-2}$ M. At the latter concentration a 100 percent response of the syphon was produced.

Effect of NaCl

Freshwater mussel is less sensitive to NaCl. Even at a concentration as high as 10^{-1} M the syphon and the adductors responded only in 15 percent of cases. $5 \cdot 10^{-1}$ M concentration produced contraction in 85 percent of cases, but even 1 M solution failed to produce 100 percent response (*Fig. 3b*). It is to be mentioned that in case of $2-3 \cdot 10^{-2}$ M concentration the closure of the inflow syphon was observed in 10–20 percent of cases, other reactions, however, were not registered.

Effect of NH_4Cl

At $2.5 \cdot 10^{-2}$ M concentration the response of the syphon was observed in 15 percent of cases, and at $5 \cdot 10^{-2}$ M concentration in 100 percent of cases. At these concentrations a response of similar order was produced on the adductors (*Fig. 3c*).

Effect of CaCl_2

The response manifesting itself in the closure of the syphon and the valves presented itself even at 10^{-3} M concentration, but an increase in number of responses was produced only by concentrations beyond $2.5 \cdot 10^{-1}$ M. At this concentration both syphon and adductor responded with closure in 40 percent of cases. By rising the concentration of CaCl_2 two times higher, a 100 percent value of both responses was obtained (*Fig. 3d*).

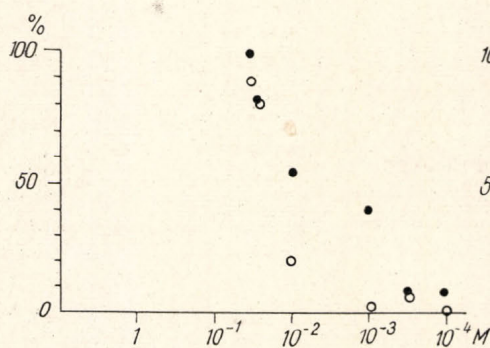
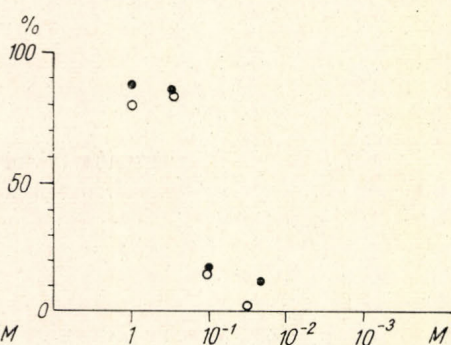
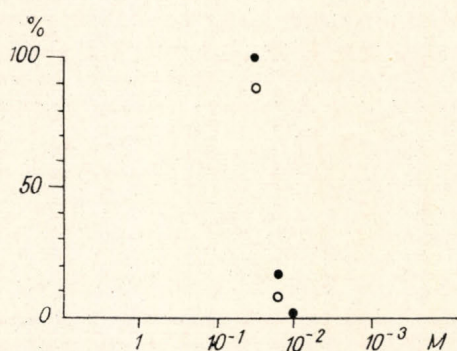
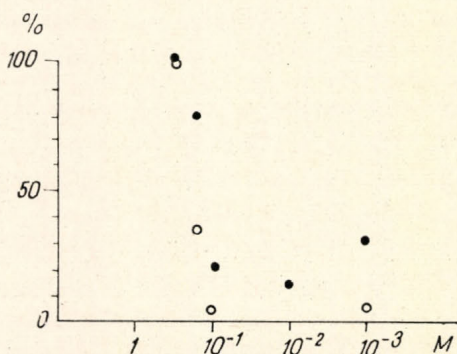
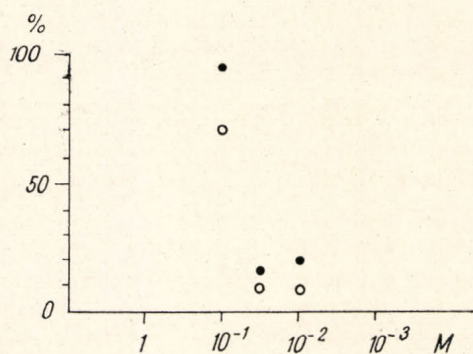
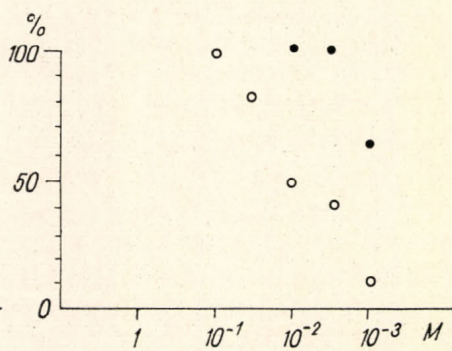
Effect of MgCl_2

The response of both syphon and adductors presented itself at 10^{-2} M concentration, and the about 10–20 percent value remained unchanged up to $5 \cdot 10^{-2}$ M concentration. At 10^{-1} M concentration, however, an approxi-

Fig. 3. Response of the outflow syphon (●) the response of the adductors (o) in the percentage of cases tested

a — KCl; b — NaCl; c — NH_4Cl ; d — CaCl_2 ; e — MgCl_2 ; f — CdCl_2

3. ábra. A kiáramló szifó válasza (●), ill. a záróizom válasza (o) a tesztelt esetek %-ában
a — KCl; b — NaCl; c — NH_4Cl ; d — CaCl_2 ; e — MgCl_2 ; f — CdCl_2

a*b**c**d**e**f*

mately 100 percent response of the syphon was registered and the closure of the adductors was also observed in 70 percent of cases. In this case also the response approached the maximum steeply and within a relatively narrow domain of concentration (*Fig. 3c*).

Effect of CdCl₂

CdCl₂ was the other agent which in the course of its lasting effect produced fundamental, consequent and concentration dependent changes on the periodic activity (SALÁNKI 1960a). The syphon responded even at the lowest examined concentration (10^{-3} M) in more than 60 percent of cases, and an increase of response to 100 percent was noted at $5 \cdot 10^{-3}$ M concentration. At 10^{-3} M concentration the valves responded in 10 percent of cases. From here onward the increase of the percentual value of responses was rather protracted, and 100 percent response was obtained only at 10^{-1} M concentration (*Fig. 3f*).

It was observed in the case of CdCl₂ only, when testing 10^{-2} – 10^{-1} M solutions of this agent, that following 4–5 times repeated treatment the animal which up to that time was open and behaving normally closed lastingly at first its syphon, than its valves and opened these only after a couple of hours. The regular occurrence of this phenomenon suggests that it cannot be taken for the consequence of the rest period in sequence which might occur in the course of the normal rhythmic activity of the animal but much rather for the effect of CdCl₂ application.

Discussion

Only little knowledge is available on the chemical sensitivity of Pelecypoda, and the role of the osphradium as a chemoreceptor has not been cleared up either. This function might be accounted for by the location of the osphradium around the syphon, for clearing this question ultimately, however, detailed physiological examinations are to be performed, as has been done lately in connection with the Gastropoda (BAILEY and LOVERACK 1966). The examinations of HOPKINS (1932) evidencing that the contraction of the tentacles of the oyster is susceptible to salts have set up an order of susceptibility for the cations: $K > Na > NH_4 > Li$. The examinations of WOORTMAN (1926) suggest that the mantle of *Mytilus* is most obviously selectively susceptible to other chemical agents too. About the freshwater mussel as much is known, that the application of crystalline KCl or NaCl into the mantle of the animal induces an increased activity of the ganglia (VERESCHAGIN 1960, SOKOLOV 1966).

Marked reaction was observable when applying the drugs to be tested to the anterior border of the mantle. This showed itself partly only in the closure of the syphon, partly in the contraction of the adductors, which resulted in the closure of the valves. The difference of effect was the function of the salt concentration applied. This also suggests that the syphon and its vicinity might be considered as special chemoreceptor zones. As observed, always the out-flow syphon responded firstly to the lower effective concentrations. Considering that osphradium is located just behind the syphon in the cloacal

cavity, it appears most probable that this is indeed a very important chemoreceptor area.

The agents examined might be ranged according to the following order of effectiveness:

a) concerning their threshold concentration:

$KCl > CdCl_2 > CaCl > MgCl_2 > NH_4Cl > NaCl$

b) concerning 100 percent closure of valves

$KCl > CdCl_2 > NH_4Cl > MgCl_2 > CaCl_2 > NaCl$

The difference between the two orders is that the succession of $CaCl_2$, $MgCl_2$ and NH_4Cl is turned. This order of cations corresponds only roughly to that observed by HOPKINS (1932) in *Ostrea virginica*, and to those established in the case of other animals as regards the responsiveness of the chemoreceptors (DETHIER 1956). The $K > Ca > Na$ order namely is in conformity with literary data, in the order of HOPKINS, however, NH_4 is preceded by Na, whereas in a number of animals it stands before K. Disregarding this exception it may be concluded that the responsiveness of *Anodonta* against the cations is in conformity to the rules which characterize also other chemoreceptors.

Besides differences in their effective concentrations the salts examined differed in other respects too. In case of some the threshold concentration and the concentration which produced maximum response were close to each other (Mg , NH_4), whereas in case of others (K , Ca , Cd) a rise from threshold to maximum was observable in the domain of concentration between 10^{-3} and 10^{-1} M. A special emphasis may be laid, in this respect, on K and Cd , namely, in chronic experiments their effect on the activity of *Anodonta* appeared to be strongly concentration dependent (KOSHTOYANTS and SALÁNKI 1958, SALÁNKI 1960a).

This might find an explanation in the fact that the response produced by K and Cd in the chemoreceptors is very much dependent on concentration, whereas in the case of Mg and NH_4 it might be of all or none character, which holds true not only in case of temporary but also in the case of lasting effects. At the same time, however, the lack of responsiveness towards Na may help to explain why high concentrations of NaCl do not influence either rhythmic or periodic activity.

The peculiar effect of Cd manifesting itself following the repeated application of it in the lasting closure of the syphon and later on of the valves too might be explained by the irreversible linkage of Cd to the tissues. The high affinity of Cd to SH groups is well known, as has also been demonstrated on the syphon of the mussel in the course of other examinations of ours (SALÁNKI and LUKACSOVICS 1965). In this sense, naturally, it is also a matter of question which reaction or process produces generator potential in the receptor following application of Cd . It is not out of question that the effect of Cd might be realized through more transfers than those of other cations examined.

The results suggest that the chemoreceptor area of the syphons may have an important role in the determination of the reactions of the animal by the transfer of stimuli received, and thus may also be involved in the mechanism regulating both rhythmic and periodic activity as it has been indicated by our previous studies of different nature (SALÁNKI 1961a, b).

The reactions provoked might most obviously be taken for reflex responses. This holds true concerning the closure of the syphon and the movement of the valves as well. The response of the syphon may be a local one (HORRIDGE 1958), though it might also be assumed, that the proper sensory area is the osphradium beside the visceral ganglia and might be identical to the epithelial cells of the lobus branchialis (ZS.-NAGY 1966). In that case the path of the reflex is closed in the visceral ganglion. A prerequisite of the contraction of the adductor (reaction of the valves) is the activation of at least the visceral ganglia, but perhaps also that of the cerebral ganglia (SALÁNKI et al. 1968, LÁBOS et al. 1968, SALÁNKI and GUBICZA 1968) and the participation of the latter may be dependent on the strength of the reaction.

Response was not produced on every occasion following application of the agents either in high or low concentrations, i.e. the response was occasionally only a partial one (only syphon, both syphons, syphon and valve). Differences in responsiveness were observed in the single specimens too. It is suggested that the great lability of responses to the chemical effects is not only linked with the properties of the chemoreceptors, but also with the condition of the reflex center and further with the properties of the effector organ too. These problems, however, might be elucidated only by special, and firstly by electrophysiological studies.

Summary

Examining the responsiveness of *Anodonta* to various salts it was established:

1. The outflow syphon responded to the least effective concentration of the stimulatory chemical agent tested. Closure of the valves (contraction of adductors) was produced by stimuli of sufficient intensity.

2. The order of the cations on basis of closure of inflow syphon was:
 $K > Cd > Ca > Mg > NH_4 > Na$.

3. This order changed slightly with regard to concentrations producing closure of the valves:

$K > Cd > NH_4 > Mg > Ca > Na$.

4. A surprisingly great difference was observed between threshold concentration and concentrations producing the highest possible response in the case of the cations K, Ca and Cd, which might give an explanation to the high concentration dependency of the effect of K and Cd on the rhythmic and periodic activity.

5. It is assumable that the receptor zone of the syphons might considerably influence the central mechanism of activity regulation.

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Összefoglalás

ADATOK A TAVI KAGYLÓ (*ANODONTA CYGNEA* L.) KÉMIAI ÉRZÉKENYSÉGÉHEZ

Lukacsovics Ferenc és Salánki János

Anodonta különböző sók iránti érzékenységét vizsgálva megállapítást nyert, hogy

1. a szifóhoz juttatott kémiai ingerkeltő anyag legkisebb hatásos koncentrációjára a kiáramló szifó reagál, kellő ingerinterzitás esetén pedig héjzárás (záróizomkontrakció) lép fel,

2. a beáramló szifó zárására vonatkoztatva a kationsorrend a következő:

$K > Cd > Ca > Mg > NH_4 > Na$,

3. a héjzárást kiváltó koncentrációkat tekintve a sorrend ettől alig tér el:

$K > Cd > NH_4 > Mg > Ca > Na$,

4. a K, Ca és Cd küszöb, ill. maximális választ előidéző koncentrációi közötti különbség feltűnően nagy, ami magyarázatot adhat a K és Cd ritmikus és periodikus aktivitást befolyásoló hatása esetében tapasztalt jelentős koncentrációfüggésre,

5. elfogadható, hogy a szifók receptorzónája jelentős befolyással lehet az aktivitátszabályozás központi mechanizmusára.

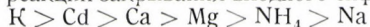
К ВОПРОСУ О ХИМИЧЕСКОЙ ЧУВСТВИТЕЛЬНОСТИ БЕЗЗУБКИ

Ф. Лукачевич и Я. Шаланки

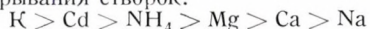
При изучении химической чувствительности беззубки к различным солям установлено, что:

1. При подаче раздражающих химических веществ в область сифонов реакция на пороговую концентрацию всегда осуществляется выходным сифоном, и в случае достаточно интенсивного раздражения наступает закрывание створок, т. е. сокращение запирательных мышц.

2. По реакции закрывания входного сифона получен следующий ряд для катионов:



3. Этот ряд почти полностью соответствует тому, который получен при изучении реакции закрывания створок:



4. Разница между пороговой концентрацией и концентрацией, вызывающей максимальный ответ, при применении калия, кальция и кадмия очень велика, этим может объясняться та сильная зависимость от концентрации этих катионов, которую наблюдали при изучении ритмической и периодической активности беззубок.

5. Высказывается предположение, что рецепторные зоны сифона могут оказывать значительное влияние на центральные механизмы регуляции активности беззубок.

FINE STRUCTURAL ANALYSIS OF THE NEURONS OF *ANODONTA CYGNEA* L. (PELECYPODA)

IMRE ZS.-NAGY

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

Received: 6th March, 1968

Only little information is available on the ultrastructure of the neurons of Pelecypoda. Electron microscopic studies on the neurosecretion of *Unio tumidus* have been performed by FÄHRMAN (1961), he has given, however, only a general description of the ultrastructural features of the nerve cells. In earlier investigations on the cerebral ganglia of *Anodonta cygnea* (ZS.-NAGY 1964) we examined the fundamental structure of the cytoplasm, the vesicular components of the axons and further the special glial structures. In some previous papers of ours some submicroscopic data (ZS.-NAGY 1967, 1968, ZS.-NAGY et al. 1965) on these structures have been presented, a comprehensive description of results obtained during these electron microscopic investigations, however, has not been given. In the course of examinations performed lately on the visceral and pedal ganglia, numerous newer details that may command interest were revealed; on the other hand, the interpretation of certain structural elements described formerly changed in the light of recent literature, thus it became actual to touch upon these questions anew.

The objective of the present study was to describe by electron microscopic methods the structure of the neurons in all three ganglia of *Anodonta cygnea* and to form a basis on cytological level for examining the functional organization of the ganglia.

Material and method

For experimental purpose 12—18 cm long specimens of *Anodonta cygnea* L. were used. The animals were obtained from fish ponds, and were kept previous to experiment in aquaria containing Balaton-lake water. The preparations of the cerebral, visceral and pedal ganglia were made as follows:

1.5 percent OsO_4 solution buffered with *s*-collidine (PEASE 1964) was used as fixative. Fixation was made at first at 0 °C for 0.5—1 hours, and subsequently at room temperature for 10—15 mins. Dehydration in graded series of alcohol solutions and later with propylene oxide. Following this the ganglia were embedded into araldite (Durocupan ACM, Fluka). Serial sections were made on LKB Ultratome III, and the micrographs were taken with TESLA BS413A electron microscope. Contrasting with saturated

uranyl acetate solution in 70 percent alcohol during dehydration (PEASE 1964). Lead citrate staining according to REYNOLDS (1963).

Experimental results

1. *Nerve cells*

Nerve cells though different in size, bear resemblance to each other as regards their submicroscopic constituents. Structural elements characterizing explicitly either large or small sized cells were not demonstrable. The larger cells, of course, exhibit a more rich structure than the smaller ones, and the single cell constituents also show a much greater variety. In the following a survey on the most important ultrastructural features of the single cell components observed in the three ganglia examined will be given.

a. Nucleus

The nuclei are either round or ovoid. Their location inside the cytoplasm is usually excentric. On occasion this eccentricity may be of such an extent that one side of the nucleus is bordered only by a very narrow rim of cytoplasm. The nucleus has an even surface and on it regular nuclear pores are observable. Occasionally nuclei with lobulated, uneven surface were also

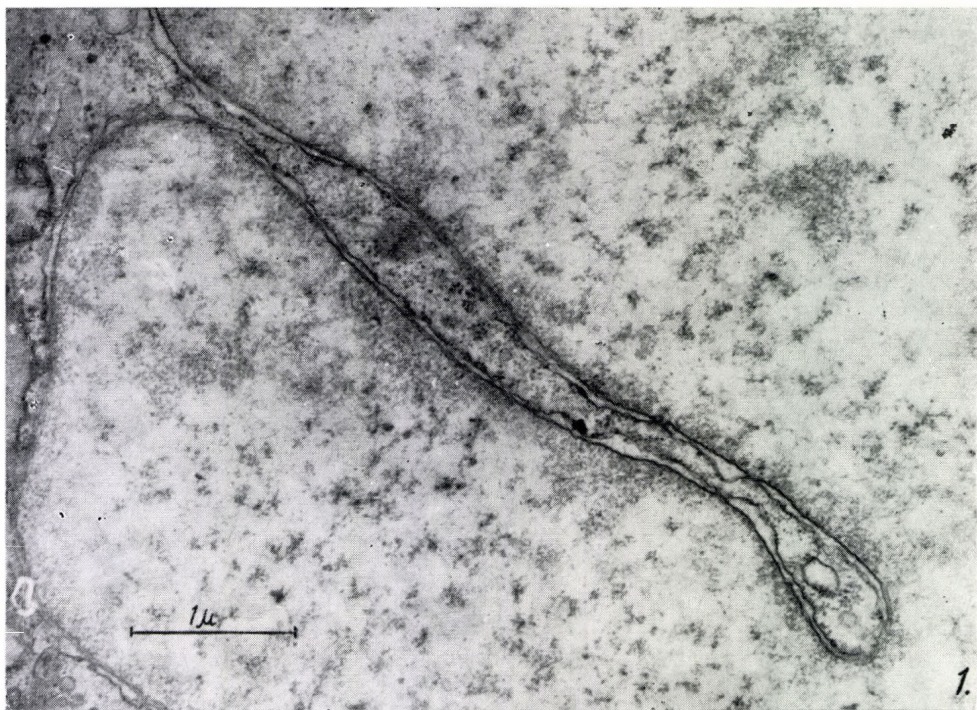


Fig. 1. Invagination of the nuclear membrane. Cerebral ganglion. $\times 22\,500$

1. ábra. Maghártyabetüremkedés képe. Cerebrális ganglion. Nagyítás: $22\,500\times$

observable, and in some instances there were also membrane invaginations seen almost all around the whole nucleus (*Fig. 1*), and dividing it into partitions. Images illustrating two completely isolated nuclei inside one single nerve

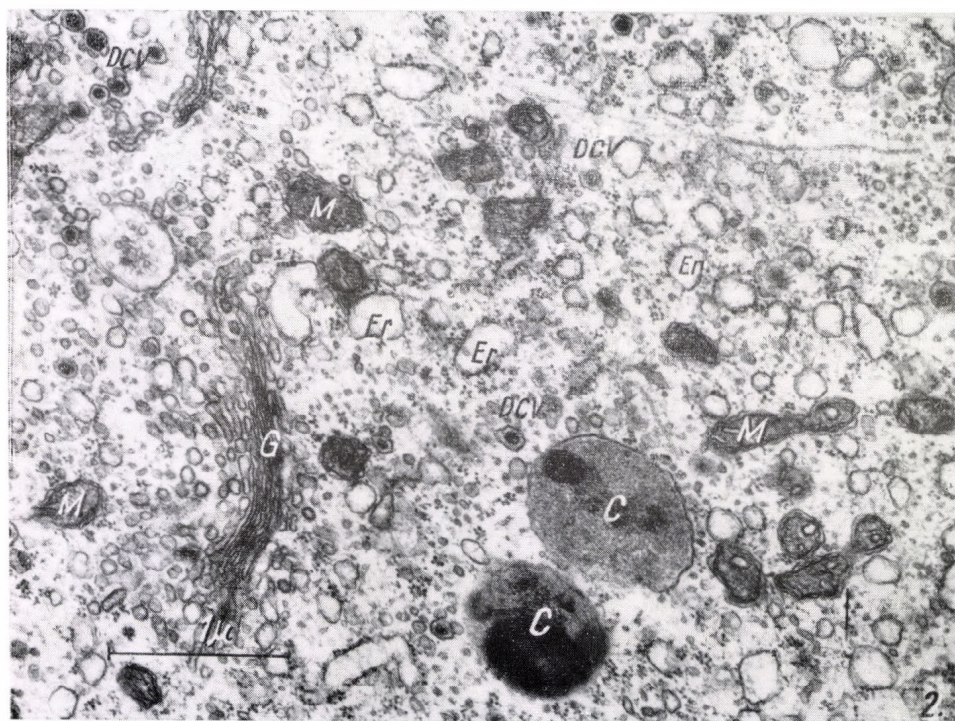


Fig. 2. A section of the cytoplasm. Cerebral ganglion

Er — endoplasmic reticulum; G — Golgi apparatus, C — cytosomes; M — mitochondria; DCV — dense-core vesicles. (Abbreviations are the same in every figure). $\times 25\ 000$

2. ábra. Citoplazmarészlet. Cerebrális ganglion. Er — endoplazmás reticulum; G — Golgi apparátus, C — cytosomák; M — mitochondriumok; DCV — dense-core vezikulumok. (A rövidítések a további ábrákon is ugyanazt jelentik.) Nagyítás: 25 000 $\times$

cell originate, most probably, from transversal sectioning of such invaginations. The nuclear membran is mostly complete on the whole surface of the nucleus but sometimes a certain loosening up is observable on it. The nuclear substance is of varying density. Beside one or more nucleoli a narrow rim of granular substance of higher electron density than the nucleus itself is seen attached to the internal surface of the nuclear membrane, whilst on other occasion, and this is more frequent, the nuclear substance is homogeneous.

b. Cytoplasm

The endoplasmic reticulum of vesicular type forms the ground substance of the cytoplasm (*Fig. 2*). The external wall of the vesicles is smooth-surfaced,

very often, however, ribosomes, too, are observable on them. Their internal surface is always smooth. The vesicles are either translucent or contain a substance of very fine distribution and of low electron density. Their diameter is of varying length, and they appear occasionally, especially in the large cells as $1\ \mu$ great, wide cysternae, and on other occasions as flattened or bifur-



Fig. 3. Lamellar formation consisting of 5 cysternae (LB). Visceral ganglion. $\times 20\ 000$
 3. ábra. 5 ciszternából álló lemezes képlet (LB). Viscerális ganglion. Nagyítás: $20\ 000\times$

cating vesicular elements. They are to be found everywhere inside the cytoplasm amidst the other cell constituents.

There is in the endoplasmic reticulum a peculiar formation which is constituted of two or more flattened, parallelly arranged cysternae (*Fig. 3*). The gap between the opposite surfaces of the cysternae is $100\text{--}150\ \text{\AA}$ wide, whilst the width of the cysternae proper is about 2–3 times as great. The inner part of the cysternae is less dense than the zone between them, and this produces a pattern of alternate dark and light lamellae. The fact, that ribosomes are frequently observed on the outer membrane of cysternae indicates that the cysternae belong to the endoplasmic reticulum. Cysternae are arranged generally side by side 2–8 in number, resulting in 1–7 dark bands. These formations might extend in the plain with a maximum length of $6\ \mu$, and maximum thickness of $0.4\ \mu$ depending on the number of lamellae. The fre-

quency of their occurrence suggests that they are most possibly present in many cells, only they may be absent from the plain of section. Occasionally even 2 or 3 such formations were observable within one single cell.

The Golgi apparatus is located in general, but not explicitly, near the nucleus (*Fig. 4*). It appears in the form of kidney-shaped formations, the

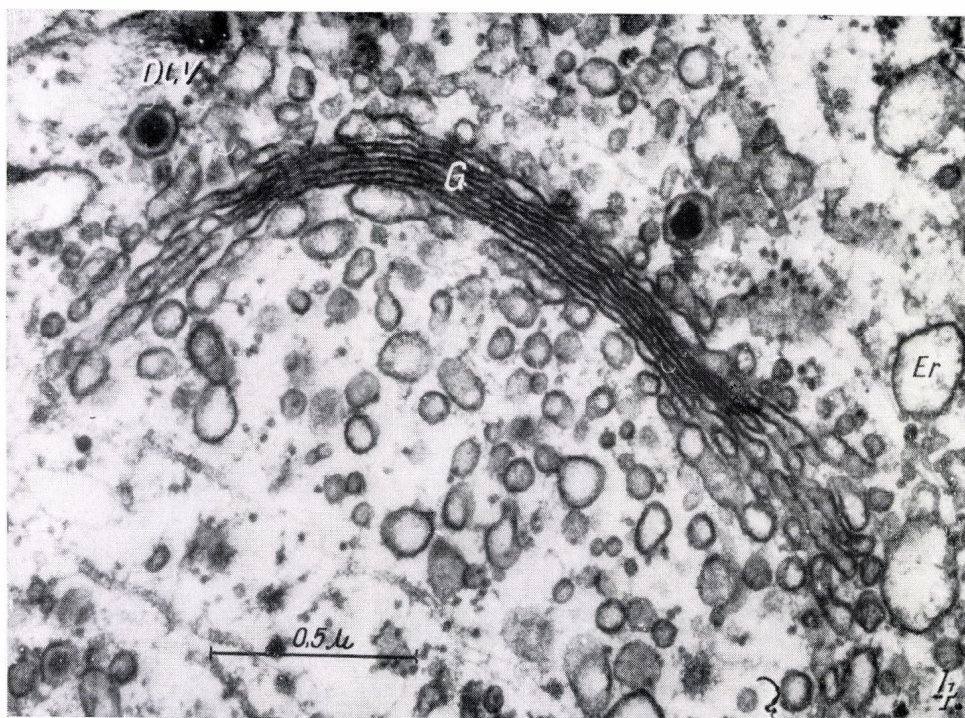


Fig. 4. Golgi apparatus and its surroundings. Cerebral ganglion. $\times 58\ 500$

4. ábra. GOLGI apparatus és környezetének képe. Cerebrális ganglion. Nagyítás: 58 500 $\times$

middle part of which is made up by several parallelly arranged lamellae (Golgi cisternae), and at its two poles there are several translucent vesicles mostly about 1000 Å or sometimes even much greater in diameter. There is a substance of high electron density inside certain vesicles which are very similar to dense-core vesicles (DCV). Golgi areas in which the lamellae were not parallelly but irregularly arranged were also noticed, and in such cases the whole lamellar system much rather resembled a pile of vesicles.

Obligate constituents of the cytoplasm are the microtubuli (*Fig. 5*). These generally range from 100 to 150 Å in thickness, and the average thickness of their wall ranges from 25 to 30 Å. Inside they seem to be translucent. It is not possible to determine their length exactly; sometimes, namely, they may be trailed in some microns length, another time, however, they are leaving soon, after a short run, the plain of section. A characteristic feature of their

location inside the cytoplasm is that they show a tendency to converge towards the area where the axons are originating from.

As already reported in our previous publication (ZS.-NAGY 1967) there are to be found in the cytoplasm two different types of mitochondria (mitochondria with dark or light matrix). Also certain ultrastructural features of the

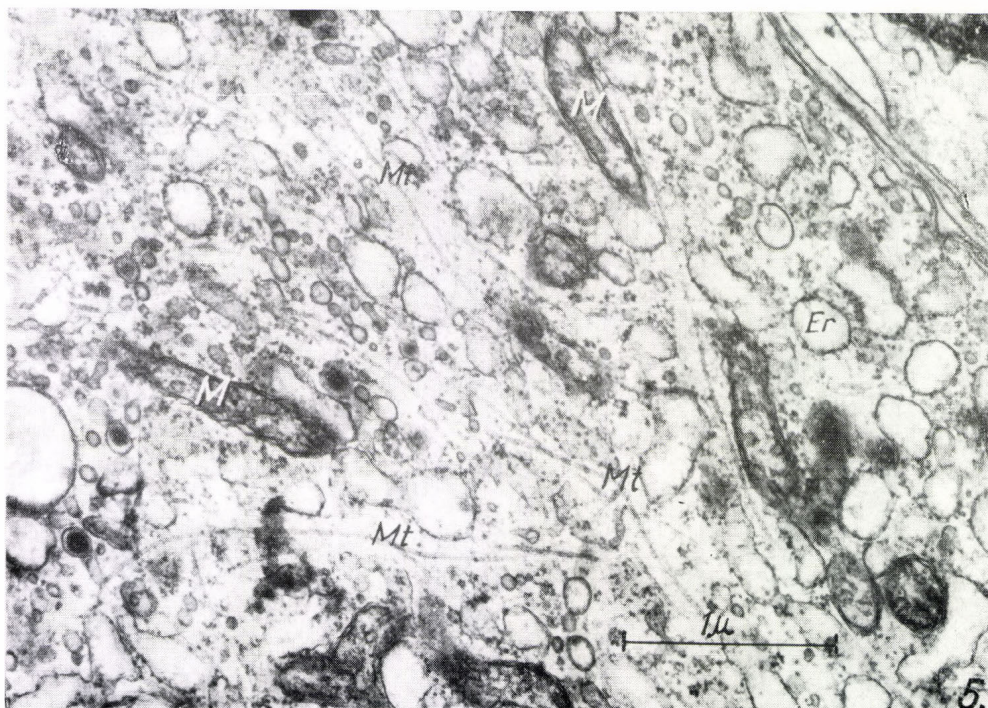


Fig. 5. Section of the cytoplasm with numerous microtubuli (Mt). Cerebral ganglion. $\times 30\,000$

5. ábra. Sok mikrotubulust (Mt) tartalmazó citoplazmarészlet. Cerebrális ganglion. Nagyítás: 30 000 $\times$

cytosomes were described in the same paper. These, however, must be complemented by the following data: the mitochondria are most variable components of the cytoplasm. They are generally $0.3-1.0\ \mu$ in length. Greater ones are very seldom found. They exhibit a large variety of shape from simple ovoid or rod shape to bizarre, bended forms with invaginations and protrusions on their surface. Mitochondria with typical cristae were not observed, their majority being much rather of tubular character.

The cytosomes (Fig. 6) are round-shaped or ovoid formations, their size ranging from 0.3 to $12\ \mu$. Those of $1-3\ \mu$ in size are of more frequent occurrence. They are identical with the yellow pigment granules observed in the cells in native condition. They are „unite membrane” bound which at certain places is not continuous. Their internal substance exhibits great variety.

Very dark homogeneous areas are alternating with similarly homogeneous spots of less electron density located inside them. Besides these a lamellar system similarly of „unite membrane” construction and resembling very fine myelin figures, further a granular substance and vesicles too might also be located inside the cytosomes. The varying ratio of occurrence of these con-

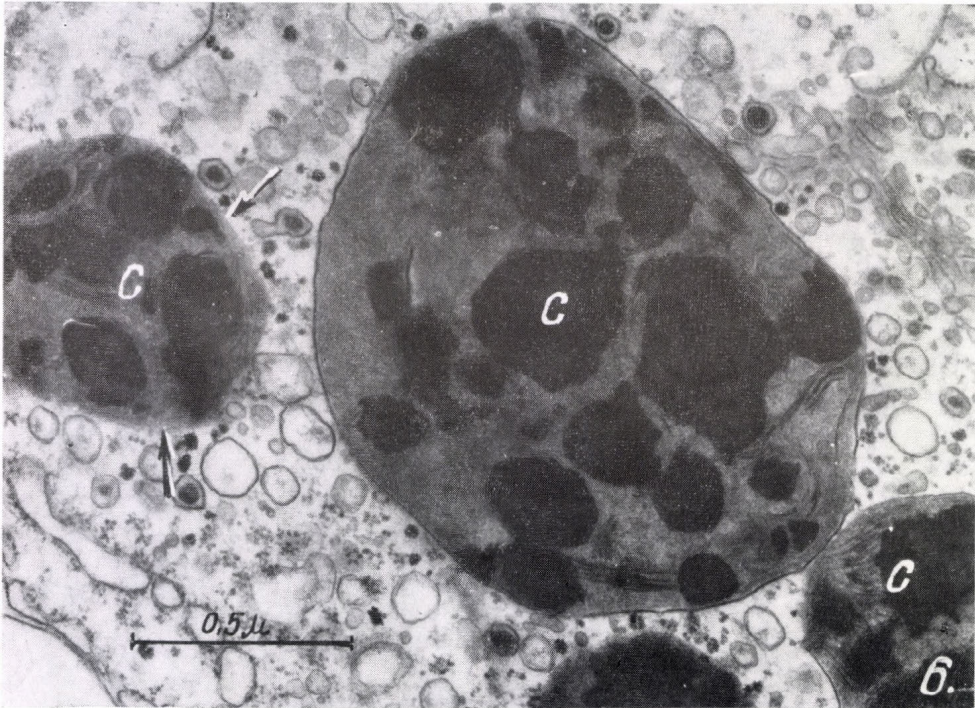


Fig. 6. Typical cytosome. Arrow indicating areas where cytosome-membrane cannot be recognized. Cerebral ganglion. $\times 62\,400$

6. ábra. Típusos citosoma képe. A nyíl olyan helyekre mutat, ahol a citosoma-membrán nem ismerhető fel. Cerebrális ganglion. Nagyítás: $62\,400\times$

stituents results in an almost untipifiable richness of forms. Great sized cytosomes very often exhibit irregular, complex forms. They are demonstrable usually arranged in groups in most diverse areas of the cytoplasm even in the place of origin of the axons.

Formations also occur which so to say represent transitions between mitochondria and cytosomes. On basis of their outer membrane and tubuli they might be taken for mitochondria, their internal substance, however, exhibits the characteristics of cytosomes: they contain substance of granular and lamellar structure (*Fig. 7*).

Permanent constituents of the cytoplasm (*Fig. 8*) are also the multi-vesicular bodies (SOTELO and PORTER 1959). These are $0.2-0.5\ \mu$ sized membrane bound formations with numerous vesicles ranging from 200 to $400\ \text{\AA}$ in diameter inside them.

Besides the above organelle the cytoplasm contains numerous ribosomes, vesicles and other granules too, the amount of which varies in nearly every single cell. These organelle as a whole can be ranged into the group of microsomes. Large masses of ribosomes occur free in the cytoplasm, a number of them, however, is connected to the vesicles of the endoplasmic reticulum.

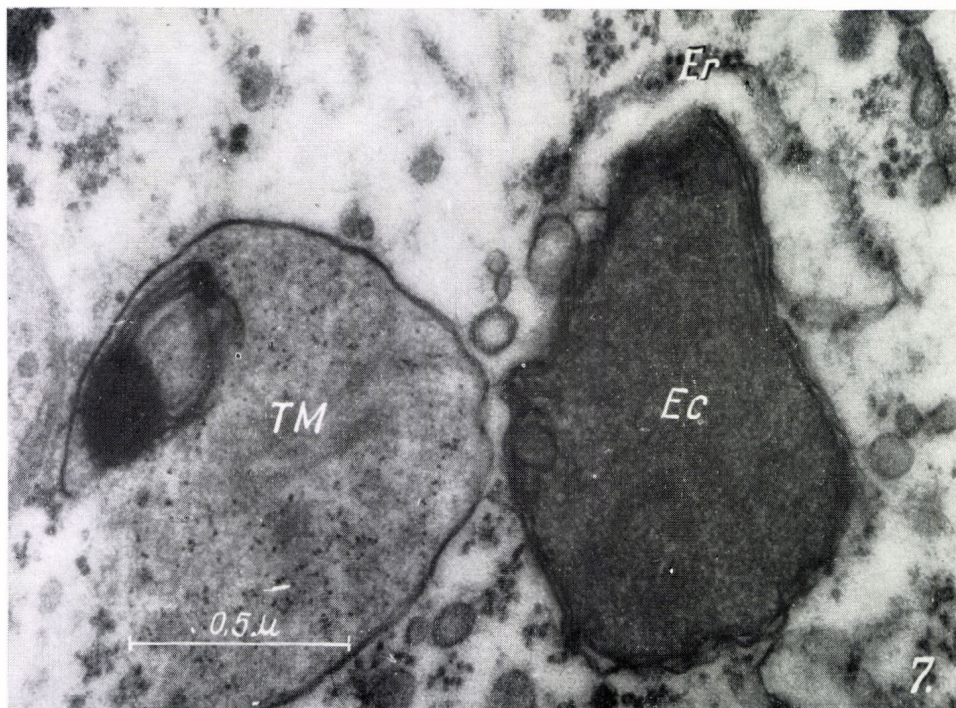


Fig. 7. Mitochondrion in the condition of transformation, in its inner part accumulation of granular substance (EC). Beside it an „emptying” cytosome (TM). Cerebral ganglion. $\times 62,400$

7. ábra. Átalakulóban levő mitochondrium, amelynek belsejében szemcsés állomány halmozódott fel (EC). Mellette kiürülőben levő citoszoma (TM). Cerebrális ganglion. Nagyítás: 62 400 $\times$

There are also polyribosomes observable in the cytoplasm. Special granules (Fig. 9) may also occur in certain cells. They are of high electron density and range from 200 to 500 Å in size, and their surface is irregular. They appear in certain cells only following contrasting with uranyl acetate and lead citrate. It is most practical to call them simply dark granules. They are usually located in areas in which the cytosomes also occur. On occasions they might be observed arranged in regular rows around the cytosomes.

In some rather rarely occurring cells DCVs are also to be found in large numbers. Their sporadic occurrence in few numbers in the cytoplasm is not uncommon (Figs 2, 4), their mass appearance, however, was noted only in few

cells. They are membrane bound with a substance of high electron density in their middle part, and range from 1000 to 2000 Å in size. Morphologically they appear to be identical to the DCVs seen in the axons, but in the cytoplasm their average size is greater. A more detailed description of them will be given in connection with the axons, it is to be remarked, however, right here that the DCVs of the cytoplasm do not exhibit depletion phenomena.

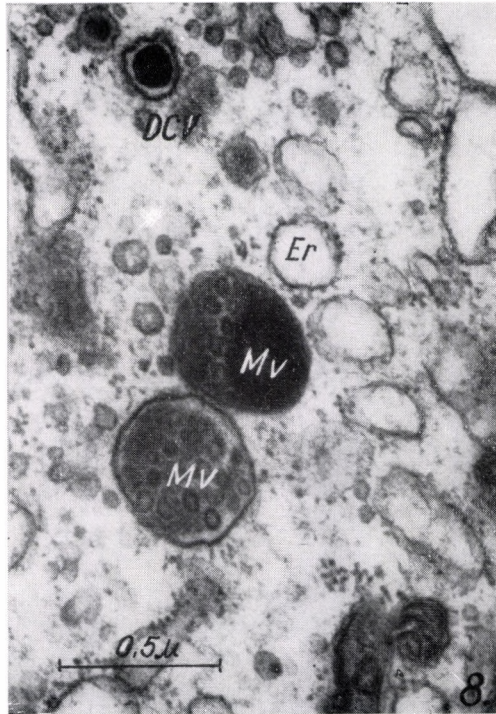


Fig. 8. Multivesicular bodies (MV). Cerebral ganglion. $\times 45\,000$

8. ábra. Multivezikuláris testek (MV). Cerebrális ganglion. Nagyítás: 45 000 $\times$

2. Processes

a. Axons

The axons constitute the bulk of the ganglia. The whole neuropil is made up of numbers of axons and glial elements, lots of axons were, however, found also among the nerve cells in the cortical area. The axons are naked, in general, and unsheathed. The free surfaces of the parallelly running axons are contiguous with each other, and the processes of glial cells are located only around bundles of several hundred or thousand axons, and are forming there a thin layer. Regular round cross sections of axons are seldom observable, because the axons passing side by side in large numbers completely fill the area at their disposal, and this results in a great variety of cross section images (*Fig. 10*).

The axons are of most varying thickness. The thinner ones are $0.3\ \mu$ in diameter, but every size up to $4\ \mu$ might occur, but axons greater than $2\ \mu$ in thickness are relatively rare. With the rise in diameter certain structural differences appear in the substance of axo-plasm. It is most practical, therefore, to divide the axons into two groups: those below $1\ \mu$ in thickness are termed thin (*Fig. 11*), those of greater diameter are called thick (*Fig. 12*).

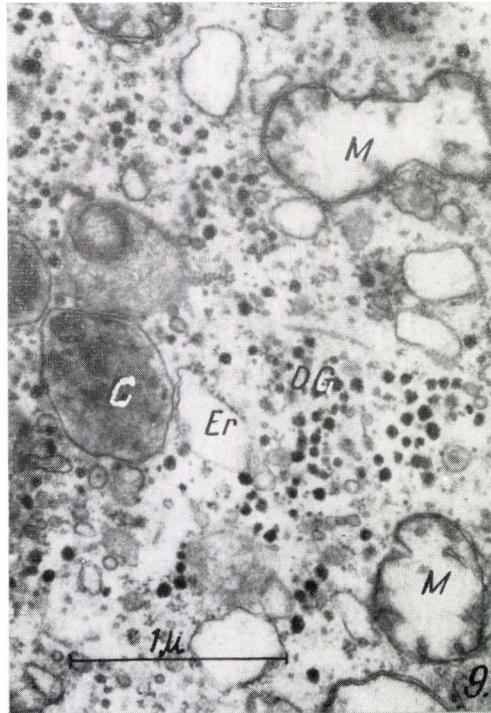


Fig. 9. Dark granules (DG). Pedal ganglion. $\times 30\ 000$

9. ábra. A sötét granulumok képe (DG). Pedális ganglion. Nagyítás: $30\ 000\times$

The thick axons are originating from large-sized cells. The axolemma is a direct continuation of the cell-membrane. The axons are considered to originate in that place where the normal cytoplasmic structure terminates and continues in the axoplasm of more pure content. This transition is more distal in the initial part of the process.

The thin axons are partly the processes of smaller nerve cells, or partly afferent fibres originating obviously from other ganglia or from the periphery. Thin fibres originating from the branching-off of thick axons were also observable.

Microtubuli that might sometimes be thicker than those of the cytoplasm are constant components of the axoplasm. They are occurring generally in masses in parallel orientation to the longitudinal axis of axons (*Fig. 11*).

The measurements show that they may range up to $6\ \mu$ in length, but, obviously, there may be longer ones, too. There are places where microtubuli are not observable, instead of them, however, a very fine network consisting of fibres much thinner than the tubuli were demonstrable. This is mainly characteristic of thick axons (*Fig. 12*).

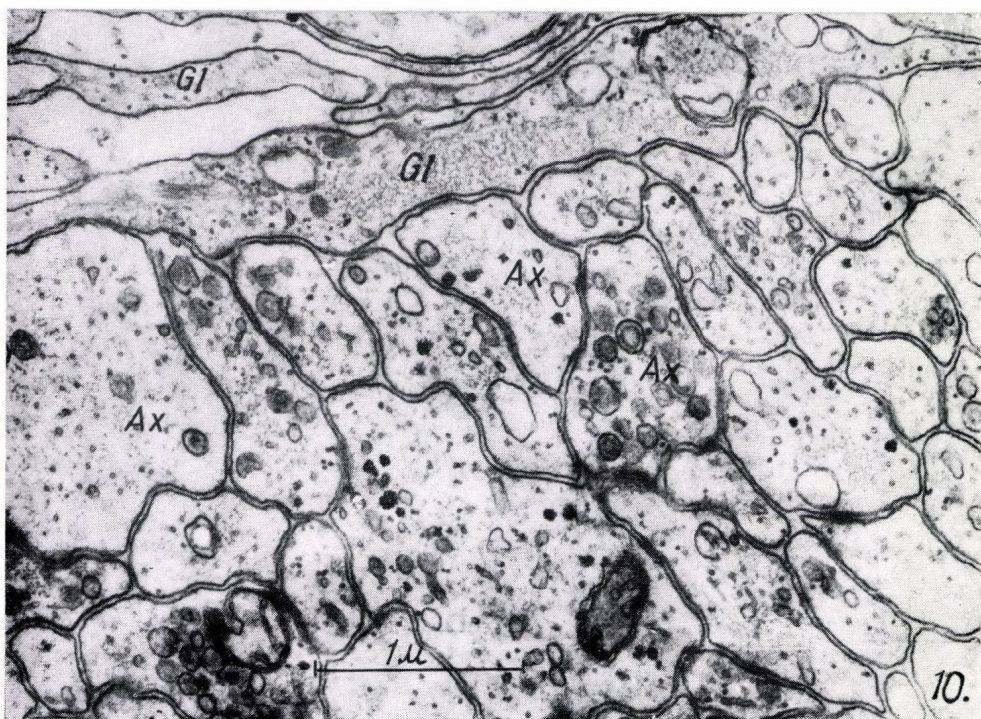


Fig. 10. Transverse section of grouped axons. Ax — axons; Gl — processes of glial cells. Pedal ganglion. $\times 30\ 000$

10. ábra. Axonesoport keresztmetszeti képe. Ax — axonok; Gl — gliasejtnyúlvány. Pedális ganglion. Nagyítás: $30\ 000\times$

In the axoplasm there are very tiny vesicle-like formations too, occurring sporadically in the cytoplasm. They bear resemblance to the endoplasmic reticulum, on basis of the irregularity of their shape, however, they may be definitely distinguished from other vesicular components of the cytoplasm, which will be discussed in the following.

The mitochondria of the axons exhibit a tubular character, their matrix is always dense and they contain tubuli in relatively large numbers. They are small in general, they may, however, range up to $2\ \mu$ in length in certain thick axons. There are relatively few mitochondria present in the axons.

The most conspicuous structural element of the axons is constituted by the vesicles. They range from 700 to $1400\ \text{\AA}$ in diameter, the most frequent

are, however, those of 1000 Å in size. Exceptionally forms 2000 Å in diameter might also be found among smaller ones; this occurs, however, very seldom, in about 0.25 percent of the cases. 26 percent of them are empty inside, and in the others a „nucleus” of varying diameter and high density is to be found (Fig. 13). Their membrane, which is thinner than the axolemma, has a „unite

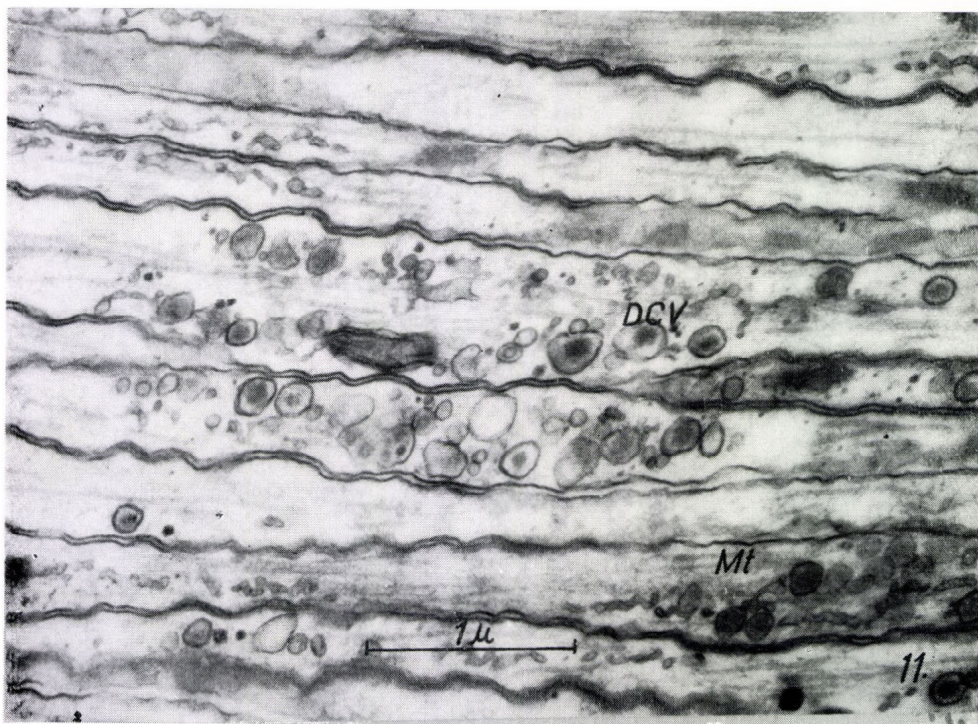


Fig. 11. Longitudinal section of thin axons. Visceral ganglion. $\times 30\,000$

11. ábra. Vékony axonok hosszmetzeti képe. Viscerális ganglion. Nagyítás: $30\,000\times$

membrane” construction. It is mostly continuous, there may be, however, openings visible on it too. A light halo of varying thickness is located beneath the membrane surrounding the dark nucleus. In about one half of cases (46 percent) its greatest diameter comes to two thirds of the outer diameter of the vesicles. In other instances, however, the middle part is smaller (28 percent). Inside one axon several varieties may also occur, but only one form dominates in general, thus resulting in characteristic axon-petterns. In case of some DCVs,

Fig. 12. A detail of a thick axon presented in longitudinal section. Visceral ganglion. $\times 32\,500$

12. ábra. Vastag axon részlete hosszmetzetben. Viscerális ganglion. Nagyítás: $32\,500\times$



a loosening of the dark inner part is observable, which may often become so expressed that the whole vesicle appears to be made up of two concentric rings. It is distinctly to be seen at higher resolution, that the „nuclei” of the DCVs are not homogeneous but have a granular structure. *Fig. 14* illustrates the distribution in size of vesicles in the axons. The DCVs may occur, in general, everywhere along the axons, in more dilated areas, however, they may be observed also in groups of several 100. These places are most obviously formations identical to nerve terminations. In such places mitochondria, microtubuli and more seldom cytosomes too were encountered. These latter do not occur in general in the axoplasm, and are encountered only exceptionally.

In some thick axons a „limiting membrane”, consisting of a row of vesicles is observable in general near the contact line between cortex and neuropil, which separates certain areas from one another inside the axons (*Fig. 15*). This row of vesicles is built up of round or elongated vesicles, and appears to form a porous membrane. It also happens, that this porous membrane proceeds directly as a regular axolemma, and the two parts of axons bound only by a porous membrane are passing on henceforth as two axons separated from each other by a regular axolemma. It has been also observed that on both sides of the porous membrane the axoplasm was of different character.

b. Dendrites

Besides the axons there are also other processes which originate from the surface of the nerve cells. They are of varying thickness, they are generally short, some-times branching off, and inside them a structure similar to the cytoplasm of nerve cells is observable. These processes are identical to the dendrites and, in conformity to the fact that the majority of cells is unipolar, they are rather seldom encountered. They usually have contact with the axons (*Fig. 13*).

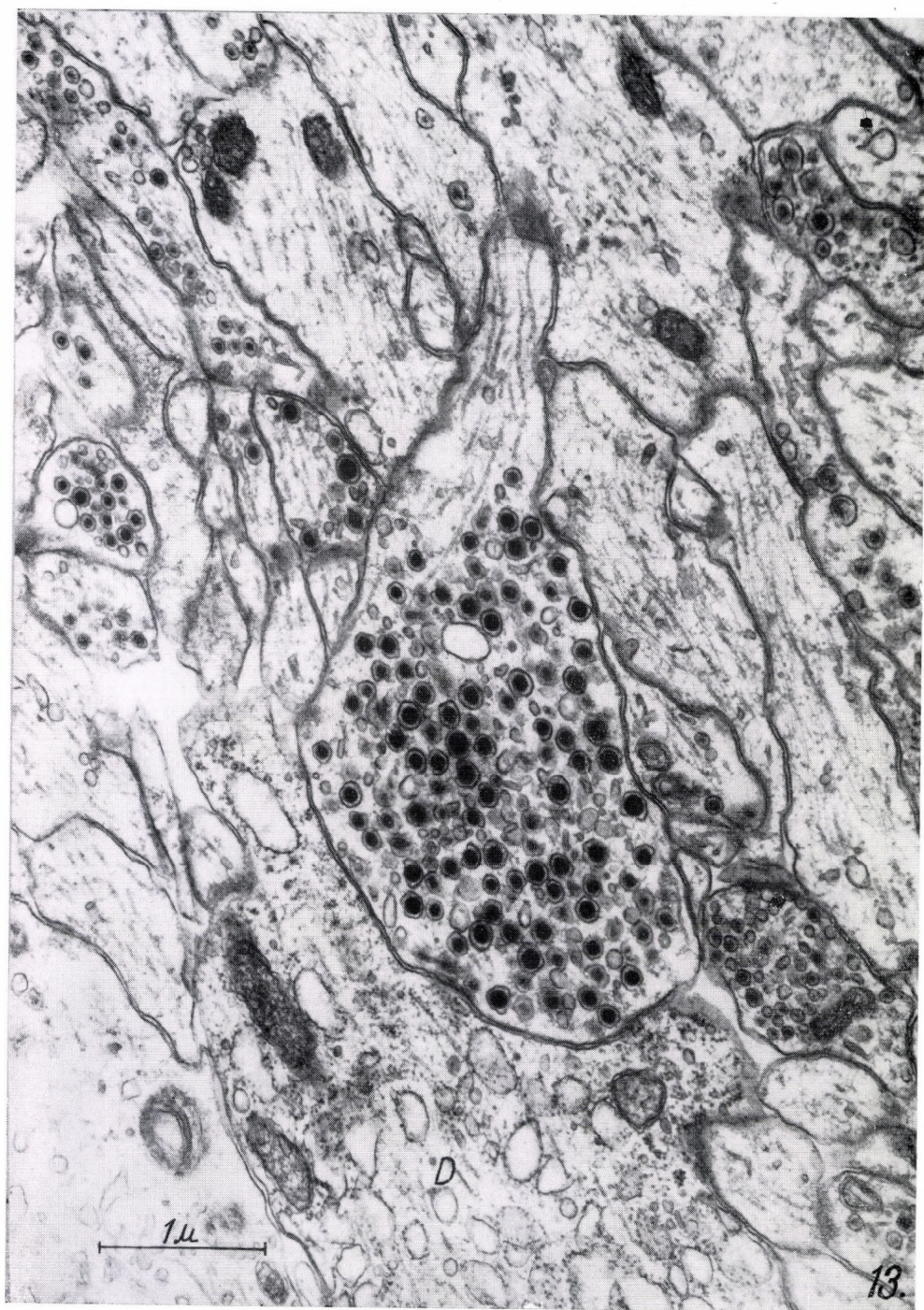
3. Interneuronal connections

a. Soma - soma

A close contact may exist between nerve cells lying side by side, when, namely, only a narrow intercellular space exists between the cell membranes. On occasion this space becomes dilated and forms lymphatic channels. Direct cytoplasmic connections were not observed between adjoining cell bodies. In certain places glial cells forming layers of 1–2 are located between the soma of two nerve cells.

Fig. 13. DCVs of different type in the axons of the cerebral ganglion. D — dendrite.
× 25 000

13. ábra. DCV-ok különböző típusai a cerebrális ganglion axonjában. D — dendrit.
Nagyítás: 25 000 ×



b. Axon-soma and axon-dendrite

Similar to that described in connection with the cerebral ganglion (Zs.-NAGY 1964), in the visceral and pedal ganglia too, the axons are very often contiguous with the body of the nerve cells. A contact may be formed on the surface of the soma (*Fig. 16*), when the dilated part, most probably the termination of the axon, which is filled with DCVs, fits closely on the cell

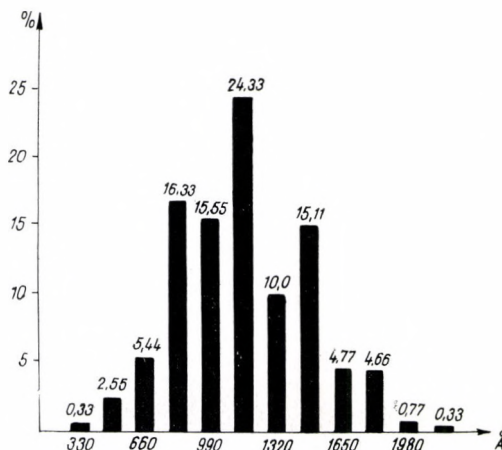


Fig. 14. Distribution according to the size of the vesicular substance of the axons as expressed in the average of measurements on 3000 vesicles

14. ábra. Az axonok vezikuláris állományának nagyság szerinti megoszlása mintegy 3000 vezikulum mérésének átlagában

membrane. On the surface of contact the membranes may be thickened and sometimes blurred. The massing of DCVs in the axons is observable near the place of contact, and close to this there are very often DCVs seen, which are either in the process of depletion or empty. The grouping of an electron dense substance on the soma side of the contact may also be observed, this is, however, mostly lacking. A certain type of axo-somatic connection may also come about, when, namely, one or more axons are deeply invaginating into the substance of the soma and are forming there a close contact with the cell membrane.

Axo-somatic connections were demonstrable mostly near the place of origin of the axons; they may, however, occur at any place on the surface of the soma.

The structure of axo-dendritic connections resembles that of the axo-somatic ones. Rather seldom do we find, however, connections that might be identified as such with certainty. This is attributable to the smaller number of dendrites.

c. Axon-axon

Axo-axonic connections represent enormous surfaces, because practically every axon is contiguous in its whole course with the other ones, and the axons are separated only by interaxonal spaces from each other. Areas in

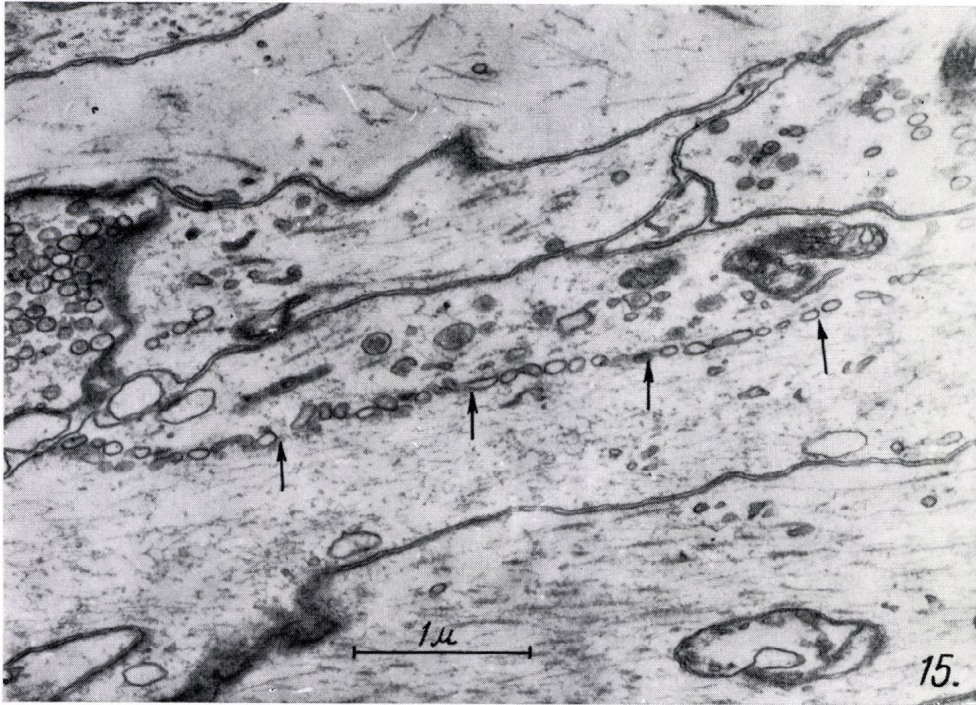


Fig. 15. Limiting membrane-like formation of vesicles in the longitudinal section of axons. Visceral ganglion. $\times 25\,000$

15. ábra. Vezikulumokból álló választófal axonok hosszmetzeti képén. Viscerális ganglion. Nagyítás: $25\,000\times$

which the grouping of DCVs occur on the one side (presynapsis) along certain places of the contiguous axolemmae, may most obviously be of distinguished importance. In such places the axolemma is somewhat thickened on both sides, and the interaxonal space is slightly broader than elsewhere, and inside it very thin, fine transverse bridges appear. One axon may form several such contacts with neighbouring axons. DCVs may occur on both sides of such contacts, but on the one side there is always the grouping of DCVs observable and depletion phenomena also frequently occur.

Such contacts may often be found in the initial section of thick axons, where, namely, the thick axons assumably represent the postsynaptic side. Such connections may, nevertheless, exist also between axons running parallel, where that part of axon which might be considered as presynaptic is evidently not a nerve termination (*Fig. 17*).

In the course of this study we observed only very seldom, not more than only in some instances such axo-axonic connections in which formations closely resembling synaptic vesicles characteristic of nerve terminations of higher animals were seen on the presynaptic side, and a subsynaptic specialization on the other side.

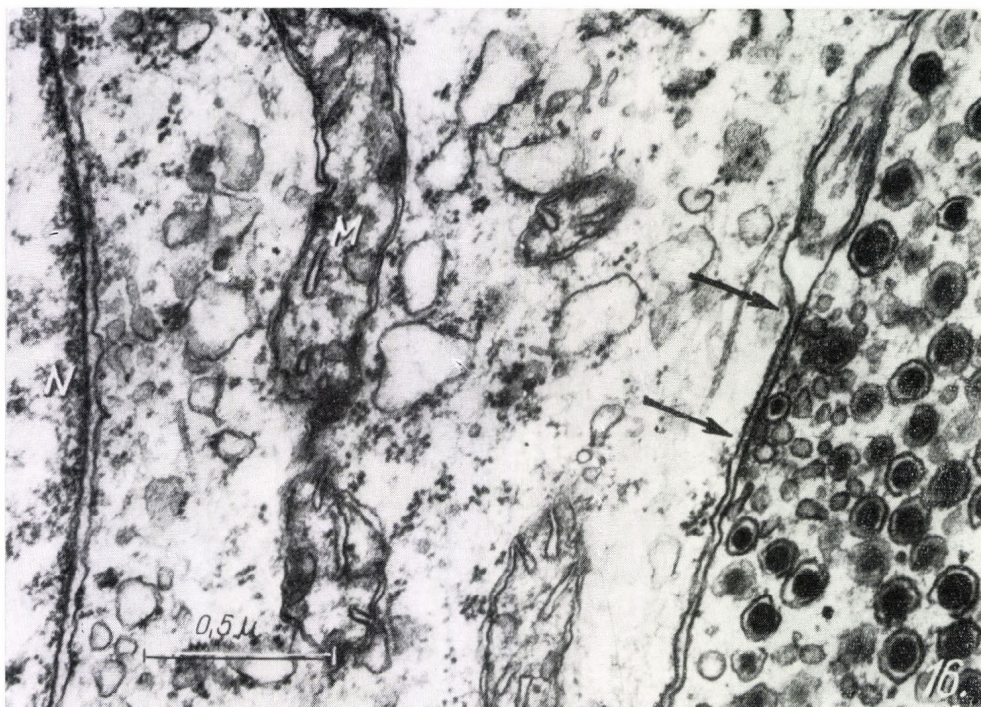


Fig. 16. Structure of axo-somatic synapses (arrow) N — nucleus. Cerebral ganglion. $\times 48\,750$

16. ábra. Axon-somatikus synapsis szerkezete (nyíl). N — sejtmag. Cerebrális ganglion. Nagyítás: $48\,750\times$

4. Glial tissue

Two forms of glial cells may be distinguished. One is located in the cortical part, and is thus nominated cortical glia as opposed to the medullary glia located in the neuropil. The cortical glial cells which are identical to the lamellar glial cells described previously (Zs.-NAGY 1964) in the cerebral ganglia, are demonstrable in all three pairs of ganglia. Most surprisingly, the DCVs were also found to occur occasionally in the cortical glial cells. Glial cells do not form trophospongium.

The medullary glial cells are of much more complicated structure, as their shape is not flattened but extends in every direction in space. A narrow rim of plasma is seen near their nucleus, and from there processes are passing in every direction into the axons of the neuropil (Fig. 10) and appearing to

furnish with a sheath the greater groups of axons. This sheath is, however, not closed in the least. In the medullary glia the structure of the plasm is similar to that observed in the cortical glial cell, inside it, however, DCV was never observed, whereas a very fine fibrillar substance was demonstrable in its plasm, which, in turn, is not the property of the cortical glia.

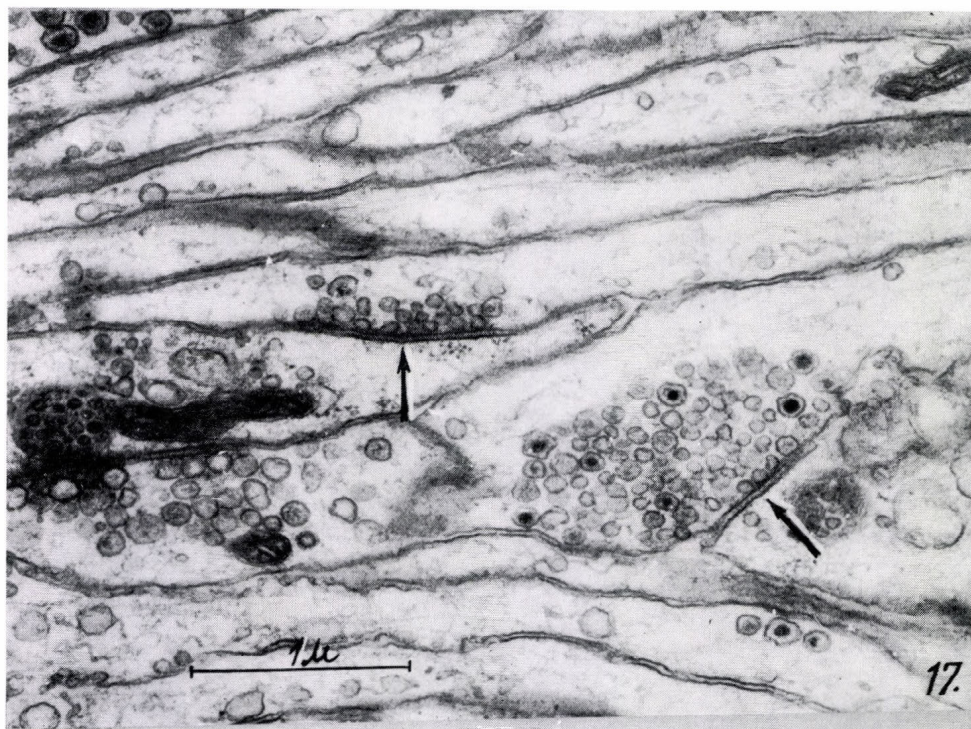


Fig. 17. Axo-axonic synapses between parallel running axons (arrow). Cerebral ganglion $\times 30\,000$

17. ábra. Axo-axonikus synapsisok párhuzamosan futó axonok között (nyílak). Cerebrális ganglion. $30\,000\times$ nagyítás

Discussion

The fact that the nuclear membrane might become loosened up in some cases, indicates that under certain conditions the nucleo-cytoplasmic connection might become more intensive. This and the differences observed in the nuclear substance necessitate the supposition of functional changes. The invaginations of the nuclear membrane, which increase the surface considerably for the metabolic activity of the nucleoplasm, might be considered analogous to similar phenomena observed in the nerve cells of higher animals (TSCHENTZOV et al. 1961). As demonstrated by BRODSKY (1961) nuclei of similar morpho-

logical appearance might intensively participate in the protein synthesis of cells. This is in complete accordance with the experimental observation, that in the *Anodonta cygnea*, in the course of restitution processes following the depletion of the monoamines by reserpine, when, namely, there is a very vigorous catecholamine production, and thus obviously an enhanced metabolic activity too in nearly every nerve cell of the CG, the loosening up of the nuclei and their invaginations are more frequently noticed, than under normal conditions, and the nucleus itself also appears to be more active (Zs.-NAGY 1968).

The peculiar lamellar formations of the endoplasmic reticulum may be paralleled to those formations described by FERNANDEZ—MORÁN (1957) in the Purkinje-cells of the rat, which were further examined by HERNDON (1964) and termed by him as „lamellar bodies”. Similar formations were described by KÁSA and JOÓ (1965) in the Purkinje cells of the guinea-pig. A parallel arrangement similar to that of the endoplasmic reticulum but of different type was observed by LEMOS and PICK (1966) in the sympathetic trunk of the rat. To our knowledge, such formations were not described heretofore in the nerve cells of the molluscs. It is suggested that this lamellar formation may be identical with a certain form of the endoplasmic reticulum which differentiated to perform a special function.

The fact that the Golgi apparatus is rich in structural elements, that it has connections with the DCVs, and that its activity increases following reserpine treatment (Zs.-NAGY 1968), suggests that it may have an important role in the formation of DCVs. Similar phenomena were reported by others (AMOROSO et al. 1964, LANE 1964, SIMPSON et al. 1964, NOLTE et al. 1965) in the nerve cells of molluscs.

The importance of the microtubules is unknown as yet. As suggested by TOKIN (1966) the microtubules may be considered as generally occurring cell organella, which most probably form a cytoskeleton, and this may be of importance not only mechanically in the orientation of the cell organella, but may have an active role as well.

The mitochondria exhibit a characteristic structure. The variety with light matrix is identical to that one described by NOLTE et al. (1965) in the ganglion cells of Gastropods, and the variety with dark matrix is completely similar to the mitochondria described by FÄHRMANN (1961) in the nerve cells of *Unio tumidus*. Nevertheless, the latter author refers in the text to mitochondria of the crista type. This appears to be a mistake, because it is not the dark but the light matrix variety that does not show the typical morphological characteristics of the crista type mitochondria, and though they differ in some sense also from tubular mitochondria still they are standing much closer to them.

Considering, that on the effect of reserpine treatment the majority of mitochondria appear in the form of the dark matrix variety (Zs.-NAGY 1968), whilst under normal conditions the light matrix variety prevails, further that both may occur inside the very same cell, it seems to be justified to suggest that the two forms represent varieties with different functions, and that in the course of intracellular changes they may be transformed into each other.

The cytosomes are very conspicuous formations of the cytoplasm. This term was firstly used by NOLTE et al. (1965) for designating those special formations in the nerve cells of molluscs, which were already known to previous authors as pigment granules (SCHULTZE 1879, RAWITZ 1887, BOCHENEK 1905).

The progress made in the field of ultrastructural researches has led to the accumulation of data evidencing that formations similar to the cytosomes occur widely in the kingdom of invertebrates, and are not absent from certain tissues of higher animals either. Though the term „cytosome” has not been adopted by every author, the situation remains the same, namely, the formations described are morphologically identical to the cytosomes. The most important works on molluscs were collected and reviewed on by NOLTE et al. (1965). Formations identical to cytosomes were described in the nerve cells of the Annelida by RÖHLICH et al. (1962), COGGESHALL and FAWCETT (1963) and in the corpus cardiacum of the Insects by SCHARRER (1963). Cytosomes occur also in certain nerve cells of the vertebrates and even in other tissues of them (LEMONS and PICK 1966).

Cytosomes are normal constituents of the nerve cells in the molluscs. Their relationship to other well defined cell organella is not clear, it is worth to note, however, that even FÄHRMANN (1961) considered it possible that they might take their origin from mitochondria. Mitochondria that might be taken as transitional forms to the cytosomes were observed by SCHARRER (1963) in the corpus cardiacum of the Insects. A transition of similar nature of the mitochondria was reported by GAUDECKER (1963) in the larvae of *Drosophila*. It is assumed that those forms of mitochondria which we have observed in the nerve cells of *Anodonta cygnea* and in which the appearance of granular or lamellar substance was observable, also speak in favour of the suggestion that the cytosomes may originate from the mitochondria by way of a special transformation. The fact that the membrane of the mitochondria is thinner than that of the cytosomes, and that the latter has the construction of the „unit membrane”, seems to contradict, in some respect, to this hypothesis. Considering, however, that the membranes of the cytosomes are most variable, and may open up or disappear even under normal conditions, it is thought not improbable that at a certain stage of the process of cytosome formation the membranes are also rebuilt, and this may be the explanation to the above contradiction.

The lysosomes are in some respect similar to the cytosomes morphologically. Questions pertaining to this and to the relationship between cytosomes and neurosecretory are discussed in our previous paper (ZS.-NAGY 1967).

The origin of the dark granules in the cytoplasm has not been explained as yet. It seems probable that they may originate from the polyribosomes, respecting, however, their close topographic connection with the cytosomes, it is assumable that the substance of the cytosomes is also implicated in their formation. They somewhat resemble morphologically glycogen granules that are observable in other cells; on the basis of the observation, however, that they appear only following contrasting with uranyl acetate and lead citrate, and that subsequent to contrasting with lead citrate, the glycogen granules are of low electron density, whereas the ribosomes of a high one (REYNOLDS 1963), their identity is considered disputable.

A small proportion of nerve cells and an overwhelming majority of the axons contain DCVs. The DCVs appear to be identical morphologically to formations in the sympathetic nervous system of higher animals. At present there are numerous data evidencing that noradrenaline is localized in the DCVs of the vertebrates. The literature on this subject has been thoroughly reviewed by HÖCKFELT (1967).

The DCVs are common in the nerve fibres of other molluscs, too (SCHLOTE 1957, FÄHRMANN 1961, GERSCHENFELD 1963, ROSENBLUTH 1963, BAXTER and NISBET 1963, SCHLOTE and HANNEFORTH 1963, RÖHNISCH 1964, NOLTE 1964, SAKHAROV et al. 1965 etc.). GERSCHENFELD (1963) believes them to be non-cholinergic synaptic vesicles in case of Gastropoda, and suggests that they might contain catecholamines and perhaps serotonin as well. FÄHRMANN (1961), SCHLOTE and HANNEFORTH (1963) are of the opinion that the DCVs of the Gastropoda are comparable to primary neurosecretory granules. Several types of these granules were described on basis of their size and the state of the middle part by the latter authors. GERSCHENFELD (1963) also adopted tipification according to size. We have already called attention (Zs.-NAGY 1964) to the risk involved in tipifying according to size, and our recent experimental evidences speak also in favour of this. A significant decrease in diameter of granules and a considerable loosening up of their inner substance was demonstrated by RINNE and ARSTILA (1966) in the rat following reserpine treatment. Evidences to the same effect were obtained by our own experiments with reserpine (Zs.-NAGY 1968). All these seem to support the suggestion proposed by us that both in the cells and in the axons the DCVs of different size correspond to representants of the same organelle being in different state.

According to the above the empty vesicles may be the representants of completely depleted forms of the DCVs. This suggestion is supported by the fact that the empty vesicles are very often observable close by the synaptic connection, where the consumption of the substance of the DCV may be maximal. It is also likely that the empty vesicles are of other nature than the depleted DCV. Neither can the suggestion be rejected that those empty vesicles which occur seldom and alone without DCVs in the very small-sized nerve terminations, and which never range beyond 4–500 Å in diameter are such that differ from the DCV and perhaps correspond to the synaptic vesicles of the vertebrates.

In another paper of ours (Zs.-NAGY 1968) we deal with the origin of the DCVs and with their relation to the catecholamines.

Besides the presence of DCVs, the axons may be also characterized by the absence of sheath and branching tendency. The conduction of stimuli with high decrement might be explained, at least partly, by these morphological features (LÁBOS et al. 1963).

A most peculiar phenomenon observed is the porous membrane in certain axons. Our present knowledge does not allow to interpret it functionally. Even if it is a fixation by-product, it may indicate a special state in certain places of the axolemma. It is assumable that the separation into two areas of the axon by this porous membrane may be of functional importance; this is indicated, at least, by the fact that there are often observable on both sides of the porous membrane parts of axons which have different structures. The question, however, remains open, i.e. do the two separated areas correspond to processes of two different nerve cells, or do they represent two parts of the same axon? In view of the branching property of axons it is difficult to decide. It still remains to be answered, whether the porous membrane may be considered an axolemma either in the making or decomposing, or is it always functioning in this porous form.

It has been found, on the one hand, when examining the structure of interneuronal connections that similar to the observation of LAMPARTER (1966)

in the prothoracal ganglia of the ant, in the *Anodonta cygnea* there is no direct cytoplasmic connection between the soma of the nerve cells. On the other hand, a variety of interneuronal connections may occur (Axon-soma, axon-dendrite, axon-axon) in all three ganglia, which constitutes an essential difference as compared to the Gastropoda in which the existence of axo-somatic synapses is disclaimed in general (BULLOCK and HORRIDGE 1965). Naturally, as long as there are no direct physiological data available evidencing that the axo-somatic places of contact observed by us are functioning really as true synapses, we may only hypothetically speak of the existence of an axo-somatic synapsis in fresh water mussel. The probability of the existence of such synapses is, nevertheless, suggested by the structure of axo-somatic contacts observed.

In this respect it is most decisive that depletion phenomena observed in the DCVs are most expressed in the vicinity of such places, and that just the same unloading phenomena occur when the catecholamine content of the axons is depleted with reserpine (Zs.-NAGY 1968), and this is accompanied by a decisive change in the activity of the whole nervous system of the animal, i.e. the animal is incapable of tonic contraction of its adductors (SALÁNKI 1963) and its other muscles are relaxing too. Chemical transfer of stimuli may most obviously be expected to occur in areas of the membrane in which the structural conditions for such a transfer are given. In the light of the above it is thought that the special places of axo-somatic, axo-dendritic and axo-axonic contacts where accumulation of DCV, depletion phenomena, membrane thickening and perhaps also subsynaptic massing, further the filling up of the intermembraneous spaces with special bridges occur, may be considered as synapses with consideration for analogues existing in other animals (LEMOIS and PICK 1966, CASTEJON and VILLEGAS 1964).

Summary

Author describes the general submicroscopic structure of the neurons in the three pairs of ganglia of *Anodonta cygnea*. He describes the different forms of appearance of the nuclei. The special lamellar structure of the endoplasmic reticulum is also discussed. He gives a detailed description of the structural characteristics of other cytoplasmic components (Golgi apparatus, microtubuli, cytosomes, dense-core vesicles) and describes the structure of axo-somatic and axo-axonic synapses. Data on the two types of glial cells are also presented.

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ÚJABB ADATOK AZ ANODONTA CYGNEA L.
(PELEOCYPODA) NEURONJAINAK SZUBMIKROSZKÓPOS
SZERKEZETÉHEZ

Zs.-Nagy Imre

Összefoglalás

Szerző leírja a neuronok általános szubmikroszkópos szerkezetét az *Anodonta cygnea* mindhárom ganglionjában. Ismerteti a sejtmagok különböző megjelenési formáit. Beszámol az endoplazmás retikulum különleges lemezes képződményeiről. Részletesen taglalja az egyéb citoplazmatikus komponensek (Golgi apparátus, mikrotubulusok, cytosomák, dense-core vesiculumok) szerkezeti sajátosságait, s ismerteti az axo-somatikus és axo-axonikus synapsisok szerkezetét. Adatokat közöl továbbá a gliasejtek két típusáról.

НОВЫЕ ДАННЫЕ О СУБМИКРОСКОПИЧЕСКОМ СТРОЕНИИ НЕЙРОНОВ
БЕЗЗУБКИ

И. Ж.-Надь

Описано субмикроскопическое строение нейронов во всех трех парах ганглиев беззубки. Отмечены существующие различия в форме клеточного ядра. Описаны особые пластинчаткообразные структуры эндоплазматической сети. Дается подробное описание других структур цитоплазмы (аппарат Гольджи, микротубулы, цитосомы, везикулы с электронноплотным центральным зерном), а также строения аксо-соматических и аксо-аксонных синапсов. Обнаружены два типа глиальных клеток.

INVESTIGATION OF THE ROLE AND MECHANISM OF EFFECT OF NUCLEOTIDES ON THE ISOLATED HEARTS OF MOLLUSCS

KATALIN S.-RÓZSA and TIBOR PÉCSI

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

Received: 29th February, 1968

Nucleotides as constituents of nucleic acids, synaptic membranes and receptors of cell surfaces perform many functions in the organism. Although their direct participation in the generation, conduction and transmission of the nerve impulse has not been proved, the number of authorities indicating the importance of the change in the free nucleotide level during excitatory processes is continuously increasing (ROBB 1956, POSKONOVA 1961, KOSHTOYANTS 1963, KUPERMAN et al. 1964, FORRESTER 1966). The adenine and uracil nucleotides also play a part in liberation of the heart of lower vertebrates and molluscs from inhibitory nervous effects (POSKONOVA 1961, S.-RÓZSA 1966). In addition to this a concurrent antagonism has been demonstrated in the effect of ATP and an inhibitory transmitter on the heart of molluscs (SAKHAROV and NISTRATOVA 1963). Such antagonism between uracil nucleotides and acetylcholine was described earlier on the heart of frogs (PUTINTZEVA 1962).

Data showing that stimulatory transmitters (catecholamines, 5-HT) are stored bound to ATP (EULER 1966, ROBERTS 1966) indicate that nucleotides released together with transmitters may also have some connection with the generation and elimination of the nerve impulse. The importance of nucleotides is also emphasized by the data showing the realization of the effect of stimulatory transmitters passing through nucleotide metabolism on the heart of vertebrates (STAN and HONIG 1965, SUTHERLAND and ROBINSON 1966) and molluscs (S.-RÓZSA 1967).

On the heart of invertebrates the effect of nucleotides has not yet been studied except in the case of ATP, and because it seems that they are of major importance in the regulation of heart activity, their systematic investigation becomes necessary. The present article contains the data obtained in the course of investigating adenine, guanine, uracil and cytosine nucleotides. The aim of our experiments was particularly to find out which of the above mentioned nucleotides influence the function of molluscan heart and the effect of the excitatory transmitters.

Method

The experiments were performed on the isolated hearts of *Helix pomatia* L. and *Anodonta cygnea* L. The isolated organ was obtained as described in a previous article (S.-RÓZSA and PÉCSI 1967). In case of *Helix* hearts MENG's solution was used (MENG 1958), while for *Anodonta* hearts we applied that proposed by MARCZYNSKI (MARCZYNSKI 1959).

During the experiments the following agents were used: adenosine triphosphate (ATP), adenosine diphosphate (ADP), Reanal; adenosine monophosphate (AMP), guanosine triphosphate (GTP), guanosine diphosphate (GDP), guanosine monophosphate (GMP), uridine triphosphate (UTP), uridine diphosphate (UDP), uridine monophosphate (UMP), cytidine monophosphate (CMP), Koch-Light; cytidine triphosphate (CTP), cytidine diphosphate (CDP), Sigma; 5-hydroxytryptamine (5-HT), Fluka.

The agents were applied in MENG and MARCZYNSKI solution respectively in concentrations of 10^{-10} — 10^{-2} M. They were passed into the cannula by means of a pipette, and care was taken to return the same quantity of fluid to the heart as had been taken from it.

The experiments were conducted in the spring, summer and autumn months at room temperatures (20—25 °C). All the agents investigated had been tested both in the autumn and spring.

Results

1. Effect of nucleotides on the isolated *Helix* and *Anodonta* hearts

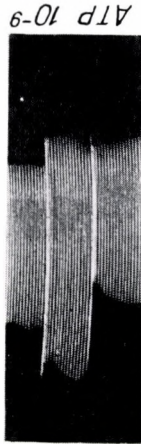
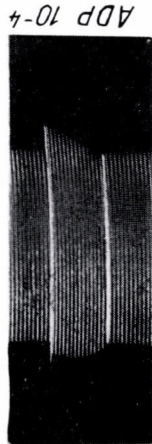
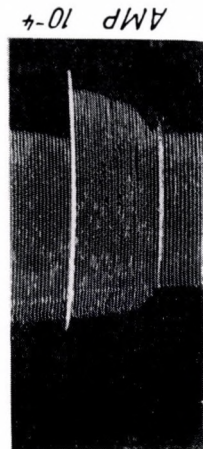
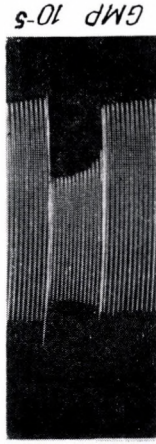
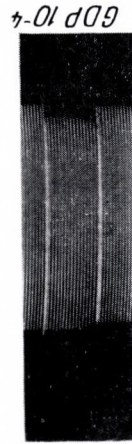
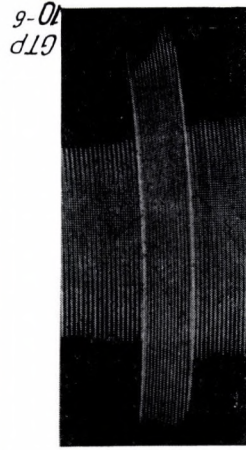
Adenine nucleotides

At low concentrations AMP, ADP and ATP produced on a *Helix* heart a moderate stimulatory effect which was indicated by an increase of amplitude (Fig. 1). The threshold concentration proved to be 10^{-6} M in case of AMP and ADP. The degree of stimulatory effect was independent of the concentration between 10^{-6} — 10^{-4} M, appearing with unchanged intensity with both nucleotides. ATP produced a stronger stimulation (Fig. 1) than the two other adenine nucleotides, the threshold concentration being 10^{-9} M. When applying higher concentrations the stimulatory effect of adenine nucleotides ceased. With concentrations between 10^{-3} — 10^{-2} M, ATP and ADP have a negative inotropic effect, while AMP turns the regularly functioning heart into an arrhythmic one. The effect of adenine nucleotides ceases quickly after washing out, only an increase of tone being observable in the case of ATP (Fig. 1) as an after-effect.

→

Fig. 1. Effect of adenine and guanine nucleotides on the isolated *Helix* heart
A — Type of effect of AMP, ADP and ATP; B — Seasonal change of GDP effect, GMP effect; C — Seasonal change of GTP effect

1. ábra. Adenin és guanin nukleotidok hatása izolált *Helix* szíven
A — AMP, ADP és ATP hatástípusa; B — GDP hatásának szezonális változása, GMP effektus; C — GTP hatásának szezonális ingadozása



On the *Anodonta* heart the above mentioned nucleotides produce their effects with considerably higher concentrations. The threshold concentration of ATP was between 10^{-5} — 10^{-4} M, so that a concentration of 10^{-5} M was inactive, while that of 10^{-4} M was of positive inotropic effect and it turned an arrhythmic heartbeat into a regular one. With hearts of weak activity and a concentration of 10^{-3} M, the initial positive inotropic effect was transformed gradually into systolic contraction by a continuously decreasing amplitude, but strongly beating *Anodonta* hearts were not affected at that concentration. A further increase of the concentration (10^{-2} M) results in an immediate systolic contraction of all hearts. If we leave the hearts for a while after washing out, then the heartbeat started again automatically. The frequency of heart activity was not significantly influenced by the adenine nucleotides.

The effect of ADP is like that of ATP, but its threshold concentration is higher (10^{-4} — 10^{-3} M). An ADP concentration of 10^{-2} M results in an immediate systolic contraction. Its effect can be washed out and the *Anodonta* heart responds repeatedly to further ADP dosing.

The effect of AMP is even more weak on the heart of *Anodonta*. The threshold concentration is 10^{-3} — 10^{-2} M. The concentration of 10^{-2} M produced a weak decrease in amplitude which was easily eliminated by washing out.

Guanine nucleotides

Contrary to the adenine nucleotides the effect of two guanine nucleotides, namely that of GDP and GTP, has a seasonal change on the *Helix* heart. As with the adenine nucleotides the effect of GMP does not show any seasonal change, but unlike those it does not produce any stimulation, but only inhibition.

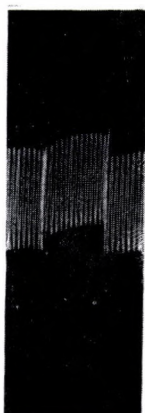
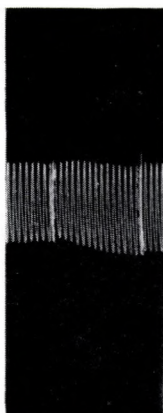
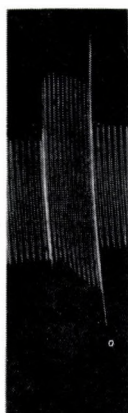
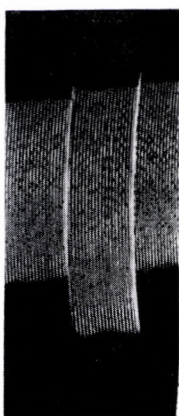
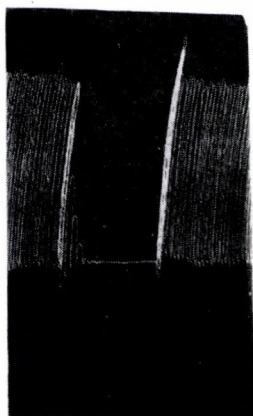
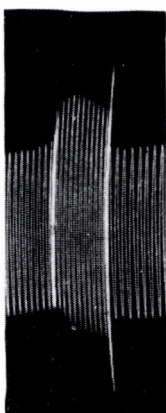
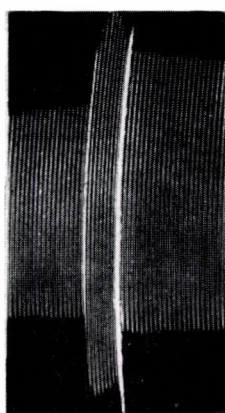
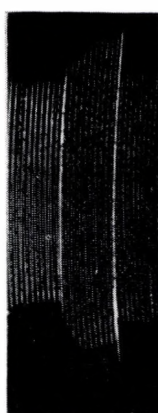
In the course of our experiments on the *Helix* heart, the GMP proved to be the least effective, producing only an inhibition with a concentration of 10^{-3} — 10^{-5} M and above, without causing a decrease of amplitude greater than 30%. A systolic arrest of the heart was, however, never observed. GDP was inactive in the spring and summer months (from March on), while in autumn it caused a complete arrest of the heart from 10^{-8} M onwards. GTP produced an increase in amplitude up to 90% in the spring and summer periods from 10^{-7} M on, while causing an inhibition at the same concentration from the autumn months (October to November). The inhibition was easily washed out in the case of GDP and GTP and the activity of the heart remained undamaged for a longer time (*Fig. 1*).

As to the *Anodonta* heart GMP proved to be less effective. A concentration of 10^{-2} M resulted in a decrease in amplitude and increase in frequency, but a systolic arrest of the heart was never observed.

→

Fig. 2. Effect of uracil and cytosine nucleotides on the isolated *Helix* heart
A — Effect of UMP and seasonal change of UDP effect; B — Seasonal change of UTP effect; C — Effect of CMP, CDP and CTP

2. ábra. Uracil és citozinnukleotidok effektusa izolált *Helix* szíven
A — UMP hatása és az UDP effektus szezonális változása; B — UTP hatás szezonális ingadozása; C — CMP, CDP és CTP effektus

UMP 10^{-8} UDP 10^{-8} UDP 10^{-8} UTP 10^{-9} UTP 10^{-9} CMP 10^{-7} CDP 10^{-10} CTP 10^{-4}

A concentration of 10^{-3} M of GDP caused only a slight increase in tone-level, while after 10^{-2} M a systolic contraction developed, but the arrest of the heart followed only after some minutes.

The GTP threshold of the *Anodonta* heart was around 10^{-4} M. The concentration of 10^{-4} M produced a decrease of amplitude and increase of tone, while 10^{-2} M caused a gradually developing systolic contraction. The effect of GTP is like that of ATP—ADP, but its effect is weaker, as the high concentration of the latter (10^{-2} M) resulted in an immediate systolic arrest.

The effect of guanine nucleotides on the *Anodonta* hearts can also be washed out easily and the heart reacts again to a repeated nucleotide application. No seasonal change of the effect of guanine nucleotides was experienced with the *Anodonta* hearts.

Uracil nucleotides

Among the uracil nucleotides UMP is ineffective in all seasons on the *Helix* heart. UDP has a stimulatory effect in spring and summer (from March onwards) with a concentration of 10^{-8} M on. UTP produces a considerable increase of amplitude in spring and summer, but with an increased concentration (10^{-8} — 10^{-2} M) there is no increase in intensity, while the same concentration of UTP on the *Helix* hearts in autumn (from November on) results in all cases in a complete arrest of the heart (*Fig. 2*). The effect of uracil nucleotides can be washed out quickly and the heart does not adapt to these agents. UTP produces in the same season exactly the opposite effect to the guanine nucleotides.

On *Anodonta* hearts UMP proved to be ineffective in all concentrations used. A seasonal change of effect with the application of uracil nucleotides could not be observed on *Anodonta* hearts.

The threshold concentration of UDP was around 10^{-4} M and this produced a weak positive inotropic and chronotropic effect. Higher concentrations (10^{-3} — 10^{-2} M) resulted in a pronounced increase of amplitude and frequency and the tone was also increased, but no arrest of heart activity was observed.

The threshold concentration of UTP on *Anodonta* hearts was between 10^{-6} — 10^{-5} M. 10^{-5} M has a weak, 10^{-4} M a pronounced positive inotropic effect. At 10^{-3} M concentration it produces an increase of amplitude around 25%, and an increase of tone can also be observed. A concentration of 10^{-2} M causes a systolic arrest of the heart, but unlike ATP of similar concentration the heart begins to beat again in a short time without washing out (*Fig. 3*). The heartbeat thus spontaneously restored was of a lower amplitude and higher frequency (an increase of 50%), but after a few minutes of functioning the original level is restored again.

Effects produced by UTP and UDP can be quickly eliminated by washing out and the heart reacts again to a repeated application of nucleotide.

Cytosine nucleotides

Cytosine nucleotides, like the adenine nucleotides, do not show a seasonal change in their effect on *Helix* hearts. CMP caused a positive inotropic effect from a threshold concentration of 10^{-10} M onwards and even at high concentrations (10^{-3} — 10^{-2} M) it had no inhibitory effect. Among all the nucleotides

investigated, CDP proved itself to be the most effective stimulatory factor, producing at concentrations of 10^{-10} – 10^{-2} M a pronounced stimulatory effect which was hardly to be washed out and manifested itself in an increase of amplitude (Fig. 2). CTP has also a stimulatory effect at concentrations of 10^{-5} – 10^{-2} M (Fig. 2) and the effect manifests itself also in an increase of amplitude, the frequency remaining constant.

Between *Anodonta* and *Helix* hearts we observed the most conspicuous divergence in relation to cytosine nucleotides. Thus with *Anodonta* hearts two cytosine nucleotides proved themselves to be completely ineffective (CDP, CMP). Only a concentration of 10^{-2} M of CTP resulted in a weak negative inotropic and positive chronotropic effect, which was easily washed out.

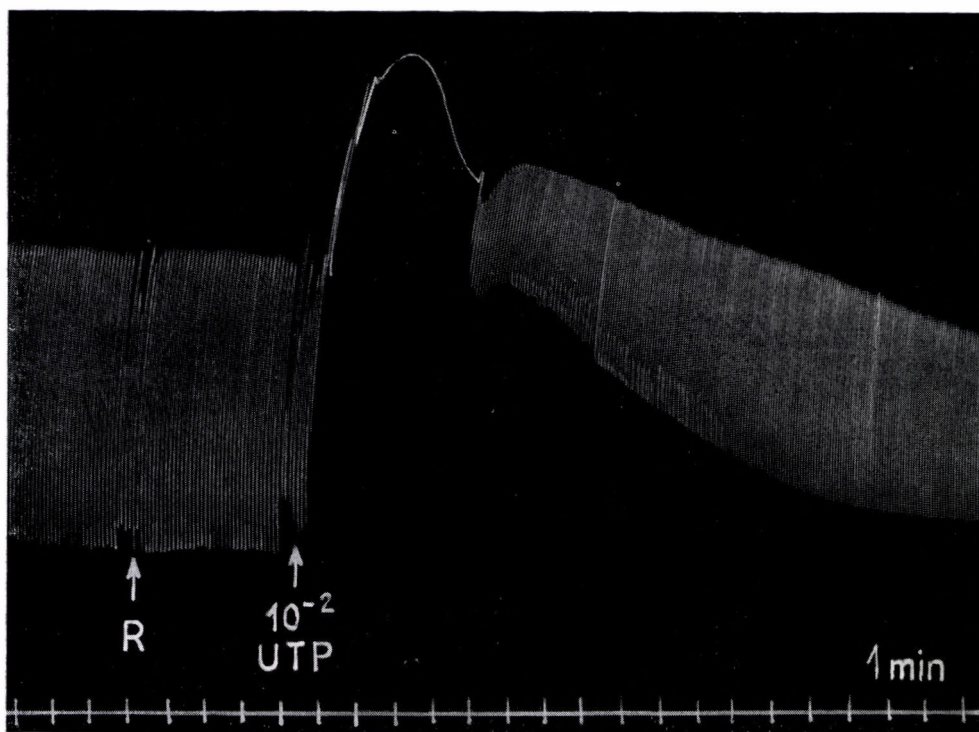


Fig. 3. Effect of 10^{-2} M uridine triphosphate on the isolated *Anodonta* heart

3. ábra. 10^{-2} M UTP hatása izolált *Anodonta* szíven

2. Influence of nucleotides on the stimulatory effect of 5-HT

In order to clear up whether the above mentioned nucleotides have a role in realizing the effect of stimulatory transmitters, we investigated the effect of 5-HT on hearts previously treated with nucleotides. These experiments

were conducted on *Helix* hearts because these proved themselves to be several times more sensitive to both the nucleotides and 5-HT.

Our experiments showed that none of the adenine nucleotides (ATP, ADP, AMP) and the monophosphates (AMP, GMP, UMP, CMP) had any influence on the 5-HT effect. Even after a long (30–60 minutes) preincubation with a high concentration (10^{-4} – 10^{-2} M) of the above agents, 5-HT produced an unchanged stimulatory effect with the threshold concentration (10^{-10} – 10^{-9} M) and intensity. GDP proved itself also to be ineffective in influencing the effect of 5-HT.

After pretreatment with a solution of UDP of a concentration of 10^{-6} – 10^{-5} M lasting for 25–30 minutes, the 5-HT caused no further rise in the stimulatory effect produced by the UDP, the amplitude remaining constant even with 5-HT concentrations of 10^{-6} – 10^{-5} M. If the heart was repeatedly washed out with physiological solution after the UDP treatment, then 5-HT produced again its stimulatory effect corresponding to the control. CDP had the same effect. These mutual effects appeared most clearly around the threshold concentrations of UDP, CDP and 5-HT.

Pretreatment with the triphosphates (GTP, UTP and CTP) reversed the effect of 5-HT. Preincubation was effected in the season when these nucleotides produced a stimulatory effect. In *Fig. 4* the effect of UTP and CTP on the 5-HT response is shown. After a treatment of 15 minutes with UTP with a concentration of 10^{-9} M, 5-HT arrests the heart. Later on the heart was liberated from the inhibitory effect, but the original level of amplitude was not reached (*Fig. 4B*). 10^{-5} M CTP has a similar effect (*Fig. 4C*). In the same season 5-HT always produces a stimulatory effect on the control hearts (*Fig. 4A*).

Carrying out incubation in the season when UTP and GTP have an inhibitory effect (i.e. in autumn for GTP and spring for UTP) 5-HT starts the heart stopped by the two nucleotides, but this effect is not worth measuring since the same can be established by applying a physiological solution too. The capacity of CTP to modulate the effect of 5-HT remains unchanged in every season, i.e. 5-HT produces an inhibitory effect on a heart pretreated with CTP both in autumn and spring.

Discussion

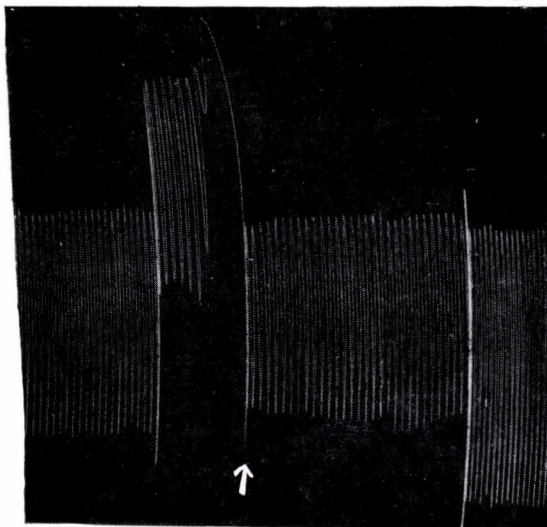
In the case of hearts of vertebrates the effectivity and type of influence of nucleotides is connected with the OH group positioned at the sixth carbon atom of the pyrimidine ring (positive inotropic effect), or else with the group NH_2 of the purine base (negative inotropic effect) (DRURY and SZENT-GYÖRGYI 1923, VERSPRILLE 1964). In our case we have to look for an other explanation, partly because some of the nucleotides investigated showed reactions on the

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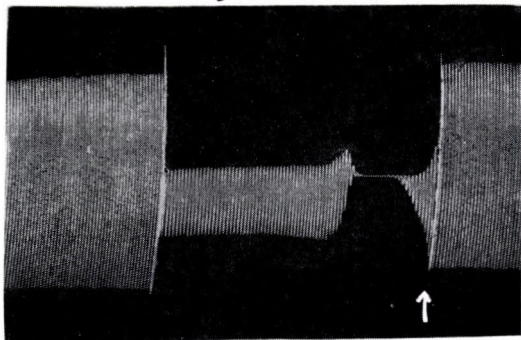
Fig. 4. Effect of triphosphonucleotides modulating the 5-HT effect
A — Effect of 5HT on the control heart; B — Effect of 5HT on a heart pretreated with UTP; C — Effect of 5HT after preincubation with CTP

4. ábra. Trifoszfónukleotidok 5HT hatást moduláló effektusa
A — 5HT effektus kontroll szíven; B — 5HT effektus UTP-vel előkezelt szíven; C — 5HT hatás CTP előinkubálás után

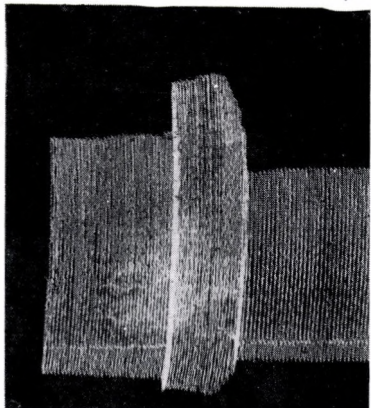
C. 5HT 10-9



B. 5HT 10-9



A. 5HT 10-9



heart of molluscs deviating from those observed with the hearts of vertebrates, and partly because in the effects of a series of nucleotides seasonal changes could be observed which cannot at all be explained by the purely stable physico-chemical characteristics of the nucleotides investigated. For the sake of comparison we compared our data with the results gained in the course of experiments on frog hearts (VERSPRILLE 1963, 1964, PUTINTZEVA and BOBROVA 1964), since between *Helix* and *Anodonta* hearts — apart from the seasonal changes — up to a concentration of 10^{-3} M only threshold concentration differences were obtained, without any deviation in the type of effect. The *Anodonta* heart reacted to nucleotide concentration 30–40 times higher than the *Helix* heart and proved itself to be practically insensitive to cytosine nucleotides. The *Anodonta* heart has already been shown to have a lower sensitivity to amines too (S.-RÓZSA and PÉCSI 1967), and our present results corroborate our previous observation that it is less suited for biotesting than the *Helix* heart.

The adenine nucleotides have a positive inotropic effect with concentrations of 10^{-9} – 10^{-4} M which can be regarded as physiological. This effect is not preceded by the negative chronotropic response which characterizes the effect of all three adenine nucleotides and particularly that of ATP on frog hearts (VERSPRILLE 1963, 1964, PUTINTZEVA and BOBROVA 1964). AMP and ADP have a weaker effect on *Helix* and *Anodonta* hearts and the effect of ATP is distinct from the former ones only in that it manifests itself with a dosage of lower concentrations (Fig. 1).

Among the guanine nucleotides GMP has no effect on frog hearts, while on *Helix* and *Anodonta* hearts it causes inhibition. GTP and GDP produce a weak stimulation on frog hearts, corresponding to the spring stimulatory effect of GTP on *Helix* hearts. In the other seasons of the year GDP and GTP inhibit both *Helix* and *Anodonta* hearts. For the GDP effect it is characteristic that we have a change from a stimulatory to an inhibitory effect depending on season, but only with *Helix* hearts.

UMP is ineffective with all three kinds of hearts. The UTP and UDP effects show a seasonal change on *Helix* hearts, inhibiting in spring and stimulating in autumn. Their effect is thus exactly opposite to that of GTP. On frog hearts both have a stimulatory effect. Cytosine agents are ineffective with *Anodonta* hearts, while with frog hearts they have a stimulatory effect — except CMP —, and the same is true for *Helix* hearts in all seasons. On *Helix* hearts CDP is the most effective stimulant among all the nucleotides.

In connection with the effect of the above mentioned nucleotides two problems must be dealt with:

1. What are the causes of the inhibitory or stimulatory effects?
2. How can we explain the seasonal change observed in the effects of guanine and uridine nucleotides?

As to the first question, we can take into account only the effect around the threshold concentration, since an inhibition produced by a concentration of 10^{-2} M could hardly be taken as a physiological one. The stimulatory effect can be explained only in the case of adenine (ATP, ADP, AMP) and cytosine (CTP, CDP, CMP) nucleotides by the structure of these agents, since in the effect of these no seasonal change is present. Nevertheless — unlike the vertebrates (VERSPRILLE 1964) — the cytosine nucleotides are more effective stimulators on *Helix* hearts, CDP being the most effective of them.

This is in contradiction to the previous observation that polyphosphates have in general the highest effectivity (PUTINTZEVA and BOBROVA 1964, VERSPRILLE 1964). On vertebrates the order of triphosphates concerning their positive inotropic effect was $ATP > UTP > GTP > CTP$. For explaining of the positive inotropic effect of ATP and CTP we may suppose that the effect is connected with the configuration. In any case we have to exclude the possibility that the effect takes into account the existence of purine or pyrimidine base, since one of the nucleotides contains the former, the other the latter of these; thus the adenine nucleotides have the character of electron donors, while for the cytosine nucleotides the quality of electron acceptor is characteristic. The effect does not show a correlation to these properties. ATP cannot in this case be taken into account as a phosphate-donor, it is more probable that it takes a part in the process as the substrate of the regulatory enzyme systems (adenylcyclase, cyclic 3'5'-AMP system). The effect of CTP may be related to its role in the lipid synthesis (BRADY and TOWER 1960). It is well known that lipids are important structural elements of all membranes on which the excitatory effects take place. So the effect of cytosine nucleotides in case of the isolated heart can be explained by their effect on the cell surface.

The effect of guanine and uracil nucleotides may be connected with their role in metabolism. It is well known that guanine nucleotides play a specific part in brain metabolism and that among all the nucleotides only the content of GTP and GDP increases with a stimulatory effect in the brain. The uracil nucleotides are connected with the carbohydrate metabolism of the brain and the same connection has been proved also for muscles (BRADY and TOWER 1960).

Thus it is clear why the effect of these two nucleotides changes from a stimulatory into an inhibitory one or vice versa depending on the season. It has been established that the spring period in case of gastropods coincides with the end of hibernation, while the autumn is the period of preparation for hibernation, and both states are accompanied by a change in the type of metabolism (RAGHUPATHIRAMIREDDY and SWAMI 1967). The guanine and uracil nucleotides may balance the inhibitory and stimulatory effects in the myocardial elements through their effect in influencing metabolism. So we are able to explain the fact that their effect on the heart of these animals may change before and after hibernation depending on the changes of type of metabolism.

Data showing a connection between the realization of the nucleotides and type of transmitter effect prove that nucleotides are connected with the formation of the type of the effect of transmitters too. The two diphosphonucleotides (UDP, CDP) only cease the stimulatory effect of 5-HT, while the three triphosphonucleotides (GTP, UTP, CTP) convert it into an inhibitory one.

The change in the type of the effect of transmitter on *Helix* heart preincubated by nucleotides may be taken as analogous to the seasonal change of the stimulatory effect obtained by the stimulation of the extracardial nerve. According to our previous data (S.-RÓZSA and GRAUL 1964) on *Helix* heart, no stimulatory effect can be produced by the stimulation of the extracardial nerve before hibernation, while in spring, after waking up from hibernation the stimulatory effects prevail. Supposedly the change of configuration of those receptor structure may be responsible for the modulation of the 5-HT effect, through which this effect realizes under normal conditions. Similar changes can be produced as a result of seasonal changes too. Considering that a lipid

nature is attributed to the 5-HT receptors (WOOLLEY and GOMMI 1966) the role of the CTP in this process should be cleared first of all. As to the two other nucleotides (GTP, UTP), we may connect their capacity to convert the 5-HT effect into an inhibitory one with their effect on general metabolism.

Summary

1. All the four groups of nucleotides investigated (adenine, guanine, uracil and cytosine) influence the functioning of the isolated *Helix* hearts. On *Anodonta* hearts cytosine nucleotides proved themselves to be ineffective. On the isolated *Anodonta* hearts the threshold concentration of the above nucleotides is 30–40 times higher than on *Helix* hearts.

2. In the effects of adenine and cytosine nucleotides no seasonal changes appeared either on *Helix* or *Anodonta* hearts. Adenine nucleotides had a positive inotropic effect on *Helix* hearts with concentrations between 10^{-9} – 10^{-4} M and on *Anodonta* hearts with concentrations between 10^{-5} – 10^{-4} M, while with concentrations of 10^{-3} – 10^{-2} M they produced a decrease in frequency and a systolic arrest on both hearts. Cytosine nucleotides on *Helix* hearts have a stimulatory effect up to a concentration of 10^{-2} M, CDP being the most effective with a threshold concentration of 10^{-10} M.

3. Guanine and uracil nucleotides have different effects in spring and autumn on *Helix* hearts, but not on *Anodonta* hearts. This change in the effect is characteristic for nucleotides containing di- and triphosphates. CTP has a stimulatory effect in spring with concentrations of 10^{-7} – 10^{-2} M, while the same concentrations lead to a complete inhibition in autumn. UTP (10^{-9} – 10^{-2} M) and UDP (10^{-8} – 10^{-2} M) exert a reversed effect, i.e. inhibitory in spring and stimulatory in autumn. The seasonal changes can be connected to the change in types of metabolism before and after hibernation. On *Anodonta* hearts the guanine nucleotides proved to have an inhibitory effect (10^{-4} – 10^{-2} M), while the uracil nucleotides have a stimulatory character (10^{-6} – 10^{-3} M).

4. The *Helix* hearts are protected by UDP and CDP against the stimulatory effect of 5-HT, while GTP, UTP and CTP transform it into an inhibitory one. Adenine nucleotides and those containing monophosphate are ineffective as regards modulation of the 5-HT effect. The CTP effect can be connected to the influence exerted on the 5-HT receptors of lipid nature, while the effect of UTP and GTP influencing the 5-HT effect should be connected with effects exerted on metabolic processes.

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NUKLEOTIDOK SZEREPÉNEK ÉS HATÁSMECHANIZMUSÁNAK VIZSGÁLATA MOLLUSZKÁK IZOLÁLT SZIVÉN

S.-Rózsa Katalin és Pécsi Tibor

Összefoglalás

1. Mind a négy vizsgált nukleotida (adenin, guanin, uracil és citozin) befolyásolta az izolált *Helix* szív működését. *Anodonta* szíven a citozin nukleotidok hatástalannak bizonyultak. Az izolált *Anodonta* szíven, a fenti nukleotidok küszöbkonzentrációja 30—40 nagyságrenddel magasabb mint *Helix* szíven.

2. Az adenin és citozin nukleotidok hatásában sem a *Helix*, sem az *Anodonta* szíven nem észleltünk szezonális változásokat. Az adenin nukleotidok *Helix* szíven 10^{-9} – 10^{-4} M, *Anodonta* szíven pedig 10^{-5} – 10^{-4} M koncentrációkban pozitív inotróp hatásúak voltak, 10^{-3} – 10^{-2} M koncentrációban mindkét szíven frekvencia-csökkenést és systolés leállást hoztak létre. A citozin nukleotidok *Helix* szíven 10^{-2} M koncentrációig bezárólag serkentő hatásúak, leghatásosabb a CDP, melynek küszöbkoncentrációja 10^{-10} M.

3. A guanin- és uracil nukleotidok tavasszal és ősszel eltérő hatásúak *Helix* szíven, de *Anodonta* szíven nem. Ez a változás a di- és trifoszfát tartalmú nukleotidokra jellemző. A GTP tavasszal 10^{-7} – 10^{-2} M koncentrációkban serkent, ugyanez a koncentrációssal ősszel teljes gátlást okoz. Az UTP (10^{-8} – 10^{-2} M) és UDP (10^{-9} – 10^{-2} M) fordítva, tavasszal vált ki gátlást és ősszel serkentést. A szezonális változások a téli álm előtti és utáni anyagcsere-típus változásokkal hozhatók összefüggésbe. *Anodonta* szíven guanin nukleotidok gátló (10^{-4} – 10^{-2} M), az uracil nukleotidok serkentő (10^{-6} – 10^{-3} M) hatásúaknak bizonyultak.

4. *Helix* szíven az UDP és CDP kivédik az 5HT serkentő hatását, a GTP, UTP és CTP pedig gátlóvá alakítják át. Az adenin nukleotidok és a monofoszfátot tartalmazó nukleotidok hatástalanok az 5HT modulálása tekintetében. CTP hatást a lipid-természetű 5HT receptorokra kifejezett hatással, az UTP és GTP 5HT-effektust befolyásoló hatását pedig anyagcserefolyamatokra kifejtett változásokkal hozzák összefüggésbe.

ИССЛЕДОВАНИЕ РОЛИ И МЕХАНИЗМА ДЕЙСТВИЯ НЕКОТОРЫХ НУКЛЕОТИДОВ НА ИЗОЛИРОВАННОМ СЕРДЦЕ МОЛЛЮСКОВ

Каталин Ш.-Рожа и Т. Печи

При изучении влияния ряда нуклеозидфосфатов на сердце виноградной улитки и беззубки установлено следующее:

1. Все изученные нуклеотиды эффективны в отношении сердца улитки, а на сердце беззубки производные цитидина оказались неэффективными.

2. Не наблюдались сезонные изменения в эффектах адениловых и цитидиновых нуклеотидов на обоих сердечных препаратах. Адениловые нуклеотиды первые оказывали на оба сердца стимулирующее действие, но на сердце улитки пороговая концентрация была на 30–40 порядка ниже. В высокой концентрации (10^{-3} – 10^{-2} M) адениловые нуклеотиды тормозили биения сердца как улитки, так и беззубки. Производные цитидина на сердце улитки оказывали стимулирующее действие в концентрациях 10^{-10} – 10^{-2} M. Наиболее сильным из них оказался ЦДФ.

3. Гуанидин- и уридинфосфаты оказывают на сердце улитки весной и осенью противоположное действие, но на сердце беззубки такие сезонные изменения эффектов не наблюдались. ГТФ 10^{-7} – 10^{-2} M весной стимулирует, а осенью тормозит сердце улитки. УТФ и УДФ, напротив, весной вызывают торможение, а осенью стимуляцию сердцебиений. Обсуждается связь этих сезонных изменений с изменениями типа обмена веществ до и после зимней спячки. На сердце беззубки гуанидинфосфаты вызывают торможение, а уридинфосфаты стимуляцию.

4. УДФ, ЦДФ, ГТФ, ЦТФ и УТФ видоизменяют реакцию сердца улитки на медиаторы, превращая при некоторых условиях стимулирующее действие (серотонина) в тормозное. Монофосфорные производные и аденозинфосфаты не играют роли в модуляции ответа на серотонин.

STUDIES ON THE EFFECT OF IONTOPHORETICALLY APPLIED L-GLUTAMATE ON THE GIANT NERVE CELLS OF GASTROPODA (*HELIX* AND *LYMNAEA*)

JÁNOS SALÁNKI

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

Received: 13th February, 1968

Attention has been called by ECCLES (1962) to a group of acidic amino acids, and inside this to the glutamic acid as possible transmitters. On basis of their studies made with iontophoretic application KRNJEVIC and WHITTAKER (1965) speak in favour of the supposition that glutamate is certainly a transmitter in the cortical cells of the vertebrates, whereas CURTIS (1965) is of the opinion that the effect of glutamate is not a specific one. Glutamate is suggested to function as a transmitter on neuromuscular level in the crab (TAKEUCHI and TAKEUCHI, 1964), in the locust (USHERWOOD and MACHILL, 1966) and in the cockroach (KERKUT and WALKER, 1966). The effect of glutamate on the cells of the central nervous system in the snail was examined by KERKUT and WALKER (1961, 1962), following administration of this compound as a perfusate, and by GERSCHENFELD and LASANSKY (1964) following iontophoretic application. They made the observation that this drug influenced the activity of numerous nerve cells. Due to the contradiction in the results obtained and to the fact that the agent was effective only in higher concentrations, the latter authors arrived to the conclusion that the effect produced is not specific.

As the influence of glutamate on the nervous regulation of vertebrates has been emphasized recently (KRNJEVIC et al 1966) and further KERKUT et al (1965) have demonstrated the release of glutamate from the muscle of retractor pharyngis following nerve stimulation, and also its appearance in the perfusate, which furnishes a strong evidence on its function as a transmitter, it has been considered most useful, in spite of the results obtained by GERSCHENFELD and LASANSKY, to examine again by iontophoretic application the effect produced by glutamate on the cells of the central nervous system of the snail, in the course of which regard should be paid first of all to concentration conditions which might be of importance in the estimation of the effect produced by the transmitter.

Method

The examinations were conducted on the giant cells of the subpharyngeal ganglia of *Helix aspersa*, *Helix pomatia* and *Lymnaea stagnalis*. These ganglia contain large numbers of cells ranging from 100 to 200 μ in diameter, or even

greater ones which as a result of their size and their surface location may most suitably be used for penetration with a microelectrode and for the discrete, extracellular iontophoretic application of the compound examined.

The membrane potential and cell activity were recorded intracellularly with glass electrodes (5–15 Mohm) filled with 2.5 M KCl. Active cells as well as those at standstill were used for experimental purposes.

For iontophoretic application capillary tubes with 1–2 μ opening were filled with 1 M L-glutamate Na (pH 7.5–8). The capillary filled with glutamate was applied under microscope and with the help of a manipulator to the cell surface into which the recording electrodes were inserted previously. Iontophoresis was performed with negative potential applied to the capillary and at a current intensity of 100 nA. At the time of interruption of iontophoresis outflow of glutamate was stopped by a countercurrent.

Cells examined for the effect of glutamate have been tested also concerning their reaction to acetylcholine (ACh) for deciding if they might be taken for D (depolarizing) or H (hyperpolarizing) cells according to the nomenclature of TAUC and GERSCHENFELD (1960). This was achieved by introducing directly 10^{-6} g/ml ACh into the bath liquid. Following this the preparation was again thoroughly washed through by perfusion before the examination of the next cell.

During the time of examination a constant slow perfusion of the physiological solution was maintained in the chamber holding the preparation.

Experimental results

The experiments were conducted on 20–25 different cells of the three species each. Because in the different preparations the cells cannot always be identified with certainty and their selection is also a matter of chance, the figures presented are only rough estimates.

In all three species about 2/3 of the cells were performing spontaneous rhythmic activity. The frequency of the action potentials varied, and the type of activity patterns were also different. An overshoot of 10–30 mV was also, but not regularly observable at a membrane potential of 40–60 mV. It also happened that the action potential was preceded by a definite EPSP (excitatory postsynaptic potential), in other instances, however, the cells appeared to perform their own rhythmic activity. One single preparation could be most suitably used for hours, moreover, the activity of certain cells could also be registered for hours. There was a fluctuation of some measure observable even under normal conditions, this, however, could be easily distinguished from changes induced by the compound, as the latter presented itself suddenly and was of temporary duration only. Essential differences in the properties of cells in the three species were not observable and therefore a summarized presentation of results will be given.

The effect induced by glutamate

Only about 40 percent of cells examined responded to the iontophoretic application of glutamate. In a number of these cells depolarization and the increase in frequency of the action potentials (*Fig. 1*) was observed, in other

instances, decrease in frequency i.e. the complete cessation of cell discharges (Fig. 1b) was registered. In such cells in which following penetration of the microelectrode no activity, only a proper membrane potential was observable, the appearance of action potentials was observed on the effect of glutamate in several cases (Fig. 1c). The effects produced presented themselves within

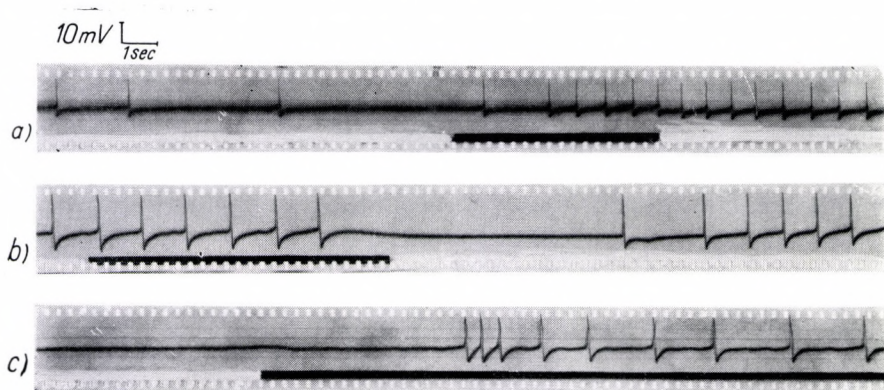


Fig. 1. The effect of iontophoretically applied l-glutamate on the spontaneous bioelectric activity recorded intracellularly in the giant cells of *Helix*. a, b, c — characteristic cell types (explanation in text)

Thick line: duration of iontophoresis

1. ábra. Iontoforetikusan applikált l-glutamát hatása *Helix* óriássejtek intracellulárisan regisztrált spontán bioelektromos aktivitására

a, b, c — jellegzetes sejttypusok (magyarázat a szövegben)

Vastag vonal: iontoforezis időtartama

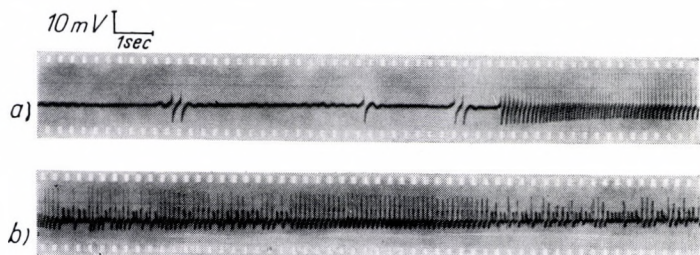


Fig. 2. The effect of 10^{-4} M glutamate, added to the bath, on the bioelectric activity of the giant cells in *Helix*. 10 sec interval between a and b

Thick line — administration of 10^{-4} M glutamate to the bath, without washing

2. ábra. Fürdőfolyadékba adott 10^{-4} M glutamát hatása *Helix* óriássejt bioelektromos aktivitására a és b között 10 sec intervallum

— 10^{-4} M glutamát adása a fürdőfolyadékba, kimosás nincs

1–5 sec following the onset of iontophoresis and disappeared soon after an application time not longer than 15–20 sec. Using this method for glutamate application it is possible to provoke a repeated effect be it stimulatory or inhibitory.

Examining the effect of higher concentrations (10^{-3} — 10^{-4} M) of glutamate administered to the bath solution, on cells that do not respond to iontophoretic application, it was observed that most of such cells responded either with stimulation or by inhibition. Not seldom stimulation was accompanied by an increase in EPSP, whereas inhibition by the appearance of IPSP (inhibitory postsynaptic potential). These phenomena are most obviously indicative of changes in the activity occurring in a synaptic way, another time, however, only the increase in frequency of action potentials i.e. a considerable shift in the membrane potential was observable (*Fig. 2*). Following application of glutamate in such great concentrations either decrease or the complete cessation of the reactivity of cells was also observed.

Relationship between glutamate-effect and ACh sensitivity

The discrimination of D and H cells (TAUC and GERSCHENFELD 1960) in the course of sensitivity studied with ACh was the first step in the classification of the nerve cells of the snail. In the course of the examinations, therefore, the effect of glutamate was examined in this respect.

It was found that every cell which exhibited activity changes following iontophoretic application of glutamate responded with depolarization to the administration of ACh, i.e. they were D cells. The cells that appeared to be insensitive to glutamate iontophoresis were inhibited by the addition of ACh, i.e. they proved to be H cells. As the results show, the response to ACh and the sensitivity to glutamate are both indicative of a parallel distribution. The D-cells responding to glutamate, might be, nevertheless, divided into two groups on the type of reaction produced:

1. those with increased activity following application of glutamate.
2. those with inhibited activity following application of glutamate.

In view of the very damaging effect of high concentrations on cell activity the response of cells that proved to be susceptible only to high doses of glutamate was not examined following application of ACh.

Discussion

According to recent conception (FLOREY 1961) at least 5 criteria must be satisfied for making certain that an agent is functioning as a transmitter or not. One of these is that an effect whether stimulatory or inhibitory is produced by a suitably low concentration of the agent on the excitable structure. As iontophoresis allows of fairly low concentration, it is indisputable that the effect of glutamate on the nerve cell of the snake complies this requirement.

GERSCHENFELD and LASANSKY (1964) performed iontophoresis from a capillary of much greater opening (3 — $10\ \mu$ in diameter), which precludes in a less degree the possibility of passive leakage of glutamate during iontophoresis.

The aspecific effect of glutamate has been concluded by these authors from the different responses obtained for the different concentrations of the compound in the perfusate and from the desensitization occurring following repeated glutamate application. The different effects produced by concentrations of different order are already known in connection with ACh being reputed

a classic mediator, accordingly, on this basis it cannot be decided whether an agent is functioning as a transmitter or not. Similarly, the possibility of desensitization also exists against ACh (ZEIMAL and VULFIUS 1968), thus not even this can be advanced as a decisive argument against glutamate as a transmitter.

It cannot be doubted that the direct contact between cells and the liquid and even more the perfusion itself automatically secure the elimination of low concentrations of glutamate from the cell (as opposed to examinations on the cerebral cortex or the spinal cord of the vertebrates), and this substance is not necessarily decomposed by special enzymes, the presence of which constitutes another important requisite to the role of a compound as a transmitter. KERKUT and EDMONDSON (cit KERKUT et al. 1965) demonstrated the presence of glutamate synthesizing and decomposing enzymes in the tissues of the snail. It is therefore also assumable that the effect is eliminable physiologically.

There is reasonable ground for believing that this effect is specific, because the cells do not respond uniformly to the administration of glutamate, i.e. they respond either with an increase or a decrease of activity, and there are others which remain unaffected. With regard to this the results obtained conform to the data obtained by GERSCHENFELD and LASANSKY, they differ, however, from those, inasmuch as the character of the response is uniform on the same cell following discrete, iontophoretic application of glutamate. The character of the response appeared to be defined by the sensitivity of cells to ACh, inasmuch as glutamate was effectual only on D-cells. This is indicative also of the fact, that the response obtained cannot be interpreted either by the release of ACh or by the inhibition of ACh-receptors for this would result in an effect which is either identical or contradictory to the effect produced by ACh, which, however, was not so in our case. It seems to be more reasonable to consider the influence of glutamate on the ion permeability, because this results in different effects depending on the difference in the properties of the receptors of the membranes in the various cells. Worthy of note is in this respect the result obtained by AMES et al. (1967) demonstrating that on the influence of glutamate permeability changes occur in the membrane of retinal cells of the rabbit and that the inorganic ions (Na^+ , K^+ , Ca^{++} , Cl^-) are being shifted in the direction of their electrochemical gradients. This might explain the depolarizing effect of glutamate, with regard to the inhibition of activity, however, we are of the opinion that it is due to another ion-mechanism.

One of the most critical prerequisite that a compound is considered a transmitter is its presence in the hypothetical place of the effect, i.e. the possibility of the release of the substance by excitation. Glutamate has been demonstrated by KERKUT and COTTRELL (1962) in the lymph of the snail. They also demonstrated the release of glutamate from musculus retractor pharyngis following stimulation (KERKUT et al. 1965). Such examinations have not been performed on ganglia.

Studying the concentration and distribution of glutamate in the spinal cord of the cat GRAHAM et al. (1967) demonstrated that this compound is not of uniform distribution, which might be explained by the role of glutamate as a transmitter. The observation of TAKEUCHI and TAKEUCHI (1964) that glutamate exerts its effect on the outer membrane of the neuromuscular junction in the muscle fibers of the crab, emphasizes similarly the specificity of effect. The present experiences demonstrating the selective effect of discrete glutamate iontophoresis also speak in favour of this specificity. All these seem to

confirm the theory that glutamate might indeed be functioning as a transmitter in certain well defined nervous structures or synapses respectively.

Summary

Following iontophoretic application of l-glutamate on the nerve cells of *Helix* and *Lymnaea* we have established:

1. Following iontophoresis from a micropipette with 1–2 μ opening the activity of a number of cells appears to be susceptible to the effect, while that of other cells was not influenced.

2. Upon discrete glutamate application activity changes could be registered only in D-cells, in the H-cells they were not observable. The majority of D-cells responded with increased activity, their minority with a decrease of activity.

3. The selective effect observable following iontophoretic application speaks in favour of the function of glutamate as a transmitter, this effect, however, should be distinguished from the aspecific effect taking place following application of high doses of glutamate.

Acknowledgements: This work was began at the Dept. Physiology and Biochemistry of the Southampton University. I wish to express my gratitude to Professor K. A. MUNDAY, the Head of the Department and to Professor G. A. KERKUT for the research facilities as well as to R. J. WALKER and their colleges for helping and consulting during my work at that period.

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IONTOFORETIKUSAN APPLIKÁLT L-GLUTAMÁT HATÁSÁNAK VIZSGÁLATA GASTROPODÁK (*HELI*X ÉS *LYMN*AEAE) ÓRIÁS IDEGSEJTJEIN

Összefoglalás

Salánki János

L-glutamát iontoforetikus applikálásával *Helix* és *Lymnaea* idegsejtjein azt találták, hogy

- 1—2 μ -os csúcsátmérőjű mikropipettából történő iontoforezissel a sejtek egy részének aktivitása befolyásolható, másoké nem.
2. Csak a D-sejtek aktivitása változott diszkrét glutamátapplikálásra, a H-sejteké nem. A D-sejtek többsége aktivitásfokozással, kisebb része aktivitáscsökkenéssel reagált.
3. Az iontoforetikus applikálásra fellépő szelektív hatás a glutamát transzmitter szerepét látszik alátámasztani, s ezt el kell különíteni nagy glutamát dózisok specifikus hatásától.

ИССЛЕДОВАНИЕ ДЕЙСТВИЯ ИОНТОФОРЕТИЧЕСКИ ВВЕДЕННОГО ГЛУТАМАТА НА ГИГАНТСКИЕ НЕРВНЫЕ КЛЕТКИ БРЮХОНОГИХ (*HELI*X и *LYMN*AEAE)

Я. Шаланки

На гигантских нервных клетках виноградной улитки и большого прудовика в условиях ионтофоретического введения глутамата было найдено, что:

1. Этот агент при ионтофорезе через капилляр кончиком в 1—2 микрона видоизменяет активность определенных клеток, в то время как активность остальных остается без изменений.
2. При введении глутамата изменялась активность только так называемых D-клеток, а активность H-клеток оставалась без изменений. Часть D-клеток отвечала на глутамат увеличением своей активности, другая, меньшая часть D-клеток — снижением активности.
3. Селективный эффект глутамата, наблюдающийся при ионтофоретическом введении этого агента, говорит в пользу его медиаторной роли. Этот эффект следует отличать от неспецифического действия, имеющего место при применении больших доз глутамата.

EFFECT OF SOME WATER-MISCIBLE ORGANIC SOLVENTS ON THE ACTIVITY OF ACETYLCHOLINESTERASE IN NERVOUS- AND MUSCULAR TISSUES OF *ANODONTA CYGNEA* L. (PELECYPODA)

ISTVÁN VARANKA

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

Received: 4th March, 1968

Several papers deal with the effect of alcohols and other organic solvents on the activity of cholinesterases (ChE). MIKHELSON (1941) found that alcohols inhibit ChE activity; ETTINGER et al. (1941) obtained the same result. HEIM and FAHR (1940) when investigating the effect of ethanol and pentanol (amyl-alcohol) state that at low concentrations they increase the enzyme activity, while they inhibit it at higher-ones, but they treat only this latter case in detail. GENUIT and LABENZ (1941) emphasize the ChE-activatory effect of alcohols. In order to clear the contradictions FELLOWES et al. (1950a, b) as well as TODRICK et al. (1951) carried out extensive investigations with several ChE-s and corroborated both the inhibitory and activatory effect of alcohols for the activation of acetylcholinesterase (AChE), except for the ChE of horse-serum, where they found only an activation, but no inhibition.

In recent years COLHOUN (1961) investigating the activation of AChE in the ganglia of cockroach (*Periplaneta americana*) by the effect of some water-miscible organic solvents stated that besides the alcohols also acetone increases the activity. Similar results were obtained by LEWIS (1967) investigating the ChE activity in the head of the honey-bee (*Apis mellifera*), discussing besides the alcohols and acetone also (among the ethers) the activity-increasing effect of the metoxyethanol. SHATOURY (1963a, b), on the other hand, investigated in detail the AChE activation by butanol on the head and brain of the house-fly (*Musca domestica*).

Though the above mentioned authors investigated the effect of both straight-chain (n-) and branched-chain (i-) alcohols on the enzyme-activity, there are no data available concerning bi- or tri-valent alcohols. Furthermore, the investigations were conducted on vertebrates and insects, so that it may be of interest to study a representant of another group of animals, the fresh water mussels how the cholinesterase activity in the ganglia and in the adductor muscles of these animals is influenced by the above mentioned and other water-miscible organic solvents.

Method

Our experiments were conducted on the homogenate of ganglia and adductor muscles of the fresh water mussel *Anodonta cygnea* L. (Mollusca,

Pelecypoda); the compounds contained 50 mg respectively 20 mg wet weight of tissue for 1 ml. Homogenization was accomplished at 0 °C during 5 min, the homogenate was stored in refrigerator (maximum one week), its AChE-activity did not change during this period.

For the preparation of the homogenate of ganglia 50–150 animals were used while for the same purpose 15–20 of the adductor muscles were needed and for the latters separate homogenates were prepared for the yellow „phasic” and „white tonic” parts (ZHUKOV 1956).

The final volume of the incubation mixture was 5 ml, pH was 8.0 and its composition was the same as published before (SALÁNKI et al. 1967). The incubation took place always at temperatures of 20 ± 0.2 °C this being in the vicinity of the physiological temperature; its duration was 180 minutes with AChE-activity measurements of the ganglia and 60 minutes with the observations of „phasic” and „tonic” parts of adductor muscles.

The incubation mixture was incubated with the organic solvents for 15 minutes before adding the substrate.

Determination of the enzyme activity was made—using a 2 ml part of the incubation mixture — by the method of HESTRIN (1949), with Beckman GU 2400 spectrophotometer at 530 m μ . As a substrate, the solution of ACh-Cl of 5 mM final concentration was used and the degree of enzyme hydrolysis was expressed in μ g-s of hydrolysed substrate during one hour by a homogenate of 1 mg N-content (μ g ACh/mg N/hour).

The N-content of every homogenate was determined as published previously (VARANKA 1968) after KJELDAHL.

The experiments were made in January and February. We used the following p. a. agents:

acetylcholinchloride (AChCl) Fluka, acetone, ether (diethylether), methanol, ethanol, n-propanol, n-butanol, n-pentanol (n-amylalcohol), benzil-alcohol, glycol (ethylen glycol), glycerine.

Results

Fig. 1 shows the effect of some water miscible organic solvents used in our experiments when influencing the acetylcholinesterase activity of homogenates of ganglia. In these experiments the incubation mixture of 5.0 ml final volume contained 0.3 ml of organic solvents. Under such experimental conditions the degree of activation by the alcohols increases with the increase of the C-atomic number from 1 to 3 (121, 182 and 315%), then it decreases after having reached a maximum at the n-propanol. The extent of decrease is such that the C₅-alcohol already inhibits enzyme activity as related to the 45% of the control. The only aromatic alcohol investigated, to benzil alcohol produces a full scale AChE-activity-inhibition at the given concentration (it furnished a saturated solution under the given conditions owing to its weak water-solubility).

Among the non-alcoholic organic solvents ether inhibited the enzyme activity to a small extent (16%), while acetone produced an activatory effect (153%). The bi-valent glycol and tri-valent glycerine-alcohols all produced a weak AChE-activity-increase (150–115%).

Fig. 2 demonstrates the effect of organic solvents on AChE-activity of adductor muscles under the same concentrations as above. We can state that in case of the same organic solvent the difference between AChE-activity of „phasic” and „tonic”-parts of adductor muscles does not surpass 30% (n-propanol). On the contrary there exists a significant deviation as against the

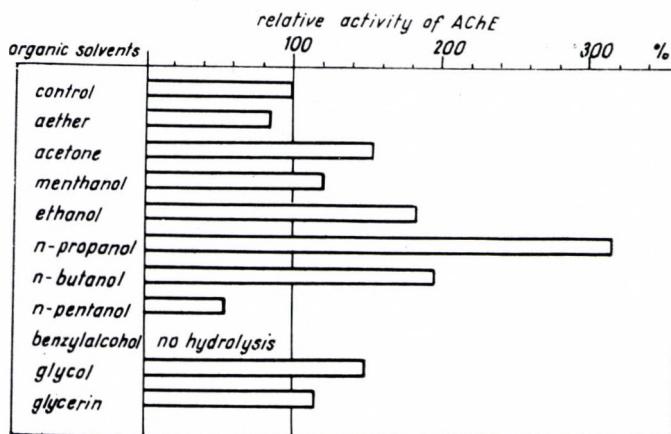


Fig. 1. Effect of organic solvents on AChE activity of homogenates of ganglia (0.3 ml organic solvent given into a 5.0 ml final volume)

1. ábra. Szerves oldószerek hatása a ganglion homogenizátum AChE aktivitására (0,3 ml szerves oldószer adva 5,0 ml végtérfogatba)

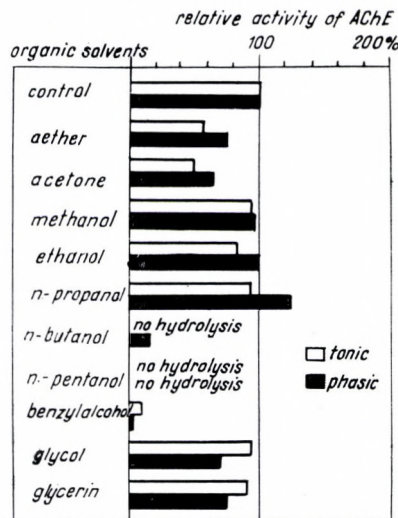


Fig. 2. Effect of organic solvents on AChE activity in the homogenates of „phasic” and „tonic” parts of adductor muscles (solvents as in Fig. 1)

2. ábra. Szerves oldószerek hatása a záróizom fázis és tónusos rész homogenizátumának AChE aktivitására (oldószer mennyiség mint az 1. ábránál)

results obtained with the homogenates of ganglia. An increase of the enzyme activity owing to the influence of organic solvents presents itself only with the effect of *n*-propanol on the homogenate of the phasic part of adductor muscles, while in all other cases the enzyme-activity undergoes—more or less—an inhibition.

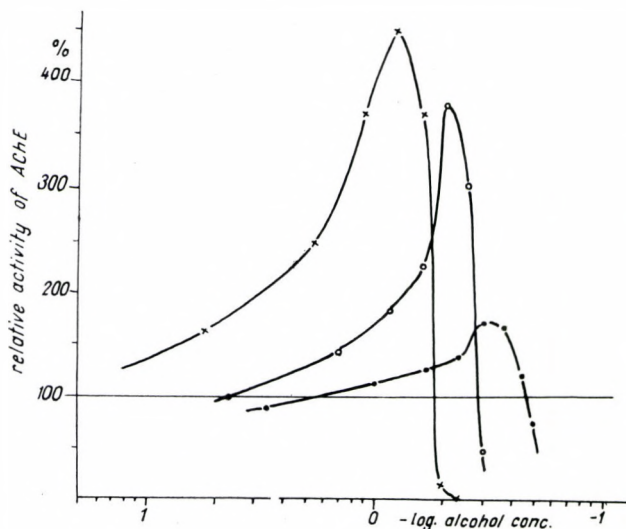


Fig. 3. Relation between AChE activity of the homogenates of ganglia and the concentration of alcohols

--- = metanol, o-o-o = ethanol, x-x-x-x = *n*-propanol

3. ábra. A ganglion homogenizátum AChE aktivitásának függése az alkoholok koncentrációjától

--- = metanol, o-o-o = ethanol, x-x-x-x = *n*-propanol

No connection could be detected between alcohols with increased C-atomic number and their effect on AChE in the case of adductor muscles, i.e. there is no similarity to the ganglion homogenates in this respect. The AChE-activity of the „tonic” part of adductor muscles is inhibited only to a small extent by the C_{1-3} -alcohols (16–18%), while the C_{4-5} alcohols produce a complete inhibition. Benzil-alcohol reduces the enzyme-activity below 10%. The inhibition produced by glycol and glycerine is unimportant (6–9%), while ether and acetone cause an inhibition of 40–50%. The AChE-activity of the „phasic” part of adductor muscles is influenced by methanol and *n*-propanol similar to the „tonic” part. In case of *n*-propanol an increase in the activity by 20–25% can be observed. The degree of inhibition of enzyme activity in case of the „phasic” part of the adductor muscles is less than that obtained in the „tonic” part, if we use ether, acetone, ethanol and *n*-butanol; while in case of glycol and glycerine higher inhibition than before was obtained (21–28%).

With regards to the fact that in experiments under the given conditions, the Mol-concentration of organic solvents had different values, it seemed

necessary to investigate also the relation between the enzyme activity and concentration values of the organic solvent for a more detailed evaluation of the results.

Fig. 3 contains the results of experiments made with several straight-chain alcohols on homogenates of ganglia under conditions explained above. It can be seen that the alcohols increase the enzyme activity in case of low concentration values, then after reaching an activation maximum the curves show a steep fall, while at higher concentrations an inhibition of the enzyme activity follows. The maximum of both activatory and inhibitory effects shifts towards the smaller concentration values with the increase of length of the C-chain, at the same time the degree of maximum activation is increasing, too (Table 1).

Table 1

Connection between maximum activation of AChE and of its inhibition on the one hand and the concentration of alcohols on the other, in case of a homogenate of ganglia

Alcohols	With maximum activation	Inhibitory concentration range
Methanol	2.95 M	4.50 M <
Ethanol	2.05 M	2.80 M <
N-propanol	1.02 M	1.85 M <

Discussion

In previous communications. On the basis of our earlier investigations (SALÁNKI et al. 1966, 1967) on the enzyme hydrolysing ACh in the ganglia and adductor muscles of *Anodonta cygnea* L. it was supposed that most part is a „specific” ChE, i.e. acetylcholinesterase (acetylcholin acetyl-hydrolase, EC, 3.1.1.7, AChE) and this supposition was taken as valid for further work too.

Our experiments show that the AChE-activity of the homogenate of ganglia of *Anodonta cygnea* is increased by straight-chain C_{1-3} alcohols in the range of low concentrations, while it is inhibited by all higher concentrations. These results agree with those obtained by FELLOWES et al. (1950a, b), as well as by TODRICK et al. (1951) on the AChE in brains of rats and in human erythrocyte. These authors also reported that the activation of the enzyme is immediate and it is reversible by dialysis, while the inhibition develops more slowly and it is not reversible by dialysis.

According to our experiments made with homogenates of ganglia we stated that — in agreement with the $n-C_{1-4}$ univalent alcohols — the bi-valent glycol and tri-valent glycerine possess an activatory effect. Ether and aromatic benzilalcohol are on inhibitory character with the concentrations used (0.3 ml solvent in a 5.0 ml final I. volume).

It is surprising that the AChE activity of both parts of adductor muscles is inhibited by the organic solvents with the exception of n-propanol used in the investigations even at such concentrations where they increase the enzyme activity of the ganglion.

For the explanation of activation of AChE activity by organic solvents several conceptions are known. FELLOWES et al. (1950b) supposed that the alcohols decrease the substrate inhibition characteristic for AChE-s which result in an increased enzyme activity. COLHOUN (1961) supposed that during homogenization the enzyme did not get exposed entirely or the active centre remained masked by some inhibitor, so that part of the enzyme was inactive against the substrate. The alcohols further the unmasking of the enzyme after homogenization respectively they dissolve the inhibitor covering the active centers and so the enzyme becomes active. For this conception stands the observation of BULLOCK (1951), who found an increased AChE activity and enzyme solubility after extraction by organic solvents. In his opinion the extraction of lipids is not basically important from the point of view of enzyme function.

The above conception seems to be contradicted by the results of SHATOURI (1963), who isolated three AChE fractions (water-soluble fraction, water-soluble hydrolysate of the water-insoluble residue and the water-insoluble residue of the hydrolyzate (from the brain of house-fly (*Musca domestica*))). According to him n-butanol exerts the same effect on all the three fractions, and so he supposed that the three fractions represent three different forms of the same enzyme.

RUMBSBY and FINEAN (1966a, b, c) investigated the extraction of lipoids by organic solvents and the histological changes of lipoproteine structure. They state that alcohols in high concentrations extract cholesterol nearly completely but only 50–70% of phospholipids and this latter value is different in the case of methanol and etanol. The effect is strongest with the C₃₋₄-alcohols, because — according to their opinion — in these alcohols an optimal equilibrium exists between the hydrophilous and lipophilous characteristics.

Besides the electrophysiological investigations of ARMSTRONG and BINSTOCK (1965), MOORE et al. (1965) data of OKADA (1967) are of interest, who investigated the neuromuscular junction of frogs, and obtained a tendency in the variations of end plate potentials and ACh-potentials as a result of the effect of alcohols (amplitude-increase at a lower alcohol concentration and decrease at a higher concentration), similar to our findings when investigating AChE activity.

The most obvious explanation for the increase of AChE activity as a result of the effect of organic solvents is that of LEWIS (1967), who supposes that the active center of a part of enzyme is masked by a lipoid, thus being inactive. The organic solvents by dissolving the covering lipoid increase the quantity of active enzyme and so they increase — by implication — the enzyme activity. This would produce a satisfactory explanation for the quick development of activity-increase and for its reversibility by dialysis too.

With our experiments AChE activity of the homogenates of ganglia was 225 μg , while for the „tonic” part of adductor muscles we obtained 740 μg , and for the „phasic” part 812 μg ACh/mg N/hour. The two latter values are smaller than previously reported (SALÁNKI et al. 1967) as we used in our present experiments uncentrifuged homogenates. The fact that the low AChE activity of ganglia increases owing to the influence of certain alcohol concentrations, while the same alcohols have no similar effect on the higher AChE-activity of adductor muscles, admits the supposition according to LEWIS (1967) that there is a difference in the storing mode of AChE of the two tissues.

It can be assumed namely, that in the ganglia a part of the enzyme is present under „in vivo” conditions in an inactive form, i.e. in the form of a lipoprotein complex which is inaccessible for the substrate. After the dissolution of the lipid by alcohols this enzyme quantity also takes part in the hydrolysis of the substrate resulting in an increase of activity. Contrary to this, with the adductor muscles the whole quantity of AChE is present in an active state, without being stored with lipoids, so that the effect of organic solvents can not cause an increase of activity, while a denaturation of the enzyme may start, thus decreasing the activity. It should be noted that AChE-activity of adductor muscles is not entirely the result of AChE of neural origin, but for a part of the activity the myosin—cholinesterase may also be responsible which is present in the uncentrifuged homogenates. By any means it is probable that a functional deviation presents itself also in a structural difference.

The explanation of the inhibitory effect of alcohols on AChE-activity is more obvious and generally acceptable than that suggested for the activatory effect. SHATOURI (1963a) explained the inhibition of enzyme activity by butanol with the denaturation of the enzyme, which is a well known effect of alcohols.

Summary

The effect of the straight-chain alcohols of C_{1-5} atomic numbers, of the aromatic bensil-alcohol, of the bi-valent glycol and tri-valent glycerine as well as that of the ether and acetone on the AChE-activity of the homogenates of ganglia and adductor muscles of *Anodonta cygnea* L. was investigated. It could be stated, that:

a) with the concentrations used (0.3 ml solvent in a final volume of 5 ml) all agents — with the exception of ether, bensil-alcohol and pentanol — increase AChE-activity in the homogenates of ganglia.

b) All agents — with the exception of n-propanol — do not influence or inhibit the AChE-activity of the „tonic” and „phasic” part of the adductor muscles.

c) Alcohols with C_{1-3} atomic numbers increase AChE activity of homogenates of ganglia at low concentration and inhibit it at higher concentrations.

d) The maximum of the activation shifts towards the lower concentration values with increasing Mol-weight of the alcohol respectively with its chain length, at the same time the degree of the maximum activation also increases.

e) Author corroborates the conception that in the ganglia part of the active site of the enzyme is masked by a lipid and supposes that in the adductor muscles the whole quantity of the enzyme is in active state, which may have functional consequences.

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NÉHÁNY VIZOLDÉKONY SZERVES OLDÓSZER HATÁSA
ANODONTA CYGNEA L. (PELECYPODA) IDEG- ÉS IZOMSZÖVET
 ACETILKOLINESZTERÁZ AKTIVITÁSÁRA

Összefoglalás

Varanka István

Vizsgálták a C_{1-5} atomszámú, egyenes szénláncú alkoholok, továbbá az aromás benzilalkohol, a kétértékű glikol és háromértékű glicerín, valamint az éter és acetón AChE aktivitását befolyásoló hatását az édesvízi kagyló *Anodonta cygnea* L. ganglion és záróizom homogenizátumán. Megállapították, hogy

a) az alkalmazott koncentrációban (0,3 ml szolvens 5 ml végtérfogatban) ganglion homogenizátumán az éter, benzilalkohol és pentanol kivételével a többi anyag az AChE aktivitást fokozza.

b) A záróizom tónusos és fázisos részének AChE aktivitását a *n*-propanol kivételével a többi anyag nem befolyásolja vagy gátolja.

c) A C_{1-5} atomszámú alkoholok alacsony koncentrációban fokozzák, nagyobb koncentrációban gátolják a ganglionhomogenizátum AChE aktivitását.

d) Az aktiváció maximuma az alkohol M-súlyával, ill. a láncossz növekedésével alacsonyabb koncentrációk felé tolódik el, s egyúttal az aktiváció maximuma is nő.

e) Megerősítik, hogy a ganglionokban az enzim egy részének aktív helyét egy lipoid burok takarja, s feltételezik, hogy a záróizomban az enzim teljes mennyisége aktív állapotban van, aminek funkcionális jelentősége lehet.

ВЛИЯНИЕ НЕКОТОРЫХ ВОДОРАСТВОРИМЫХ ОРГАНИЧЕСКИХ РАСТВОРОВ НА АКТИВНОСТЬ АЦЕТИЛХОЛИНЭСТЕРАЗЫ НЕРВНОЙ И МЫШЕЧНОЙ ТКАНЕЙ БЕЗЗУБКИ

И. Варанка

Изучено влияние спиртов с атомным числом C_{1-5} и прямой углеродной цепью, ароматического бензального спирта, двухвалентного гликоля, трехвалентного глицерина, эфира и ацетона на активность ацетилхолинэстеразы в гомогенате ганглиев и запирающей мышцы беззубки. Получены следующие результаты:

1. За исключением эфира, бензола и пентанола, все изученные вещества повышают активность ацетилхолинэстеразы в гомогенате ганглиев.

2. Активность холинэстеразы тонической и фазной частей запирающей мышцы изменяется только под влиянием *n*-пропанола, остальные изученные вещества неэффективны.

3. Спирты с атомным числом C_{1-3} в низких концентрациях увеличивают, а в высоких снижают активность холинэстеразы гомогената ганглиев.

4. Максимальное увеличение активности при увеличении атомного числа и углеродной цепи спиртов наступает при более низких концентрациях, одновременно увеличивается и степень максимальной активности.

5. Автор приходит к выводу, что активный участок одной части фермента в ганглиях покрыт липоидным слоем, в то время как в запирающей мышце весь фермент находится в активной форме. Обсуждается функциональное значение этого различия.

BIOCHEMICAL INVESTIGATION OF CHOLINESTERASE IN THE CENTRAL NERVOUS SYSTEM OF *LYMNAEA STAGNALIS* L. (GASTROPODA)

ISTVÁN VARANKA

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

Received: 4th March, 1968

In recent years an important role has been attributed among bioactive agents involved in excitatory including transmission in Molluscs — to the acetylcholine (ACh) (HORRIDGE 1961, TAUC and GERSCHENFELD 1961, 1962 KERKUT and THOMAS 1963, PUPPI 1963, GERSCHENFELD et al. 1967).

Also the presence of ACh has been proved in the ganglia of some species of Gastropods (BACQ 1935, CORTEGGIANI 1938, WELSH 1956, KERKUT and COTTRELL 1963), in Pelecypods (WELSH 1956, COTTRELL 1966, FRONTALI et al. 1967) as well as in Cephalopods (BACQ and MAZZA 1935, CORTEGGIANI 1938, ROSENBERG et al. 1966, LOE and FLOREY 1966).

In spite of existing literary data we have little knowledge in the nervous system of Molluscs about biochemical properties of acetylcholinesterase (acetylcholine acetylhydrolase, EC. 3.1.1.7 AChE) decomposing ACh. The properties of this enzyme were studied in the nervous tissue of Gastropods by AUGUSTINSSON (1946a) as well as by DETBARN and ROSENBERG (1962), in Pelecypods by SALÁNKI et al. (1966), while in Cephalopods by NACHMANSOHN and MEYERHOF (1941) furthermore by LOE and FLOREY (1966) and it was identified as AChE. Several authors found AChE in other tissues of Molluscs too (VINCENT and JULLIEN 1938a, b, SMITH and GLICK 1939, AUGUSTINSSON 1951a, b, BÜLBRING et al. 1953, VARGA 1959, NELSON 1963, NISTRATOVA and YUZHANSKAIA 1965, KALAMKAROVA and KRYUKOVA 1966, SALÁNKI et al. 1967), nevertheless detailed biochemical investigations on the properties of the enzyme was made only in a few cases (AUGUSTINSSON 1951a, b, SALÁNKI et al. 1967).

The ACh decomposing enzyme in the central nervous system of *Lymnaea stagnalis* L. (Gastropods) was investigated by ZS.-NAGY and SALÁNKI (1965) using a histochemical method. The enzyme in animals in active state was identified with butyrylcholinesterase (acetylcholine acyl-hydrolase, EC. 3.1.1.8. ChE), while that one in inactive animals kept for two weeks at 4 °C was found to be arylesterase. ROSCA et al. (1966) studied the dependence of activity of AChE enzyme in the mantle of the same species on the thermal adaptation and on the osmotic pressure, but without details about its biochemical properties.

As the biochemical properties of cholinesterase in the central nervous system of *Lymnaea stagnalis* L. (Gastropods) were not yet investigated our

aim was partly to recognize them and partly to identify the enzyme. A further purpose of our investigations was to contribute to the role and importance of the cholinergic mediation in the processes of the central nervous system in this species.

Method

The investigations were conducted on *Lymnaea stagnalis* throughout the year. The animals were kept in areated aquaria with circulating Balaton-water. The water temperature has not fallen under 5 °C in the cooler winter period either. The animals were in active stage.

Preparation of the homogenate

The ganglia excised from the animal were collected in a small quantity of bidistilled water of 0 °C. We used some 25–100 animals on one occasion.

The ganglia were washed three times with bidistilled water, then the superfluous water was dried down by blotting paper. After weighing the tissue was homogenized in a glass Potter for 5 min under continuous cooling. The volume of the homogenate was diluted by bidistilled water to a concentration of 2.5 mg wet weight of tissue (1 ml), in a few cases the wet weight content was 5.0 mg/ml. The homogenate was stored for 10 days at best in a refrigerator at 0 °C. During this period the ChE activity of the homogenate did not change.

The preparation of the homogenate deviated from that described above only when the pH dependence was investigated, here 1 ml of the homogenate contained 5.0 mg of wet tissue. The coarser tissue elements were removed by centrifuging at 1500 g, for 15 min, and for the measuring of enzyme activity the supernatant was used. After centrifuging the enzyme activity was about 15–20% higher than that of the uncentrifuged homogenate.

Measurement of the enzyme activity

The enzyme activity of the homogenate was determined with HESTRIN's (1949) method based on the quantitative reaction of cholinesters in a medium alkalized with hydroxyl-amine. Measurement of the complex light-absorption of the ferroautohydroxamate was accomplished by a BECKMAN GU 2400 spectrophotometer at 530 m μ . The calibration curve was made using acetylcholine perchlorate (ACh-OC Cl_4) and corresponding substrates.

The incubation mixture (5 ml) contained:

- 2 ml bidistilled water
- 1 ml 0.2 M tris-maleate buffer (usually at pH 7.0)
- 1 ml homogenate and
- 1 ml 25 mM-substrate

Spontaneous hydrolysis of the substrates with a sample free from the homogenated was measured parallel with the enzyme hydrolysis. The final concentration of the substrate was throughout 5.0 mM.

The HESTRIN-reaction was accomplished using 2 ml of the incubation mixture immediately after having added the substrate to the other constituents; the process was repeated again after incubation. Simultaneously the

same enzyme hydrolysis was carried out in 3 test tubes and parallelly spontaneous hydrolysis in 2 test-tubes. When calculating the value of enzyme hydrolyses we made the correction to the autohydrolysis of the substrate. Experiments were repeated 5–10 times and our data are average values of these measurements.

The incubations lasted 60 min at temperatures $20 \pm 0.2^\circ\text{C}$ in a water-bath.

Determination of pH-dependence of the enzyme activity was made in the same manner except for the pH-value of the buffer.

When investigating the dependence of the enzyme activity on the substrate concentration for higher substrate concentrations we applied diluted incubation mixtures instead of 2 ml incubation mixture we used 0.1–1.5 ml complemented to 2 ml with bidistilled water as the light absorption of the compound is no more linear in case of a higher ester-concentration. The grade of dilution was taken into account with the calculation of the amount of hydrolysis.

For the inhibition of enzyme activity an adequately concentrated solution of inhibitor was added instead of 1 ml of bidistilled water.

Nitrogen content of the homogenate determination

The nitrogen content of every newly prepared homogenate was determined. The destruction was carried out according to KJELDAHL in the presence of a catalisator (from the mixture of 5.0 g Se + 200 g K_2SO_4), then the ammonia was distilled over into an excess of boric acid (H_3BO_3) with a PARNAS—WAGNER apparatus according to the modification of WINKLER. Titration took place with 0.01 n HCl solution in the presence of a GROACK-indicator.

When investigating the pH-dependence we used instead of the homogenate its supernatant to measure the enzyme activity, as well as its N-content of the supernatant was determined.

The values of the enzyme hydrolysis are expressed in μg substrate/mg nitrogen/hour ($\mu\text{g}/\text{mg N/h}$).

Substrates and inhibitors used in the experiments were as follows:

Acetylcholinechloride, (ACh—Cl) FLUKA
 Acetylcholinebromide (ACh—Br) DE LAIRE
 Acetylthiocholineiodide (AThCh—J) FLUKA
 Acetyl- β -methylcholinebromide (MeCh—Br) SCHUCHARDT
 Propionylcholinechloride (PrCh—Cl) EGA
 Butyrylcholinechloride (BuCh—Cl) EGA
 Butyrylcholineiodide (BuCh—J) FLUKA
 Butyrylchyocholelineiodide (BuThCh—J) LOBA
 Benzoylcholinechloride (BeCh—Cl) LEIGHT
 Succinyl(mono)cholinechloride (SuCh—Cl) B. D. H.
 Succinyl(di)cholinechloride ($\text{Su}[\text{Ch—Cl}]_2$) LEIGHT
 Physostigminesulphate, B. D. H.
 Neostigmine bromide, MERCK
 Diisopropyl fluorophosphate (DFP)
 Tetraethylpyrophosphate (TEPP) FLUKA

Results

Determination of the enzyme activity of the homogenate material

To ensure the linearity of the enzyme-hydrolysis — we used a homogenate of 2.5 mg wet weight per 1 ml (respectively in one case the centrifuged supernatant of 5.0 mg) 1 ml homogenate with 5 mM substrate concentration. In these cases the hydrolyzed substrate was on the average $33\,062\ \mu\text{g ACh/mg N/h}$ ($226, 1\ \mu\text{M ACh/mg N/h}$), with extremes of $30\,000$ and $36\,000\ \mu\text{g ACh/mgN/h}$

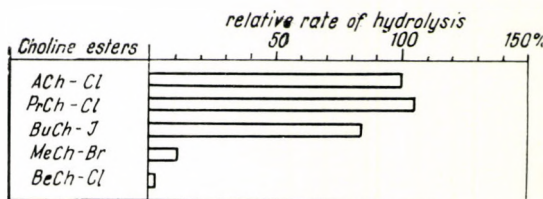


Fig. 1. Substrate pattern of the enzyme expressed in percent of equivalent quantities (pH 7.0, 5 mM substrate concentration, incubation time 60 min at 20°C)

1. ábra. Az enzim szubsztrát-mintája, ekvivalens mennyiségek %-ában kifejezve (pH 7.0; 5 mM szubsztrát koncentráció, 20°C -on 60 perces inkubáció)

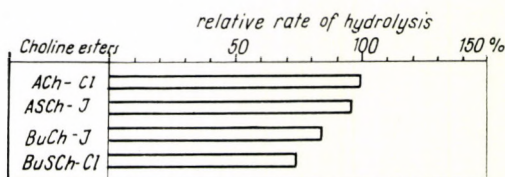


Fig. 2. Enzyme hydrolysis of O- and S-cholinesters, expressed in percents of their equivalent quantities (pH 7.0, 5 mM substrate concentration, incubation time 60 min at 20°C)

2. ábra. O- és S-kolin észterek enzimés hidrolízise, ekvivalens mennyiségek %-ában kifejezve (pH 7.0; 5 mM szubsztrát koncentráció, 20°C -on 60 perces inkubáció)

Substrate specificity of the enzyme

The substrates hydrolyzed by the homogenate of 1 mg N-content per hour was related to their equivalent quantities, i.e. μM -s. The mean values of experimental series — related to the hydrolysis of ACh-Cl — are shown in Fig. 1. We found that among the substrates playing the most important role with substrate specificity of cholinesterases the homogenates decompose the PrCh roughly in the same degree or even more (105%) than ACh. BuCh splitting is lower (84%), while hydrolysis of MeCh is much less, only 10% of that of ACh. The hydrolysis of BeCh on the other hand is negligible (2%).

The relation between the hydrolysis of cholinesters and their thyo-derivates is remarkable (*Fig. 2*). The hydrolysis of ACh and BuCh is higher than that of the corresponding thyo-derivates: the deviation is not high (4–10%) but fairly regular.

We further investigated the hydrolysis of SuCh and Su(Ch)₂, but the cholinesterase present in the homogenates did not decompose these esters.

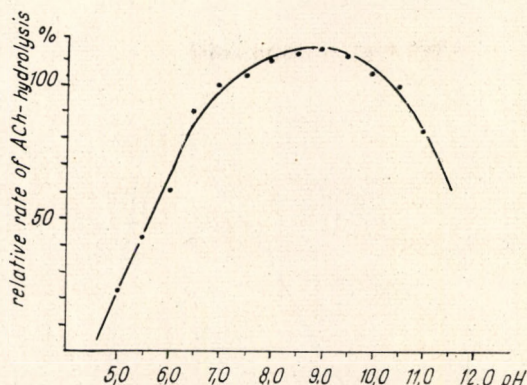


Fig. 3. pH-dependence of enzyme activity
(5 mM ACh—Cl substrate, incubation time 60 min at 20 °C)

3. ábra. Az enzim-aktivitás pH-függése
(5.0 mM ACh—Cl szubsztrát, 20 °C-on 60 perces inkubáció)

The pH-dependence of enzyme activity

The pH of the incubation mixture was adjusted to different values between 5.0 and 11.0 with an accuracy of 0.05 by a tris-maleate buffer. The final concentration of the buffer was 40 mM. In the experiment, where the pH was supposed to be 11, this value did not fall under 10.75. In these experiments we used the supernatant of 5 mg wet tissue (1 ml homogenate) see in Methods. The hydrolysis values related to the percentages of ACh hydrolysis carried out at pH 7.0 are shown in *Fig. 3*.

Between pH 5.0 and 7.0 the enzyme activity shows a steep increase with increasing pH but the curve flattens out when approaching higher pH-values. Around the pH-value of 9.0 the maximum enzyme activity surpasses by 14% its value measured at pH 7.0. A further increase in pH is accompanied by a decrease of enzyme activity. At pH 11.0 the enzyme activity is 82% of that found at pH 7.0. At the same time the spontaneous hydrolysis of ester increases rapidly in the higher pH ranges.

Substrate concentration dependence of enzyme activity

Fig. 4 contains values (showed as function of pS) related to hydrolysis values obtained with a substrate concentration of 5 mM. The enzyme activity was measured between 5×10^{-4} — 2×10^{-2} M ACh—Cl substrate concentrations.

The enzyme activity increases with increasing substrate concentrations, reaching a maximum at 15 mM and decreasing afterwards. The shape of the

curve below the optimum value, corresponding to a lower substrate concentration is S-shaped.

Dependence of enzyme activity on the substrate concentration when studied in the presence of BuCh-Cl substrate shows a similar picture to the former (*Fig. 4*). There is a substrate inhibition here too, but the optimal substrate concentration for the enzyme is to be found here at a higher level

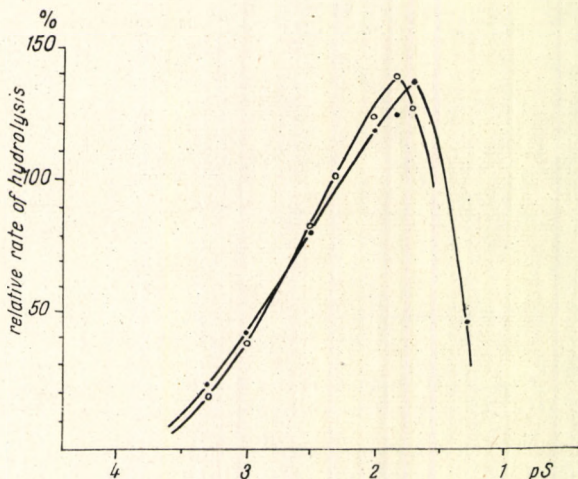


Fig. 4. Substrate concentration dependence of enzyme activity, in cases of ACh and BuCh substrates
(pH 7.0; incubation time 60 min at 20 °C)
o-o-o = ACh-Cl, - - - - = BuCh-Cl

4. ábra. Az enzimaktivitás szubsztrát-koncentráció-függése, ACh- és BuCh szubsztrát alkalmazása esetén
(pH 7.0; 20 C°-on, 60 perc inkubáció)
o-o-o: ACh-Cl, - - - -: BuCh-Cl

(20 mM BuCh). Thus curve below the optimum is somewhat flatter than in case of ACh substrate and the whole curve is not symmetrically „bell-shaped”.

Inhibition of enzyme activity

For the inhibition of cholinesterase activity of ganglia homogenates we used as tertiary and quaternary amino-derivatives physostigmine and neostigmine and as phosphor derivatives DFP and TEPP. Before adding the substrate the enzyme was incubated by the inhibitor for 15 min.

The inhibitory effect of physostigmine was investigated with ACh and BuCh substrates of 10^{-4} – 10^{-9} M (*Fig. 5*). The value of pI_{50} was found 7.0 for ACh substrate and 7.2 for PrCh. With higher concentrations of the inhibitor we get a nearly constant inhibition independently of the substrate used. It is also of interest that low concentrations of the inhibitor inhibit the hydrolysis of the substrate in different manner: for the enzyme hydrolysis

of PrCh a lower physostigmine-concentration is more effective than for the hydrolysis of ACh.

Neostigmine was used in a concentration range of 10^{-8} – 10^{-4} M for both substrates (*Fig. 6*). It is well marked that the inhibition curves are less-steep than they were with physostigmine, i.e. that neostigmine is a significantly less effective inhibitor for this enzyme. For the value pI_{50} we obtained

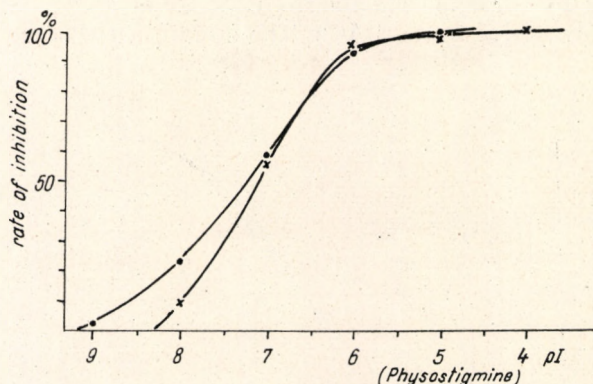


Fig. 5. Inhibition of enzyme-activity by physostigmine, in case of ACh and PrCh substrates
x-x-x- = ACh-Cl, --- = PrCh-Cl
(5.0 mM substrate concentration; pH 7.0; incubation time 60 min at 20 °C)

5. ábra. Az enzimaktivitás gátlása fizosztigminnal, ACh és PrCh szubsztrát alkalmazása esetén
x-x-x-: ACh-Cl, ---: PrCh-Cl
(5.0 mM szubsztrát koncentráció; pH 7.0; 20 C°-on 60 perc inkubáció)

5.66 for both substrates. In the case of this inhibitor too, a lower concentration inhibits more the hydrolysis of PrCh than that of ACh.

The effect of DFP was studied on ACh-Br substrate (*Fig. 7*). It inhibits strongly the ChE activity of the homogenized compound, its pI_{50} value is 8.1. The curve is characteristically steep, it covers two concentration ranges. Thus, DFP proved to be the most effective inhibitor.

The inhibitory effect of TEPP was investigated in the concentration range of 10^{-10} – 10^{-6} M on ACh-Cl substrate (*Fig. 7*); the inhibitory effect

Table 1. — 1. Táblázat

I_{50} value of different inhibitors
A különböző gátlószerek I_{50} értékei

substrates	I_{50}			
	physostigmine	neostigmine	DFP	TEPP
ACh-Cl	$7.49 \cdot 10^{-8}$	$2.19 \cdot 10^{-9}$	$7.94 \cdot 10^{-9}$	$1.58 \cdot 10^{-8}$
PrCh-Cl	$6.31 \cdot 10^{-8}$	$2.19 \cdot 10^{-6}$	no tested	no tested

here was weaker than that of DFP. The value of pI_{50} was 7.8 but the S-shape of the inhibition curve is much more protracted and flatter than that of DFP (it covers three concentration ranges).

Discussion

According to our experiments the enzyme in the ganglia of *Lymnaea stagnalis* is highly active against ACh. The activity of a homogenate contain-

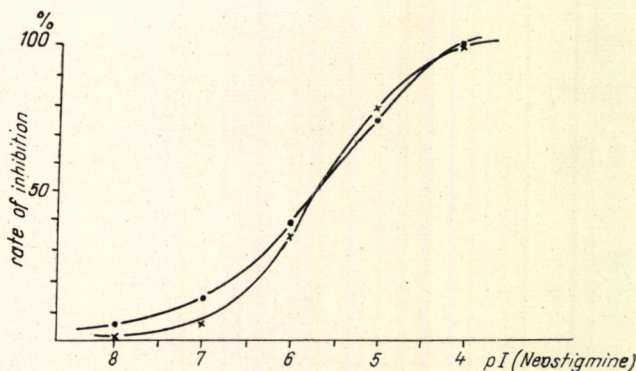


Fig. 6. Inhibition of enzyme activity by neostigmine, in cases of ACh and PrCh substrates
 x-x-x- = ACh-Cl; -.-.- = PrCh-Cl
 (5.0 mM substrate concentration, pH 7.0; incubation time 60 min at 20 °C)

6. ábra. Az enzimaktivitás gátlása neosztigminnel, ACh és PrCh szubsztrát alkalmazása esetén

x-x-x: ACh-Cl -.-.-: PrCh-Cl
 (5.0 mM szubsztrát koncentráció, pH 7.0; 20 °C-on 60 perc inkubáció)

ing 1 ml tissue of 2.5 mg wet weight in a substrate concentration of 5 mM, measured at pH 7.0, at 20 °C, incubated for 60 min, related to 1 mg N-content and 1 hour was 33.0 mg (226 μ M).

No seasonal variations were found in the enzyme activity during the experiments.

It is of interest to record here the data of PAVLIC (1967) who investigated an acetylcholinesterase compound of the electric organ of *Torpedo* and found a higher than 50% inhibition of the enzyme activity by 50 mM Tris in the presence of Mg^{2+} and Ca^{2+} , while in their absence the enzyme activity increased. In our experiments the final concentration of Tris was 40 mM. We have not made experiments to state, whether or not this concentration influences in any direction the cholinesterase activity.

Other authors, e.g. MYERS (1952) pointed out the influence of inorganic salts on the enzymatic hydrolysis of ACh. In our experiments we used homogenate with bidistilled water containing 2.5 mg wet tissue for 1 ml. Under these conditions the inorganic salts will be strongly diluted and they can not modify the enzyme activity.

Investigating the substrate specificity we found that the cholinesterase of the ganglia homogenate of *Lymnaea stagnalis* decomposes PrCh in a similar or only slightly higher extent than ACh. The amount of BuCh hydrolysis on the other hand is somewhat lower (84%). The enzyme hydrolysis of MeCh and BeCh is remarkable as the decomposition of MeCh is weak (10% of ACh hydrolysis), the decomposition of BeCh being insignificant (2.0%). Most

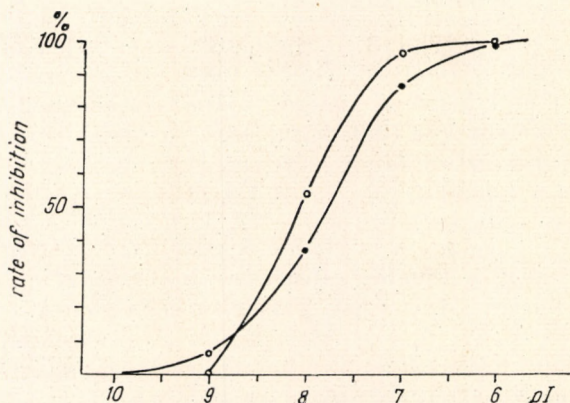


Fig. 7. Inhibition of enzyme activity by DFP and TEPP

o-o-o- Inhibition by DFP (5.0 mM ACh—Br substrate, pH 7.0; incubation time 60 min at 20 °C)

- - - - = Inhibition by TEPP (5.0 mM ACh—Cl substrate, pH 7.0; incubation time 60 min at 20 °C)

7. ábra. Az enzimaktivitás gátlása DFP-vel és TEPP-el

o-o-o: DFP gátló hatása

(5.0 mM ACh—Br szubsztrát, pH 7.0; 20 °C-on 60 perc inkubáció)

- - - : TEPP gátló hatása

(5.0 mM ACh—Cl szubsztrát, pH 7.0-en, 20 °C-on 60 perc inkubáció)

authors agree that the specific substrates alone are not suitable to differentiate in homogenates between cholinesterases and acetylcholinesterases (ORD and THOMPSON 1950, MENDEL and MYERS 1955, AUGUSTINSSON 1946b, 1948, 1959). Nevertheless it is a fact that the cholinesterase of the ganglia homogenate of *Lymnaea stagnalis* is similar to the acetylcholinesterase of *Helix* blood as regards its low MeCh hydrolysing activity (AUGUSTINSSON 1946a, 1951a, b).

At a substrate concentration of 5 mM and at pH 7.0 the enzyme activity with the ACh- and BuCh-esters is higher than with their O-analogous. The opposite of this was observed by KOELLE (1950) for some other cholinesterases.

The enzyme of the homogenate does not hydrolyze succinyl mono- and di-choline. Other authors described the hydrolysis of these substrates by blood serum ChE (GLICK 1941, WHITTAKER 1951, WHITTAKER and WIJESUNDERA 1952), but no data are reported concerning their hydrolysis by acetylcholinesterases.

Summarizing the data obtained with different substrates we can state that the characteristics of the cholinesterase of the ganglia homogenate of *Lymnaea stagnalis* deviate from the properties of cholinesterases (EC 3.1.1.8)

(the hydrolysis of BuCh being smaller than that of ACh, the hydrolysis of BeCh being insignificant) and they approach those of acetylcholinesterases (EC 3.1.1.7). Nevertheless it should be noted that for a typical AChE the high BuCh and low MeCh hydrolysis is not characteristic, though with this latter the AChE of *Helix* blood shows similar properties.

We found the pH optimum of cholinesterase activity of ganglia in the presence of ACh substrate to be around pH 9.0. Several authors have determined the pH-optimum of ACh hydrolysis produced by AChE (BERGMANN et al. 1956, 1958, ALLES and HAWES 1940 etc.) and according to most of them its exact value is pH 8.25. The pH optimum of serum ChE is somewhat higher (BERNHEIM and BERNHEIM 1936, GLICK 1937). In general no considerable differences were found between the pH optima of purified and crude prepartes. However we suppose that in our case the high pH optimum could be attributed to the crude state of the enzyme. It is less probable that we have to deal here with a specific property of the enzyme. A definite explanation of the problem can only be given after the purification of the enzyme.

Studying the dependence of cholinesterase activity from the concentration of ACh and BuCh at a higher substrate concentration an inhibition of the enzyme activity was found. The pS_{opt} is lower (1.81) for ACh than for BuCh concentration (1.70).

It is well known that the pS optimum of AChE is generally at about 3×10^{-3} M ACh concentration. According to our data the concentration optimum of the cholinesterase substrate is in the ganglia of *Lymnaea stagnalis* higher than this value. However we have to take into account that we used a homogenate which may have modified the real substrate concentration optimum (BERGMAN and SEGAL 1955). On the other hand we have to accept the fact of the existing inhibition. It is known from literary data that the inhibition of activity of AChE at higher substrate concentrations is due to the formation of an inactive enzyme substrate (ALLES and HAWES 1940, MENDEL and RUDNEY 1943, NACHMANSOHN and ROTHENBERG 1945, AUGUSTINSSON 1946, 1949) and that the substrate activity curve of the enzyme has a „bell-shape”. In our investigations the substrate activity curve is not of a symmetrical „bell-shape”, since below the optimum it is less steep than above it.

Substrate inhibition is not suitable — like the substrate specificity — to differentiate between acetylcholinesterase and cholinesterase (HAWKINS and MENDEL 1946), so we can not draw yet any final conclusion from the above results. Investigations of LOE and FLOREY are of interest (1966) who found instead of a decrease only a stagnation of the enzyme activity after increasing the substrate-concentration above the optimum in *Octopus dofleini*.

Among the tertiary and quaternary amino-derivatives used with the inhibition of enzyme activity the cholinesterase activity was inhibited to a higher degree by physostigmine than by neostigmine both with ACh and PrCh substrates (Table 1). Physostigmine inhibits the hydrolysis of ACh somewhat more than that of PrCh. The I_{50} values obtained with neostigmine are the same for both substrates.

It is generally accepted that all cholinesterases are sensitive against a low (below 10^{-5} M) physostigmine concentration but they should not be considered as selective inhibitors differentiate AChE from ChE (AUGUSTINSSON 1948, AUGUSTINSSON and NACHMANSOHN 1949, BAIN 1949). On the other hand all cholinesterases are inhibited by a 10^{-5} M concentration of physostigmine

while this is true only for a few of other esterases. According to our data the cholinesterase activity of the ganglia of *Lymnaea stagnalis* is completely inhibited by 10^{-5} M physostigmine and even at a concentration of 10^{-6} M the decomposition is very small.

Literary data show (BODANSKY 1946, MAZUR and BODANSKY 1946, MENDEL and HAWKINS 1947, BAIN 1949, ALDRIDGE 1953) that the acetylcholinesterases are less sensitive to organic phosphoric derivatives than other cholinesterases. Thus a rather good separation can be obtained by applying them, though the inhibition shows strong derivations in different species and organs. With our investigations DFP is a stronger inhibitor for the enzyme activity than TEPP, but both are more effective than the quaternary amino-derivatives investigated.

A comparison of all the partial results suggests that the biochemical properties of cholinesterase found in the ganglia of *Lymnaea stagnalis* in their entirety comply with the requirements set by the characteristics of the „specific” or „acetylcholinesterases” (EC 3.1.1.7).

There is no contradiction between the above hypothesis and the statement of Zs.-NAGY and SALÁNKI (1965) who demonstrated by histochemical methods that arylesterase is present in the central nervous system of inactive animals, since we used in our experiments ganglia of animals in active state. On the other hand there is a contradiction in the identification of the enzyme of active animals with butyrylcholinesterase, observed by the above authors and with acetylcholinesterase, shown by us in the present paper. This contradiction is to be attributed to the difference of methods used in the experiments.

The present investigations show that in the central nervous system of *Lymnaea stagnalis* L. (Gastropod) the acetylcholinesterase needed for the physiological hydrolysis of acetylcholin, is present. Thus we concluded that one of the criteria of cholinergic mediation is given, and the high enzyme activity emphasizes the importance of cholinergic mediation.

Summary

Cholinesterase activity in the homogenates of the central nervous system of *Lymnaea stagnalis* L. (Gastropod) and some biochemical properties of the enzyme were studied. It could be stated that:

1. The enzyme is active against cholinesters. The value of ACh hydrolysis by the homogenate is 33.0 mgACh/mg N/h.

2. The substrate pattern of the enzyme is: ACh 100%, BuCh 84%, PrCh 105%, MeCh 10% and BeCh 2%. Succinyl mono- and di-choline are not hydrolysed.

3. S-esters of ACh and BuCh are splitted to a lesser extent than their O-analogons.

4. pH optimum of enzyme activity with the use of ACh substrate is around: pH 9.0.

5. In cases of ACh and BuCh substrates the enzyme activity is inhibited with the increase of substrate concentration. pS_{opt} of ACh is 1.81, that of BuCh is 1.70.

6. pI_{50} values of the inhibition of enzyme activity are: for physostigmine with ACh substrate: 7.10, with PrCh substrate: 7.20; for neostigmine with ACh

and PrCh substrates: 5.66; for DFP and TEPP with ACh substrates: 8.10 and 7.80 resp.

7. The enzyme is identified with acetylcholinesterase (acetylcholine acetyl-hydrolase, EC 3.1.1.7).

8. Biochemical evidences are suggested for the cholinergic mediation in the central nervous system in *Lymnaea stagnalis*.

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LYMNAEA STAGNALIS L. (GASTROPODA)
KÖZPONTI IDEGRENSZERÉBEN LEVŐ KOLINESZTERÁZ
BIOKÉMIAI VIZSGÁLATA

Összefoglalás

Varanka István

Szerző a *Lymnaea stagnalis* (Gastropoda) központi idegrendszerének homogenizátumában tanulmányozta a kolineszteráz aktivitást és az enzim néhány biokémiai tulajdonságát. Megállapította, hogy

1. az enzim igen aktív a kolinészterek irányában. A homogenizátum általi ACh hidrolízisének mértéke 33,0 mgACh/mg N/óra.

2. Az enzim szubtrát-mintája: 100% ACh, 84% BuCh, 105% PrCh, 10% MeCh és 2% BeCh. A succinil mono- és dikolint az enzim nem hidrolizálja.

3. Az ACh és BuCh S-észtereit az enzim kisebb mértékben bontja, mint azok O-analógjait.

4. Az enzim-aktivitás pH optimuma ACh szubsztrát alkalmazásakor pH 9,0 körül van.

5. ACh és BuCh szubsztrátok esetében a szubsztrát-koncentráció növelésével az enzimaktivitás gátlást szenved. Az ACh pS_{opt} -a 1,81, a BuCh pS_{opt} -a 1,70.

6. Az enzimaktivitás gátlásának pI_{50} értékei a következők: fizosztigmin ACh szubsztrátnál 7,10, PrCh szubsztrátnál 7,20, neosztigmin ACh és PrCh szubsztrátnál 5,66, DFP és TEPP ACh szubsztrátnál 8,10 és 7,80.

7. Az enzimet acetilkolineszterázzal azonosítják (acetylcholine acetyl-hydrolase, EC 3.1.1.7).

8. Biokémiai bizonyítékot szolgáltatott a központi idegrendszerben a kolinerg mediációhoz *Lymnaea stagnalis*on.

БИОХИМИЧЕСКОЕ ИССЛЕДОВАНИЕ ХОЛИНЭСТЕРАЗЫ ЦЕНТРАЛЬНОЙ НЕРВНОЙ СИСТЕМЫ БОЛЬШОГО ПРУДОВИКА

И. Варанка

Активность и некоторые биохимические свойства холинэстеразы центральной нервной системы большого прудовика изучали в гомогенате. Результаты исследования показывают, что:

1. Фермент очень активен в отношении эфиров холина. Для ацетилхолина (АХ) скорость гидролиза в гомогенате составляет 33,0 мг/мг азота/час.
2. Для других субстратов скорость гидролиза составляет, считая скорость для АХ за 100: бутирилхолин 84, пропионилхолин 105, ацетил- β -метилхолин 10, бензоилхолин 2. Сукцинилмоно- и дихолин не расщепляются ферментом.
3. Ацетил- и бутирилтиохолин гидролизуются хуже, чем соответственно АХ и бутирилхолин.
4. Оптимальная рН при использовании в качестве субстрата АХ составляет около 9,0.
5. Увеличение концентрации субстрата (АХ и бутирилхолин) приводит к торможению активности фермента.
6. Отношение фермента к ингибиторам было следующим (указывается отрицательный логарифм молярной концентрации, вызывающей торможение на 50%): физостигмин 7,10 (субстрат АХ); неостигмин 5,66 (субстраты АХ и пропионилхолин);ДФФ и ТЭПФ, соответственно, 8,10 и 7,80 (субстрат АХ).
7. Найденный фермент идентифицируют как ацетилхолинэстеразу.
8. Приводятся биохимические данные в пользу наличия холинергической медиации в центральной нервной системе прудовика.

THE NEMATODES OF LAKE BALATON. II. THE NEMATODES OF THE OPEN WATER MUD IN THE KESZTHELY BAY

KÁLMÁN BIRÓ

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

Received: 1 March, 1968

The first data concerning the Nematoda-fauna of Lake Balaton were first published at the end of the last century, in the comprehensive work titled „Resultate der Wissenschaftlichen Erforschung des Balatonsees (DADAY 1897). This was the first and for a long time afterwards the sole work which gave a systematic and summary report on the nematodes of the lake, and it was only at the beginning of the thirties that however MESCHKAT (1934) in his extensive study on the Phragmitetum of Lake Balaton, established the important role of nematodes in the structure of the coatings of the reed.

BÉLA ENTZ (1954) found, by sifting through 0.1 mm mesh sieves sediment samples material for mudliving animals collected by an EKMAN—BIRGE dredge, that Nematodes occurred in 41 individual percentage numbers of the animals found in the samples (about 2 per cent in weight). The inference was that these animals play a significant role in the mud of the open waters (eprofundal).

Table 1

Some data of the collecting conditions

Date	Water temperature in C°	Depth of water	Remarks
1966 V. 17.	19	270	strong waves
VI. 14.	23	296	
VII. 26.	19.5	297	
VIII. 23.	22	287	
IX. 21.	17	274	strong waves
X. 18.	16	280	
XI. 15.	4	241	
1967 IV. 11.	12	282	medium waves
V. 16.	19	268	
VI. 20.	20	271	
VII. 17.	20	268	
VIII. 15.	20	244	
IX. 19.	16.5	255	
X. 17.	16	266	

The changes in the life of our lake made it necessary to attempt a new assessment of the mud fauna. The aim of our investigations was a survey of the qualitative and quantitative conditions of the nematodes in the sediment of the Keszthely Bay, with, as far as possible, observations on their spatial and temporal distributions.

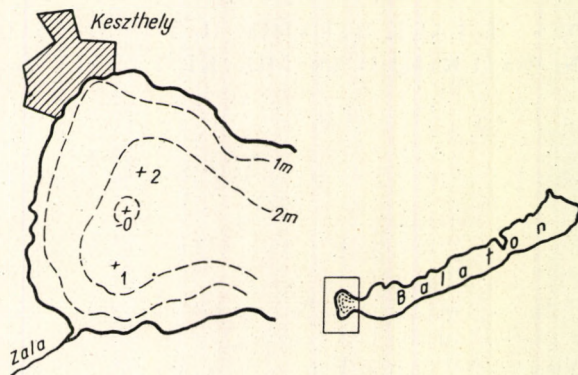


Fig. 1. Sampling points in the Keszthely Bay (1, 0, 2)

1. ábra. Gyűjtőhelyek a Keszthelyi-öbölben
1, 0, 2 a mintavétel helye

Collecting and methods

Material was collected monthly, from May till November, 1966, and from April till October, 1967, in three points of the Keszthely Bay, from the bottom mud of the open water at nearly 3 m depths (Fig. 1). Three samples were taken at one point each, and the samples combined and treated as a single one. Thus one sample derived from about 40 cm². Table I shows some date of the conditions of collecting. The samples were taken from the upper 1–2 cm layer of the mud by a modified Craib apparatus, suitable for both qualitative and quantitative studies (PONYI, BIRÓ and P.-ZÁNKAI 1967). The mud sample was filled up to 400 ml and, after a thorough shaking, 120 ml placed in a No. 25 plankton net; then the mud and other ingredients of a colloidal order of magnitude eliminated by filtered tap-water, added continuously and in a fine stream to the sample. The clear and transparent sample was poured into a Petri dish, and the living nematodes selected from among the detritus particles under a $\times 10$ magnification.

Results and discussion

1. *Nematodes new for the fauna of the lake*

DADAY* reported 28 nematodes from the lake, while MESCHKAT only 1, thus a total of 29 species became known from the Balaton. Of the species

* DADAY (1897) listed 36 nematode species from the entire lake. Since 1897, several species have been synonymized; some described ones are not generally accepted (spec. inqu.) (ANDRÁSSY, 1958, A. MEYL, 1960, Soós, 1940).

listed by these authors we have found 8, and 9 further ones new for the lake (Table 2).

Paraphanolaimus behningi is known from merely some few localities in Europe. Though already shown from Hungary, the hitherto unknown male sex was now also found (Fig. 2). The spicules of the 26 collected male specimens are long, curved, the gubernaculum short, the number of the well developed, tubiform, praeanal organs is 11–16, but mostly 13. The tail of the male specimens is similar in length and shape to that of the females.

♂ L = 0.9–1.2 mm, a = 29–35, b = 4.0–4.5, c = 5.4–8.1

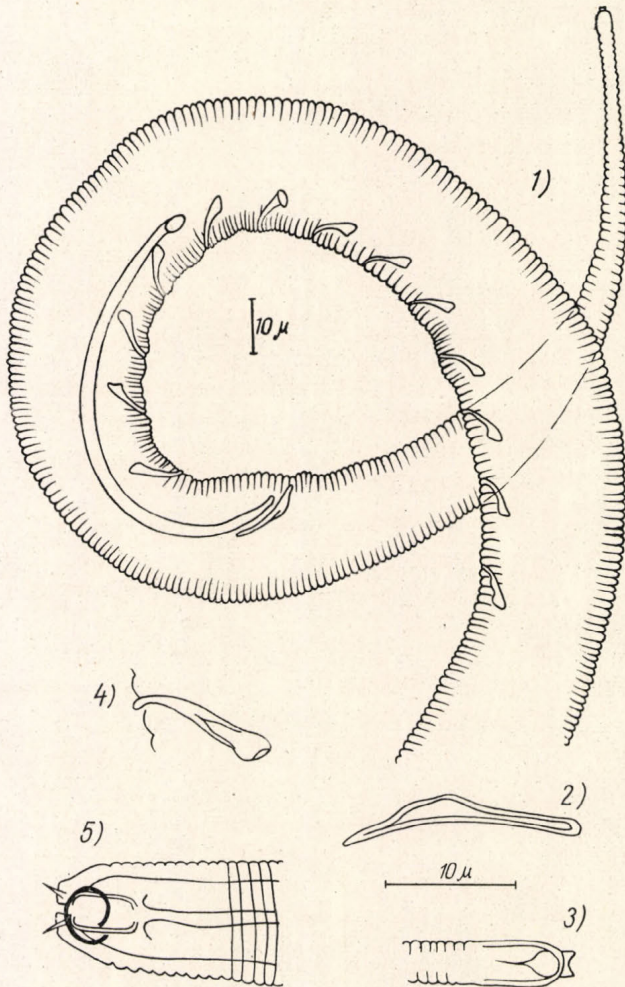


Fig. 2. *Paraphanolaimus behningi*, male

1. Caudal section, 2. Gubernaculum, 3. Caudal end with anal tube, 4. Praeanal papilla, 5. Cephalic extremity

2. ábra. Hím *Paraphanolaimus behningi*

1. Az állat caudalis része; 2. Gubernaculum; 3. Farokvég a kivezetőcsővel; 4. Praeanal papilla; 5. Állat fejrége

Table 2
Qualitative and quantitative distribution of Nematodes in the Keszthely Bay during the months April — November in
1966—1967
The data refer to 1 m²

Species	Date													
	1966							1967						
	V.	VI.	VII.	VIII.	IX.	X.	XI.	IV.	V.	VI.	VII.	VIII.	XI.	X.
<i>Aphanolaimus aquaticus</i> DADAY						31				30				29
<i>Ethmolaimus pratensis</i> de MAN										62				
<i>Hemicycliophora aquatica</i> (MIC.) LOOS														28
<i>Ironus colourus</i> STEINER													31	
<i>Ironus tenuicaudatus</i> de MAN	394	576	485	758	184	243	667	787	1031	574	395	910	788	1275
<i>Mesodorylaimus</i> sp. juv.				34				61					30	
<i>Monhystera macramphs</i> FILIPJEV	93	34		90	33		93	179					91	
<i>Monhystera paludicola</i> de MAN	757	606	29	122	393	273	971	2243	35	59		60	123	31
<i>Monhystera stagnalis</i> BASTIAN		64	61		30		30	62	33					
<i>Neochromadora izhorica</i> (FIL.) W. SCHNEIDER					120									
<i>Paraphanolaimus behningi</i> MICOLETZKY	32	242	668	397	333	576	364	363	280	455	664	270	271	516
<i>Paraplectonema pedunculatum</i> (HOFM.) STRAND	362	151	332	2907	819	212	427	362	272	421	241	755	1578	61
<i>Plectus</i> sp.										31		32		
<i>Punctodora dudichi</i> ANDRÁSSY				32										
<i>Theristus setosus</i> (BÜTS.) FILIPJEV	213	121			28	153	1151	1517	700	211	124	61	303	154
<i>Tobrilus gracilis</i> (BAST.) ANDRÁSSY	152	62		65	34		93	392	89	33		92	214	
<i>Tripyla glomerans</i> BASTIAN									64					

Neochromadora izhorica lives in brack-waters (mixohaline), occurring occasionally also in fresh water. The specimens found now, one male and three females, are new for the fauna of Hungary.

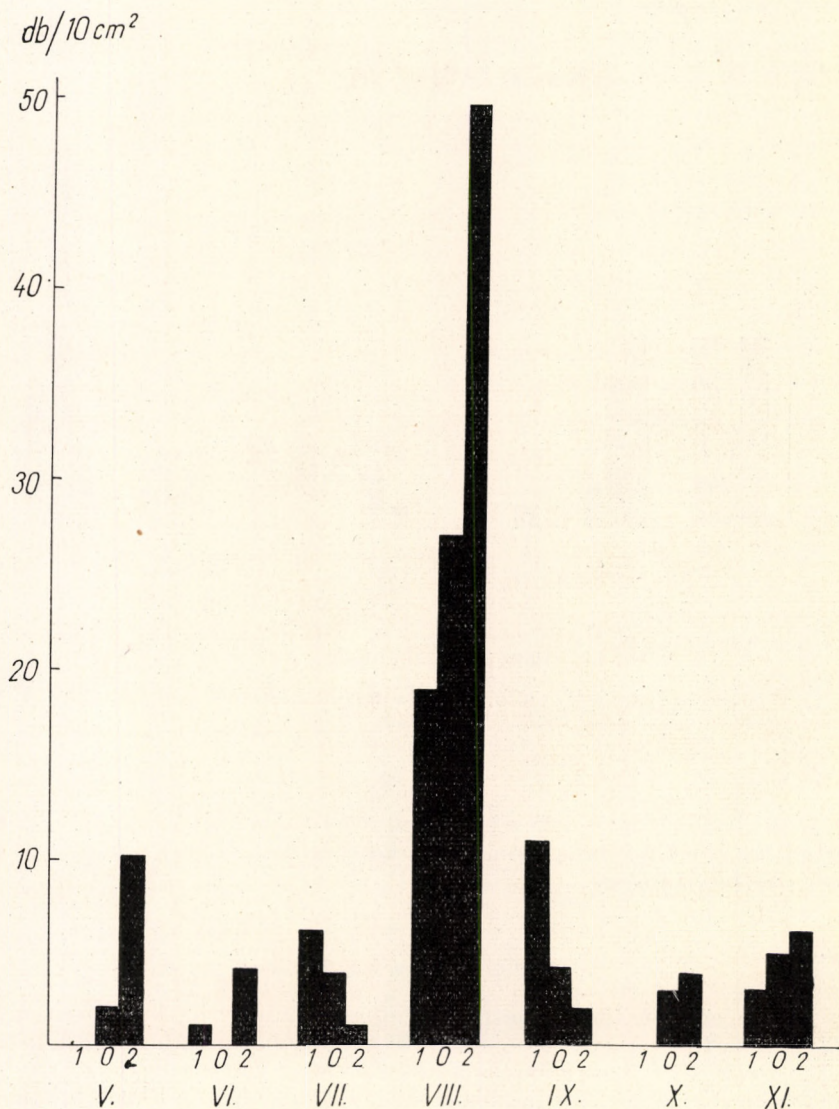


Fig. 3. The occurrence of *Paraplectonema pedunculatum* in the Keszthely Bay In May—November, 1966; Sampling point 1, 0, 2

3. ábra. *Paraplectonema pedunculatum* előfordulása a Keszthelyi-öbölben 1966 V.—XI. hónapjaiban
1, 0, 2 a gyűjtőhelyek

Paraplectonema pedunculatum is characteristically aquatic, inhabiting mainly standing or slowly streaming waters. Rare in Europe, but rather frequent in the Keszthely Bay. New for the fauna of the Balaton.

Monhystera paludicola and *M. macramphis*, as well as *Ethmolaimus pratensis*, can be usually found in every aquatic habitat; all are new for the mud fauna of the Balaton.

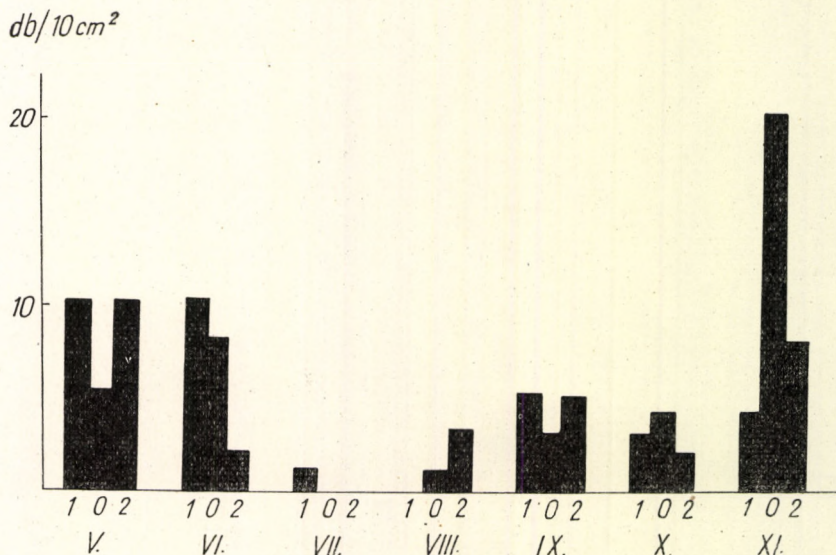


Fig. 4. The occurrence of *Monhystera paludicola* in the Keszthely Bay, in May–November, 1966; Sampling points 1, 0, 2

4. ábra. *Monhystera paludicola* előfordulása a Keszthelyi-öbölben 1966. V.–XI. hónapjaiban
1, 0, 2 a gyűjtőhelyek

Hemicycliophora aquatica and *Punctodora dudichi* ANDRÁSSY, 1966, are reported for the first time from the lake, whereas *Ironus colourus* STEINER, is new also for Hungary.

2. Quantitative conditions

Ironus attains the highest individual numbers in the Keszthely Bay (Table 2). On the basis of the quantitative data obtained during the two years research work, this species shows a more or less even occurrence. No unequivocal seasonal changes can be demonstrated, though its location in the three points of the bay is rather varying. Some calculations have been made to see whether a significant difference as to individual numbers exists between the several collecting localities, per months or years. No such were found; indeed, a correspondence above 50 per cent could be established ($P > 0.5$). In the survey period, the main occurrence of *Ironus tenuicaudatus* was 58 ind/dm².

Paraplectonema pedunculatum occupies quantitatively the second place with reference to the survey period. Its nearly uniform and even occurrence was severely interrupted in August, 1966. A significant difference can be shown between the months July, August, and September (Fig. 3). The number of *Paraplectonema* specimens again increased at the end of summer in 1967, though at a smaller rate. Owing to this great change in numbers, no satisfactory average can be given for the entirety of the research period.

The quantity of *Paraphanolaïmus behningi* was practically the same or nearly the same in both years, though its occurrence in the 3 survey points of the Keszthely Bay was uneven. No differences as to months or years could be shown. The occurrence main was 31 ind/dm² during the research period.

The occurrence data of *Monhystera paludicola* refer to a greater frequency in colder waters. According to the observations in 1966, the species appears in greater numbers during autumn and in the spring, its occurrence being meagre in summer (Fig. 4). The data of 1967 show a similar tendency.

The occurrence of *Theristus setosus* resembles that of *Monhystera*. It inhabits rather cold waters.

Summary

The author investigated the open water mud of the Keszthely Bay in the Balaton, in the months May—September, 1966, and April—October, 1967. It was demonstrated that about 90 per cent of the Nematode population are represented by 5 species (*Ironus tenuicaudatus*, *Paraplectonema pedunculatum*, *Paraphanolaïmus behningi*, *Monhystera paludicola*, and *Theristus setosus*). The hitherto unknown male of *Paraphanolaïmus behningi* was discovered. *Paraplectonema pedunculatum*, being rare all over Europe, was observed in great numbers. *Neochromadora izhorica* and *Ironus colourus* is reported as new for the fauna of Hungary.

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A BALATON NEMATODÁI II. A KESZTHELYI-ÖBÖL NYILTVÍZI ISZAPJÁNAK NEMATODÁI

Összefoglalás

Biró Kálmán

A szerző 1966. V.—XI. és 1967. IV.—X. hónapban vizsgálta a Balaton Keszthelyi-öblének nyíltvízi iszapját. Kimutatta, hogy 5 faj (*Ironus tenuicaudatus*, *Paraplectonema pedunculatum*, *Paraphanolaimus behningi*, *Monhystera paludicola*, *Theristus setosus*) adja a Nematoda-állomány mintegy 90%-át. Megtalálta a *Paraphanolaimus behningi* eddig ismeretlen hímét. Megfigyelte az Európa-szerte ritka *Paraplectonema pedunculata*-t nagy számban. Feljegyezte a Magyar Faunára új fajként a *Neochromadora izhorica*-t.

НЕМАТОДЫ ОЗЕРА БАЛАТОН. II. НЕМАТОДЫ ИЛИ ОТКРЫТОЙ ЧАСТИ КЕСТХЕЙСКОГО ЗАЛИВА

К. Биро

Ил открытой части Кестхейского залива озера Балатон исследовали с мая по ноябрь 1966 г. и с апреля по октябрь 1967 г. Установлено, что 90% нематод представлено пятью видами: (*Ironus tenuicaudatus*, *Paraplectonema pedunculatum*, *Paraphanolaimus behningi*, *Monhystera paludicola*, *Theristus setosus*). Обнаружен ненаходимый до сих пор самец *Paraphanolaimus behningi*. В большом количестве найден *Paraplectonema pedunculata*, который редко встречается в Европе. Описан новый для фауны Венгрии вид *Neochromadora izhorica*.

**INFORMATORY INVESTIGATIONS ABOUT QUALITATIVE AND
QUANTITATIVE CONDITIONS OF THE CRUSTACEAN PLANKTON OF
THE DANUBE SECTION NEAR ALSÓGÖD (HUNGARY)
(DANUBIALIA HUNGARICA, XLVII)**

ANNA BOTHÁR and JENŐ E. PONYI

*Hungarian Danube Research Station, Alsógöd and
Biological Research Institute of the Hungarian Academy of Sciences, Tihany,
Hungary*

Received: 28th February, 1968

We have as yet very few and scattered data about crustacean plankton-stand of the main branch of the Hungarian Danube section. UNGER (1916) in course of his search on the Danube has found during recessions a few scattered specimens of *Bosmina longirostris* and *Daphnia longispina*. WOYNÁROVICH (1944), when investigating inundation-areas of the Danube—Drava-corner took samples from the Danube, too. He stated that very few lower-degree water fleas and copepods were to be found in the river, he found only 4 pieces of *Cyclops* sp. in one litre of water. PONYI (1962) studied the samples collected between Esztergom and Mohács during the time from 30th September till 4th October 1958. He was able to identify 15 species — and/or varieties and forms — of Cladocera and 4 of Copepoda. BOTHÁR (1967) succeeded in finding 14 new Cladocera and/or Copepoda species — in the summer months of 1965, during the great inundation — for the Hungarian section of the Danube, while finding 3 of them to be new for the whole fauna of the river.

During the years 1955—1966 we made further informatory investigations in order to get a more complete picture of the occurrence of Crustacea species.

Sampling and treatment

In the time between the 23rd March 1965 and 28th December 1966 we took samples once a week on the average, at the ferry-station of Alsógöd. When taking the samples we drew 30 litres of water and filtered in through a plankton-net No. 25. Then we counted all the Crustacea-individuals (including the nauplius and copepod stadium too) to be found in the filtrate. In the laborious work of sampling and counting the Laboratory assistants Mrs. G. HORVÁTH and Miss ÉVA SZALKAI have taken part too.

**Review of the species found during the investigations
and some remarks concerning them**

During the period of search, the following 39 Cladocera and 16 Copepoda species, varieties and forms were taken out of the Danube:

1. *Sida crystallina* (O. F. MÜLLER)
2. *Diaphanosoma brachyurum* (LIEVIN)
3. *Daphnia magna* STRAUS
4. *Daphnia hyalina* (LEYDIG)
5. *Daphnia longispina* O. F. MÜLLER
6. *Daphnia cucullata* G. O. SARS
7. *Daphnia atkinsoni* BAIRD
8. *Daphnia curvirostris* EYLMANN
9. *Scapholeberis mucronata* (O. F. MÜLLER)
10. *Simocephalus vetulus* (O. F. MÜLLER)
11. *Simocephalus exspinosus* (KOCH)
12. *Simocephalus exspinosus* var. *congener* SCHOEDLER
13. *Ceriodaphnia laticaudata* P. E. MÜLLER
14. *Ceriodaphnia reticulata* (JURINE)
15. *Ceriodaphnia reticulata* var. *serrata* (G. O. SARS)
16. *Ceriodaphnia quadrangula* (O. F. MÜLLER)
17. *Ceriodaphnia pulchella* G. O. SARS
18. *Ceriodaphnia dubia* RICHARD
19. *Moina rectirostris* (LEYDIG)
20. *Moina macrocopa* (STAUS)
21. *Bosmina longirostris* f. *pellucida* STING.
22. *Bosmina longirostris* (O. F. MÜLLER) f. *typica*
23. *Bosmina longirostris* f. *cornuta* (JUR.)
24. *Bosmina longirostris* f. *similis* LILLJ.
25. *Bosmina longirostris* f. *curvirostris* FISCH.
26. *Bosmina coregoni coregoni* (BAIRD)
27. *Macrothrix laticornis* (JUR.)
28. *Eurycercus lamellatus* (O. F. MÜLLER)
29. *Alona intermedia* G. O. SARS
30. *Alona rectangula* G. O. SARS
31. *Alona quadrangularis* (O. F. MÜLLER)
32. *Alonella rostrata* (KOCH)
33. *Alonella exigua* (LILLJ.)
34. *Leydigia leydigii* SCHOEDLER
35. *Pleuroxus trigonellus* (O. F. MÜLLER)
36. *Pleuroxus aduncus* (JUR.)
37. *Pleuroxus uncinatus* BAIRD
38. *Chydorus sphaericus* (O. F. MÜLLER)
39. *Leptodora kindtii* (FOCKE)
40. *Macrocyclus albidus* (JUR.)
41. *Eucyclops* (s. str.) *serrulatus* (FISCH.)
42. *Paracyclops fimbriatus* (FISCH.)
43. *Cyclops vicinus* ULJ.
44. *Acanthocyclops viridis* (JUR.)
45. *Acanthocyclops vernalis* (FISCH.)
46. *Acanthocyclops vernalis* f. *robustus* (G. O. SARS)
47. *Acanthocyclops bicuspidatus* (CLAUS)
48. *Microcyclus gracilis* (LILLJ.)
49. *Mesocyclops* (s. str.) *leuckarti* (CLAUS)
50. *Mesocyclops* (*Thermocyclops*) *crassus* (FISCH.)
51. *Eudiaptomus gracilis* (G. O. SARS)
52. *Eudiaptomus graciloides* (LILLJ.)
53. *Eudiaptomus vulgaris* (SHMEIL.)
54. *Nitocrella hibernica* (BRADY)
55. *Bryocamptus* (*Rheocamptus*) *pygmaeus* (G. O. SARS)

Two taxa of the collected material — *Simocephalus exspinosus* KOCH and *Simocephalus exspinosus* var. *congener* SCHOEDLER — were new as regards the fauna of the Danube. In this respect we accepted the authenticity of the list of species of DUDICH (1967). The following species were found the first time by us on the Hungarian section of the Danube: *Scapholeberis mucronata* O. F.

MÜLLER, *Moina macrocopa* STRAUS, *Bosmina longirostris* f. *curvirostris* FISCHER, *Bosmina longirostris* f. *similis* LILLJ., *Alonella exigua* LILLJ., *Pleuroxus aduncus* JUR., *Pleuroxus trigonellus* O. F. MÜLLER, *Pleuroxus uncinatus* BAIRD, *Macro-*

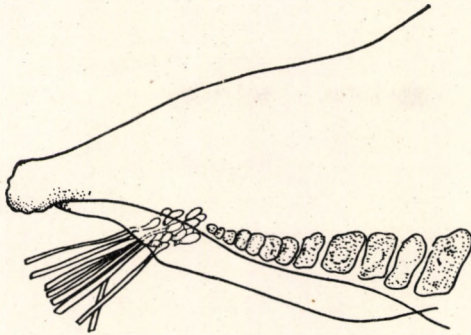


Fig. 1. *Daphnia curvirostris* ♀, 1. antenna
1. ábra. *Daphnia curvirostris* ♀, 1. antenna

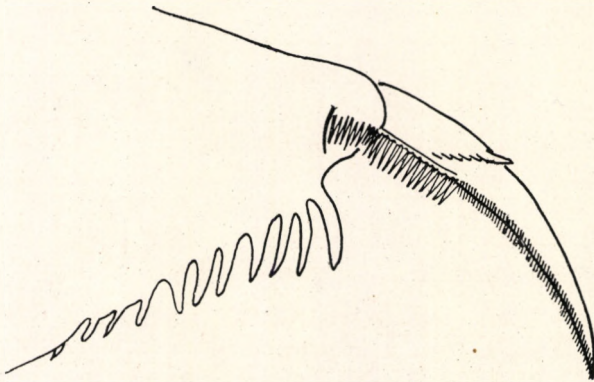


Fig. 2. *Daphnia curvirostris* ♀, claw
2. ábra. *Daphnia curvirostris* ♀, végkarom

cyclops albidus (JUR.), *Paracyclops fimbriatus* (FISCH.), *Acanthocyclops bicuspidatus* (CLAUS), *Microcyclops gracilis* (LILLJ.), *Mesocyclops* (*Thermocyclops*) *crassus* (FISCH.), *Nitocrella hibernica* (BRADY), *Bryocamptus* (*Rheocamptus*) *pygmaeus* (G. O. SARS).

Remarks on the taxonomic relations and Hungarian occurrence of some species

Daphnia curvirostris EYLMANN 1886 emend. JOHNSON 1952. According to the works of WAGLER (1936, 1937) the species taken as "*Daphnia pulex*" includes several taxa. It is a common property of these that they have relativ-

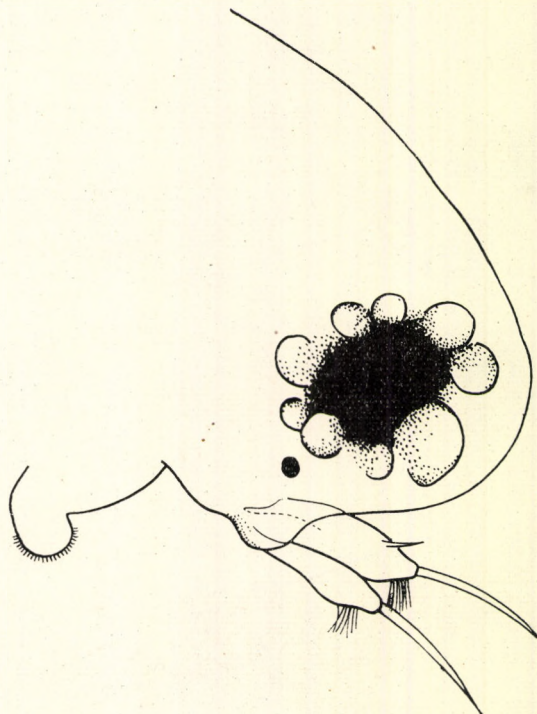


Fig. 3. *Daphnia curvirostris* ♂, head

3. ábra. *Daphnia curvirostris* ♂, fej

ely big comb-teeth lying distally on the claw. The investigations of JOHNSON (1952) and HRBÁČEK (1959) proved that *Daphnia curvirostris* is an independent species and its occurrence is characteristically European according to BROOKS (1957).

The ♀ can be differentiated easily from the *pulex* (Fig. 2) by its vestigial antennule (Fig. 1), as well as by the high number of its comb-teeth (distally: 8–13, proximally: 10–16). It is a characteristic feature of ♂ that we can find a remarkable bulge on the forward part of the head, above the joining place of the antennule (Fig. 3).

The present article is the first report of an assured occurrence in Hungary of this species, since the investigations of earlier Hungarian authors (DADAY 1888, KOTTÁSZ 1913) could not be used in this respect, and more recently it

was not mentioned. Besides the habitats in the Danube the species has been found on the following spots, too: Tihany, Gödrös (8.8. 1966), Kelebia, pool, (1.5. 1967).

Ceriodaphnia dubia RICHARD 1895
(Syn.: *Ceriodaphnia affinis* LILLJEBORG 1900)

Description of this species was given first by RICHARD in 1895; later on LILLJEBORG identified the same animal as *C. affinis* (1900). Since the species has an extended occurrence (Europe, southern part of Asia, Sumatra, Africa,

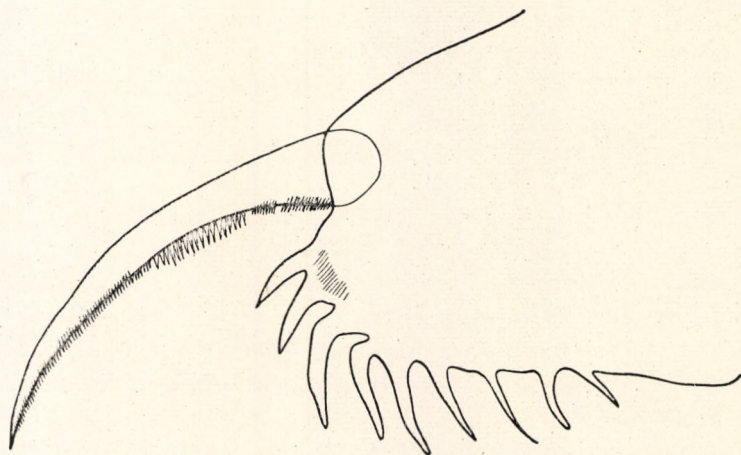


Fig. 4. *Ceriodaphnia dubia* ♀, claw
4. ábra. *Ceriodaphnia dubia* ♀, végkarom

America), most of the samples coming from different places were mentioned partly with the name *dubia*, partly with *affinis*, though some of them were synonymized earlier. Part of the European general works record them either as a variety of *C. quadrangula* (WAGLER 1937) or with the name *affinis* (BEHNING 1941, MANUILOVA 1964). The works of BREHM (1933) and others point to that we deal with a unique species and we are of the same opinion on the basis of our investigations. We note, however, that STEPHANOIDES (1948) treats „*dubia*” and „*affinis*” as separate species, though the differences mentioned by him are not sufficient to define two different species.

A very significant characteristic of the animal — used by several investigators for a differential diagnosis too — is represented by the comb on the claw consisting of very fine teeth (Fig. 4), nevertheless these can not be well observed in every case.

The more recent Hungarian literature records the animal as a variety of *C. quadrangula* respectively as *C. affinis*.

Alonella rostrata (KOCH 1841)
(Syn.: *Rhynchotalona rostrata* KOCH)

Following recent investigations made on the pores of head shield of Chydoridae-family (FREY 1959) the animal is ranged with the *Alonella* genus. Besides the present collections the species can be found everywhere on the Ercsi—Mohács section of the Danube (between 1614—1448 kms of the river) (PONYI 1962).

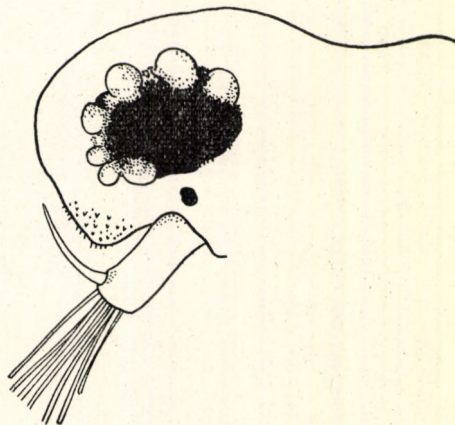


Fig. 5. *Ceriodaphnia pulchella* ♀, head
5. ábra. *Ceriodaphnia pulchella* ♀, fej

Ceriodaphnia pulchella G. O. SARS 1862

This species is treated even in our days in the Hungarian limnological and faunistical works — probably after the work of WAGLER (1937) — as a variety of *C. quadrangula*. The Russian (BEHNING 1941, MANUILOVA 1964) and English (SCOURFIELD, HARDING 1958) literatures record them as different species. It can be separated easily from *C. quadrangula* by the spinosity of abdomen and particularly by the structure of its head (Fig. 5).

Acanthocyclops vernalis (FISCHER 1853) f. *robustus* (G. O. SARS 1863)

According to recent investigations (PONYI 1967), the characteristics used to separate the „*vernalis*” and „*robustus*” denotations are developed in very various forms and as regards samples from Balaton they show fluctuations corresponding to the seasons.

The *robustus*-individuals collected in the frame of these investigations are nearer to the typical form as regards their characteristics. From the interstitial water near Bratislava a great quantity of *robustus*-individuals came up (J. PONYI and L. PONYI 1961).

Development of quantity-conditions of the Crustacea-plankton

On the basis of the method used with the investigations it seems, that in the most part of the year the occurrence of cladocerans and copepods is so

small that they do not play any significant part in this respect in the plankton community, contrary to the Rotatoria representing the bulk of plankton community.

Within the crustacean the cladocerans are on the lead as regards the number of species, while the copepods have the lead regarding the number of

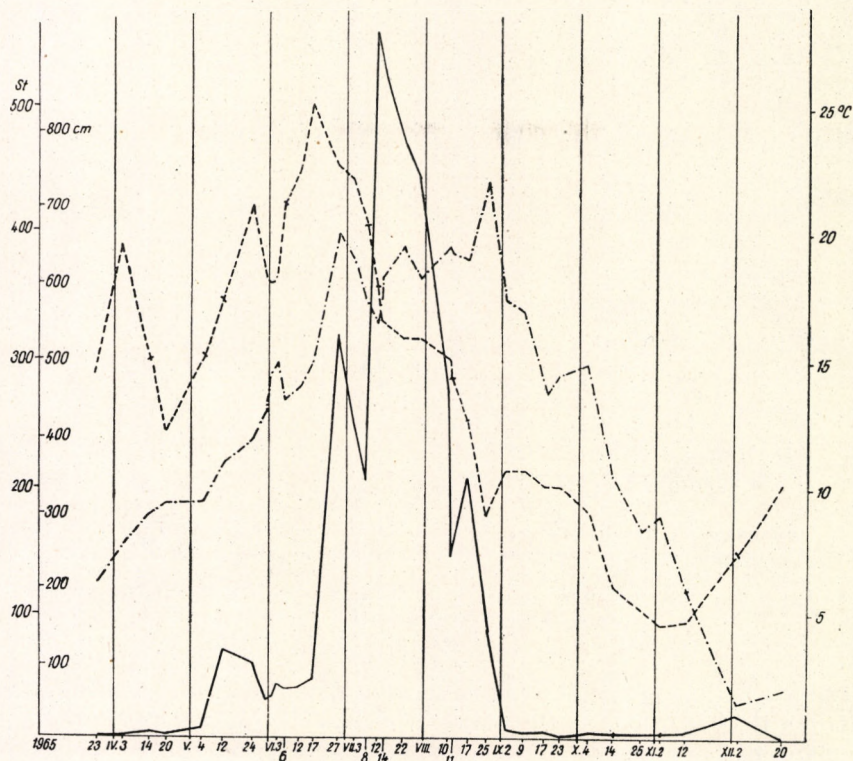


Fig. 6. Connection of the number of individuals of crustaceans with the water level and temperature in the year 1965

———— = number by sample
 - - - - - = water level in cm
 = temperature in °C

6. ábra. Crustacea egyedszám összefüggése a vízállással és hőmérséklettel 1965. év folyamán

———— = Stück (Proben, db.) minta
 - - - - - = Wasserstand in cm, vízállás cm-ben
 = Temperatur in °C, hőmérséklet C°-ban

individuals. The bulk of the individuals, however, consists of young Copepoda-individuals and of such being in nauplius-stadium.

It seems (Fig. 6) that during 1965 the water level variations were of decisive influence on the number of Crustacea species and individuals occurring in the Danube. After a long-lasting high water level the retreating flood-wave takes with it the plankton of the inundation area and of the pools of the environment, while in the period of warming up it enriches the rather poor plankton

of the river. In this period such crustaceans — cladocerans in particular — not to be found there either in the foregoing, or in the ensuing time appear in the water in a relatively high number.

The year 1966 had a different flood structure on the Danube, influencing also the formation of Cladocera-Copepoda-community (Fig. 7). In this year

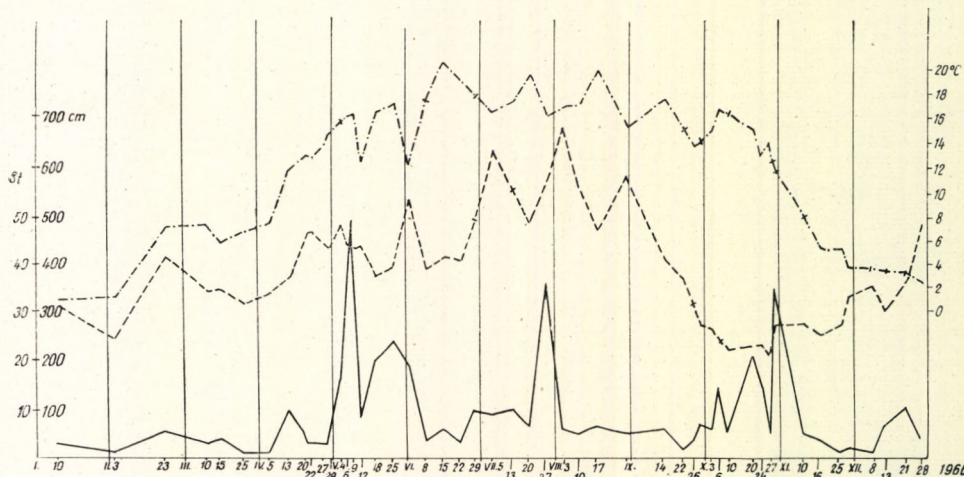


Fig. 7. Connection of the number of individuals of crustaceans with the water level and temperature in the year 1966. (Explanation: see with Fig. 6)

7. ábra. Crustacea egyedszám összefüggése a vízállással és hőmérséklettel 1966. év folyamán. Magyarázatot lásd 6. ábránál

the Danube had no great flood-wave which could create a stable level-difference similar to that of 1965. In the period from early spring till late autumn (1.4—31.10) apart from minor oscillations the total number of crustaceans was nearly uniform with an average number of individuals about 12 by sample, and the bulk of this was represented by nauplius and young copepod individuals. In the period lasting from late autumn till spring the average number of individuals by sample was as low as 4.

The species found can be divided in two groups according to the frequency of their occurrence:

a) Some very widely distributed species of great ecological valence: among the cladocerans the *Chydorus sphaericus* and various forms of *Bosmina longirostris*, most frequently the f. *pellucida*; among the copepods besides the *Eucyclops serrulatus* only animals in the nauplius stadium and young cyclopids. The occurrence of these in the water of the Danube is to be expected during the whole year except for a few weeks in winter and early spring.

b) Independently of the season and without any regularity the following species are encountered many times: *Daphnia longispina*, *Daphnia cuculata*, *Alonella rostrata*, *Acanthocyclops viridis*, *Acanthocyclops vernalis* f. *robostratus*.

Animals occurring by chance in single samples at times can not be regarded as characteristic species: e.g. *Daphnia hyalina*, *Pleuroxus trigonellus*, *Acanthocyclops bicuspidatus* etc.

Summary

The crustacean plankton of the Alsógöd section of the Hungarian Danube was investigated in 1965–1966. In this period 39 species of cladocerans and 16 of copepods, respectively their varieties and forms could be identified. Among these two were new for the fauna of the whole Danube, while for the Hungarian section 15 new taxa were found.

A detailed analysis of taxonomical and occurrence conditions of 5 Crustacea species was made.

On the basis of the informatory investigations conducted for two years the authors could state that the number of Crustacea species as well as that of the individuals were decisively influenced by the water-level conditions. The species found were divided in two groups according to the frequency of their occurrence.

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TÁJÉKOZÓDÓ VIZSGÁLATOK A MAGYAR DUNA ALSÓGÖDI SZAKASZA
PLANKTONRÁKJAINAK MINŐSÉGI ÉS MENNYISÉGI VISZONYAIRÓL
(DANUBIALIA HUNGARICA, XLVII)

Összefoglalás

Bothár Anna és Ponyi Jenő

A szerzők 1965—66-ban hetenként vizsgálták a magyar Duna alsógödi szakaszának Crustacea-plankton tagjait. Ebben az időszakban 39 Cladocera és 16 Copepoda fajt, ill. varietást és formát mutattak ki. Ezek közül az egész Duna faunájára nézve 2, a magyarországi szakaszra vonatkozóan pedig 15 új taxont találtak.

Részletesebben foglalkoznak 5 rákfaj rendszertani és elterjedési viszonyaival.

A 2 éves tájékoztató vizsgálatok alapján úgy vélik, hogy a Dunában előforduló Crustacea faj és egyedszám változását döntően a vízállás befolyásolja. A talált fajokat az előfordulásuk gyakorisága szerint két csoportra osztják.

ОРИЕНТИРОВОЧНЫЕ КОЛИЧЕСТВЕННЫЕ И КАЧЕСТВЕННЫЕ ИССЛЕДОВАНИЯ ПЛАНКТОННЫХ РАКОВ НА УЧАСТКЕ ДУНАЯ У АЛШОГЕД

А. Ботхар и Й. Поньи

Еженедельно в течение 1965—66 годов исследовали состав планктонных ракообразных на участке Дуная у Алшогед. За указанный период найдены 39 видов Cladocera и 16 видов или разновидностей Copepoda. Из этого числа 2 вида являются новыми для Дуная и 15 для венгерской части дуная.

Дается подробное описание систематики и распространения 5 видов рачков.

Делается вывод, что видовое разнообразие и плотность популяции ракообразных определяется уровнем воды. Найденные виды разделены на две группы по частоте встречаемости.

THE EFFECTS OF SOME ADRENERGIC BLOCKING AGENTS ON THE MOBILISATION OF FATTY ACIDS IN LOWER VERTEBRATES

TIBOR FARKAS

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

Received: 4th March, 1968

According to our present knowledge catecholamines stimulate the hydrolysis of triglycerides in mammalian adipose tissue through a β -adrenergic system. The hormones stimulate the adenyl cyclase — supposed to be identical with the β -receptor — which synthesises cyclic 3',5' adenosine monophosphate (cAMP) from ATP in the presence of Mg^{++} . This nucleotide mediates the lipolytic effects of catecholamines and other physiological effects of other hormones as well (SUTHERLAND et al. 1965). BUTCHER et al. have shown (1965), that the increase of intracellular level of cAMP in rat adipose tissue precedes the increase of break down of triglycerides when the tissues are incubated in the presence of catecholamines.

We have demonstrated earlier, that frog adipose tissue responds by an increase in phosphorilase activity to norepinephrine administered in vivo or in vitro (FARKAS 1966.). It was concluded that there exists an adrenergic system consisting of adenyl cyclase-cAMP-phosphorilase — in frog adipose tissue. On the other hand we have found that the adipose tissue of lower vertebrates — unlike to that of mammals — does not respond to catecholamine with an increase in lipolytic activity. However catecholamines decreased the production of free fatty acids in fish or frog adipose tissue both in vivo and in vitro conditions. Taking into account the close relationship between the carbohydrate metabolism and free fatty acid production in mammalian adipose tissue, it may be inferred that catecholamines decrease the production of free fatty acids in lower vertebrates through the same mechanism in which they stimulate the decomposition of glycogen in mammalian adipose tissue.

The purpose of the present investigation is to obtain information about the nature of adrenergic receptors present in adipose tissue of lower vertebrates on the one hand and to determine whether these receptors are involved into the effect of catecholamines. The effect of two adrenergic blocking agents was tested: ergotamine was used to block the α -adrenergic and dichloroisoproterenol (DCI) the β -adrenergic receptors. Both agents were shown to block the lipolytic effect of catecholamines and the effect of catecholamines on phosphorilase in other tissues (GOODMAN et al. 1959, WENKE et al. 1962, BUTCHER et al. 1965, ZSÖTÉR et al. 1966).

Material and methods

The experiments were carried out on the bream (*Abramis brama* L.), pike perch (*Lucioperca lucioperca* L.) weighing 250–300 g, marsh frog (*Rana ridibunda* L.) weighing 60–80 g and on grass snake (*Natrix natrix* L.) weighing 80–100 g. The fishes were collected from Lake Balaton 6–7 days before

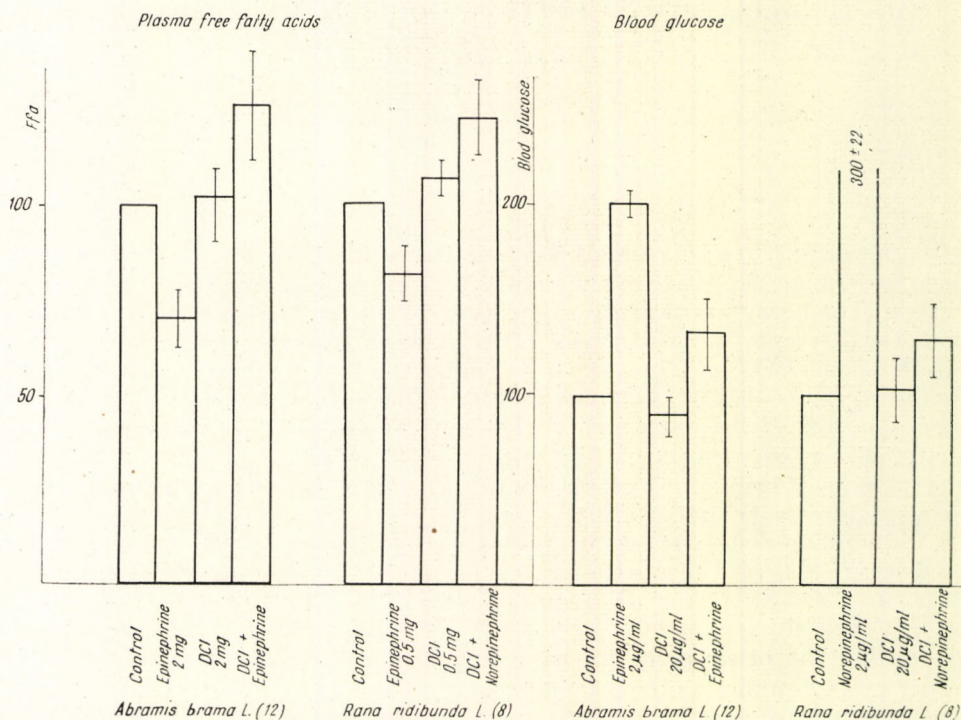


Fig. 1. Effect of catecholamines and dichloroisoproterenol on the mobilisation of fatty acids and glucose in fish and frog

The results are expressed in the percentage on the controls

1. ábra. Catecholaminok és dikloroisoproterenol hatása zsírsavak és glukóz mozgósítására halban és békában

Az eredményeket a kontroll százalékában fejeztük ki

the experiment and kept in suitable aquaria. The frogs were bought from a dealer and the grass snakes collected in the vicinity of the institute. Both were kept in terraria. The animals did not get any food during captivity.

The drugs were administered to the fishes by intramuscularly injection and to the frogs by injection into the ventral lymph sac two hours before killing. The control animals received only physiological solution.

The in vitro experiments were carried out at room temperature in a frog ringer solution buffered to pH 7.4. The freshly removed adipose tissues were cut into pieces of 10–20 mg and 150–200 mg of tissue was put into one vessel.

The free fatty acid content of the tissues was determined according to DOLE (1956) at the beginning and at the end of the experiment. The difference between the two determinations represented the free fatty acid production during the experiment.

Blood was obtained from the fishes by cutting the caudal vein and from the frogs by decapitation. Heparinized centrifuge tubes were used to collect

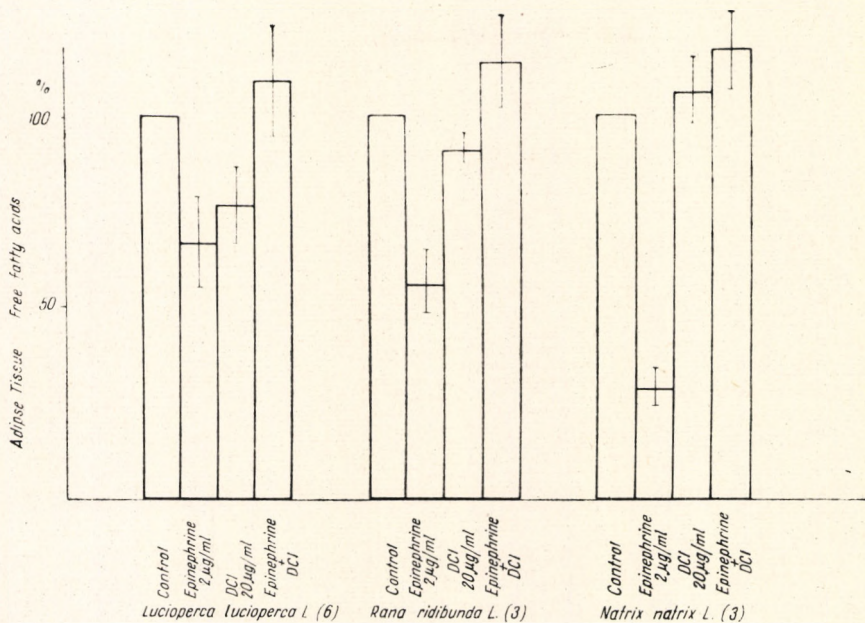


Fig. 2. Effect of epinephrine and dichloroisoproterenol on the production of fatty acids in fish, frog and grass snake adipose tissues incubated in vitro
The results are expressed in the percentage on the controls

2. ábra. Adrenalin és dikloroisoproterenol hatása hal, béka és vízisikló zsírszövet szabad zsírsav termelésére in vitro körülmények között
Az eredményeket a kontroll százalékában fejeztük ki

the blood. The amount of the free fatty acids in the plasma was determined by the method of DOLE (1956) and blood glucose colorimetrically according to HYVÄRINEN et al. (1962).

Results

DCI alone, administered in vivo, increased the plasma free fatty acid level and blood sugar level in mammals (ZSÖTÉR al. 1966). However, when DCI was administered together with catecholamines it abolished the lipolytic effect of catecholamines (WENKE et al. 1962). Fig. 1 shows that DCI injected into fish or frogs does not influence either the free fatty acid or the blood glucose level. Norepinephrine on the other hand decreased the level of free fatty acids

in the blood of both animals. When DCI and norepinephrine were injected simultaneously no decrease was obtained in the free fatty acid levels of the plasma. The level of fatty acids in the plasma increased slightly but not significantly. It was also found that the hyperglycemic effect was reduced by DCI.

DCI administered alone (like catecholamines) increases the decomposition of triglycerides in mammalian adipose tissue under *in vitro* conditions (LOVE

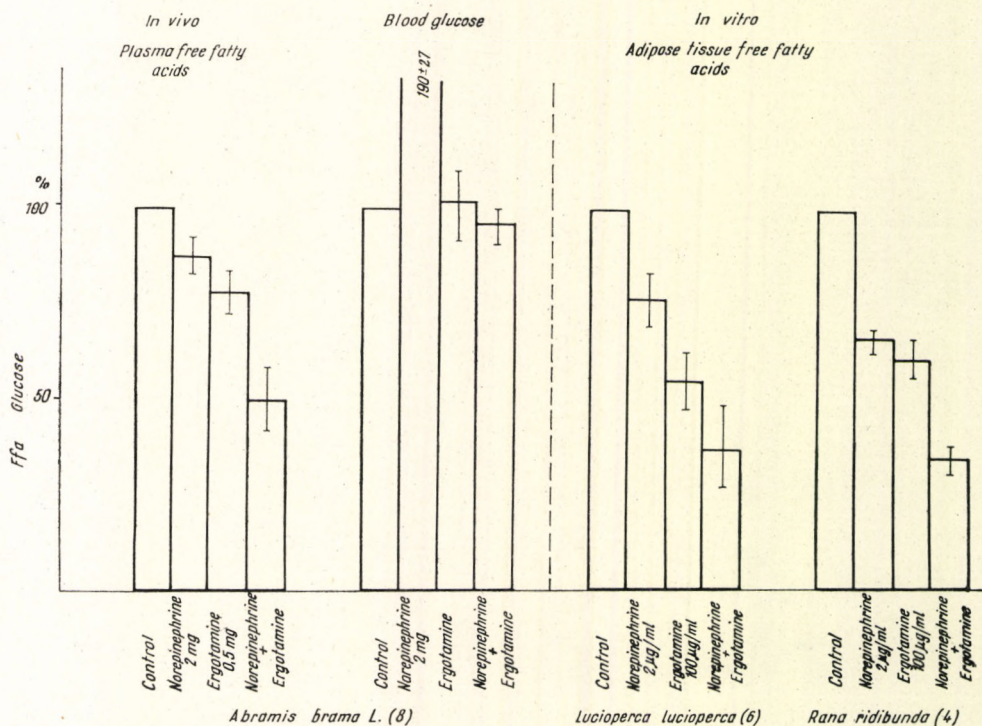


Fig. 3. Effect of norepinephrine and ergotamine on the mobilisation of fatty acids and glucose in fish and frog
The results are expressed in the percentage on the controls

3. ábra. Noradrenalin és ergotamin hatása zsírsavak és glukóz mozgósítására halban és békában

Az eredményeket a kontroll százalékában fejeztük ki

et al. 1963) but reverses the lipolytic effect of catecholamines. Similarly DCI eliminated the decreasing effect of epinephrine on free fatty acid production in fish, frog and grass snake adipose tissue (Fig. 2). The adipose tissues incubated in the presence of epinephrine and DCI produced more free fatty acids than the controls but the difference in production is not significant.

Fig. 3 shows that ergotamine-like norepinephrine-decrease the plasma free fatty acid level in the fish *Abramis brama*. This drug however (unlike to DCI) does not reverse the effect of norepinephrine, while the simultaneous presence of both agents in the fish actually resulted in a further decrease in

free fatty acids in the plasma. On the other hand, ergotamine was found to reverse the hyperglycemic effect of norepinephrine in the fish.

Fish and frog adipose tissues when incubated in the presence of ergotamine produced less free fatty acids than the controls. Ergotamine however did not eliminate the effect of norepinephrine on adipose tissue lipolytic activity. The simultaneous presence of both drugs resulted in a further decrease in free fatty acid production.

Discussion

The present results and those obtained earlier on the frog adipose tissue phosphorilase (FARKAS 1966) suggest that in the adipose tissue of lower vertebrates there exists (as in mammals) a β -adrenergic receptor system. Since DCI — which is a known inhibitor of β -receptors — abolished the effect of catecholamines on the free fatty acid production of adipose tissues of the investigated animals, and because the β -receptor is believed to be identical with adenylyl cyclase (BLOOM et al. 1966) it is obvious that the hormones examined exert their effect through the adenylyl cyclase-cAMP system. DCI alone, supposedly owing to its chemical structure (which is very similar to that of catecholamine) increases the free fatty acid production of mammalian adipose tissue (ZSÖTÉR et al. 1966). Its effect on the adipose tissue of lower vertebrates is also like that of catecholamines in that it decreases the free fatty acid production. Although BUTCHER et al. (1965) did not find any change in the intracellular level of cAMP in adipose tissues incubated in the presence of DCI, it is tempting to assume that this nucleotide mediates the lipolytic effect of DCI too. This supposition is also supported by the fact that DCI stimulates the formation of cAMP other tissues (i.e.: cardiac muscle). If this hypothesis is correct it would offer an explanation for the catecholamine-like effect of DCI both in mammals and in the lower vertebrates.

Both ergotamine and DCI antagonize the hyperglycemic effect of catecholamines in mammals and inhibit the increase of phosphorilase activity in mammalian liver in vitro (HORN BROCK et al. 1963). Similarly ergotamine and DCI inhibit the effect of catecholamines on the mobilisation of glucose in fishes. Since the hyperglycemic effect of catecholamines is equally inhibited by ergotamine and DCI both in mammals and fishes it may be inferred that the structure of the adrenergic receptor in the liver is similar in all the vertebrates. In contrast to this the present results suggest, that the β -receptor present in the adipose tissue of fishes and amphibians is somewhat different from that present in mammalian adipose tissue. While the lipolytic effect of catecholamines in rat adipose tissue is inhibited also by α -receptor blocking agents, ergotamine did not block the effect of catecholamines on fish and frog adipose tissue. On the contrary, the simultaneous presence of both drugs results in a further decrease in free fatty acid production of fish and frog adipose tissue. We are inclined to suggest that ergotamine diminishes the accumulation of free fatty acids in the same way as catecholamines. It has been shown that in certain tissues of mammals (heart) ergotamine is able to stimulate the adenylyl cyclase and increase the intracellular level of cAMP (MURAD et al. 1962).

The mechanism by which the drugs tested decrease the production of free fatty acids in adipose tissue of lower vertebrates however needs further clarification.

Summary

In agreement with our earlier observations it has been shown that catecholamines decrease the free fatty acid level of the blood in the fishes (*Abramis brama* L.) and in the marsh frog (*Rana ridibunda* L.) and the production of the free fatty acid in fish, frog and grass snake (*Natrix natrix* L.) adipose tissue in vitro. DCI alone has the same effect on free fatty acid production in vitro as the catecholamines but inhibits their effect both in vivo and in vitro. Ergotamine alone reduces the free fatty acid production in vitro but is not able to antagonize the catecholamines in vivo or in vitro, while ergotamine and DCI inhibit the development of hyperglycemia after administration of catecholamines in fish. It is probable that catecholamines trigger their effect on the free fatty acid production in adipose tissue of lower vertebrates through the same mechanism by which they stimulate the lipolysis and glycogenolysis in mammalian adipose tissue.

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NÉHÁNY ADRENERG GÁTLÓSZER HATÁSA A ZSIRMOZGÓSÍTÁSRA ALACSONYABBRENDŰ GERINCESEKBEN

Összefoglalás

Farkas Tibor

Korábbi megfigyeléseinkkel egybehangzóan catecholaminok csökkentik halak (*Abramis brama* L.) és tavi béka (*Rana ridibunda* L.) vérének szabadzsírsav szintjét in vivo és zsírszöveteik szabad zsírsav termelését in vitro. DCI egymagában a catecholaminokhoz hasonlóan csökkenti a szabad zsírsav felhalmozódást és megszünteti catecholaminok ezen hatását in vivo és in vitro körülmények között. Ergotamin, mely egymagában szintén csökkenti a zsírszövet szabad zsírsav termelését, nem képes antagonizálni catecholaminok hatását. Mindkét adrenerg blokkolószert megakadályozza a hyperglycemia kialakulását a catecholaminok hatására. Valószínű, hogy catecholaminok ugyanazon az adenyl cyclase-cAMP-rendszeren keresztül csökkentik az alacsonyabbrendű gerincesek zsírszövetének szabad zsírsavtermelését, amelyen keresztül az emlősökben ugyanezt a folyamatot stimulálják.

ВЛИЯНИЕ НЕКОТОРЫХ АДРЕНЕРГИЧЕСКИХ ИНГИБИТОРОВ НА МОБИЛИЗАЦИЮ ЖИРА У НИЗШИХ ПОЗВОНОЧНЫХ

Т. Фаркаш

Согласно нашим предыдущим данным, катехоламины понижают уровень свободных жирных кислот в крови рыб и лягушки in vivo и понижают синтез свободных жирных кислот в жировой ткани этих животных in vitro.

DCI, подобно катехоламинам, уменьшает накопление свободных жирных кислот и предотвращает отмеченное выше действие катехоламинов in vivo и in vitro. Эрготамин, снижая синтез свободных жирных кислот, не снимает эффекта катехоламинов. Оба ингибитора препятствуют развитию гипергликемии, наступающей под влиянием катехоламинов. По всей вероятности, катехоламины снижают синтез свободных жирных кислот у низших позвоночных, действуя через ту же систему аденилциклаза — циклическая-АМФ, которая описана как система стимулирования этого процесса у млекопитающих.

HELMINTHOLOGICAL INVESTIGATIONS OF FISH IN LAKE BALATON II. (MONOGENOIDEA)

ISTVÁN MATSKÁSI

Zoological Department of the Hungarian Natural History Museum

Received: 28 February, 1968

The research work, aiming at obtaining a possibly complete picture of the rate of infection by helminths of the fish in lake Balaton by examining a great number of fish specimens, continued, one year after its conception, also in 1967. In this year, studies were extended to the monogenetic trematode species also. The present paper submits a short survey of the species belonging to the genera *Dactylogyrrus*, *Gyrodactylus*, and *Tetraonchus*, collected in the year in question.

The following fish species have been examined: carp (*Cyprinus carpio*), bream (*Abramis brama*), white bream (*Blicca bjoerkna*), crucian carp (*Carassius carassius*), roach (*Rutilus rutilus*), red eye (*Scardinius erythrophthalmus*), qalin (*Aspius aspius*), ruffe (*Acerina cernua*), razor-fish (*Pelecus cultratus*), European wels (*Silurus glanis*), pike-perch (*Lucioperca lucioperca*), Volga dike-perch (*Lucioperca volgensis*), pike (*Esox lucius*), perch (*Perca fluviatilis*), European eel (*Anguilla anguilla*).

The specimens examined were adult fish, captured by sweepnet by the local fishermen.

Family: *Dactylogyridae*

All *Dactylogyrrus* species have been collected from the gills

Dactylogyrrus auriculatus (NORDMANN, 1832), NYBELIN, 1936, Fig. 2.

Host: *Abramis brama*

Date of collecting: 23 May, 1967

Dactylogyrrus cornu LINSTOW, 1878, Fig. 4

Host: *Blicca bjoerkna*

Date of collecting: 23 May, 1967

Dactylogyrrus crucifer WAGENER, 1857, Fig. 3

Host: *Rutilus rutilus*

Date of collecting: 23 May, 1967

Dactylogyrrus difformis WAGENER, 1857, Fig. 1

Host: *Scardinius erythrophthalmus*

Date of collecting: 23 May, 1967

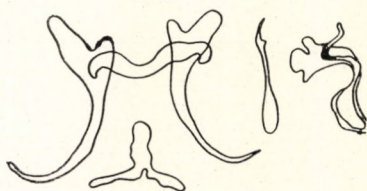


Fig. 1

1. ábra. *Dactylogyrus difformis*
WAGENER, 1857

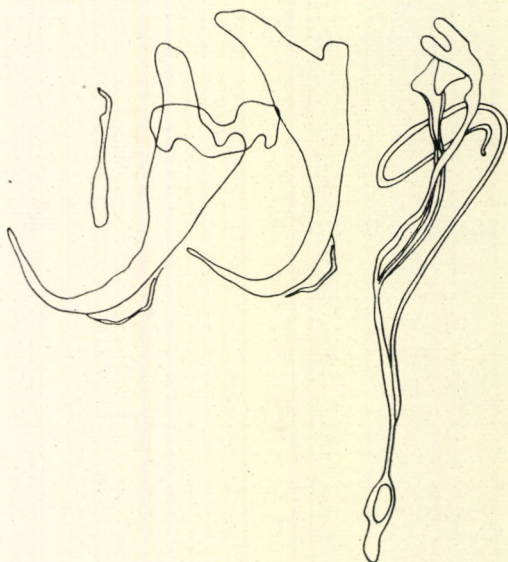


Fig. 2

2. ábra. *Dactylogyrus auriculatus*
(NORDMANN, 1832), NYBELIN, 1936

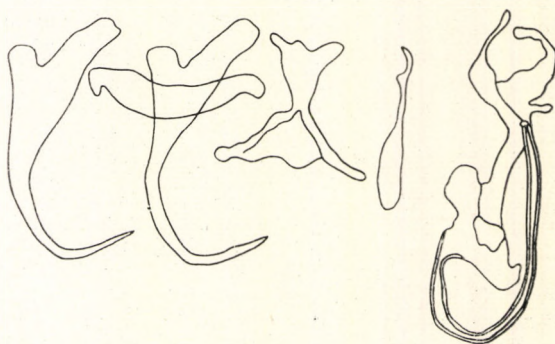


Fig. 3

3. ábra. *Dactylogyrus crucifer*
WAGENER, 1857

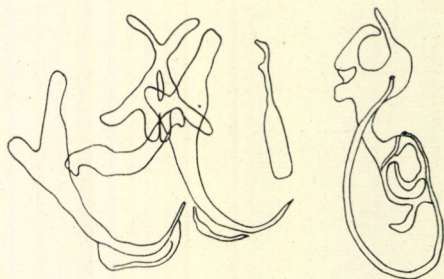


Fig. 4

4. ábra. *Dactylogyrus cornu* LINSTOW, 1878

Dactylogyrus distinguendus NYBELIN, 1937Host: *Blicca bjoerkna*

Date of collecting: 23 May, 1967

Dactylogyrus extensus MUELLER et VAN CLEAVE, 1932Host: *Cyprinus carpio*

Date of collecting: 23 May, 26 Sept., 1967

Dactylogyrus falcatus (WEDL, 1857)Host: *Abramis brama*

Date of collecting: 23 May, 1967

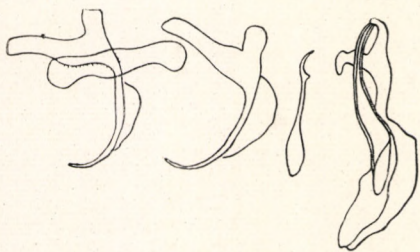


Fig. 5

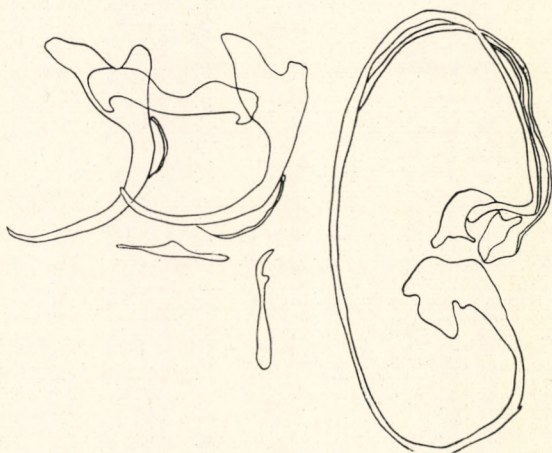
5. ábra. *Dactylogyrus intermedius* WAGENER, 1909

Fig. 6

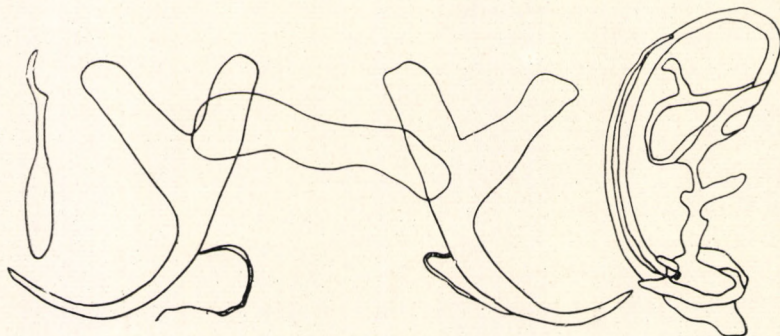
6. ábra. *Dactylogyrus tuba*
LINSTOW, 1878

Fig. 7

7. ábra. *Dactylogyrus fallax* WAGENER, 1857

Dactylogyrus fallax WAGENER, 1857, Fig. 7

Host: *Rutilus rutilus*

Date of collecting: 23 May, 1967

Dactylogyrus intermedius WAGENER, 1909, Fig. 5

Host: *Carassius carassius*

Date of collecting: 23 May, 26 Sept., 1967

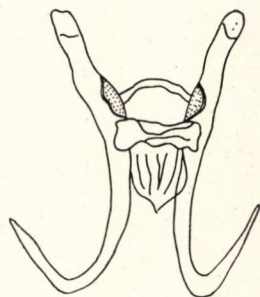


Fig. 8

8. ábra. *Gyrodactylus longiradix*
MALMBERG, 1956

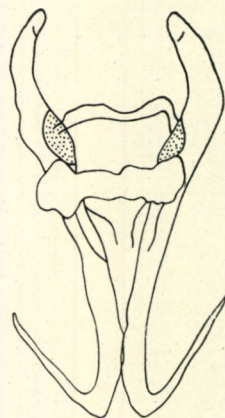


Fig. 9

9. ábra. *Gyrodactylus luciopercae*
GUSSEV, 1962

This gill-inhabiting parasite has been published from Hungary by MOLNÁR and NÉMETH. Their figure shows a specimen slightly differing from the nominate form. My own exemplars stand nearer to the typical form, insofar as their radical appendage is not tapering, its surface straight or slightly concave, the connecting dorsal plate finely arcuate, its margin not sinuous.

Dactylogyrus tuba LINSTOW, 1878, Fig. 6

Host: *Aspius aspius*

Date of collecting: 23 May, 26 Sept., 1967

Dactylogyrus wegneri KULWIEC, 1927

Host: *Carassius carassius*

Date of collecting: 23 May, 1967

Dactylogyrus wunderi BYCHOWSKY, 1931

Host: *Abramis brama*

Date of collecting: 23 May, 26 Sept., 1967

Dactylogyrus zandti BYCHOWSKY, 1931

Host: *Abramis brama*

Date of collecting: 23 May, 26 Sept., 1967

Family: *Gyrodactylidae*

Gyrodactylus longiradix MALMBERG, 1956, Fig. 8

Host: *Carassius carassius* — fins

Date of collecting: 26 Sept., 1967

Gyrodactylus luciopercae GUSSEV, 1962, Fig. 9

Host: *Lucioperca lucioperca* — fins

Date of collecting: 26 Sept., 1967

These two species have not yet been recorded from Hungary.

Family: *Tetraonchidae*

Tetraonchus monenteron (WAGENER, 1857) DIESING, 1858

Host: *Esox lucius* — gills

Date of collecting: 23 May, 26 Sept., 1967

Summary

The paper submits a survey of monogenetic trematode species belonging to the genera *Dactylogyrus* (13 sp.), *Gyrodactylus* (2 sp.) and *Tetraonchus* (1 sp.), found in fish of the Lake Balaton. The species *Gyrodactylus longiradix* and *G. luciopercae* have not yet been published from Hungary.

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A BALATONI HALAK HELMINTHOFAUNÁJÁNAK VIZSGÁLATA II (MONOGENOIDEA)

Összefoglalás

Matskási István

A közlemény balatoni halakból gyűjtött 13 *Dactylogyrus*, 2 *Gyrodactylus* és 1 a *Tetraonchus* genusba tartozó monogenetikus trematoda faj áttekintését tartalmazza.

A *Gyrodactylus longiradix* és *Gyrodactylus luciopercae* hazánk faunájából eddig még nem közölt faj.

ИЗУЧЕНИЕ ГЕЛЬМИНТОФАУНЫ РЫБ ОЗЕРА БАЛАТОН

И. Мачкаши

Автором описаны трематоды балатонских рыб, относящиеся к следующим группам: *Dactylogyrus* (13 видов), *Gyrodactylus* (2), *Tetraonchus* (1). Два из обнаруженных видов являются новыми для фауны Венгрии: *Gyrodactylus longiradix* и *Gyrodactylus luciopercae*.

HELMINTHOLOGICAL INVESTIGATIONS OF FISH IN LAKE BALATON II. PARASITIC NEMATODES FROM FISH IN THE LAKE

FERENC MÉSZÁROS

Zoological Department of the Hungarian Natural History Museum

Received: 28 February, 1968

In 1967, our helminthological investigations, aiming at the complete survey of the helminthofauna of fish in Lake Balaton (MÉSZÁROS 1966), were further continued. The present paper discusses the parasitic nematodes of fish species collected in 1967.

Material and methods

In the course of the year under discussion, 180 fish specimens have been studied on three occasions. The nematodes were cleared in lactophenol for identification.

Results

Of the investigated 180 fish specimens, 164 (91.8 per cent) were infested by parasitic worms. Nematodes had been shown in 95 fish specimens (57.5 per cent).

Table 1 shows the rate of infection by nematodes of the examined fish species.

The following nematode species have been identified:

Anisakidae spec.

Host: *Lucioperca lucioperca*

Localization: liver

Date of collecting: 23 May, 1967

Host: *Abramis brama*

Localization: liver

Date of collecting: 26 Sept., 1967

Camallanus lacustris (ZOEGER, 1776)

Host: *Perca fluviatilis*

Localization: pyloric appendages, intestine

Date of collecting: 23 May, 23 Aug., 26 Sept., 1967

Camallanus truncatus (RUDOLPHI, 1814)

Host: *Lucioperca lucioperca*

Table 1 — 1. Táblázat

Rate of infection of the fish species examined
A fertőzöttség mértéke a vizsgált halfajokon

Fish species Halfajok	Number of examined specimens Vizsgált halak száma	Number of parasitized specimens Fertőzött halak száma	Percentage of extensivity Extenzitás %-a
<i>Esox lucius</i>	8	5	—
<i>Rutilus rutilus</i>	20	2	10
<i>Scardinius erythrophthalmus</i>	19	12	63.1
<i>Aspius aspius</i>	15	13	86.6
<i>Alburnus alburnus</i>	1	—	—
<i>Blicca bjoerkna</i>	3	1	—
<i>Abramis brama</i>	63	37	58.7
<i>Pelecus cultratus</i>	5	—	—
<i>Carassius carassius</i>	7	2	—
<i>Cyprinus carpio</i>	2	—	—
<i>Silurus glanis</i>	1	—	—
<i>Anguilla anguilla</i>	1	—	—
<i>Lucioperca lucioperca</i>	23	16	69.5
<i>Lucioperca volgensis</i>	2	2	—
<i>Perca fluviatilis</i>	8	5	—
<i>Acerina cernua</i>	2	—	—
altogether összesen	180	95	52.7

Localization: pyloric appendages, intestine

Date of collecting: 23 May, 14 Aug., 26 Sept., 1967

Host: *Lucioperca volgensis*

Localization: pyloric appendages, intestine

Date of collecting: 23 May, 1967

Host: *Perca fluviatilis*

Localization: pyloric appendages, intestine

Date of collecting: 23 May, 26 Sept., 1967

Host: *Aspius aspius*

Localization: intestine

Date of collecting: 23 May, 14 Aug., 1967

Host: *Esox lucius*

Localization: intestine

Date of collecting: 23 May, 14 Aug., 26 Sept., 1967

Philometra ovata (ZEDER, 1803)

Host: *Abramis brama*

Localization: air bladder, body cavity (in fish infected by *Ligula*)

Date of collecting: 23 May, 14 Aug., 26 Sept., 1967

Host: *Rutilus rutilus*

Localization: air bladder

Date of collecting: 20 April, 23 May, 1967

Philometra rischta SKRJABIN, 1917

Host: *Blicca bjoerkna*

Localization: gill surface

Date of collecting: 23 May, 1967

Philometra sanguinea (RUDOLPHI, 1819)

Host: *Carassius carassius*

Localization: air bladder, body cavity

Date of collecting: 14 Aug., 26 Sept., 1967

MOLNÁR has already shown this species (1966) from the Crucian carp in another locality in Hungary.

Philometra sp.

Host: *Aspius aspius*

Localization: air bladder, body cavity

Date of collecting: 23 May, 14 Aug., 1967

Of the 15 examined specimens, I found this *Philometra* species in 10 fish exemplars. Identification was not possible, since the females were not mature. The males stand near *Ph. rischta* SKRJABIN, but their spicules were twice bigger than those of this latter species (MOLNÁR, 1967, p. 300).

Skrjabillanus erythrophthalmi MOLNÁR, 1966

Host: *Scardinius erythrophthalmus*

Localization: air bladder, body cavity

Date of collecting: 23 May, 14 Aug., 1967

Host: *Aspius aspius*

Localization: air bladder, body cavity

Date of collecting: 14 Aug., 1967

The occurrence of this parasite from the balin has not yet been published.

Host: *Abramis brama*

Localization: air bladder, body cavity

Date of collecting: 26 Sept., 1967

I have collected four mature female specimens and a male exemplar. This nematode was heretofore unknown from the bream.

Skrjabillanus scardinii MOLNÁR, 1966

Host: *Scardinius erythrophthalmus*

Localization: air bladder, body cavity

Date of collecting: 23 May, 14 Aug., 1967

Capillaria sp.

Host: *Aspius aspius*

Localization: intestine

Date of collecting: 23 May, 1967

Host: *Abramis brama*

Localization: intestine

Date of collecting: 14 Aug., 1967

Summary

Author established the occurrence of ten nematode species, on the basis of the examination of 180 fish exemplars comprising 17 fish species. The new hosts, recorded herein, of *Skrjabillanus erythrophthalmi* are *Aspius aspius* and *Abramis brama*.

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A BALATONI HALAK HELMINTHOLÓGIAI VIZSGÁLATA II
PARAZITA NEMATODÁK A BALATONI HALAKBÓL

Összefoglalás

Mészáros Ferenc

A szerző 10 Nematoda — fajelőfordulását állapította meg 17 fajhoz tartozó 180 balatoni hal vizsgálata alapján. A *Skrjabillanus erythrophthalmi* szerző által megállapított új gazdái az *Aspius aspius* és az *Abramis brama*.

ГЕЛЬМИНТОЛОГИЧЕСКОЕ ИССЛЕДОВАНИЕ БАЛАТОНСКИХ РЫБ. II.
ПАРАЗИТИЧЕСКИЕ НЕМАТОДЫ РЫБ ОЗЕРА БАЛАТОН

Ф. Месарош

При обследовании 180 особей балатонских рыб, относящихся к 17 видам, обнаружено 10 видов нематод. Показано, что хозяином *Skrjabillanus erythrophthalmi* являются *Aspius aspius* и *Abramis brama*.

UNTERSUCHUNGEN ÜBER DIE LIGULA-INFEKTION DER UNGARISCHEN FISCHFAUNA

KÁLMÁN MOLNÁR, LÁSZLÓ BÉKÉSI und GYULA HÁMORI

*Veterinärmedizinisches Forschungsinstitut der Ungarischen Akademie
der Wissenschaften, Budapest*

(Eingegangen am 28. Február, 1968)

Obwohl in Ungarn das Vorkommen von Riemenwürmern (*Ligula* sp.) schon seit längerer Zeit bekannt ist, liegen über den Befall der einzelnen Fischarten nur wenig, und über die Verbreitung der Ligulose im Lande überhaupt keine Angaben vor.

Der erste Hinweis auf eine Riemenwurm-Infektion von Fischen des Balaton stammt von RÁTZ, der 1897 über den Befall von 4 Tischarten berichtete (*Abramis brama*, *Tinca tinca*, *Perca fluviatilis* und *Lucioperca lucioperca*). Jedoch ist es aus dieser Beschreibung nicht zu entnehmen, ob der von RÁTZ als *Ligula simplicissima* CREPLIN bezeichnete Schmarotzer der nach der gegenwärtigen Nomenklatur als *Ligula intestinalis* (L., 1758), oder der als *Digamma interrupta* (RUD., 1810) bezeichneten Art entspricht. Weiterhin scheint das Vorkommen der *Ligula*-Parasiten bei den Wirtsarten *Perca fluviatilis* und *Lucioperca lucioperca* zweifelhaft zu sein, da es weder durch unsere eigenen Untersuchungen, noch durch einschlägige Literaturangaben bestätigt werden kann.

Bei seinen ausführlichen Untersuchungen ebenfalls an Balatonfischen fand JACZÓ (1941) in der Bauchhöhle von Bleien (*Abramis brama*), Schleien (*Tinca tinca*), Plötzen (*Rutilus rutilus*), Rotfedern (*Scardinius erythrophthalmus*), Karauschen (*Carassius carassius*) sowie Steinbeißern (*Cobitis taenia*) Riemenwürmer, die er als *Ligula intestinalis* identifizierte. Einige Jahre später wies der gleiche Autor (JACZÓ, 1949) in Ungarn als erster auf die wirtschaftliche Bedeutung und ökologischen Verhältnisse der Ligulose hin. Er sagte, daß diese Parasitose bei Bleien (*Abramis brama*) und Güstern (*Blicca björkna*) des Balaton beträchtliche Verluste verursache.

Riemenwürmer aus Fischen der Donau hat zum ersten Mal DUDICH (1948) beschrieben. Bei unseren eigenen Untersuchungen verließen wir uns vorwiegend auf die Arbeiten von DUBININA (1950, 1953, 1957, 1964), die die Taxonomie und Evolution der Familie Ligulidae ausführlich bearbeitet hat; hinsichtlich der Verbreitung der Ligulose beziehen wir uns auf die einschlägigen Angaben von KAMENSKI (1962), KOZICKA (1958, 1959), ORR (1967), SCHÄPERCLAUS (1954), SCHUVAEV (1966) und ŽITŇAN (1964).

Die Untersuchung der *Ligula*-Infektion wurde teils im Rahmen unserer allgemeinen faunistischen Arbeiten, teils als zielgerichtete Untersuchungen zur zahlenmäßigen Erfassung des Befalles von einigen Wirtsarten, vornehmlich aus dem Balaton, durchgeführt.

Im Laufe der zielgerichteten Untersuchungen sahen wir von der Differenzierung zwischen *Ligula intestinalis* (L., 1785) und *Digramma interrupta* (RUD., 1810) ab, da sie auf technische Schwierigkeiten stieß.

Da für die fortlaufenden, zahlenmäßig auswertbaren Untersuchungen ausschließlich Fische aus Fängen des Balatons verwendet werden konnten, beziehen sich die vorliegenden exakten Angaben nur auf die Fischpopulation dieses Sees. Für die anderen einheimischen Gewässer wurde die Stärke des Ligulabefalles an Hand der faunistischen Beobachtungen ermittelt.

Untersuchungen an Fischen des Balatons

Die Mehrzahl der untersuchten Fische wurde aus den Fischzügen des Balaton-Fischereiunternehmens (Balatoni Halászati Vállalat) bezogen; ein kleinerer Teil wurde selbst gefangen. Die von dem Unternehmen gefangenen Fische wurden während der Verarbeitung in der Konservenfabrik untersucht.

Mit dieser Methode erhielten wir detaillierte und statistisch gut auswertbare Angaben über den Riemenwurmbefall der drei Fischarten des Balatons, des Bleis (*Abramis brama*), der Ziege (*Pelecus cultratus*) und der Plötze (*Rutilus rutilus*), die konservenmäßig verarbeitet werden. Unter den selbstgefangenen Fischen kam nur der Ukelei (*Alburnus alburnus*) in einer entsprechend hohen Anzahl vor, um Folgerungen über den prozentualen Befall mit *Ligula*-Arten zu erlauben. Da aber die genannten 4 Wirte die häufigsten Arten der Cyprinidenpopulation des Balatons darstellen, dürften die über ihre *Ligula*-Infektion erhaltenen Angaben ausreichend sein, um ein Bild von der Gesamtbefallsstärke des Sees zu geben.

Die von uns identifizierten zwei *Ligula*-Arten wurden ausschließlich bei Cypriniden aufgefunden, weshalb wir nicht auf die Beschreibung der bei sonstigen Wirtarten erzielten Ergebnisse eingehen.

Neben den separat tabulierten Arten Blei, Ziege und Plötze, haben wir die folgenden Cypriniden untersucht:

Fischarten	Untersuchte Zahl der Fische	Befallene Zahl der Fische
<i>Ukelei (Alburnus alburnus)</i>	410	9
<i>Karpfen (Cyprinus carpio)</i>	6	—
<i>Schlei (Tinca tinca)</i>	7	—
<i>Karassche (Carassius carassius)</i>	2	—
<i>(Gobio albipinnatus)</i>	4	—

Im Falle der Wirtsarten Blei, Plötze und Ziege wurde in der Tabelle nur die Zahl der in der Konservenfabrik untersuchten Fische aufgeführt. Das gleiche Material diente auch für die statistische Auswertung.

Da ein recht großes Fischmaterial bearbeitet wurde, konnten wir keine genaue Altersbestimmungen durchführen. Wir teilten die Fische nach der Körperlänge in drei Größengruppen auf und schätzten ihr Alter danach ein. Die Ergebnisse waren zufriedenstellend korrekt; dabei war uns die von PÉNZES (1966) für die Bleie erarbeitete Methode der Ermittlung des Alters auf Grund

der Körperlänge von großer Hilfe. Im Falle der Plötze und der Ziege ließ sich aber diese Methode nicht mehr anwenden; wir verließen uns daher auf die Angaben von BAUCH (1953) sowie auf unsere eigenen stichprobenartigen Messungen. *Tabelle 1* zeigt die volle Körperlänge der untersuchten Individuen sowie das entsprechende Alter, wie wir es in der vorliegenden Arbeit eingeschätzt haben.

Tabelle 1. — 1. Táblázat

	Größen- gruppen:	bis 20 cm	von 20 bis 25 cm	über 25 cm
Blei	Alter:	bis 3. Sommer	4 bis 5 Sommer	über 6 Sommer
Ziege		bis 3. Sommer	4. Sommer	über 5 Sommer
Plötze		bis 6. Sommer	6 bis 8 Sommer	über 8 Sommer

Der Zusammenhang des Alters der Bleie mit ihrer Körperlänge wurde auch von SCHÄPERCLAUS (1954) in bezug auf die Bleienpopulation der Havel bei Gatow erarbeitet, wobei er auch die verschiedene Größe der Fische mit und ohne Riemenwurmbefall in Betracht zog. Leider konnten wir diese recht gute Methode wegen der rascheren Entwicklung der Balaton-Bleie selbst nicht anwenden, und wir waren auch nicht in der Lage, die Korrektur für befallene und nicht befallene Fische zu benutzen; bei der Auswertung der Ergebnisse zogen wir jedoch diese Fehlerquelle in Betracht.

Während der Bearbeitung in der Konservenfabrik wurden insgesamt 10 880 Bleie, Plötzen und Ziegen untersucht. Die Anzahl der während der einzelnen Untersuchungsperioden besichtigten Fische sowie die entsprechenden Prozentanteile der Befallsstärke wurden in *Tabelle 2*, die nach den Größengruppen so wie nach Arten summierten Angaben in *Tabelle 3* aufgeführt.

Den höchsten Prozentanteil der Befallsstärke fanden wir bei den Plötzen, unter denen 4.83% der untersuchten Individuen mit Ligulen befallen waren; in der jüngsten (unter 20 cm großen) Altersgruppe erreichte die Befallsstärke sogar 8.51%. Einen ähnlich hohen Riemenwurmbefall stellten wir auch bei den Bielen fest, bei denen die durchschnittliche Befallsstärke 4.19% ausmachte. Im Vergleich mit den vorigen zwei Arten bei der Ziege dürfte die Befallsstärke als belanglos betrachtet werden, da sie sogar in der Größengruppe unter 20 cm bloß 0.32% war.

Die Auswertung der in den Tabellen 2 und 3 aufgeführten Angaben ergibt, daß die Befallsstärke bei allen drei Arten in der jüngsten Größengruppe am höchsten war. Bei den 20 bis 25 cm großen Fischen war sie verhältnismäßig niedriger, obwohl im allgemeinen noch immer ziemlich hoch, unter den älteren Fischen dagegen fanden wir nur wenige, unter den Ziegen sogar keine befallene Individuen.

Diese Beobachtungen weisen darauf hin, daß bei der Fischpopulation des Balatons der Riemenwurmbefall mit dem fortschreitenden Alter abnimmt.

Tabelle 2.

Untersuchungs- zeiten	Blei											
	bis 20 cm			20—25 cm			über 25 cm					
	n	l	p	n	l	p	n	l	p	n	l	p
6. XI. 1965	427	33	7,7	286	18	6,2	174	—	—	22	8	36,3
13. XI.	63	25	39,6	52	16	30,7	43	1	2,3	10	1	10,0
20. XI.	182	7	3,8	438	4	0,9	380	1	0,2			
26. XI.	233	9	3,8	168	4	2,3	53			28	1	3,5
30. XI.	310	6	1,9	225	2	0,8	105	—	—			
1. XII.	452	23	5,0	268	12	4,5	188	—	—	43	1	2,3
6. XII.	292	3	1,0	215	—	—	49	—	—			
5. III. 1966	570	23	4,0	724	33	4,5	449	—	—	38	1	2,6
18. III.	155	37	23,8	108	20	18,5	15	1	6,6			

n = untersuchte Individuen

l = befallene Zahl

p = % Befallsstärke



Abb. 1. Mit Riemenwürmern infizierte Bleie

1. kép. Ligulálakkal fertőzött dévérek

Der Vergleich des Infektionsgrades mit dem Zusammenhang zwischen Größe und Alter (Tabelle 1) ergibt, daß die Ligulose der Balatonfische nur bis zum 5- bis 6sömmrigen Alter von Bedeutung ist. Über dieses Alter kommt die Riemenwurmkrankheit nur vereinzelt vor.

Die Tatsache, daß der Befall der unter 20 cm großen Plötzen den der gleich großen Bleie übertrifft, wogegen in der 20 bis 25 cm Größengruppe die Ligulose bei den letzteren häufiger ist, bestätigt weiterhin die Beobachtung, daß im Balaton die Ligulose die Erkrankung der einige Jahre alten Fische ist, da die Plötzen der ersten Gruppe wegen ihrer langsamen Entwicklung nach ihrem Alter den Bleien erster und zweiter Kategorie gleichkommen. Die Stichproben wurden jeweils dem durch das Fischereiuunternehmen ausgefangenen Material entnommen: die gleiche Maschenweite des Netzes läßt aber Fische von

— 2. Táblázat

Plötze						Ziege								
20—25 cm			über 25 cm			bis 20 cm			20—25 cm			über 25 cm		
n	l	p	n	l	p	n	l	p	n	l	p	n	l	p
42	5	11,9	12	—	—	104	4	3,8	208	—	—	43	—	—
9	—	—	9	1	11,1	564	3	0,5	920	1	0,1	110	—	—
						200	1	0,5	320	—	—	80	—	—
52	1	1,9	20	—	—	255	2	0,7	287	—	—	98	—	—
89	—	—	25	—	—	210	1	0,4	266	1	0,3	115	—	—
46	4	8,6	31	—	—									

Tabelle 3. — 3. Táblázat

Fischarten	Gesamtlänge der Fische	Untersuchte Zahl der Fische	Zahl der befallenen Fische	% Befallsstärke
Blei	bis 20 cm	2684	166	6,18
	20—25 cm	2484	109	4,38
	über 25 cm	1456	3	0,20
	insgesamt	6624	278	4,19
Plötze	bis 20 cm	141	12	8,51
	20—25 cm	238	10	4,20
	über 20—25 cm	97	1	1,03
	insgesamt	476	23	4,83
Ziege	bis 20 cm	1333	11	0,82
	20—25 cm	2001	2	0,10
	über 25 cm	446	0	—
	insgesamt	3780	13	0,34

gleicher Körpergröße durch, demgemäß waren die ausgefangenen schnell wachsenden Bleie 2—3sömmrig, die langsam wachsenden Plötzen und die langen Ziegen noch älter.

Aus dem gleichen Grund sehen wir von der statistischen Auswertung der Ligulose bei dem Güster (*Blicca björkna*) ab, da diese Art, obwohl sie ziemlich häufig ist, langsam wächst und nur selten die der Netzreife entsprechende Körpergröße erreicht. Untersuchungen der selbstgefangenen aber nicht ausgewerteten Individuen jedoch zeigen einen verhältnismäßigen Befall mit *Ligula-Plerocercoiden* sowohl bei dem Güster (*Blicca björkna*) als auch beim Ukelei (*Alburnus alburnus*), und obwohl diese Arten keinen besonderen wirtschaftlichen Nutzen haben, dürften sie bei der Aufrechterhaltung der Ligulose eine bedeutende Rolle spielen.

Die Riemenwurminfektion der Balatonfische wurde weiterhin unter zwei Gesichtspunkten studiert: einerseits wurde untersucht, welche Faktoren für die Verschiedenheit des Befalles in den einzelnen Altersgruppen verantwortlich sind, andererseits durch welche Wirt-, bzw. Zwischenwirtkreise die Infektion erfolgt.

Ein höherer Prozentanteil der Riemenwurminfektion unter den niedrigeren Altersgruppen der Bleie, Plötzen und Rotfeldern wurde von KAMENSKI und SCHUVAEV bei der Fischpopulation des Kachovskier Wasserspeichers bzw. der Achatarsker Bucht beobachtet. Unsere Ergebnisse stimmen auch mit denen von SCHÄPERCLAUS (1954) überein, der bis zum Alter von 4–6 Sommern

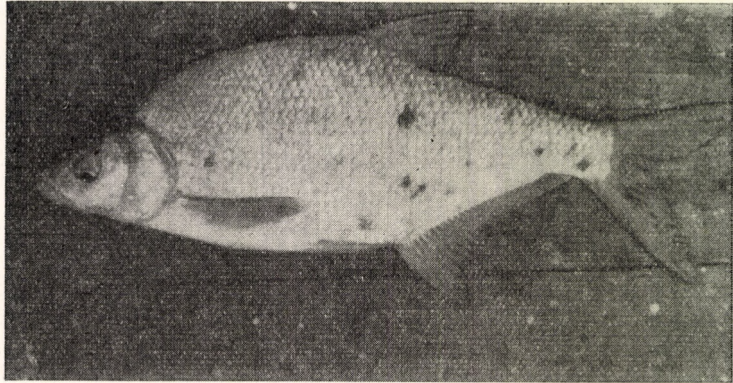


Abb. 2. Nichtinfizierter Blei

2. kép. Liguláktól mentes dévér

einen allmählichen Anstieg, darnach ein Abnehmen der Ligulose beschrieb. Der von SCHÄPERCLAUS nachgewiesene Zusammenhang zwischen der Größe und dem Alter der Bleie steht im guten Einklang mit unseren Beobachtungen. ŽITŇAN dagegen behauptet, bei der Plötzenpopulation eines Grubenteiches sei der Infektionsgrad mit dem Alter angestiegen und habe bei manchen älteren Individuen sogar 100% erreicht.

Der Widerspruch dieser Angaben wird verständlich, sobald die Entwicklung der Ligulose in Abhängigkeit der Ernährungszustände untersucht wird. In dem von ŽITŇAN beschriebenen Grubenteich dürften die Fische — wie überall in ähnlichen Gewässern — nur zu wenig Nahrung gekommen haben und dementsprechend fraßen auch die älteren Fische zumeist Plankton, das die Quelle der Infektion ist. Dagegen im Balaton u.a. Teichen sowie in den Wasserspeichern ernähren sich die Fische, nachdem sie ein gewisses Körpergewicht erreicht haben, vornehmlich von Nahrung vom Teichboden, wobei die Chancen der Infektion auf das Minimum reduziert werden. Dies dürfte die fallende Tendenz der Ligulose bei den über 25 cm großen Fischen erklären. Weiterhin geht ein Teil der infizierten Fische an der Ligulose zugrunde, und bei den Überlebenden verlangsamt sich die Entwicklung so, daß sie die Größenstufe über 25 cm meistens nicht erreichen können. Die von den Riemenwürmern befallenen Fische verbleiben Planktonfresser und ihre Körperdimensionen nehmen nur im geringen Grade zu.

Sowohl *Ligula intestinalis* als auch *Digamma interrupta* sind außerordentlich schädliche Schmarotzer der Fische. Die Besiedlung durch einen einzigen Parasiten kann bereits zu einer andauernden, ja sogar tödlichen

Schädigung des Wirtes führen, durch Deformierung, Verwachsung der inneren Organe, parasitische Kastration usw. oder aber durch Prädisponierung für sonstige Parasitosen (z. B. Philometrose). Da nach unseren Beobachtungen ein einziger Wirt sogar von 3–5 Riemenwürmern besiedelt werden kann, dürfte die Ligulose der Balatonfische als eine wirtschaftlich bedeutende Schädlichkeit

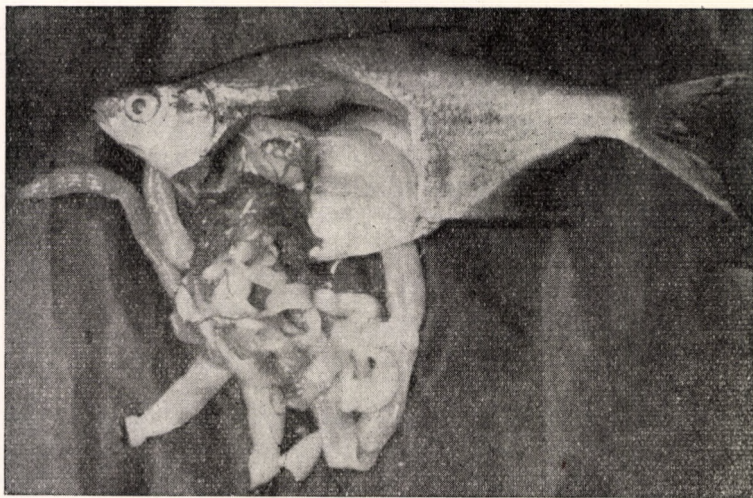


Abb. 3. Infizierter Blei mit aus der Bauchhöhle herausgehobenen Riemenwürmern

3. kép. Ligulás dévér a hasüregből kiemelt ligulákkal

aufgefaßt werden. Die Frage ist, welche Faktoren die Entstehung der Infektion begünstigen. Aus den Arbeiten von DUBININA ist es bekannt, daß der Entwicklungsgang der zwei Bandwürmer im großen und ganzen gleich ist und neben den die Plerocercoiden beherbergenden Fischen Krebschen (*Cyclops* und *Diaptomus*-Arten) als Zwischenwirte und fischfressende Wasservögel als Endwirte eine Rolle spielen.

Sämtliche Entwicklungsphasen der *Ligula*-Arten haben einen verhältnismäßig breiten Wirtskreis. Zweifellos kommen die häufigsten Krebs-Zwischenwirte, wie *Cyclops strenuus*, *Acanthocyclops viridis*, *Eucyclops serrulatus* und *Diaptomus gracilis* reichlich im Balaton vor, meistens in der Nähe der Brutstellen der Wasservögel im Schilf. Auch die Plerocercoid-tragenden Cypriniden sind recht häufig. Daraus aber läßt sich die vorliegende hohe Inzidenz der Ligulose nicht erklären, da die Wasservogel-Fauna recht ärmlich ist.

Infolge des Ausbaus des Balatonufers und der damit verbundenen Ausrottung des Schilfes an vielen Stellen hat „der große Balaton“ einen beträchtlichen Teil seiner Vogelwelt verloren, besonders aber die zur Familie Ardeidae gehörigen Reiherarten, die groß genug sind, auch die Plerocercoid-tragenden Bleie und Plötzen auffressen zu können.

Demgemäß dürfte angenommen werden, daß, obwohl die Ligulose des Bleis als des häufigsten Balatonfisches die höchste Inzidenz zeigt, die Infektionskette doch nicht durch den Blei-Reiher Kreis, sondern vielmehr

durch die Verbindung einer kleineren Fischart und eines kleineren Raubvogels aufgehalten wird, mit Einschließung von Cyclopoden als Zwischenwirte.

Unter den Raubvögeln kommen in erster Linie die Lappentaucher (Podicipitidae) in Frage, die viel häufiger als die Reiher sind. Der Lappentaucher kann noch 3–4sömmrige Plötzen verzehren. Weiterhin kommen auch die Möwen und Seeschwalben (Laridae), die meistens von Ukeleien infiziert werden, in Betracht.

Untersuchungen an Fischen aus sonstigen Gewässern

In den Flüssen Ungarns (Donau, Theiß, Kőrös) dürfte die Ligulose der Fischpopulation unbedeutend sein, da wir bislang nur bei Ukeleien (*Alburnus alburnus*) aus der Donau die *Ligula intestinalis* nachweisen konnten. In den toten Armen der Flüsse werden jedoch öfter von Riemenwürmern befallene Fische, namentlich Bleie, aufgefunden.

Im Velencer-See, der dem Balaton ähnlich auch eine recht große Wasseroberfläche darstellt, dürfte sich die Ligulose der Fischpopulation ähnlich wie im Balaton gestalten, obwohl im Laufe unserer faunistischen Untersuchungen die Riemenwurminfektion in erster Reihe bei der Rotfeder (*Scardinius erythrophthalmus*) beobachtet werden konnte.

In Kulturteichen ist die Ligulose des Karpfens (*Cyprinus carpio*) eine Rarität. Die jüngst eingeführte pflanzenfressende Fischart, der Graßkarpfen (*Ctenopharyngodon idella*) erwies sich jedoch recht empfänglich sowohl für *Ligula intestinalis* als auch für *Digamma interrupta*. In manchen Fischwirtschaften wurde unter den 2–3sömmrigen Graßkarpfen ein 20–50%iger Riemenwurmbefall mit tödlichem Ausgang beobachtet.

In einer Fischwirtschaft im Gebiet zwischen der Theiß und der Donau trat eine schwere Ligulose unter Karauschen (*Carassius carassius*) auf. In diesem Fall war ausschließlich *Digamma interrupta* für die Infektion verantwortlich.

Diskussion

Unsere Untersuchungen zeigten, daß die Ligulose sowohl in den natürlichen Teichen als auch in den Kulturteichen Ungarns eine bedeutende und weit verbreitete Fischkrankheit ist. Sämtliche Cypriniden sind für die Riemenwurmkrankheit empfänglich, jedoch scheint ihr Auftreten von der Art, der Altersgruppe sowie von den ökologischen Verhältnissen der einzelnen Biotope stark beeinflußt zu sein. Dies erklärt die Tatsache, daß der Befall mit Riemenwürmern in manchen Teichen bei der Karausche, in anderen bei dem Graßkarpfen und der Rotfeder, im Balaton dagegen bei den Bleien und Plötzen am stärksten war, obwohl in den gleichen Gewässern auch sonstige Fischarten als Wirte in Frage kommen können. Diese Annahme wird auch von Kozickas Beobachtungen bestätigt, wonach im Druzno-Teich die Inzidenz der Riemenwurmkrankheit bei den Bitterlingen am höchsten war (72.2%), bei denen wir in den ungarischen Gewässern überhaupt keine Ligulen aufgefunden haben.

Die Bedeutung der Ligulose beruht auf ihrem großen wirtschaftlichen Schaden, der besonders in den Fischwirtschaften eingeschätzt werden kann.

In den Kulturteichen nämlich verendete beinahe die Hälfte der mit *Ligula* infizierten Fische. Nach unseren Beobachtungen dürfte aber die Schädlichkeit der Riemenwurmkrankheit auch in den natürlichen Gewässern nicht ohne Belang sein; die Mortalität kann zwar nicht eingeschätzt werden, aber im Laufe unserer Untersuchungen in der Konservenfabrik konnte bei 4.19% der Bleie, die mit Riemenwürmern befallen waren, ein großer Verlust an Wert und Marktgängigkeit festgestellt werden.

Ein weiterer Schaden erwächst aus der parasitischen Kastration der befallenen Fische. Im Einklang mit ORRS Beobachtungen (1967) an der Rotfeder (*Scardinius erythrophthalmus*) fanden auch wir bei den meisten untersuchten Fischen eine Verkümmern der Geschlechtsorgane.

Unsere hier erörterten Angaben, die auf einem viel umfangreicheren Material beruhen als die bisherigen einschlägigen Berichte, bestätigen im wesentlichen die über die ökologischen Zusammenhänge der Ligulose ausgebildeten Vorstellungen und tragen zugleich einheimische Angaben bei.

Zusammenfassung

Der Befall von Balatonfischen und Kulturfischen mit Plerocercoiden der *Ligula intestinalis* und *Digramma interrupta* wurde untersucht.

Unter den wirtschaftlich bedeutenden Fischen des Balatons war die Ligulose bei 4.19% der Bleie, 4.83% der Plötzen und 0.34% der Ziegen festgestellt. Innerhalb der einzelnen Arten war das Auftreten der Krankheit unter den 3 bis 5-sömmrigen Fischen am höchsten.

In den Fischwirtschaften kommt die Ligulose in erster Reihe unter den Graßkarpfen und Karauschen vor, in hohem Prozentanteil und oft mit tödlichem Ausgang.

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VIZSGÁLATOK A MAGYARORSZÁGI HALAK LIGULÁS FERTŐZÖTTSÉGÉRE VONATKOZÓAN

Összefoglalás

Molnár Kálmán, Békési László és Hámori Gyula

A szerzők a balatoni és tógazdasági halak *Ligula intestinalis* és *Digramma interrupta* plerocercoidokkal való fertőzöttségét vizsgálták.

Megállapították, hogy a Balaton halászatilag fontos halai közül a dévér 4,19%-a, a koncér 4,83%-a, a gardának pedig 0,34%-a fertőzött ligula plerocercoidokkal. Az egyes halfajokon belül elsősorban a 3—5 nyaras halak fertőzöttsége számottevő.

Tógazdasági vonatkozásban a ligulózis elsősorban az amur és a kárász állományban jelentkezik, ahol súlyos elhullásokra vezető magasfokú fertőzöttséget okozhat.

ИЗУЧЕНИЕ ЗАРАЖЕННОСТИ РЫБ ВЕНГРИИ

К. Мольнар, Л. Бекеши и Д. Хамори

Изучалась зараженность рыб озера Балатон и искусственных водоемов видами *Ligula intestinalis* и *Digramma interrupta*.

Как установлено, у рыб Балатона зараженность такова: лещ — 4,19%, плотва — 4,83% и чехонь — 0,34% (цифры для зараженности *Ligula* p.). Особенно сильно заражены рыбы в возрасте 3—5 лет.

Из рыб искусственных водоемов сильнее всего заражены амур и карась.

ÜBER DIE CHEMISCHEN VERHÄLTNISSE DES OFFENEN WASSERS DES BALATONSEES NACH UNTERSUCHUNGEN IM JAHRE 1966 UND 1967

ÉVA ORSÓS

*Station des Gesundheits- und Seuchenbekämpfungsdienstes des Komitats,
Veszprém*

Eingegangen: am 28 Februar, 1968

Über die chemische Zusammensetzung des Wassers des Balatonsees sind in den letzten 10 Jahren mehrere Artikel erschienen. Als erstes möchte ich die Arbeit von BÉLA ENTZ (1959) erwähnen, welche sich in Verbindung mit der Beschreibung der Eigenheiten und der Verunreinigung der Gewässer in der Umgebung des Balatonsees auch mit der Erforschung des Wassers des Balatonsees beschäftigt hat. SZILÁRD PAPP und seine Mitarbeiter veröffentlichten im Jahre 1960 eine Arbeit, »Komplexe hygienische Untersuchung des Wassers des Balatonsees«, welche sich mit den Ergebnissen der Untersuchungen von 1957 und 1958 beschäftigt und auch die biologischen und bakteriologischen Verunreinigungen beinhaltet. Als letztes erschien im Jahre 1963 eine umfassende Veröffentlichung aus dem Wissenschaftlichen Wasserwirtschaftsforschungsinstitut, »Die Untersuchung der Wasserqualität des Plattensees«, welche die Ergebnisse der Forschungen von 1957 bis 1960 zusammenfasst. Seit 1960 sind unseres Wissens nach gleichartige umfangreiche Untersuchungen nicht geschehen. Die massenhafte Fischverendung im Jahre 1965 hat die Aufmerksamkeit wieder auf die qualitative Untersuchung des Wassers des Balatonsees gelenkt. Die hydrobiologischen, bakteriologischen, chemischen und nach pesticiden Resten forschenden Untersuchungen begannen unter Einbeziehung verschiedener Institute mit grossem Aufwand. Davon übernahm das wasserchemische Laboratorium der Seuchenbekämpfungsstation Veszprém die nach Segmenten und nach Tiefen vorgehende Untersuchung der gewöhnlichen die Wasserzusammensetzung charakterisierenden Komponenten des Wassers des Balatonsees, dazu kamen die an Ort und Stelle ausführbaren Untersuchungsmöglichkeiten, die ergänzt wurden durch die routinemässig ausführbaren Kationen- und Anionenuntersuchungen. Die Bestimmung von Spurenelementen oder besonderen organischen Bestandteilen konnten wir in solchem großen Umfang nicht durchführen, jedoch entsprachen die untersuchten Komponenten fast vollkommen den Elementen, die in den vorhergehenden sich mit Balatonseewasser beschäftigenden Arbeiten vorkommen und sind somit vergleichbar.

Wasserprobenentnahmestellen, analytische Methoden

Die Wasserprobenentnahme geschah vom Schiff des Biologischen Forschungsinstitutes zu Tihany aus zusammen mit der Probenentnahme für bio-

logische Untersuchungen an den durch das Institut bestimmten Probenentnahmestellen (*Abb. 1*). In den Segmentlängen, die auf der Balatonseekarte zu sehen sind, haben wir jeweils an 3 Stellen in 3 Tiefen Proben entnommen und die an Ort und Stelle durchführbaren Messungen durchgeführt. 1966 haben wir 360 Proben, 1967 315 Proben auf folgende Komponenten hin untersucht;

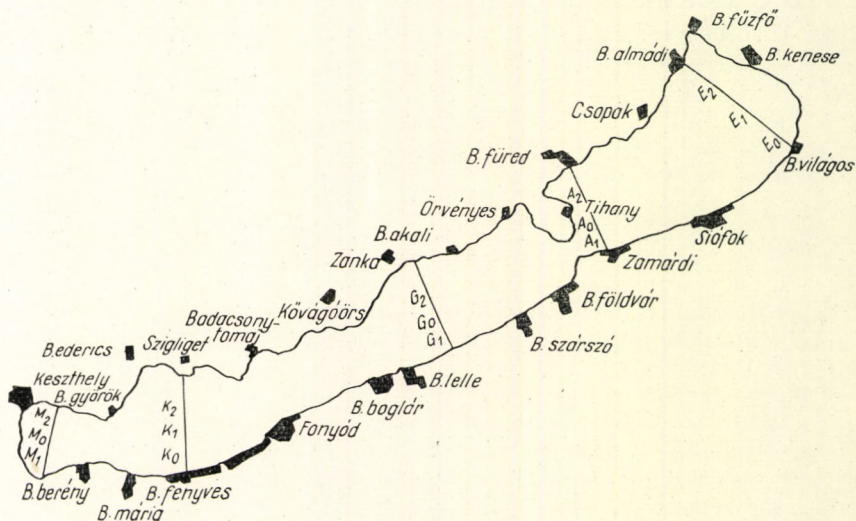


Abb. 1. Die schematische Darstellung der Landkarte des Plattensees mit der Angabe der einzelnen Probeentnahmestellen

1. ábra. A Balaton vázlatos térképe a mintavételi helyek megjelölésével

1. An Ort- und Stelle- im Wasser gelöstes Oxygen, freie Kohlensäure, Wasser- und Lufttemperatur.

2. Weiterhin-sämtliche feste Bestandteile, der Gehalt organischer Substanzen, Chloridgehalt, Gehalt an Nitrit, Nitrat, Ammoniak, Sulfat, Eisen, Mangan, Kalzium, Magnesium, Basizität, Gesamthärte, Siliziumdioxidgehalt, Fluor, Phenol an den exponierten Stellen, in der Nähe der Einmündungen industrieller Abwässer und bakteriologische Untersuchung auf *E. coli*. Als Bestimmungsmethode haben wir in Übereinstimmung mit der Wasserabteilung des Staatlichen Volksgesundheitsinstitutes den vom ungarischen Normungsamt 1963 veröffentlichten »Wasseruntersuchungsnormen«-Band Seite 448/1–448/31 verwendet, für die bakteriologische Untersuchung Seite 22.901–54. Diese Methoden zeigen eine geringe Abweichung von den im Wissenschaftlichen Wasserwirtschaftsforschungsinstitut angewendeten Normverfahren.

Ergebnisse

Auf Grund des Abimpfens gemäß der Norm für natürliche Trinkwässer war das Wasser des Plattensees in bakteriologischer Hinsicht im allgemeinen als negativ zu bezeichnen. 1966 waren unter allen Proben 34 positiv, das sind ca. 10%. Die darunter positivsten Werte, 50–100 Coli, haben wir in dem

Segment Balatonalmádi—Balatonvilágos gefunden. Aus bakteriologischer Hinsicht war das Wasser im Segment Balatonszemes-Ságpusztá am saubersten, wo keine der Proben positiv war. 1967 waren 72 Proben, das sind cca. 20% der Gesamtproben, positiv, in dieser Hinsicht zeigte sich also eine leichte Verschlechterung.

Aus chemischer Hinsicht lassen sich auf Grund der Daten folgende Rückschlüsse ziehen: (die Tiefendurchschnittswerte sind der *Tabelle 1* zu entnehmen).

Der Sauerstoffverbrauch zeigte verschiedene Werte, jedoch zeigte der Anteil der organischen Stoffe der zu verschiedenen Zeiten in verschiedenen Segmenten und Probenentnahmestellen und Tiefen entnommenen Proben an den jeweiligen Stellen keine wesentlichen Veränderungen. Den höchsten Sauerstoffverbrauch zeigten die in der Gyenesdiás-Zala-Mündungslinie entnommenen Proben, er lag im allgemeinen bei 5 mg/l oder sogar noch darüber. Bei diesem Wert spricht man bereits laut von vom Staatlichen Volksgesundheitsinstitut veröffentlichten Normen für qualitative Einteilung der Oberflächenwasser von einer mittelstarken Verschmutzung. Der Anteil der organischen Stoffe zeigt in Richtung des Segments Szigliget-Balatonmáriafürdő eine fallende Tendenz, jedoch liegt der Durchschnitt immer noch über 4 mg/l. In der Linie Balatonszemes-Ságpusztá ist der Wert noch geringer, er steigt kaum über den erlaubten Grenzwert des Trinkwassers. Am niedrigsten liegt er in der unteren Segmentlänge Balatonfüred—Zamárdi, im Durchschnitt bei 2,8—3 mg/l. Der Plattensee wird durch den in die Keszthelyer Bucht mündenden Zala und durch die mit ihm kommenden Abwässer, weiterhin durch die Schlachthofabwässer und durch den durch die Stadt fließenden und ebenfalls hier einmündenden Büdös-Árok (zu deutsch »stinkender Graben«) stark verschmutzt. Diese Gewässer lassen ihre verunreinigende Wirkung noch auf große Entfernung hin bemerkbar werden, da die Selbstklärungsfähigkeit des Sees zur Verminderung des Gehaltes an organischen Anteilen unzureichend ist. Damit proportional wäre zu erwarten, daß die Sauerstoffsättigung in dieser Bucht die kleinste sei. Die Verminderung des Gehaltes an gelöstem Sauerstoff steht jedoch mit der Erhöhung des Sauerstoffverbrauches in keinem Verhältnis, wie wir es von den Gewässern mit geringerer Wasserenergieigkeit gewöhnt sind, jedoch wird der gelöste Sauerstoff durch neuen ersetzt, da das Wasser mit der Luft an einer großen Oberfläche in Berührung kommt, somit ist er im allgemeinen nur an wenigen Stellen unter dem Grad der vollständigen Sättigung. Natürlich vermindert er sich hauptsächlich mit der Zunahme der Temperatur, im allgemeinen jedoch befindet er sich im gesättigten Zustand. Der Gehalt des Wassers an gelöstem Sauerstoff vermindert sich proportional mit der Tiefe, der Sauerstoffgehalt der an der Oberfläche bzw. in Tiefe von 0,3, 1,2 und 3 m entnommenen Proben vermindert sich pro Meter um 0,2—0,3 mg/l. Dies kann jedoch mit der Wassertemperatur in den tiefen Regionen in Zusammenhang gebracht werden, so daß das Wasser letzten Endes auch dort als gesättigt angesehen werden kann.

Nitrate und Nitrite waren nirgends in meßbaren Mengen zu finden, an einigen Stellen war Ammoniak in Spuren nachweisbar.

Die Werte der Basizität und der Gesamthärte zeigten ein ziemlich ausgeglichenes Bild, der erstere 5—5,5 ml n HCl/l, letzterer 14—15 D°. Innerhalb der Gesamthärte hat sich jedoch an den verschiedenen Entnahmestellen die Menge des Kalzium- und Magnesiumsalzes verändert.

Mangan konnten wir im Laufe der Untersuchungen auf Schwermetalle nicht nachweisen, sein Wert war überall gleich null. Eisen fand sich in sehr

Tabelle 1 — 1. Táblázat
Chemische Zusammensetzung der in den Jahren 1966—1967 aus dem Balatonsee entnommenen Wasserproben
A Balatonból vett vízminták kémiai összetétele 1966—1967 évben

Sammelstellen Gyűjtőhelyek	Datum Dátum	Coli-Zahl Coli szám	O ₂ Verbrauch, mg/l O ₂ fogy., mg/l	Alkalinität HC/l	Gesamthärte Összkeménység	SO ₄ ²⁻	Fe ⁺⁺	Ca ⁺⁺ mg/l	Mg ⁺⁺ mg/l	SiO ₂ mg/l	Gelöstes O ₂ mg/l Oldott O ₂ mg/l	Gesamtfestbe- standteil mg/l Összes szilárd a. rész mg/l	Lufttemperatur Levegőhőfok C°	Wassertempe- ratur Víz hőfok, °C	Cl ⁻ mg/l
M/2	66-05-17	0	4,46	6,0	16,4	0	0,02	63,88	22,5	2,0	13,65	585	21	19,8	13
M/0	66-05-17	0	5,17	5,6	14,3	0	0,03	69,5	11,8	3,0	12,6	562	20	20	16
M/1	66-05-17	0	5,06	6,0	15,1	0	0,02	66,6	23,16	2,3	12,5	608	19	19	16
K/2	66-05-17	0	6,32	5,7	14,4	0	0,05	82,6	11,29	0,2	12,4	529	22	19	12
K/1	66-05-17	3	5,68	5,2	11,8	0	0,02	81,27	11,04	3,3	12,12	576	22,4	19	10
K/0	66-05-17	0	4,56	5,8	11,8	0	0,02	62,39	16,7	0,45	14,4	576	20	20	12
G/2	66-05-17	0	3,89	6,3	13,6	0	0,02	50,52	18,42	0,5	12,02	545	21	19	16
G/0	66-05-17	0	4,84	6,0	12,75	0	0,01	52,41	24,17	2,3	13,25	545	21	20	16
G/1	66-05-17	4	4,08	5,7	11,65	0	0,02	54,97	24,32	2,0	13,71	550	21	19,1	16
A/2	66-05-18	0	2,8	5,1	14,75	g-n	0,02	45,02	17,67	0,2	11,51	535	24	22	10
A/0	66-05-18	0	3,1	6,1	14,4	i-g-n	0,03	41,49	13,89	0	11,8	521	24	21	12
A/1	66-05-18	0	2,6	5,4	14,6	i-g-n	0,04	40,72	14,33	0,05	11,3	484	20	20	10
E/2	66-05-18	0	3,0	5,3	16,0	g-n	0,02	48,47	27,69	0,6	11,2	517	20	20	20
E/1	66-05-18	0	2,98	5,0	14,88	g-n	0,06	48,30	27,77	0,4	11,2	530	20	20	16
E/0	66-05-18	0	2,8	5,3	14,8	g-n	0,04	42,17	13,55	0,5	11,55	469	22	20	14
M/2	66-06-14	0	4,24	6,2	15,2	g-n	0,02	51,8	28,89	0,4	8,05	597	26	24	12
M/0	66-06-14	0	4,58	6,2	15,2	g-n	0,025	55,1	28,03	0,1	8,25	510	23	25	16
M/1	66-06-14	0	5,44	6,0	15,0	g-n	0,02	54,8	28,11	0,4	8,4	575	24	23	14
K/2	66-06-14	0	4,64	6,0	15,0	g-n	0,02	53,42	29,90	0,4	8,74	519	26	23	16
K/1	66-06-14	0	4,36	5,7	12,7	g-n	0,02	54,15	28,13	0,6	9,53	575	28	23	20
K/0	66-06-14	0	3,96	6,0	13,0	g-n	0,04	52,2	28,38	0,4	8,22	550	28	23,5	10
G/2	66-06-14	0	4,0	5,4	13,8	g-n	0,03	47,45	30,33	0,4	8,71	578	24	23	16
G/0	66-06-14	0	4,3	5,0	15,8	g-n	0,03	52,13	25,94	0,5	10,0	544	26	23	16
G/1	66-06-14	0	4,3	5,6	15,0	g-n	0,04	48,55	28,16	0,4	9,3	527	26	23	16
A/2	66-06-15	0	3,32	5,0	14,8	g-n	0,06	50,47	34,08	2,2	7,93	568	23	22	14
A/0	66-06-15	0	3,46	5,3	15,3	g-n	0,03	46,8	32,35	0,8	9,86	603	24	22	14
A/1	66-06-15	0	2,92	5,2	15,3	g-n	0,1	53,75	34,88	2,2	7,90	486	23	21	12
E/2	66-06-15	0	3,24	5,3	15,8	g-n	0,02	48,05	39,86	2,0	9,73	512	22	22	14
E/1	66-06-15	0	3,93	6,0	15,4	g-n	0,03	44,73	29,93	0,6	8,87	603	23	22	20
E/0	66-06-15	0	3,86	6,3	14,56	g-n	0,1	43,96	26,25	0,1	9,45	520	23	22	20

M/2	66-07-26	5	4,33	5,4	13,4	0	0,05	49,07	26,52	1,3	8,97	544	19	20	12
M/0	66-07-26	5	4,2	5,2	14,5	g-n	0,03	51,93	28,66	2,0	8,50	562	19	19	15
M/1	66-07-26	6	4,8	5,0	14,4	g-n	0,04	50,88	26,92	4,5	8,18	532	19	19	12
K/2	66-07-26	0	4,0	5,6	14,3	0	0,03	53,59	26,93	2,0	8,35	523	20	20	10
K/1	66-07-26	0	3,86	5,6	13,6	0	0,12	45,02	22,14	2,0	8,43	504	20	20	10
K/0	66-07-26	0	3,88	5,3	13,0	0	0,03	48,59	25,61	3,0	8,51	579	20	20	12
G/2	66-07-26	0	3,94	5,1	15,0	0	0,02	52,16	30,40	4,0	9,36	520	20	20	10
G/0	66-07-26	0	3,74	5,0	15,1	0	0,02	50,74	29,53	1,8	9,07	600	21	20	10
G/1	66-07-26	0	3,6	5,1	15,1	0	0,02	50,74	29,53	0,2	9,42	573	21	20	10
A/2	66-07-27	0	3,3	5,0	14,0	i-g-n	0,02	42,88	25,62	0	8,84	594	24	21,5	12
A/0	66-07-27	0	3,0	5,0	15,4	i-g-n	0,1	50,38	23,00	0	9,52	584	21	25	14
A/1	66-07-27	0	3,28	5,2	15,5	i-g-n	0,04	47,88	26,35	0	7,21	520	23	21	12
E/2	66-07-27	0	3,32	5,0	14,8	g-n	0,02	45,38	26,05	0	9,69	617	25	22	10
M/2	66-08-23	0	5,48	5,0	14,5	i-g-n	0,03	55,26	21,88	0	9,1	447	23	22	10
M/0	66-08-23	4	5,12	4,7	14,7	i-g-n	0,02	50,98	18,52	0,2	9,54	508	23	22	10
M/1	66-08-23	0	5,25	5,0	15,2	i-g-n	0,02	58,12	22,94	0	9,9	485	20	22	16
K/2	66-08-23	0	4,9	4,8	14,2	g-n	0,02	45,74	20,87	0,2	9,56	547	26	23	10
K/1	66-08-23	0	4,32	4,7	14,8	g-n	0,02	45,38	19,54	0,2	9,74	545	25	22,8	10
K/0	66-08-23	7	4,6	5,0	14,4	g-n	0,03	44,31	21,39	0	9,73	522	23	22	10
G/2	66-08-23	0	4,24	4,8	15,0	g-n	0,02	43,23	20,79	0,1	8,2	564	23	23	10
G/0	66-08-23	0	3,24	4,9	14,0	g-n	0,02	51,45	18,24	0	8,58	529	23	23	10
G/1	66-08-23	2	4,55	4,9	14,5	g-n	0,03	45,02	21,56	0	8,53	558	23	23	10
A/2	66-08-24	0	3,2	5,1	15,0	g-n	0,02	43,29	19,97	0	8,52	601	27	22	16
A/0	66-08-24	0	4,5	5,3	15,0	g-n	0,02	48,26	19,48	0	8,40	538	26	23	16
A/1	66-08-24	0	3,5	5,2	14,6	g-n	0,04	43,23	19,54	0	8,53	512	27	22	14
E/2	66-08-24	0	3,1	5,8	14,3	g-n	0,03	44,31	19,1	0	8,67	624	21	22	10
E/1	66-08-24	1	3,46	5,8	15,0	g-n	0,04	43,59	20,40	0	8,95	643	22	22	15
E/0	66-08-24	0	3,44	5,5	15,2	g-n	0,02	44,02	22,11	0	8,76	531	22	22	20
M/2	66-09-21	0	4,96	4,9	16,0	g-n	0,02	45,26	24,76	4,0	10,0	521	20,5	17	14
M/0	66-09-21	0	4,48	4,9	14,9	g-n	0,02	46,21	22,75	4,0	9,9	556	20	17	14
M/1	66-09-21	0	4,74	4,9	15,2	g-n	0,04	43,31	23,02	2,0	10,2	530	20,5	17	16
K/2	66-09-21	0	4,5	5,1	15,6	g-n	0,04	44,31	26,06	3,8	9,58	509	23	18	14
K/1	66-09-21	0	5,06	4,5	13,5	i-g-n	0,02	32,15	29,74	0,3	9,6	547	22	18	16
K/0	66-09-21	0	4,7	4,9	12,7	i-g-n	0,02	36,80	26,70	4,0	10,22	443	21	16,8	14
G/2	66-09-21	0	3,1	4,6	14,0	i-g-n	0,02	44,26	25,83	4,0	9,45	607	18	18,5	16
G/0	66-09-21	0	3,28	4,5	14,1	g-n	0,02	44,31	27,74	0,4	9,35	585	20	19	16
G/1	66-09-21	0	3,42	4,6	14,2	g-n	0,03	45,38	26,70	2,6	9,4	572	20,7	19	14
A/2	66-09-22	0	2,72	4,9	14,7	g-n	0,02	39,30	33,87	5,0	9,7	612	21	18	10

Tabelle 1 1. táblázat (folytatás)

Sammelstellen Gyűjtőhelyek	Datum Dátum	Coli-Zahl Coli szám	O ₂ Verbrauch, mg/l O ₂ fogy., mg/l	Alkalinität Lúgosság ml n HCl/l	Gesamthärte Összkeménység	SO ₄ ⁻	Fe ⁺⁺	Ca ⁺⁺ mg/l	Mg ⁺⁺ mg/l	SiO ₂ mg/l	Gelöstes O ₂ mg/l Oldott O ₂ mg/l	Gesamtfestbe- standteil mg/l Összes szilárd a. rész mg/l	Lufttemperatur Levegőhőfok °C	Wassertempe- ratur Víz hőfok, °C	Cl ⁻ mg/l
A/0	66-09-22	0	3,43	4,7	15,1	g-n	0,02	41,80	27,78	5,0	9,82	581	21	18	16
A/1	66-09-22	0	2,96	5,0	14,7	g-n	0,03	43,59	34,08	4,2	10,0	707	21	18,5	14
E/2	56-09-22	0	2,68	5,1	14,7	g-n	0,02	36,44	27,57	4,2	9,83	551	20,5	18	16
E/1	66-09-22	38	3,17	5,1	15,0	g-n	0,025	40,02	27,61	0	9,88	568	21	18	16
E/0	66-09-22	0	3,3	5,2	15,1	g-n	0,025	40,30	27,61	4,5	9,84	586	21	18	10
M/2	66-10-18	0	3,43	5,4	14,4	g-n	0,02	47,17	26,05	4,0	9,2	652	15	16	14
M/0	66-10-18	0	4,18	5,0	14,6	g-n	0,03	47,64	23,02	4,0	9,12	589	16	16	14
M/1	66-10-18	0	4,38	5,4	14,2	g-n	0,03	50,03	26,05	4,5	8,9	600	15	16	14
K/2	66-10-18	12	3,77	5,4	14,5	g-n	0,02	51,81	29,09	4,0	9,5	503	16	16	14
K/1	66-10-18	0	4,08	5,4	14,5	g-n	0,02	51,45	29,74	5,0	9,28	594	16	16	14
K/0	66-10-18	0	3,98	5,0	14,4	g-n	0,02	50,02	27,57	4,2	9,03	617	16	16,2	16
G/2	66-10-18	0	4,0	5,4	14,8	g-n	0,02	47,17	31,04	4,2	9,25	521	16	18	10
G/0	66-10-18	4	4,48	5,1	14,4	g-n	0,02	50,74	29,96	5,0	9,27	538	18	16	16
G/1	66-10-18	0	3,36	5,6	14,3	g-n	0,02	52,88	30,40	5,0	9,3	508	18	16	16
A/2	66-10-19	0	2,6	5,0	15,4	g-n	0,02	45,38	36,04	4,0	9,43	509	20	17	14
A/0	66-10-19	0	2,94	5,0	15,2	g-n	0,02	47,03	34,08	4,0	9,91	566	17	19	12
A/1	66-10-19	0	3,5	5,0	15,3	g-n	0,02	43,59	35,17	5,0	9,67	493	19	17	14
E/2	66-10-19	1	2,88	5,4	15,4	g-n	0	45,02	32,79	2,0	10,2	552	17	20	14
E/1	66-10-19	3	2,58	5,4	15,4	n	0,02	45,74	32,35	3,2	9,61	602	17	20	14
E/0	66-10-19	3	2,89	5,2	15,2	n	0,02	45,75	37,74	4,0	8,6	550	20	17	14
M/2	67-04-11	0	2,82	5,8	15,3	0	0	70,04	36,07	0	10,7	375	17	12	20
M/0	67-04-11	0	4,10	5,2	13,2	g-n	0	71,94	33,0	0	10,35	528	17,5	12	16
M/1	67-04-11	0	3,73	6,0	14,4	g-n	0,02	70,99	36,76	0	10,5	354	14	12	14
K/2	67-04-11	0	3,76	5,6	15,0	g-n	0,02	60,38	40,38	0	10,87	487	21	12	14
K/1	67-04-11	0	3,88	5,3	14,9	g-n	0,02	45,38	45,16	0	10,17	359	21	12	16
K/0	67-04-11	0	4,11	5,4	14,6	0	0	67,18	34,52	0	10,72	403	21	12	16
G/2	67-04-11	0	3,3	5,4	14,8	g-n	0	64,32	33,87	0	11,2	362	18,5	11	16
G/0	67-04-11	0	3,44	5,0	15,2	g-n	0	51,45	30,61	0	11,3	326	19,0	12	10
G/1	67-04-11	0	3,34	5,2	15,0	g-n	0	50,38	34,09	2,0	11,22	361	21,5	12	14
A/2	67-04-12	0	3,43	5,0	15,9	g-n	0	42,16	39,31	0	10,94	348	19,5	12	18

A/0	67-04-12	0	3,02	5,4	16,2	g-n	0	39,30	39,09	2,0	10,65	378	19	12	20
A/1	67-04-12	0	3,21	5,2	16,4	g-n	0	41,80	38,00	1,0	11,2	385	18	12,5	20
E/2	67-04-12	0	3,22	5,4	16,8	g-n	0	38,54	34,76	4,0	10,89	498	18	12	20
E/1	67-04-12	0	3,40	4,9	16,8	g-n	0,02	41,44	35,39	2,0	11,31	377	19	12	20
E/0	67-04-12	0	3,1	5,0	17,0	g-n	0,02	38,94	37,34	2,5	10,89	387	17	12	20
M/2	67-05-16	0	4,73	5,8	14,6	g-n	0,01	70,04	32,13	3,3	8,28	366	21	19	30
M/0	67-05-16	3	4,72	6,3	15,1	g-n	0	80,04	27,83	4,0	9,19	430	20	19	20
M/1	67-05-16	0	4,66	6,5	14,5	g-n	0,01	79,56	29,52	5,3	8,65	391	20	19	20
K/2	67-05-16	0	4,12	5,8	17,0	g-n	0,01	75,05	43,01	6,0	9,71	387	19	19	20
K/1	67-05-16	0	4,5	6,0	17,4	g-n	0	74,67	39,08	3,0	9,78	396	21	19	20
K/0	67-05-16	0	4,76	5,8	16,05	g-n	0,01	69,68	38,32	3,0	9,34	406	21	19	22
G/2	67-05-16	0	4,3	5,8	17,2	g-n	0,01	62,41	43,16	4,5	10,0	533	20	19	20
G/0	67-05-16	0	4,18	5,5	17,4	g-n	0	67,18	41,68	0	10,1	417	20	19	30
G/1	67-05-16	0	4,28	5,5	18,0	g-n	0	60,03	39,16	2,5	10,1	446	21	19	20
A/2	67-05-17	1	3,77	6,0	17,5	g-n	0	63,60	41,38	0	9,88	426	19	19	20
A/0	67-05-17	0	4,18	5,6	17,2	g-n	0	66,70	37,95	0	10,1	410	20	19	18
A/1	67-05-17	0	4,56	6,0	18,6	g-n	0,02	56,48	40,51	1,2	9,82	415	19	21	20
E/2	67-05-18	Sammlung wegen Unwetter nicht durchgeführt — Vihar miatt a gyűjtés félbeszakadt													
E/1	67-05-18	Sammlung wegen Unwetter nicht durchgeführt — Vihar miatt a gyűjtés félbeszakadt													
E/0	67-05-18	0	4,49	5,0	18,6	g-n	0	52,31	33,35	0	10,10	429	19	19	22
M/2	67-06-20	1	3,57	6,0	16,1	g-n	0,01	67,89	34,74	5,0	10,52	331	22	20	20
M/0	67-06-20	0	3,65	6,0	16,4	g-n	0,01	66,22	30,10	0,1	10,29	369	20	20	20
M/1	67-06-20	2	4,73	5,0	18,6	g-n	0	65,74	28,65	—	—	575	16	12	20
K/2	67-06-20	0	3,66	6,0	15,7	g-n	0	64,31	34,53	0,1	9,55	378	24	20	16
K/1	67-06-20	0	3,76	5,4	13,6	g-n	0	63,24	26,92	0	9,9	400	24	20	20
K/0	67-06-20	0	4,14	5,6	12,9	g-n	0,02	61,81	30,39	1,3	10,14	417	24	19,5	16
G/2	67-06-20	0	3,40	5,0	14,7	g-n	0,01	57,17	29,31	2,2	10,0	373	22	20	14
G/0	67-06-20	0	3,36	5,4	15,0	g-n	0,01	63,96	25,40	0	9,91	376	22	20	16
G/1	67-06-20	9	3,4	5,2	16,2	g-n	0	54,31	32,13	0	10,26	379	21	20	20
A/2	67-06-26	0	3,07	5,4	19,0	g-n	0	53,60	31,92	0	9,60	435	16	14	20
A/0	67-06-26	0	2,7	5,5	19,4	g-n	0	56,31	32,78	0	9,65	441	16	14	20
A/1	67-06-26	3	2,76	5,4	19,0	g-n	0	56,81	28,87	0	9,8	438	16	14	20
M/2	67-07-18	0	3,64	5,7	16,5	g-n	0,01	56,0	32,6	0	8,67	350	20	23	20
M/0	67-07-18	5	4,2	5,7	15,8	g-n	0,02	54,79	36,71	4,0	8,70	404	20	23	16
M/1	67-07-18	1	4,2	5,4	16,2	g-n	0,02	60,98	31,84	2,0	8,60	436	19,5	23	20
K/2	67-07-18	0	3,9	5,0	16,2	g-n	0,01	57,17	34,08	1,0	8,80	449	24	24	20
K/1	67-07-18	2	4,42	5,4	15,6	g-n	0	56,74	31,70	3,7	9,04	412	23	22	20

Tabelle 1—1. táblázat (folytatás)

Sammelstellen Gyűjtőhelyek	Datum Dátum	Coli-Zahl Coli szám	O ₂ Verbrauch, mg/l O ₂ fogy., mg/l	Alkalinität Lúgosság ml n HCl/l	Gesamthärte ^o Összkeménység ^o	SO ₄ ⁻	Fe ⁺⁺	Ca ⁺⁺ mg/l	Mg ⁺⁺ mg/l	SiO ₂ mg/l	Gelöstes O ₂ mg/l Oldott O ₂ mg/l	Gesamt festbe- standteil mg/l Összes szilárd a. rész mg/l	Lufttemperatur Levegőhőfok °C	Wassertempe- ratur Víz hőfok, °C	Cl ⁻ mg/l
K/0	67-07-18	1	4,0	5,5	15,8	g-n	0	63,24	34,43	2,0	8,82	399	23	23	20
G/2	67-07-19	0	3,06	6,0	16,8	g-n	0	57,88	36,72	2,0	9,0	373	23	23	20
G/0	67-07-19	6	4,0	6,0	16,4	g-n	0	56,09	32,57	0	9,0	395	25	23	16
G/1	67-07-19	60	3,76	5,6	16,2	g-n	0	60,38	37,14	0,5	8,93	380	25	23	20
A/2	67-07-20	0	3,07	6,0	19,0	g-n	0	55,74	36,24	2,0	9,1	419	27	24	20
A/0	67-07-20	1	2,76	6,0	18,0	g-n	0,02	53,24	36,04	2,5	9,12	370	25	24	22
A/1	67-07-20	0	2,96	5,0	18,4	g-n	0,02	55,38	37,56	2,1	8,94	359	26	24	20
E/2	67-07-19	0	3,15	6,0	18,0	g-n	0	58,61	36,42	0,5	9,17	360	26	24	20
E/1	67-07-19	0	3,36	6,2	18,8	g-n	0,02	62,41	36,76	0	9,0	315	26,5	24	20
E/0	67-07-19	0	2,9	6,0	19,5	g-n	0	52,88	32,79	0	9,12	397	27	23	20
M/2	67-08-15	0	3,3	6,0	17,8	g-n	0	57,17	31,40	3,0	9,07	366	17	20	22
M/0	67-08-15	0	4,84	5,4	19,4	g-n	0,01	54,31	33,87	0,1	8,90	360	17	20	20
M/1	67-08-15	0	3,7	5,8	19,0	g-n	0,02	57,17	32,42	0	8,98	370	16	20	20
K/2	67-08-15	0	3,36	5,6	18,2	g-n	0	51,16	34,29	2,0	9,7	371	22	21	20
K/1	67-08-15	4	3,86	5,4	17,4	g-n	0,01	60,38	33,44	1,2	9,81	398	23	21	20
K/0	67-08-15	0	3,80	5,4	17,6	g-n	0	58,24	33,00	1,0	9,48	393	23	21	20
G/2	67-08-15	0	3,1	6,0	18,0	g-n	0,01	56,02	32,86	0,1	9,75	387	25	21	20
G/0	67-08-15	0	2,86	6,0	18,2	g-n	0	54,67	30,83	2,5	9,6	383	26	21	20
G/1	67-08-15	1	2,9	5,9	18,2	g-n	0	55,38	30,83	1,0	9,7	371	26	21	20
A/2	67-08-16	0	2,96	5,5	18,2	g-n	0	48,25	39,94	4,5	9,4	367	26	21	20
A/0	67-08-16	1	3,0	5,8	17,8	g-n	0,01	49,31	34,08	0,5	9,72	368	23,5	21	20
A/1	67-08-16	0	3,0	5,0	17,8	g-n	0	53,24	40,40	0	9,32	383	23	21	18
E/2	67-08-16	0	3,1	5,6	17,8	g-n	0	55,73	38,98	2,0	9,56	388	25	25	18
E/1	67-08-16	0	2,96	6,0	18,1	g-n	0,02	52,88	35,39	3,5	9,65	389	25	25	20
E/0	67-08-16	0	2,98	6,1	18,0	g-n	0	50,72	38,01	0,1	9,28	398	25	21,5	20
M/2	67-09-19	7	2,77	5,6	17,2	g-n	0,02	47,64	30,30	0,1	10,0	416	17	16	20
M/0	67-09-19	6	2,64	5,4	17,2	g-n	0,01	47,64	31,55	1,0	10,05	423	13,8	16,5	22
M/1	67-09-19	0	3,06	5,1	17,4	g-n	0,01	54,02	31,84	1,0	9,92	445	13	16	20
K/2	67-09-19	0	2,88	5,5	16,8	g-n	0	52,52	31,04	2,5	10,0	437	22	17	20
K/1	67-09-19	0	2,9	5,5	17,4	g-n	0	57,17	32,56	4,0	10,0	435	17	20	20

K/0	67-09-19	0	3,04	5,8	16,9	g-n	0	54,66	37,88	6,0	9,64	426	17,5	17	20
G/2	67-09-19	0	2,4	5,4	17,0	g-n	0,01	50,5	37,63	0	9,9	442	20	18	20
G/0	67-09-19	0	2,52	5,4	16,8	g-n	0,01	53,95	31,04	8,0	10,0	482	20	18	18
G/1	67-09-19	0	2,72	5,5	17,0	g-n	0,01	54,31	34,95	1,1	10,16	434	20,5	18	20
A/2	67-09-20	0	3,06	5,1	17,6	g-n	0,01	54,64	42,43	3,2	9,5	478	19	18	20
A/0	67-09-20	0	2,5	5,3	18,0	g-n	0	56,81	36,91	5,0	9,5	427	18	18	20
A/1	67-09-20	0	2,84	5,2	17,8	g-n	0,01	58,95	38,66	3,6	9,6	445	18	17,5	22
E/2	67-09-20	0	2,86	5,2	18,0	g-n	0,01	53,24	31,91	1,1	9,6	438	18	18	20
E/1	67-09-20	0	2,92	5,0	17,4	g-n	0,16	46,71	35,61	3,0	9,65	498	18,5	18	22
E/0	67-09-20	0	2,5	5,8	17,2	g-n	0,02	46,47	37,12	1,3	9,82	492	19	18	20
M/2	67-10-17	40	3,66	5,1	16,2	g-n	0,02	54,78	34,74	0	10,38	369	18	16	20
M/0	67-10-17	30	4,8	5,4	16,3	g-n	0,01	60,98	37,64	0	10,3	374	17	16	20
M/1	67-10-17	15	4,04	5,1	16,0	g-n	0,01	67,65	43,01	1,0	10,4	375	17	16	20
K/2	67-10-17	25	3,72	5,0	15,8	g-n	0,01	67,19	36,26	3,0	10,46	397	21	17	16
K/1	67-10-17	35	4,12	5,4	16,1	g-n	0	71,57	39,97	0	10,5	402	21	17	14
K/0	67-10-17	15	4,6	5,4	16,5	g-n	0	62,53	35,22	0	10,46	390	21	16,5	20
G/0	67-10-17	20	4,2	5,0	18,0	g-n	0,01	56,09	34,74	1,0	10,2	374	22	17,5	20
G/1	67-10-17	45	4,36	5,0	19,0	g-n	0,02	56,81	34,74	2,6	9,8	365	21,5	18	20
G/2	67-10-17	30	4,2	5,2	16,0	g-n	0,02	55,40	34,31	1,5	10,3	384	19,3	18	20
A/2	67-10-23	0	3,08	5,6	18,0	g-n	0,02	54,67	32,79	6,0	10,16	420	14	12	20
A/0	67-10-23	0	3,04	5,6	17,6	g-n	0,02	54,66	34,55	3,0	10,8	432	13	12	16
A/1	67-10-23	25	3,32	5,8	18,2	g-n	0,01	56,09	34,30	6,0	10,55	412	14	12	16
E/2	67-10-23	0	3,22	5,6	18,0	g-n	0,01	54,31	34,95	5,0	10,4	483	14	14	20
E/1	67-10-23	0	3,36	5,5	18,9	g-n	0,01	55,38	31,04	0	10,5	409	14	14	20
E/0	67-10-23	0	3,86	6,0	18,0	g-n	0,02	58,24	34,52	5,0	10,4	368	17	14	20

Zeichenerklärung — Jelmagyarázat

i-g-n = sehr schwache Spuren, igen gyenge nyomok;

g-n = schwache Spuren, gyenge nyomok;

n = Spuren, nyomok

NO, NO₂, NH₄, Mn, Freier CO₂ Gehalt war in allen Proben O-Wert
szabad CO₂ tartalom valamennyi mintában 0 érték volt.

kleinen Mengen, ein Zehntel des für Trinkwasser erlaubten Grenzwertes durchschnittlich. Die Menge des Siliziumdioxides lag ebenfalls unter dem erlaubten Grenzwert, 2–3 mg/l. Im Einklang mit den vorangegangenen Untersuchungen lag der Wert des freien Kohlendioxids im Wasser des Plattensees bei null. Die Gesamtheit der festen Bestandteile lag zwischen 450 und 550 mg/l, der Chloridgehalt zwischen 12 und 16 mg/l.

Phenol gelangt aus dem mit industriellen Abwässern verunreinigten neben dem Nitrochemischen Werk Fűzfő fließendem Séd-Bach in den Balaton. Nach unseren bisherigen Untersuchungen schwankt der Phenolgehalt des einfließenden Wassers zwischen 10 und 80 γ /l. Das Phenol ist in der Nähe der Einmündung des Séd-Baches und in der Bucht bei Fűzfő noch in kleinen Mengen nachweisbar, jedoch haben wir bei den Proben, die wir an der Fűzfő am nächsten gelegenen Probenentnahmestelle entnommen haben (Punkt 2 der Segmentlänge E) immer einen negativen Wert erhalten.

Diskussion der Ergebnisse

In Übereinstimmung mit den Angaben der bisherigen sich mit dem Wasser des Plattensees befassenden Arbeiten zeigen sich keine großen Schwankungen bei den untersuchten Komponenten, wie es auch aus den Daten der Tabelle bzw. aus der ausführlichen Darlegung der Ergebnisse hervorgeht. Im Gegensatz zu den bisherigen Untersuchungen war es jedoch eine interessante Feststellung, daß der durchschnittliche Magnesiumgehalt des Wassers auf dem gesamten Gebiet des Sees den Kalziumgehalt nicht überschritten hat. Zweifellos hat sich in der Gegend der Zala-Mündung ein größerer Unterschied zugunsten des Kalziums gezeigt, das Verhältnis der Menge der zwei Kationen zueinander hat sich jedoch bei keiner Probe in Richtung des höheren Wertes des Magnesium geändert.

Durchschnittswerte 1966

	Ca mg/l	Mg mg/l
Bucht bei Keszthely	53,5 $\pm$ 0,51	23,0 $\pm$ 0,64
Szigliget-B. Mária	51,3 $\pm$ 0,83	24,0 $\pm$ 0,07
B. Szemes-Sápuszta	47,5 $\pm$ 0,67	26,8 $\pm$ 0,46
Balatonfüred—Zamárdi	45,6 $\pm$ 0,4	25,4 $\pm$ 0,25
Balatonalmádi—Világos	44,0 $\pm$ 0,5	28,0 $\pm$ 0,6

Durchschnittswerte 1967

Bucht bei Keszthely	63,76 $\pm$ 1,3	33,18 $\pm$ 0,45
Szigliget-B. Mária	61,63 $\pm$ 0,85	35,38 $\pm$ 0,96
B. Szemes-Sápuszta	56,59 $\pm$ 0,75	33,89 $\pm$ 0,45
Balatonfüred—Zamárdi	53,23 $\pm$ 0,36	36,73 $\pm$ 0,59
Balatonalmádi—Világos	50,32 $\pm$ 0,5	36,11 $\pm$ 0,84

Es ist interessant, die Unterschiede zwischen den Kalzium- und Magnesium-mg/l-Werten darzustellen, welche sich (Durchschnittswerte nach Segmentlängen, Probenentnahmestellen und Tiefen) von der Keszthelyer Bucht bis zu der Linie Balatonvilágos—Almádi folgendermassen gestaltet haben:

1966				
30,5	27,0	20,7	19,2	16,0
1967				
30,58	26,05	22,7	16,5	14,2

Die Werte zeigen also eine kontinuierlich fallende Tendenz, die aber den Nullwert nicht erreicht bzw. nicht zugunsten des Magnesiums verschoben ist. Die bisherigen, sich mit dem Balatonsee beschäftigenden Studien haben eindeutig das Übergewicht des Magnesiums gezeigt, so dass wir die Gestaltung der Werte anfangs für auffallend hielten. Die von dem Wissenschaftlichen Wasserwirtschaftsforschungsinstitut angewendete Methode weicht insofern von der staatlichen Normuntersuchungsmethode ab, als daß sie die Gesamthärte gesondert bestimmt, danach von derselben Probe gesondert das Kalzium bestimmt und das Magnesium aus dem Unterschied der zwei Messungen ermittelt. Wir haben also mit den beiden Methoden vergleichende Untersuchungen durchgeführt, danach baten wir die Wasserchemische Abteilung des Staatlichen Volksgesundheitsinstitutes, die parallelen Bestimmungen für Kalzium—Magnesium und Gesamthärte aus den von uns entnommenen Proben durchzuführen. Die beiden Untersuchungsmethoden lieferten einen geringen Unterschied, dessen Wert jedoch natürlich die Veränderung des Kalzium—Magnesium-Verhältnisses nicht erklärt. Aus den Untersuchungsergebnissen von 1967 geht hervor, daß sich das Verhältnis in diesem Jahre in gleicher Weise gestaltet hat, ähnlich wie im Jahre 1966. Bei einem einzigen Probenentnahmezeitpunkt in einer einzigen Segmentlänge in der Bucht bei Szigliget haben wir ähnlich wie in den Ergebnissen vor Jahren einen höheren Magnesiumwert erhalten, im allgemeinen haben sich jedoch die Werte ähnlich wie die Ergebnisse der 1966 entnommenen Proben gestaltet. Der Gesamtwert des Kalziums und Magnesiums sowie der Gesamthärte stimmt mit den Werten der alten Untersuchungen überein, es hat sich lediglich das Kalzium—Magnesium-Verhältnis zugunsten des Kalziums verschoben. Es ist eine bewiesene Tatsache, daß das Kalziumhydrokarbonat in Form von Kalziumkarbonat wegen seiner geringeren Löslichkeit leichter ausfällt und somit der Kalziumkarbonatgehalt des Schlammes grösser ist als der Magnesiumgehalt. Der Kalziumgehalt der Proben, die bei stürmischem Wetter entnommen wurde, ist also stets höher wegen des Aufwirbelns des Wassers. Während unserer Probenentnahme herrschte des öfteren starker Wind, es kam sogar mehrmals vor, daß wir die Entnahme wegen des hohen Wellenganges abbrechen mußten. Da der Balaton ein seichtes Gewässer ist, bedeutet ein Sturm mit auch nur geringerer Stärke eine vollkommene Aufwirbelung.

In Verbindung mit der zunehmenden Veränderung des Kalzium—Magnesium-Verhältnisses möchte ich mich auf die 1963 vom Wissenschaftlichen Wasserwirtschaftsforschungsinstitut veröffentlichte Arbeit über das Wasser des Balatonsees berufen. Es ist interessant, dass, während die Arbeit auf Grund der Untersuchungen von 1958 und 1959 das Übergewicht des Magnesiums eindeutig erwähnt (in einigen Fällen mit höheren Kalziumwerten), doch im Zusammenhang mit den Untersuchungen von 1960 erstmalig folgendes festgestellt wird: »Zum erstenmal haben wir im Balatonsee einen ausserordentlich hohen Kalziumgehalt gesehen, welcher in dem Abschnitt zwischen Tihany und Keszthely sogar die Menge des Magnesiums überschritten hat.« In der Zusammenfassung der Arbeit können wir folgendes lesen: »... wir möchten die Aufmerksamkeit auf die Untersuchungsergebnisse von 1960 lenken. Die Veränderung des Verhältnisses der Kalzium- und Magnesium-werte fand hier in der Linie der Halbinsel Tihany statt. Die Kalziumkonzentration war von hier an in dem mittleren und südlichen Becken überall höher. Eine ausführliche Untersuchung des Wassers des Balatonsees hat seit 1960 leider nicht stattgefunden.

Die Untersuchungen des Staatlichen Volksgesundheitsinstitutes beziehen sich ebenfalls auf 1958 und 1959. Über die Zeitspanne von 1960 bis 1966 fehlen jegliche Angaben, auf Grund derer wir auf eine eventuelle langsame Verschiebung des Kalzium-Magnesiumverhältnisses hätten schlußfolgern können. Falls wir auf Grund der Angaben der Untersuchungsergebnisse von 1958 bis 1960, die vom Wissenschaftlichen Wasserwirtschaftsforschungsinstitut veröffentlicht wurden, Rechnungen anstellen, kommen wir zu einer interessanten Feststellung, nach welcher sich eine geringe aber deutliche Tendenz in der Veränderung der Menge bzw. des Verhältnisses der beiden Ionen zueinander zeigt.

Die Veränderung der Durchschnittswerte der Kalzium- und Magnesium-Ionen zwischen 1958 und 1960 nach der Veröffentlichung des Wissenschaftlichen Wasserwirtschaftsforschungsinstitutes an den jeweils gleichen Probenentnahmestellen:

	Ca mg/l	Mg mg/l
1960	$47,2 \pm 0,23$	$39,6 \pm 0,18$
1959	$41,4 \pm 0,58$	$39,0 \pm 0,35$
1958	$32,8 \pm 0,33$	$42,5 \pm 0,23$

Die Errechnung des Standardfehlers des Durchschnittes:

$$s_x = \sqrt{\frac{\sum(x - x')^2}{n(n - 1)}}$$

wobei x der gemessene Beobachtungswert
 x' der mathematische Durchschnitt sämtlicher Beobachtungswerte
 n die Zahl der Beobachtungswerte ist.

Die Zahl der bei der Berechnung verwendeten Angaben betrug 1958 : 74, 1959 : 78 und 1960 : 38. Den Angaben, welche ausschließlich von den Probenentnahmen gewisser Buchten stammten, zum Beispiel aus der Bucht bei Keszthely an der Einmündungsstelle des Zala oder aus der Bucht bei Füzö oder innerhalb des Gebietes der Wellenbrecher bei Földvár, haben wir keine Beachtung geschenkt. Diese Ergebnisse hätten die Werte unverhältnismäßig zugunsten des Kalziums verschoben. Unsere Wasserproben stammten jedoch aus offenem Wasser, somit sind unsere Angaben nicht durch den Zufluß von Oberflächenwässern beeinflußt worden.

Zusammenfassung

Zusammenfassend läßt sich feststellen, daß wir versucht haben, mit unseren Untersuchungen betreffs der allgemeinen Zusammensetzung und Verunreinigung des Wassers des Balatonsees die allgemeine Situation darzulegen. Diese Untersuchungsergebnisse stimmen teilweise mit den Ergebnissen der vor Jahren durch andere Institute durchgeführten Untersuchungen überein, anderseits lenken sie die Aufmerksamkeit auf eine in gewissem Maße bestehende Verschiebung in dem Verhältnis verschiedener Kationen. Neben den Untersuchungen mit Forschungsziel haben die allgemeinhygienischen Gesichtspunkte eine ausschlaggebende Bedeutung. Wie wir gezeigt haben, ist die Bucht bei Keszthely schon ziemlich verunreinigt, so daß wir sie vor weiterer Verschmutzung bewahren müssen und den anderen Teil des Balatonsees vor dem Beginn einer Verseuchung schützen müssen. In den vergangenen Jahren hat sich ein

Magnesiumüberschuß mit einer geringen Kalziumzunahme auf dem gesamten Gebiet des Balatonsees gezeigt. Auf Grund unserer Ergebnisse zeigte sich, daß sich dieses Verhältnis ausgesprochen zugunsten des Kalziums verschoben hat. Es würde sich eventuell lohnen, sich weiterhin mit diesem Thema zu beschäftigen, und wir würden vielleicht auch eine Antwort auf die Frage nach der Aufschlemmung des Sees erhalten.

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A BALATON NYILTVIZÉNEK KÉMIAI VISZONYAI AZ 1966. ÉS 1967. ÉVI VIZSGÁLATOK ALAPJÁN

Összefoglalás

Orsós Éva

Összefoglalva megállapítható, hogy vizsgálatainkkal igyekeztünk ismét egy alaphelyzetet rögzíteni a Balaton-víz általános összetételére és szennyezettségére vonatkozóan. Ezen vizsgálati eredmények részben megegyeztek és megerősítették az évekkel előbb más intézmények által végzett vizsgálatok eredményeit, részben pedig felhívják a figyelmet arra, hogy eltolódás mutatkozik bizonyos mértékben különböző kationok arányában. Döntő jelentősége van a közegészségügyi szempontoknak a kutatási céllal történő vizsgálatok mellett. Ahogyan, mint kimutattuk, a Keszthelyi-öböl már eléggé elszennyeződött, így meg kell védenünk a további szennyeződéstől, a tó többi részét pedig a kezdeti fertőződéstől. A megelőző években magnézium túlsúly mutatkozott az egész Balaton területén, enyhe kalcium növekedéssel, most kifejezetten a kalcium javára tolódott el az arány vizsgálati eredményeinek alapján. Ezen probléma megoldásának keretében talán a tó feliszapolódására vonatkozóan is feleletet kapunk.

О ХИМИЧЕСКОМ СОСТАВЕ ОТКРЫТОЙ ВОДЫ ОЗЕРА БАЛАТОН ПО МАТЕРИАЛАМ ИССЛЕДОВАНИЙ, ПРОВЕДЕННЫХ И 1966—1967 ГОДАХ

Ева Оршош

Исследование имело целью установить теперешний состав и загрязнение воды озера Балатон. Результаты частично подтверждают данные других авторов, полученные несколько лет назад, указывая вместе с тем на появление некоторых сдвигов в пропорциях разных катионов. Особое внимание привлекается к Кестхейскому заливу, который уже сильно загрязнен, и подчеркивается необходимость охранить его от дальнейшего загрязнения. В отличие от предыдущих лет, когда во всем Балатоне наблюдалось преобладание магния, для настоящего времени характерно преобладание ионов кальция. Этот вопрос нуждается в дальнейшем исследовании, так как он может помочь решению проблем, связанных с быстрым заболачиванием Балатона и прогрессирующим накоплением ила.

STUDIEN ÜBER DAS CRUSTACEEN-PLANKTON DES BALATON IV. BEITRÄGE ZUR KENNTNIS DER IN DER KREBSGEMEINSCHAFT DES SEES HORIZONTAL AUFTRETENDEN VERÄNDERUNGEN

JENŐ E. PONYI

*Biologisches Forschungsinstitut der Ungarischen Akademie der Wissenschaften,
Tihany, Ungarn*

Eingegangen am 14. Februar, 1968

Die Ergebnisse der sich mit der horizontalen Verbreitung der Planktonkrebse der Plattensees beschäftigenden alten Forschungen sind in den Arbeiten von ENTZ G., KOTTÁSZ J. und SEBESTYÉN O. (1937) und ENTZ G. und SEBESTYÉN O. (1940, 1946) zusammengefaßt. Die in diesen Arbeiten enthaltenen Daten sind zumeist von orientierendem Charakter. Ab 1955 kam die Reihe an die regelmäßigen Untersuchungen, von deren Ergebnissen 2 Studien berichtet haben (SEBESTYÉN O. 1960, 1964). Die erste beschäftigt sich mit den Verbreitungsverhältnissen des Crustacea-Plankton in dem Nordost-Becken, die zweite mit denen in der Bucht bei Keszthely. Darüber hinaus skizzieren die beiden Studien in groben Umrissen diejenigen physiographischen und biologischen Gesichtspunkte, welche die horizontale Verbreitung der Planktonmitglieder des Plattensees wahrscheinlich beeinflussen.

1965 tauchte die Notwendigkeit der mit dem Crustacea-Plankton des Sees verbundenen Untersuchungen — in Verbindung mit der Fischverendung im Plattensee — auf. Die Frage war die, ob außer den Fischen und einigen anderen Organismen (z. B. Diatomeen, TAMÁS 1966; Amphipoden, ENTZ B. 1965) jetzt auch die Verendung einiger Planktonkrebsarten bzw. irgendeine Veränderung in der Krebsgemeinschaft (das Verschwinden einer bzw. mehrerer Krebsarten, das Erscheinen neuer usw.) zu beobachten sei. Dazu war die genaue Bestimmung in der Systematik der Arten und die annähernde Feststellung ihrer horizontalen Verbreitung nötig.

Die vorangegangenen Untersuchungen (SEBESTYÉN 1960, 1964) haben die Verbreitung der Crustacea-Planktonmitglieder hauptsächlich von der quantitativen Seite her betrachtet (zahlenmäßige Angaben über die einzelnen Krebsgruppen und nicht Krebsarten). Das neue Problem hat aber auch die Betrachtung der qualitativen Seite nötig gemacht.

Die Zielsetzung dieser Untersuchungen war doppelt:

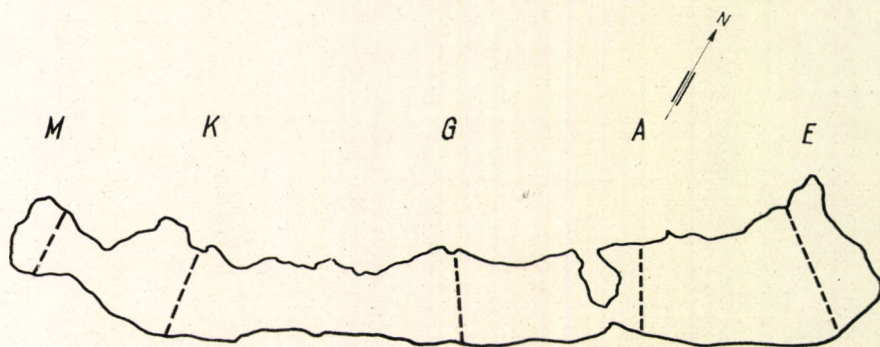
a) Praktisch gleichzeitig (innerhalb von 2 Tagen) auf Grund von Proben, die aus den den ganzen See repräsentierenden Querprofilen entnommen wurden, eine Orientierung über die Strukturunterschiede der Planktongemeinschaft des Warmwasser-zeitabschnittes zu gewinnen.

b) Weitere Angaben über die Hinzugehörigkeit und die Verbreitung der Arten der Crustacea-Planktongemeinschaft zu erhalten.

Ort und Zeit des Sammelns; weitere Angaben

Die Planktonprobenentnahmen haben in dem SW-Teil des Sees in 3, in dem NO-Teil in 2 zur Längsachse des Seespiegels rechtwinklig stehenden Querprofilen stattgefunden (vgl. SEBESTYÉN 1960, 118—119) (*Abb. 1*):

1. Gyenesdiás-Mündung des Zala; cca. 2800 m vom Ufer bei Gyenesdiás entfernt (»M«).



1. Die untersuchten Querprofile des Plattensees

1. ábra. Vizsgált szelvények a Balatonon

2. Szigliget—Balatonmária, cca. 4000 m vom Nordufer entfernt (»K«).

3. Sárgusztá—Balatonszemes, cca. 2500 m vom Nordufer entfernt (»G«).

4. Balatonfüred, Fenékfürdő—Zamárdi alsó, cca. 500 m von dem Biologischen Forschungsinstitut entfernt (»A«).

5. Balatonalmádi—Balatonvilágos, cca. 2000 m vom Nordufer entfernt (»E«).

Die Proben wurden am 8—10. 6., 1—2. 7., 3—4. 8., 7—8. 9., 13—14. 10. 1965 entnommen. Wir konnten in den Segmenten M, A, E abends und tags, in den Querprofilen K, G nur tags Proben entnehmen.

Einige, mit den Umständen des Sammelns verknüpfte Angaben sind in einer vorangegangenen Arbeit bereits bekanntgegeben worden (PONYI 1966, 184—185), z. B. Wassertiefe, Wassertemperatur, Durchsichtigkeit usw.

Probenentnahme und Aufarbeitung

Das Sammeln der Proben haben wir mit einem Planktonnetz № 6 aus einem Ruderboot in ungefähr anderthalb Meter Tiefe, mehrere hundert Meter die Querprofile entlang durchgeführt. Die Aufarbeitung des Materials wurde mit einer relativ-quantitativen Methode durchgeführt (SEBESTYÉN 1953). Ein Teil des Inhaltes der durchgeschüttelten Proben wurde in ein Zählschälchen mit quadratischer Einteilung getan und sämtliche Crustaceamitglieder gezählt. Dies haben wir mehrmals wiederholt, bis die Gesamtmenge der gezählten Exemplare 600—800 Stück erreichte. Bei den Copepoden haben wir die Weibchen, die Weibchen mit Eiern, die Männchen und die juvenilen Exemplare

während des Zählens gesondert aufgeführt. Bei den Cladoceren haben wir nur die Zahl der geschlechtsreifen und der jungen Exemplare voneinander getrennt. Im Laufe der Untersuchungen haben wir insgesamt 24 600 Tiere gezählt.

Kurzer Überblick über die bei den Untersuchungen gefundenen Arten

Die Zahl der aus den Proben nachgewiesenen Arten beträgt 24. Darunter sind folgende als echte Planktonmitglieder zu bezeichnen:

Cladocera:

Diaphanosoma brachyurum LIEVIN, *Daphnia hyalina* var. *galeata* SARS, *Daphnia hyalina* var. *lacustris* SARS, *Daphnia cucullata* SARS, *Bosmina longirostris* f. *pellucida* STINGELIN, *Leptodora kindtii* FOCKE.

Copepoda:

Eudiaptomus gracilis (SARS), *Cyclops vicinus* ULJ., *Mesocyclops* (s. str.) *leuckarti* (CLAUS), *Mesocyclops* (*Thermocyclops*) *crassus* (FISCHER).

Die Cenoxen-Planktonenelemente kommen hauptsächlich aus den Reihen der Tang-, Aufwuchs- und Schlammbewohner. Einige unter ihnen schwimmen recht gut, ihr Aufenthaltsort ist jedoch der Ufergürtel. Als solche können folgende Arten bezeichnet werden:

Cladocera:

Sida crystallina O. F. MÜLLER, *Latona setifera* (O. F. MÜLLER), *Macrothrix laticornis* (JURINE), *Alona rectangula* SARS, *Alona quadrangularis* (O. F. MÜLLER), *Alona affinis* LEYDIG, *Alonella rostrata* (KOCH), *Leydigia acanthocercoides* (FISCHER), *Pleuroxus uncinatus* BAIRD, *Monospilus dispar* SARS.

Copepoda:

Paracyclops fimbriatus (FISCHER), *Acanthocyclops viridis* (JUR.), *Acanthocyclops vernalis* (FISCHER).

Sonstige:

Ergasilus sp., *Corophium curvispinum* f. *devium* WUNDSCH.

In der Periode des warmen Wassers machen die bedeutendere Menge der Crustaceagemeinschaft nur einige Arten des *Eudiaptomus*, *Diaphanosoma*, *Mesocyclops* und 2 Arten des *Daphnia* Genus aus (vgl. SEBESTYÉN 1953, 1960, 1964). Am Sommeranfang, aber besonders zum Sommerende ist auch das *Cyclops vicinus* von Bedeutung. Nachfolgend wollen wir zuerst die Veränderungen und die Verhältnisse innerhalb der Population der die Masse der Gemeinschaft ausmachenden Arten genauer betrachten.

Eudiaptomus gracilis (G. O. Sars)

Die Entwicklung seiner Bevölkerung geht in unserem See nicht immer auf gleiche Art und Weise vonstatten; darauf weisen auch vorangegangene Beobachtungen hin (SEBESTYÉN 1960, 1964). Unsere Untersuchungen von 1965 zeigen außerdem, daß im Juni der *Eudiaptomus gracilis* (G. O. Sars) an den 2 Enden des Sees in größerer Prozentzahl vorkommt als in der Mitte des Sees, in den folgenden 2 Monaten entstehen eben diese Verhältnisse in dem mittleren (G) bzw. in dem NO-Becken. Im September ist die frühsummerliche Situation

zu beobachten (Abb. 2—5). Im Oktober ist in jedem Querprofil eine ungefähr gleiche prozentuale Verteilung zu verzeichnen.

In den verschiedenen Sammelstellen haben wir keine wesentlichen Unterschiede zwischen den Weibchen und Männchen gefunden. Dieses Verhältnis schwankte im Juni, im August und im September um 1 : 1; außer Juli, wo das Verhältnis ♀ : ♂ = 1,5 : 1 war.

Tabelle 1

Das prozentuale Vorkommen der Weibchen mit Eiern in der Population des *Eudipatomus gracilis*

Datum	M _e	M	K	G	A _e	A	E	E _e
VI. 8—9.	—	5,32	4,73	4,61	18,24	10,89	16,37	11,50
VII. 1—2.	3,92	9,80	2,37	3,67	8,02	0,00	3,06	—
VIII. 2—4.	35,38	20,00	21,82	8,50	14,81	17,46	6,52	10,99
IX. 6—8.	7,79	10,23	7,90	13,45	8,14	7,46	26,76	26,62

e = Abendprobe

Tabelle 2

Die Veränderung des Verhältnisses der geschlechtsreifen und der jungen Exemplare in der Population des *Eudipatomus* in der zweiten Hälfte des Sommers

Datum	M _e	M	K	G	A _e	A	E	E _e
VIII. 2—4.	2,82:1	1,44:1	2,93:1	1,62:1	1,42:1	1,22:1	0,83:1	0,44:1
IX. 6—8.	0,61	1,09	0,68	1,08	0,61	0,42	6,51	7,58

e = Abendprobe

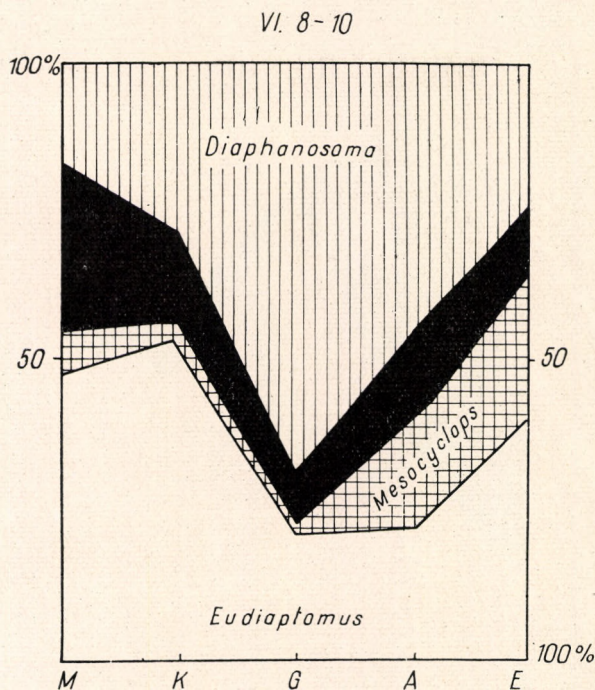
Die prozentuale Anwesenheit der ♀ mit Eiern ist in der *Eudiaptomus* Population verschieden (Tab. 1). Diese Angaben weisen darauf hin, daß die Vermehrungsintensität in den 2 Becken zu gleicher Zeit verschieden ist, und daß die Zahl der Populationen in dem NO-Becken zweimal ansteigt (vgl. SEBESTYÉN 1953).

Ein wesentlicher Unterschied im Verhältnis der geschlechtsreifen und der jungen (+ Copepodit-Stadium) Exemplare war nur in der 2. Hälfte des Sommers zu finden (Tab. 2). Im Juni und im Juli schwankt dieses Verhältnis jedes Querprofil betreffend um 1 : 1 bzw. 0,5 : 1.

Diaphanosoma brachyurum Lievin

Wiederum sind es die Angaben von SEBESTYÉN (1960, 1964), die die Aufmerksamkeit auf die Verschiedenheit der Population dieses Tieres lenken. Nach unseren Untersuchungen von 1965 entwickelte sich die relativ größere

Population der *Diaphanosoma* — anders als die der *Eudiaptomus* — in dem ersten Sommermonat in der Mitte des Sees, im Juli wird sie auf das NO-Becken und teilweise auf die Bucht bei Keszthely verlegt (Abb. 2., 3.). Von August an vermindern sich die Unterschiede, und mit einem Vorkommen um 20% werden sie im gesamten offenen Wasser gleichmäßiger.



2. Die prozentuale relative Veränderung der Crustacea-Planktongemeinschaft im Juni. Schwarzer Teil = andere Arten (hauptsächlich *Daphnia hyalina* var. *galeata*). M—E = die untersuchten Querprofile

2. ábra. Crustacea-plankton együttes %-ban kifejezett relatív változása júniusban. Fekete rész = egyéb fajok (főleg *Daphnia hyalina* var. *galeata*). M—E = vizsgált szelvények

Tabelle 3

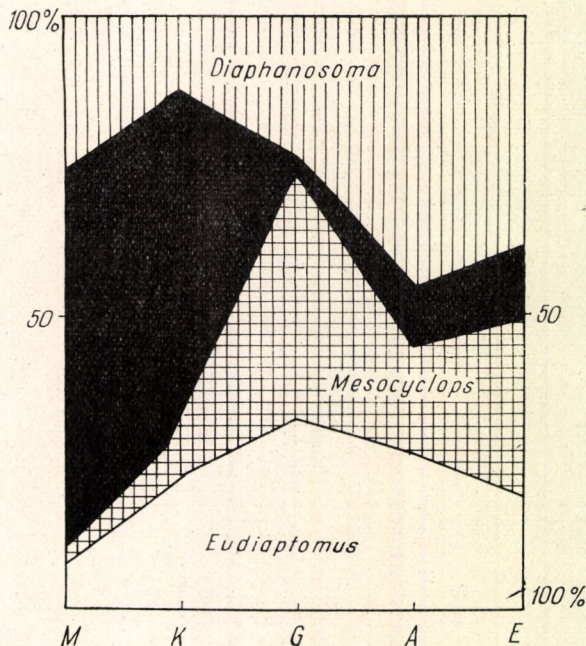
Die Verhältnisse der ausgewachsenen und der jungen Exemplare des *Diaphanosoma brachyurum* in den verschiedenen Sammelstellen

Datum	M	K	G	A _e	A	E	E _e
VI. 8-10.	0,71:1	0,52:1	0,60:1	0,40:1	—	0,51:1	0,62:1
VII. 1- 2.	0,67	0,71	0,32	1,18	1,54	1,30	1,88
VIII. 2- 4.	0,87	1,15	2,61	2,86	1,70	1,90	2,21
IX. 6- 8.	1,36	0,64	0,74	0,93	0,53	0,35	—

e = Abendprobe

Das Verhältnis der geschlechtsreifen und der juvenilen Exemplare ist in dem fröhsommerlichen Monat gleichmäßig (zwischen 0,51 : 1—0,71 : 1). Die Zahl der jungen Exemplare ist ungefähr zweimal so groß wie die der ausgewachsenen. Diese Verhältnisse ändern sich im Juli, in den Querprofilen A—E ist das Verhältnis 1,88—1,18 : 1 typisch, in den Querprofilen M—G das Ver-

VII. 1-2.



3. Die in Prozenten ausgedrückte relative Veränderung der Crustacea-Plankton-gemeinschaft im Juli. Schwarzer Teil = andere Arten (hauptsächlich *Daphnia cucullata* und *D. hyalina* var. *galeata*). M—E = die untersuchten Querprofile

3. ábra. Crustacea-plankton együttes %-ban kifejezett relativ változása júliusban. Fekete rész = egyéb fajok (főleg *Daphnia cucullata* és *D. hyalina* var. *galeata*). M—E = vizsgált szelvények

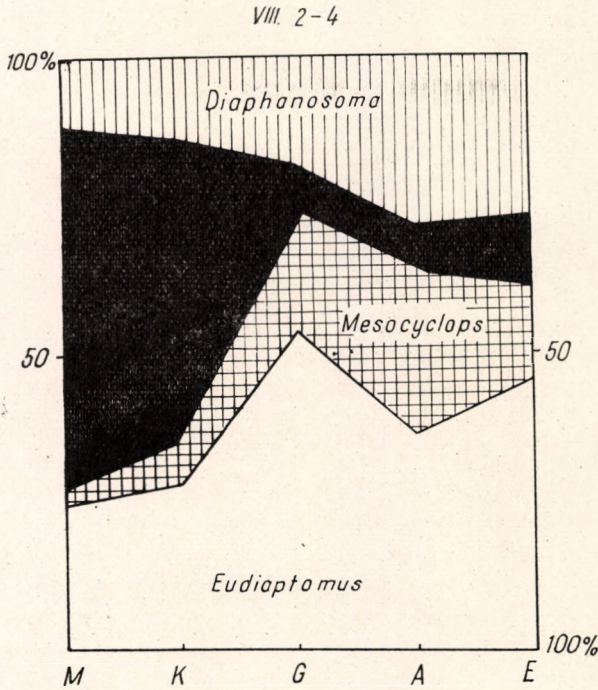
Tabelle 4

Das Verhältnis der Weibchen und der Männchen des *Mesocyclops leuckarti* in den verschiedenen Sammelstellen

Datum	M _e	M	K	G	A _e	A	E	E _e
VI. 8—10.	—	2,33:1	—	—	1,90:1	1,42:1	1,80:1	1,55:1
VII. 1— 2.	0,33	1,00	16,50	17,50	3,61	5,55	0,67	0,71
VIII. 2— 4.	—	1,00	2,83	2,91	1,62	1,80	1,94	1,00
IX. 6— 8.	0,54	—	1,75	1,96	4,12	9,92	12,66	19,66

e = Abendprobe

hältnis 0,32—0,71 : 1. In der Population der einzelnen Querprofile ist im August und im September kein eindeutiger Unterschied festzustellen, jedoch sind im August durchschnittlich zweimal soviel geschlechtsreife als junge Diaphanosomen zu finden (1,90 : 1), im September ist das Verhältnis annähernd gleich (0,74 : 1) (Tab. 3).



4. Die in Prozenten ausgedrückte relative Veränderung der Crustacea-Plankton-gemeinschaft im August. Schwarzer Teil = andere Arten (hauptsächlich *Daphnia cucullata* und *D. hyalina* var. *galeata* Arten). M—E = die untersuchten Querprofile

4. ábra. Crustacea-plankton együttes %-ban kifejezett relativ változása augusztusban. Fekete rész = egyéb fajok (főként *Daphnia cucullata* és *D. hyalina* var. *galeata* fajok). M—E = vizsgált szelvények.

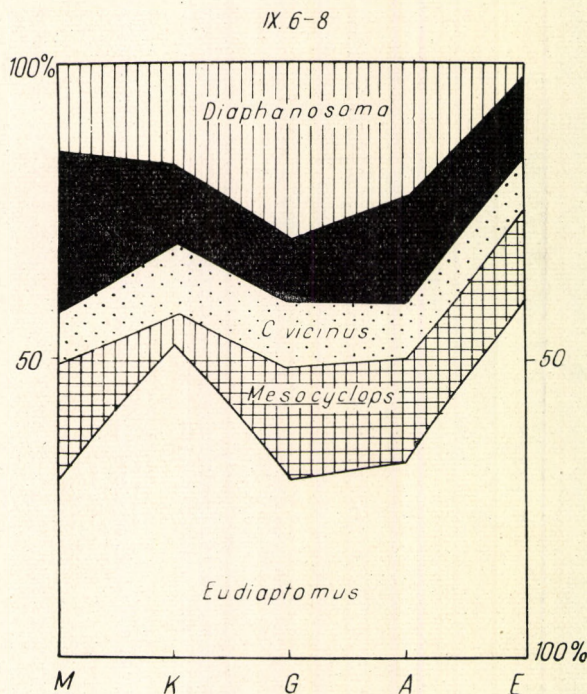
Tabelle 5

Das prozentuale Vorkommen der Weibchen mit Eiern des *Mesocyclops leuckarti* in den verschiedenen Sammelstellen

Datum	M _e	M	K	G	A _e	A	E	E _e
VI. 8—10.	—	4,54	—	—	1,50	4,12	1,17	0,00
VII. 1— 2.	0,00	5,66	3,66	2,58	11,65	6,21	6,76	7,69
VIII. 2— 4.	—	4,17	4,76	8,87	5,55	5,65	3,77	2,80
IX. 6— 8.	1,25	—	15,00	19,08	16,85	13,92	31,03	37,93

e = Abendprobe

Die Angaben von Juli und August lassen einen Unterschied in der Vermehrungsintensität der Diaphanosomen zwischen den zwei Teilen des Sees vermuten. Dem ist vielleicht auch die Abweichung der relativen Population in annähernd gleicher Zeit in den verschiedenen Gebieten des Sees zuzuschreiben.



5. Die in Prozenten ausgedrückte relative Veränderung der Crustacea-Planktongemeinschaft im September. Schwarzer Teil = andere Arten (hauptsächlich *Daphnia cucullata*). M—E = die untersuchten Querprofile

5. ábra. Crustacea-plankton együttes %-ban kifejezett relatív változása szeptemberben. Fekete rész = egyéb (főként *Daphnia cucullata*). M—E = vizsgált szelvények

Mesocyclops (s. str.) leuckarti (Claus)

Gegenüber den *Eudiaptomus*- und *Diaphanosoma*-Arten spielt er in der Warmwasserperiode eine deutlich untergeordnete Rolle. Wir konnten ihn in einer bedeutenden Prozentzahl in den Querprofilen G—E beobachten (Abb. 2—5). Eine Fluktuation größeren Umfanges in horizontaler Sicht ließ sich wie bei den vorigen 2 Arten nicht feststellen.

Es ist typisch für das Verhältnis der Weibchen und Männchen, daß die Zahl der Weibchen in den 2 Sommermonaten in dem SW-Becken (Querprofile K und G) wesentlich höher ist, als in den Querprofilen des NO-Becken. Am Sommerende besteht das Verhältnis zwischen den 2 Wassergebieten umgekehrt (Tab. 4).

Die Häufigkeit der Weibchen mit Eiern ist in den einzelnen Perioden zwischen den 2 Becken verschieden. Die höchsten Werte sind in dem NO-Becken zu beobachten (Tab. 5). Die Angaben weisen darauf hin, daß die Zahl der Population des *Mesocyclops* ähnlich wie die des *Eudiaptomus* sich ebenfalls zweimal erhöhen kann.

Auch im Verhältnis der geschlechtsreifen und der jungen Exemplare gibt es gewisse Unterschiede zwischen den 2 Teilen des Sees (Tab. 6).

Das Vorkommen der Arten des *Daphnia* Genus an den verschiedenen Gebieten des offenen Wassers des Sees

Über die horizontale Verbreitung des *Daphnia* Genus berichten im Allgemeinen die Studien von SEBESTYÉN (1960, 1964). Auch unsere Untersuchungsergebnisse beweisen das größere prozentuale Vorkommen der Daphnien innerhalb der Crustaceagemeinschaft in der Bucht bei Keszthely und in ihrer Umgebung (Querprofile M, K) im SW-Becken (Abb. 2—5). Unsere Ergebnisse bezeugen aber auch das mehr oder weniger gleichmäßige Vorkommen der Mitglieder des *Daphnia* Genus in der Krebsgemeinschaft in dem gesamten offenen Wasser während des Früh- und Spätsommers.

Betreffs des Vorkommens der Arten dieses Genus standen uns wegen Schwierigkeiten in der Bestimmung für die Systematik (vgl. PONYI 1965) keine oder wenig brauchbare Daten zur Verfügung, obwohl aus den vorangegangenen Jahren (vor 1965) viele Hinweise betreffs des Vorkommens des *Daphnia* Genus im See zu finden sind. Unsere vorherigen Untersuchungen haben geklärt (PONYI 1965), daß die unter »*Daphnia cucullata*« zusammengefaßten Krebse die folgenden drei systematischen Einheiten enthalten:

1. *Daphnia cucullata* Sars
2. *Daphnia hyalina* var. *galeata* Sars
3. *Daphnia hyalina* var. *lacustris* Sars.

Unsere bisherigen Resultate zeigen, daß neben der *Daphnia cucullata* die *D. hyalina* var. *galeata* in der Frühsommerperiode eine wesentliche Rolle spielt (Tab. 7). Von einem Querprofil abgesehen, wo die Zahl der beiden fast gleich war, überstieg ihre Exemplarzahl die der *D. cucullata* überall. In den anderen Monaten spielt sie schon eine untergeordnete Rolle, obwohl sie in der Sommermitte noch immer in einer bedeutenden Prozentzahl zu finden ist.

Tabelle 6

Das Verhältnis der geschlechtsreifen (♀ und ♂) und der jungen (juv. + cop. -Std.) Exemplare des *Mesocyclops leuckarti*

Datum	M _e	M	K	G	A _e	A	E	E _e
VI. 8—10.	—	1,54:1	—	—	0,62:1	1,49:1	1,03:1	0,63:1
VII. 1— 2.	2,00	2,12	0,74	2,15	3,53	2,77	5,00	4,36
VIII. 2— 4.	—	0,20	1,21	2,26	0,87	1,24	0,79	0,88
IX. 6— 8.	0,87	—	1,22	1,73	0,85	4,85	16,40	8,66

e = Abendprobe

Die *D. hyalina* var. *lacustris* haben wir in der ganzen Warmwasserperiode in kleiner Prozentzahl beobachtet, auffallend ist jedoch, daß ihr Vorkommen sich hauptsächlich auf das SW-Becken beschränkt, und in bedeutenderer Prozentzahl haben wir sie nur in der Bucht bei Keszthely gefunden.

Tabelle 7

Die prozentuale Verteilung der Mitglieder des *Daphnia*-genus in den verschiedenen Gebieten des Sees

Datum	Art und var.	M _e	M	K	G	A _e	A	E	E _e
VI. 8—10.	cucullata	34,24	37,50	22,81	13,64	25,56	31,94	20,01	31,82
	h. galeata	32,42	33,30	43,86	63,64	72,21	62,50	37,13	48,16
	h. lacustris	6,21	4,67	3,51	2,27	2,23	3,24	—	—
	juv. sp.	27,13	25,03	29,82	20,45	—	2,31	42,86	20,02
VII. 1—2.	cucullata	78,12	70,17	55,04	69,56	55,16	59,46	54,55	58,70
	h. galeata	18,75	12,63	24,55	17,39	23,43	15,70	21,77	28,90
	h. lacustris	3,13	—	1,29	—	—	—	—	—
	juv. sp.	—	17,19	19,12	13,05	21,41	24,84	23,80	12,41
VIII. 2—4.	cucullata	49,60	57,19	91,40	92,30	96,52	95,24	88,30	93,00
	h. galeata	25,60	26,93	3,94	5,13	2,15	2,37	8,33	6,00
	g. lacustris	—	—	—	—	—	—	—	—
	juv. sp.	24,80	15,87	4,66	2,57	1,33	2,39	3,36	1,00
IX. 6—8.	cucullata	75,00	73,44	91,78	93,33	95,59	96,00	91,43	96,95
	h. galeata	10,00	13,00	2,74	6,67	4,41	2,67	2,86	—
	h. lacustris	15,00	12,13	—	—	—	—	—	—
	juv. sp.	—	1,43	5,48	—	—	1,33	5,71	3,05
IX. 12—14.	cucullata	70,23	83,12	91,04	91,65	—	—	—	—
	h. galeata	18,18	12,99	5,97	—	—	—	—	—
	h. lacustris	2,27	—	2,98	—	—	—	—	—
	juv. sp.	9,32	3,40	—	8,35	—	—	—	—

Über einige andere Crustacea-Planktonmitglieder

1. *Cyclops vicinus* ULJ. vermehrt sich während der Kaltwasserperiode. »Es ist noch nicht untersucht worden, wie diese Art die für sie ungünstige Periode übersteht« (SEBESTYÉN 1953, S. 72). Auch unsere Untersuchungen von 1965 zeigen, daß diese Art in der Plankton-Crustacea-Gemeinschaft in den verschiedenen Querprofilen des Sees im Juni (Wassertemperatur in Oberflächennähe (W. T.): 18—19 °C) in recht kleiner Prozentzahl (0,32—2,83%) zu finden ist. Im folgenden Monat (Juli, W. T.: 22—27 °C) konnten wir nur einige juvenile Exemplare beobachten. Im August (W. T.: 20—22 °C) tauchte sie in 3 von 5 Querprofilen auf (zwischen 0,17—0,45%). Anfang September (W. T.: 18—20 °C) beträgt ihr Wert in der Planktongemeinschaft schon um 10%. Es kam zu der Vorstellung, daß die obere, lockere Schicht des Schlammes des offenen Wassers und die sich über ihr befindende Wasserschicht die zu ihrer Vermehrung noch ausreichende Temperatur (18—19 °C) trotz der stär-

ken Erwärmung der oberen 1–2 m dicken Wasserschicht gewährleisten kann. Demzufolge haben wir die quantitativen Verhältnisse des *C. vicinus* mit einem speziellen Schlammprobenentnahmeapparat (PONYI, BIRÓ und P.-ZÁNKAI 1967) in der oberen Schlammschicht und in der sich darüber befindenden schmalen Wasserschicht in den 3 Sommermonaten des darauffolgenden Jahres (1966 Juni, Juli, August) untersucht.

Die Ergebnisse weisen darauf hin (Tab. 8), daß in den 2 warmen Sommermonaten (Juli, August), wo der *C. vicinus* aus dem Plankton praktisch vollkommen verschwindet, er jedoch in der oberen Schlammschicht und in der Wasserschicht oberhalb des Schlammes in beträchtlicher Menge vorkommt. Es scheint also wahrscheinlich, daß diese Art hier die für sie ungünstige Warmwasserperiode übersteht.

2. Der *Acanthocyclops vernalis* (FISCHER) kam erstmalig im Laufe der Schlammuntersuchungen des Plattensees zum Vorschein (PONYI 1966). Dieses Tierchen besitzt eine breite ökologische Valenz. Es ist in den verschiedenartigsten Gewässern (See, Fluß, Pfützen, interstitielle Gewässer) zu finden. RYLOV (1948) hält es für einen β -mesosaprob Organismus. In einigen der Abendproben der Bucht bei Keszthely (Querprofil M) haben wir es in derart großen Mengen beobachtet (40–60%), daß wir die Zusammensetzung des Krebsplanktons in dieser Sammlung nicht reell auswerten konnten. In dem am Tage gesammelten Plankton haben wir es in 0,5–4,0% gefunden. In unserem See sind verschiedene Formen des Tieres (*vernalis*, *robustus* und Übergangsformen zwischen den beiden) zu finden, welche als saisonelle Formen angesehen werden können (PONYI 1967). Nach den bisherigen Untersuchungen ist es in dem offenen Wasser nur in der Bucht bei Keszthely zu finden.

3. Der *Mesocyclops (Thermocyclops) crassus* (FISCHER) wurde von uns in dem Plattensee erstmalig im Laufe der Röhrichtsforschung 1959 nachgewiesen (PONYI 1962). In dem offenen Wasser des Sees haben wir ihn erstmalig 1965 beobachtet. Er ist ein typischer Planktonorganismus und wird für einen β -mesosaprob Organismus gehalten. (RYLOV 1948). Wir fanden ihn in dem

Tabelle 8

Die quantitativen und Verteilungsverhältnisse des *Cyclops vicinus* in 5 Querprofilen des Schlammes des offenen Wassers des Sees im Jahre 1966 (dm²)

Datum	Wassertemperatur 30 cm unter der Wasseroberfläche in °C	M	K	G	A	E
VI. 14–15.	22–24	2 j	2 j	7 j	—	—
VII. 26–27.	19–22	5 ♀ 15 j	46 ♀ 10 cop	6 ♀ 13 j	5 ♀	—
VIII. 23–24.	22–63	105 ♀ 2 ♂	18 ♀	2 ♀	10 ♀	—

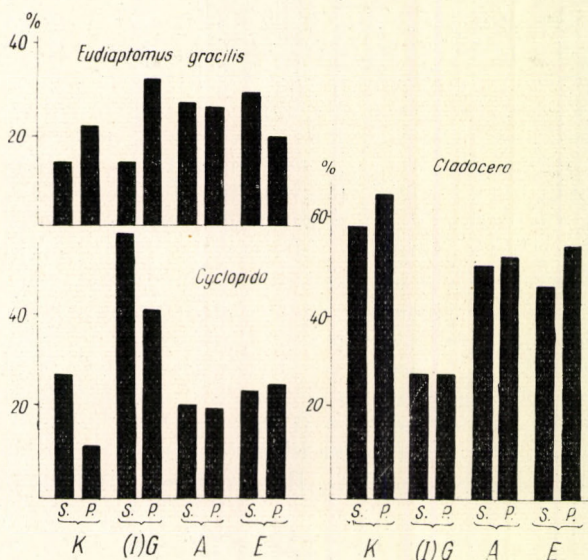
Bemerkungen: Die Angaben haben wir nach je 3 Untersuchungspunkten jedes Querprofiles berechnet

j = juvenile Exemplare
cop. = copepodites Stadium

(M) Querprofil der Bucht bei Keszthely und in dem (E) Querprofil des NO-Beckens. In dem M Querprofil war er mit 1% vertreten. Es ist anzunehmen, daß sein Erscheinen ein neues Zeichen der Veränderung des Sees ist.

Sonstige Bemerkungen

Die Ergebnisse und die Schlußfolgerungen dieser Untersuchungen beschränken sich erstrangig auf die Mitteilung von Daten. Es ist jedoch wert- und lehrreich, einen Vergleich zwischen den aus annähernd gleicher Zeitspanne stammenden Werten von SEBESTYÉN (30. 6. 1958) und den eigenen Werten



6. Die prozentuale relative Veränderung des Crustacea-Planktons im Jahre 1958 (30. 6) und im Jahre 1965 (1—2. 7.). S = SEBESTYÉN's, P = PONYI's Angaben. Andere große Buchstaben: untersuchte Querprofile

6. ábra. Crustacea-plankton %-ban kifejezett relatív változása 1958 (VI. 30) és 1965 (VII. 1—2) évben. S = SEBESTYÉN, P = PONYI adatai. Egyéb nagybetűk = vizsgált szelvények

1—2. 7. 1965) zu treffen (vgl. SEBESTYÉN 1960, Tab. 3. %-Spalte). Die Angaben von SEBESTYÉN sind die aus den absoluten Werten errechneten Prozentwerte, die unseren sind die prozentualen Daten des relativ-quantitativen Rechnens (Abb. 6). Aus den Angaben geht klar hervor, daß die relative Menge der Cladocera innerhalb des Krebsplanktons an den verschiedenen Stellen des Sees trotz der Zeitspanne von 7 Jahren fast die gleiche ist. Die auffindbaren Unterschiede weisen jedoch darauf hin, daß mit der Veränderung der Arten von Copepoda, aber auch der relativen Population — hauptsächlich in SW-Becken — eher zu rechnen ist, als mit der des Cladocera.

Zusammenfassung

1. Der Verfasser weist darauf hin, daß in der relativen Population der Planktonkrebse an den verschiedenen Stellen des offenen Wassers des Platten-sees in annähernd gleicher Zeit (innerhalb von 2 Tagen) wesentliche Unterschiede zu beobachten sind.

2. Die Entwicklung der Populationen des *Eudiaptomus gracilis* (SARS), des *Daiphanosoma brachyurum* LIEVIN und des *Mesocyclops* (s. str.) *leuckarti* (CLAUS) geht anscheinend in den 2 Becken des Sees in der Warmwasserperiode nicht gleichermaßen vonstatten.

3. Die Population der *Daphnia hyalina* var. *galeata* SARS ist in der Frühlingsperiode bedeutend und kann die der *Daphnia cucullata* übertreffen. Die *Daphnia hyalina* var. *lacustris* SARS haben wir in bedeutender Prozentzahl nur in dem SW-Becken (Bucht bei Keszthely) gefunden.

4. Der *Cyclops vicinus* ULJANIN ist in den warmen Sommermonaten, wo er aus dem Plankton praktische verschwindet, in bedeutender Menge an der Oberfläche des Schlammes des offenen Wassers bzw. in der Wasserschicht darüber zu finden.

5. Es ist anzunehmen, daß das Erscheinen des *Mesocyclops* (*Thermocyclops*) *crassus* (FISCHER) in dem offenen Wasser ein neueres Zeichen der Veränderung des Sees ist.

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CRUSTACEAE-PLANKTON VIZSGÁLATOK A BALATONON IV. ADATOK A TÓ RÁKEGYÜTTESÉBEN HORIZONTÁLISAN FELLÉPŐ VÁLTOZÁSOK MEGISMERÉSÉHEZ

Összefoglalás

Ponyi Jenő

1. A szerző rámutat arra, hogy közel azonos időben (2 napon belül), a Balaton nyíltvízének különböző helyein a planktonrákok relatív népességében jelentős különbségek észlelhetők.

2. A melegvíz időszakában az *Eudiaptomus gracilis* (SARS), *Diaphanosoma brachyurum* LIEVIN és a *Mesocyclops* (s. str.) *leuckarti* (CLAUS) populációinak kifejlődése a tó két medencéjében úgylátszik nem egyformán megy végbe.

3. A *Daphnia hyalina* var. *galeata* SARS népessége a koranyári időszakban jelentős és meghaladhatja a *Daphnia cucullata*-ét. A *Daphnia hyalina* var. *lacustris* SARS-t jelentős %-ban csak a DNY-i medencében (Keszthelyi-öböl) találtuk.

4. *Cyclops vicinus* ULJANIN, a meleg nyári hónapokban, amikor a planktonból gyakorlatilag eltűnik, jelentős mennyiségben található a nyíltvíz iszapjának felszínén, ill. az afölötti vízrétegben.

5. A *Mesocyclops* (*Thermocyclops*) *crassus* (FISCHER) megjelenése a nyíltvízben a tavi változásnak feltételezhetően egyik újabb jele.

ОБ ИЗМЕНЕНИЯХ В ВИДОВОМ СОСТАВЕ РАКООБРАЗНЫХ ОЗЕРА БАЛАТОН

Й. Поньи

1. В течение двухдневного периода обнаружены значительные различия в относительной плотности популяции планктонных рачков в разных участках открытой воды озера Балатон.

2. При прогревании воды развитие популяций *Eudiaptomus gracilis* (SARS), *Diaphanosoma brachyurum* LIEVIN, и *Mesocyclops* (s. str.) *leuckarti* (CLAUS) происходит по-разному в двух разных участках озера.

3. Плотность популяции *Daphnia hyalina* var. *galeata* SARS в начале лета значительно выше, чем популяции *Daphnia cucullata*. *Daphnia hyalina* var. *lacustris* SARS обнаруживается в значительном проценте только в Кестхейском заливе.

4. В течение жарких летних месяцев *Cyclops vicinus* ULJANIN обнаруживается в значительных количествах на поверхности или открытой части озера и в прилегающем к илу слое воды, но в планктоне в этот период этот вид не обнаруживается.

5. Появление в открытой воде *Mesocyclops* (*Thermocyclops*) *crassus* (FISCHER) является еще одним показателем происходящих в озере изменений.

AN INVESTIGATION OF THE CONTENT OF THE CHLORINATED HYDROCARBON RESIDUES OF THE CRUSTACEAN PLANKTON IN THE BALATON

JENŐ E. PONYI, FERENC CSONTI and FERENC BARON

*Biological Research Institute of the Hungarian Academy of Sciences, Tihany
and KŐJÁL Laboratory, Kaposvár*

Received: 3 March, 1968

Researches done in recent years have irrefutably demonstrated, especially with respect to the studies made on synthetic chemical substances deriving from agricultural areas and on the effects of DDT and its derivatives applied against mosquitoes, that the chlorinated hydrocarbons caused incalculable damages in the aquatic ecosystems (HUNT and BISHOFF 1960, KEIT et al. 1964, HICKEY and KEITH 1964, TARZWELL 1965, SEBESTYÉN 1967, etc.).

Investigations have currently come to the fore aiming at a better understanding of the accumulation of pesticides via the food chain. The indispensability of these studies were justified by the recognition that pesticide residues, of a relatively small concentration but arriving in the aquatic habitat, accumulate by way of the aquatic insect larvae and zooplankton organisms causing the death both of fish and fish-eating birds. The demonstration of the validity of accumulation through food chains was proved by the classic case of Clear Lake in California (HUNT and BISHOFF 1960). After treating the lake by 0.02 ppm DDT, the spray residue brought about, by concentrating through the plankton organisms (5 ppm) and fish (2 ppm) a high rate of death in the western grebe (1.600 ppm).

In the food chain, crustaceans, and especially those living in the plankton, play an important role by their very mass. Thus, the average yearly biomass of the zooplankton in the Balaton can be estimated to attain 1002 metric tons, of which the crustacean plankton constitutes 945 m. tons, hence about 94 per cent of the zooplankton (SEBESTYÉN 1958). With due regard to the fact that the yearly production of this group of organisms is about thirtyfold of the biomass (ENTZ 1954), the role and significance of the plankton crustaceans become increasingly conspicuous.

Parallel with the manufacture and application of the diverse pesticides, a number of research workers selected the notoriously sensitive *Daphnia*-species for establishing the rate of toxicity of these substances (e.g. ANDERSON 1945, 1960). In recent works, attempts have been made to use also other Crustacea genera for this purpose (SANDERS and COPE 1966, RUBER 1965, 1965a, KAMINSKI 1966, etc.). Beside these important tests field work involving crustaceans of the plankton is comparatively meagre, despite their known significance and importance (TARZWELL 1965, HICKEY and KEITH 1964).

In the course of our earlier investigations (BARON, CSONTI and PONYI 1967), we succeeded to show a significant amount of pesticide residues in the crustacean plankton of the Balaton. Since our data derive merely from some points of the lake and from the fall period, we deemed it necessary to extend our studies, as far as possible, to the entire open water body of the Balaton and the whole period of development of the crustacean plankton.

Material and methods

Samples were collected from transversal sections, at right angles to the longitudinal axis of the lake, namely 3 (M, K, G) from the SW, and 2 (A, E) from the NE sections of the Balaton (cf. SEBESTYÉN 1960, p. 118–119). Large-sized plankton-nets ($\varnothing = 0.22\text{--}0.27$ mm), towed by motorship, had been used. The collecting and analysis of the material was continuously made through 6 months, from May till October, 1967. On every occasion, about 500 g (wet weight) crustacean mass per section had been taken. The material was stored in refrigerators and worked up within a few days. The specific composition of the samples was also identified (*Table 1*).

The identification of the spray residues was made by thin-layer chromatography (BARON et al. 1967). About 300–400 g of each sample were worked up, subsequent to having left them for one hour on filter paper in order to facilitate the evaporation of surplus water. The humidity content of the crustacean plankton analysed was 90.34 ± 0.74 per cent.

The specific composition and per cent distribution of the samples was established by recourse to the relative-quantitative method (SEBESTYÉN 1953).

Results and conclusions

Of the residue components studied, only the γ -HCH and DDT derivatives could be demonstrated (*Table 2*).

Results show that the quantity of chlorinated hydrocarbons had variously evolved in space and time. In the sections, the value of the residues was the largest during the summer months (June, July, August). The summer maximum is also varying in the diverse sections (*Fig. 1*). The highest values were found in the two sections of the NE basin and in section K of the SW part of the lake.

No connection between the distribution of the pesticide residues and the per cent composition of the plankton is apparent (*Table 1*). The horizontal distribution of the content of spray residue in the crustacean plankton is therefore probably due to the fact that various amounts of pesticides became introduced to the diverse areas of the lake. The abrupt increase of DDT and its derivatives in the summer months may also be connected with campaigns attempting to destroy mosquitoes.

JONES and MOYLE's data (1963) demonstrate that the treatment of lakes by DDT is detrimental to the crustacean population. The effects appear in the periodic decrease of quantity subsequent to the treatment. The first application of DDT on the shores of the Balaton, for experimental purposes, was made in 1950–51 (MIHÁLYI and SOÓS 1952), and it is also regularly continued since

Table 1

Per cent composition of the crustacean plankton investigated for the demonstration of chlorinated hydrocarbons

Date of collection Species	M	K	G	A	E
16—18 May					
<i>Diaphanosoma brachyurum</i>	—	2.22	1.91	1.82	0.82
<i>Daphnia cucullata</i>	5.46	11.85	17.20	7.88	14.75
<i>D. hyalina</i>	20.00	31.84	10.19	12.73	12.29
<i>Eudiaptomus gracilis</i>	20.00	29.63	54.13	51.51	47.54
<i>Cyclops vicinus</i>	24.25	8.89	12.74	19.39	11.47
<i>Mesocyclops leuckarti</i>	29.10	8.14	3.18	4.24	9.02
Others	1.21	7.41	0.64	1.82	4.10
20 June					
<i>Diaphanosoma brachyurum</i>	22.05	18.49	17.68	Pesticides were not analysed	
<i>Dauphia cucullata</i>	23.57	30.39	17.68		
<i>D. hyalina</i>	12.86	14.53	10.20		
<i>Eudiaptomus gracilis</i>	12.13	4.40	5.44		
<i>Mesocyclops leuckarti</i>	24.99	30.39	46.25		
Others	4.41	1.76	2.72		
18—20 July					
<i>Diaphanosoma brachyurum</i>	37.88	37.16	47.24	9.67	38.73
<i>Daphnia cucullata</i>	17.42	7.78	6.75	12.10	2.81
<i>D. hyalina</i>	3.02	2.02	1.23	3.23	1.81
<i>Eudiaptomus gracilis</i>	9.09	15.54	30.67	59.68	30.28
<i>Mesocyclops leuckarti</i>	30.30	30.40	13.50	15.32	26.76
Others	2.27	6.08	0.61	—	—
15—16 August					
<i>Diaphanosoma brachyurum</i>	4.07	35.66	18.18	17.18	31.72
<i>Daphnia cucullata</i>	23.57	25.17	2.48	4.69	2.07
<i>D. hyalina</i>	0.81	—	—	—	—
<i>Eudiaptomus gracilis</i>	21.14	28.67	52.06	52.34	50.34
<i>Mesocyclops leuckarti</i>	45.53	9.08	27.27	23.44	14.48
Others	4.88	1.40	—	2.34	1.38
19—20 September					
<i>Diaphanosoma brachyurum</i>	20.42	22.79	11.11	11.71	34.13
<i>Daphnia cucullata</i>	7.72	8.83	11.10	11.18	22.22
<i>D. hyalina</i>	0.70	0.73	—	—	0.79
<i>Eudiaptomus gracilis</i>	57.74	44.85	68.88	65.79	34.91
<i>Cyclops vicinus</i>	6.33	6.62	4.44	4.61	1.58
Others	1.47	1.47	0.74	—	3.97

1957—58. If the average summer amount of open water crustacean plankton of 1955 and 1958 is compared (as calculated from SEBESTYÉN's data 1960), it will be found that whereas the average value was 28.40 ± 4.57 individuals/liter in 1955, it decreased to 15.60 ± 2.34 ind/l. in 1958. The two values differ significantly ($0.05 > P > 0.02$).

By comparing the pesticide content of the animal groups analysed during 1966—1967 (Table 3), it appears that the highest means derive from the crustacean plankton originating from the middle of summer. Since the objects studied do not derive from identical dates, the comparison of the values should be considered for general information only.

Comparing various summer samples of some lakes, KEITH et al. (1964) found, among others, that the highest amount was demonstrable from the suspended material (plankton!) (6.0—9.3 ppm), followed by that of fish

Table 2
The content of chlorinated hydrocarbons of samples of crustacean plankton in various areas of the Balaton

Date of collection	Section studied	Chlorinated hydrocarbon residues in ppm					
		HCH				DDT	
		γ	DDD	DDT	?	DDE	Total
V. 17.	A	ny	0.01	0.02	0.03	0.14	0.20
V. 18.	E	0.06	0.02	0.02	0.02	ny	0.12
V. 16.	G	0.06	0.06	0.06	0.06	ny	0.24
V. 16.	K	0.03	0.08	0.06	0.03	ny	0.20
V. 16.	M	0.07	0.07	0.07	0.07	ny	0.28
VI. 20.	G	0.10	0.02	0.10	ny	ny	0.22
VI. 20.	K	0.20	0.50	0.60	0.20	0.80	2.30
VI. 20.	M	0.10	0.10	0.10	0.10	0.10	0.50
VII. 20.	A	2.00	2.30	2.00	ny	3.00	9.30
VII. 19.	E	1.00	0.20	0.80	ny	0.80	2.80
VII. 19.	G	0.20	0.30	ny	ny	ny	0.50
VII. 18.	K	0.30	0.30	1.20	ny	0.20	2.00
VII. 18.	M	0.10	0.10	0.30	ny	0.10	0.60
VIII. 16.	A	0.15	0.20	0.25	ny	0.06	0.66
VIII. 16.	E	0.08	0.08	0.40	0.16	0.13	0.85
VIII. 15.	G	0.04	0.10	0.50	0.20	0.20	1.04
VIII. 15.	K	0.05	0.10	0.30	0.10	0.30	1.30
VIII. 15.	M	0.06	0.02	0.05	0.02	0.03	0.18
IX. 20.	A	0.01	0.01	0.02	0.02	0.04	0.10
IX. 20.	E	0.01	0.02	0.01	0.01	0.01	0.06
IX. 19.	G	0.01	0.02	0.01	0.02	0.02	0.10
IX. 19.	K	0.01	0.01	0.02	0.02	0.03	0.09
IX. 19.	M	0.02	0.02	0.02	0.02	0.03	0.11
X. 23.	A	ny	ny	ny	o	ny	ny
X. 23.	E	0.01	0.01	0.01	o	0.01	0.04
X. 17.	G	0.01	ny	0.01	ny	0.01	0.03
X. 17.	K	ny	ny	0.01	o	0.01	0.02
X. 17.	M	0.01	ny	0.01	o	ny	0.02

Remark: α -, β -, δ -HCH; aldrin, dieldrin were not demonstrable by the method applied
? = unknown component

Table 3
The chlorinated hydrocarbon content of some groups of organisms of the Balaton, as found by investigations in 1966—67
(mean values in ppm)

	Crustacea ²	Fish ¹	Bivalves ¹
γ -HCH	0.72	0.19	0.23
DDT (total)	2.32	1.04	0.90

¹ = Based on the data of Baron et al. 1967; the column of fish represent the means of 4 common species.

² = Mean values from July.

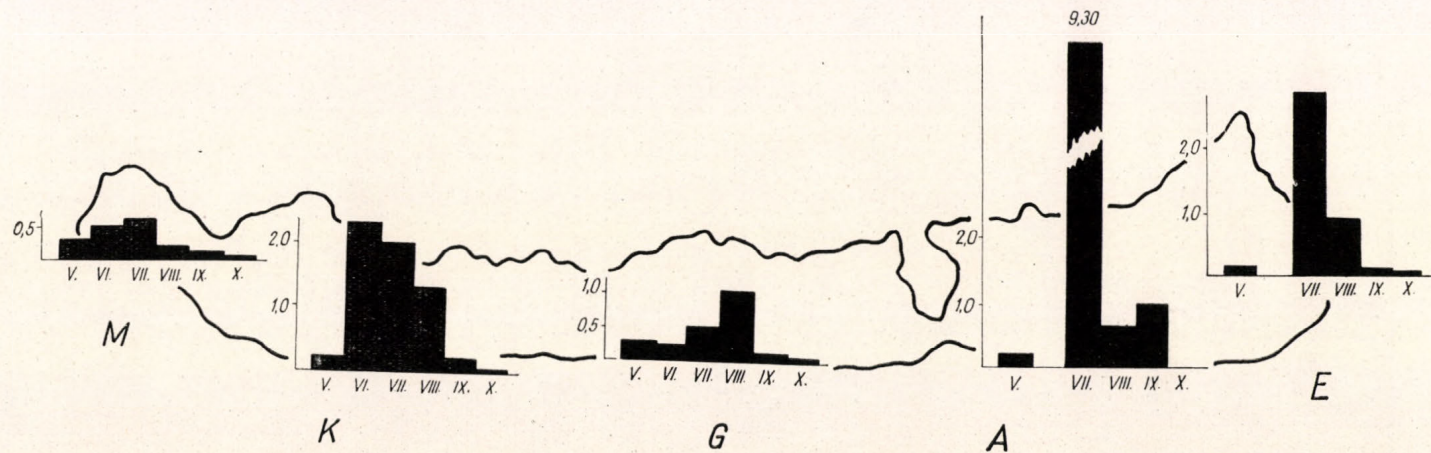


Fig. 1. The spatial and temporal fluctuation of the contents of chlorinated hydrocarbon residues in the crustacean plankton in the open water of the Balaton

1. ábra. A Crustacea-plankton klórozott szénhidrogén-maradék tartalmának tér- és időbeli változása a Balaton nyíltvizében

(1.5–3.3) and sedimented organic detritus (0.4–1.5). On the basis of the distribution of pesticides deriving from the animal groups shown in *Table 3*, we contend that the conditions in the Balaton are of the same nature, since the bivalves feed also on the fine sedimentary detritus of the bottom, and it is thus that the order of sequence

Crustacea > fish > bivalve

can be explained.

Summary

The authors investigated the amount of spray residue in the crustacean plankton in 5 transversal sections of the Balaton, during 6 months in 1967. It was established that significant quantities of residues in the various sections of the lake can be found during the summer months. The amount of pesticides accumulated in the crustaceans in various sections of the Balaton is of diverse rates.

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A CRUSTACEA-PLANKTON KLÓROZOTT SZÉNHIDROGÉN-MARADÉK TARTALMÁNAK VIZSGÁLATA A BALATONON

Összefoglalás

Ponyi Jenő, Csonti Ferenc és Baron Ferenc

Szerzők 1967-ben 6 hónapon keresztül a Balaton 5 keresztshelvényében vizsgálták a Crustacea-plankton permetmaradék mennyiségét. Megállapították, hogy a tó különböző shelvényeiben jelentős mennyiségű maradékok a nyári hónapokban találhatók. A Balaton különböző részeiben a rákokban felhalmozódott pesticidek mennyisége különböző mértékű.

АНАЛИЗ НАКОПЛЕНИЯ ПЕСТИЦИДОВ В ПЛАНКТОННЫХ РАКООБРАЗНЫХ ОЗЕРА БАЛАТОН

Й. Поньи, Ф. Чонти и Ф. Барон

Содержание пестицидов в планктонных рачках исследовали в течение 6 месяцев на пяти поперечных разрезах озера Балатон. Существенное содержание пестицидов обнаруживается в разных точках озера только в течение летних месяцев. В количественном отношении наблюдается различие между разными участками озера по содержанию пестицидов в планктонных ракообразных.

A BALATONI SZIVACSAUNA NÉHÁNY PROBLÉMÁJA TÖTÖRTÉNETI VIZSGÁLATOK TÜKRÉBEN

SEBESTYÉN OLGA

Magyar Tudományos Akadémia Biológiai Kutatóintézete, Tihany

Érkezett: 1968. február 14-én

A Balaton élővilágának és a tónak mint ekosisztémának megismerésére irányuló törekvéseink során — a tó jelenét értve — különböző részletproblémák merülnek fel, melyek megoldását récents adatok és a vonatkozó irodalom alapján nem lehet mindig kielégítően megközelíteni. Amint a kutatások kiterjednek a tavi múltra is, s az üledékek mikrofosszília-adatait paleolimnológiai szempontból értelmezzük, a kutatás területe új dimenziót nyer: lehetőség nyílik mind az élővilág (biota) felépítését, mind az ekosisztémát alakulásában, fejlődésében vizsgálni. Ez a szemlélet és megfelelő módszerek alkalmazása módot nyújthat egyes, eddigelé nyílt kérdések megvilágítására.

Ilyen probléma balatoni vonatkozásban pl. a harmincas évek elején felmerült „törpenövés” (nanizmus, dwarfism) (SEBESTYÉN 1943). Mások a fauna egyes rendszertani csoportjára pl. szivacsokra vonatkoznak. Tulajdonképpen nehéz elkülöníteni a kérdéseket aszerint, hogy vajon az élővilág összetételének, vagy pedig a tónak mint ekosisztémának problémakörébe tartoznak-e? A törpenövés kérdése, minthogy a biota több tagjával kapcsolatban fölmerült, kétségtelenül az utóbbi csoportba sorolható.

Tudjuk, hogy a törpenövés lehetőségét mind állatokon, mind algákon több szerző függetlenül egymástól fölvetette a Balatonon és a tihanyi Belső-tón is (SEBESTYÉN i. m.). A jelenség azonban mind ez ideig nincs ok-okozati összefüggésben megvizsgálva, sem kellően dokumentálva. Kiindulásképpen a törpenövés tényének megállapítása volna szükséges méretfelvételekkel balatoni és más vizekből származó récents populációkon. Tenyésztési kísérletek is megvilágíthatják e kérdést. (FREY, 1956, R 107) Egyes szervezetek szubfosszilis maradványa bőségben áll rendelkezésre az üledékekben. Ezek értelmezésével talán rá lehetne mutatni a jelenség eredetére kor és okozat szerint is. Ugyanis paleolimnológiai kutatások során alkalom nyílik bepillantani a mindenkori környezeti körülményekbe az üledékek kemizmusának feltárásával s a klíma pollenanalitikai rekonstruálása alapján. A limnológia fejlettségének mai fokán az élővilág tagjainak maradványai is támogatnak ilyen kérdésekben (FREY 1967).

A törpenövést balatoni keszezen (*Abramis brama* L.) megállapító W. WUNDER szerint e jelenséget e tömeghalon valószínűleg a nagy populáció következtében fellépő táplálékhiánynak lehet tulajdonítani (WUNDER 1930, 752). Kistermetű szabadon mozgó vízi állatokon a kiváltó okot vagy okokat inkább a környezeti hatótényezőkben lehet keresni. D. G. FREY a *Pleuroxu*s

uncinatus BAIRD v. *balatonicus* DADAY-t a faj törpeváltozatának tekinti, és a törpenövést egyben a gynandromorphismus jelenséggel is kapcsolatba hozza (FREY 1965, R 103, 107, 111).

Több évtizeddel ezelőtt a Balaton szivacsainak tanulmányozása közben felbukkantak egyes problémák (SEBESTYÉN 1936). Jelen tótörténeti vizsgálataim során újra előtérbe jöttek ezek, ui. a szubfosszilis anyag elemzése közben gyakran jegyeztem fel édesvízi szivacsok kovatűit is.

FREY „Remains of animals in Quaternary lake and bog sediments and their interpretations” c. gazdag anyagot kritikai szemlélettel feldolgozó munkájában édesvízi szivacsmaradványokkal is foglalkozik. Rámutat arra, hogy a maradványok mennyiségéből, a kovatűk fejlettségéből és állapotából a környezeti körülményekre lehet következtetni. Utal a faji felismerés nehézségeire is (FREY 1964, 20–22) (vö. RAČEK 1966, 82). Kérdés, hogy balatoni anyagon az a körülmény, hogy mind hazánknak, mind a Balatonnak, de egész Közép-Európának édesvízi szivacsfaunulája — összehasonlítva pl. Észak-Amerika, Ázsia és a trópusok területeivel — nem gazdag, megkönnyíti-e a váztűk faji hovatartozásának megállapítását?

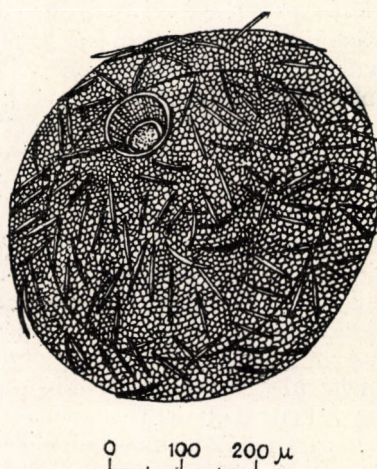
Hazánkban mindössze három *Spongilla* faj (*fragilis* LEIDY 1851, *lacustris* L. 1759, *carteri* CARTER 1849, ssp. *balatonensis* ARNDT 1923), két *Ephydatia* (*fluviatilis* L. 1759, *mülleri* LIEBK. 1856) és egy *Trochospongilla* (*horrida* WELTNER 1893) fordul elő. A *Heteromeyenia baleyi* B.W. v. *stepanovi* DYB. 1885 lelőhelyei kívül esnek határainkon. Hazánk szivacsfaunájának első összefoglalásaiban (TRAXLER 1889, VÁNGEL 1896) mindezek szerepelnek, a *Trochospongilla* kivételével. TRAXLER a *S. carterit* nem említi. A *Trochospongilla horrida* tűit a tó iszapjában TRAXLER találta meg (1898) (vö. SEBESTYÉN 1942, 93). A *Spongilla carteri* CARTER és a *Trochospongilla horrida* WELTNER egyetlen hazai lelőhelye a Balaton. Az *Ephydatia mülleri* előfordulásának bizonyosságáról személyes tapasztalatom nincs (SEBESTYÉN 1942, 92).

A *Spongilla fragilis* gyakori a Balatonban (GELEI 1929, 39, 40, 41). A telepek vékonyak, kicsinyek, sőt gyakran csenevészek. Pl. a gemmulákon a jellemző faji bélyegeket: a póruscső kijáratát többszöri megismételt vizsgálatok során lehetett csak felismerni, közös légkamrába zárt gemmulákat egyetlen esetben sem találtam. A másik két *Spongilla* fajnak, továbbá az *Ephydatia fluviatilis*nek szép telepei fejlődnek tavunkban. Újabban merült föl az a gondolat, hogy talán a *Spongilla fragilis* is besorolható azok közé a szervezetek közé, melyeken — balatoni vonatkozásban — már felmerült a törpenövés lehetősége (SEBESTYÉN 1943). Természetesen a különböző szivacsfajok ekológiai igénye, illetőleg annak viszonya a környezeti körülményekhez is tekintetbe veendő. Tudjuk, hogy egyes fajok általában nem alkotnak nagy telepeket (pl. a *Trochospongilla horrida*, ARNDT 1928, 78–79).

W. ARNDT a *Spongilla carteri* CARTER ssp. *balatonensis* ARNDT-ot a telepek sajátos morfológiai alkata alapján jól körülírt lokálformának minősíti. E körülmény arra utal, hogy az elkülönülés a messzi múltba nyúlik vissza. Tűi és gemmulái nem különböznek a törzsfajétól (ARNDT 1923) (1. ábra). ARNDT az alfajt a berlini múzeum példányai alapján írta le, s valóban a leírásnak megfelelő példányok a legszebbek tavunkban. Megjegyzendő azonban, hogy oly példányok is gyakoriak, melyeken a nyúlványok és az oszkulumok nem fejlődnek ilyen jellegzetesen. Telepek előkerülése az üledékekből nem várható, s így az alfaj-kialakulás kezdeti idejének kiderítésére mikrofosszilia-vizsgálatok aligha alkalmasak. Ki lehet deríteni talán azonban különösen gemmulák

jelenlétében azt, hogy ez a szivacs mióta lakja tavunkat. Ez egymagában is értékes adatot jelenthet a balatoni élővilág összetételének alakulásához.

A harmincas években és a következő évtized első felében még rendkívül dús telepei fejlődtek a balatonfüredi régi fürdőház egyes részein és a közeli jégtörőkön. 1937-ben a tóban való terjeszkedéséről lehetett beszámolni (SEBES-



1. ábra. *Spongilla carteri* CARTER. Balaton. Gemmula felületi nézetben, a légkamrás réteg vastagságának, rostos szerkezete vetületének, a gemmula-fedőtűknek és a pórusnak feltüntetésével. $\varnothing = 0.5$ mm

Fig. 1. *Spongilla carteri* CARTER. Balaton. Gemmule, surficial view, showing the thickness and surficial structure of the pneumatic layer, spicules and porus. Diameter 0.5 mm

TYÉN 1940b). 1951 nyarán az említett faalkotmányokat eltávolították a füredi vizekről. Az utóbbi években tapasztalt visszahúzódását mégsem tulajdoníthatjuk alzathiánynak, mert jóformán a legkülönbözőbb abiotikus alzaton megtelepszik. 1961-ben már keresni kellett, és Tihany közelében csak Balatonföldváron sikerült néhány telepére akadni. Hogy nem vészett ki teljesen, bizonyítja az 1967 őszén a füredi móló falán elég mély vízben kedvező megvilágításban feltűnt telep. Félő azonban, hogy ez a szivacs áldozatul esik a korunkat jellemző emberi beavatkozás aggasztó hatásának (táplálékhiány? vízminőség károsodása?).

Mint említettem, a *Trochospongillának* csak jellegzetes tuskés váztűit és amfidiszkuszait találta balatoni iszapban a tó északi partja mentén TRAXLER LÁSZLÓ (1864–1898) kiváló spongiológusunk, aki hazai és külföldi récents és szubfosszilis szivacsokkal egyaránt foglalkozott (SEBESTYÉN 1940a, 132, 138). Magam a harmincas években eredménytelenül kerestem TRAXLER gyűjtőhelyén, Badacsony és Révfülöp nádasaiban e ritka szivacs nem feltűnő kéregszerű telepeit (ARNDT 1928; JEWELL 1959). Az ötvenes évek derekán a tóba ömlő vizek terepmunkálatai közben szinte váratlanul akadtam egy kis elgemmulásodott telepre a somogyi part egy kővén, amelyet mind a közelben betorkolló Nyugati-övesatorna, mind a tó vize mos (Balatonmária, 1955. IX. 30., *Balatoni Faunakatalógus*, Tihany, S. O. bejegyzése). (1–3. kép.). Faji hová-

tartozását kimutatta a mikroszkópiai vizsgálat. Ui. az amfidiszkuszok e fajon rendkívül kicsinyek (nyél h. $10\ \mu$, korong átmérője $12\ \mu$, ARNDT), a korongok széle ép. A gemmulák általában elég nagyok (ARNDT 1928, 79; REZVOJ 227). Tudtommal ez a lelet az egyetlen adat e faj balatoni és egyúttal hazai előfordulására. (Készítmények: Tihanyban és az Orsz. Természettudományi Múzeum Állattárának gyűjteményében.) TRAXLER megtalálta ugyan Csap közelében — bizonyító példány is van gyűjteményében (SEBESTYÉN 1940a, 132) — e lelőhely azonban kívül esik hazánk határain. Minthogy e kis telep szinte váratlanul került elő a déli parton, remény lehet arra, hogy gondos kereséssel a tó más részein is megtaláljuk.

A *Trochospongilla horrida* szubfosszilis váztűi (makrosklera) üledék-vizsgálataim során kerültek elő ZÓLYOMI BÁLINT egyik furatmintájában. A legtöbb tű ép volt. (III. 36, Szigliget — Balatonfenyves profil, a tó közepén, 350—370 cm mélység.) Az erőteljes váztűk tüskéi, mint ismeretes, nagyságban felülmúlják az *Ephydatia mülleri* szintén tüskés tűit (ARNDT 1928, 68; REZVOJ 1928, 226—227). Szubfosszilis váztűk h. = $163\text{—}244,6\ \mu$; k. é. = $205,8\ \mu$; 16 adat.) E szivacsnak mikrosklerái nincsenek; a jellegzetes váztűknek bizonyító értékük van, amfidiszkuszok nélkül is. Makrosklerák borítják a gemmulák amfidiszkuszrétegét is.

E mintának megfelelő üledékréteg palynológiai alapon korazonos a B 28 furat 140. sz. mintájáéval (Révfülöp — Boglár profil, a tó közepén, 330 cm) s így a késő Pleistocénból származik (SEBESTYÉN 1968). A III. 36. minta *Pediastrum*-maradványokban bővelkedő anyagában könnyen feltűntek szivacsunk robusztos, jól konzervált váztűi (4—6. kép). Sima szivacsstűk és néhány mikrosklera is előfordult a mikroszkópi készítményekben, ezek faji hovátartozásával azonban egyelőre nem foglalkozhattam. Eddigél egyetlen amfidiszkusz (*Ephydatia fluviatilis* (?)) került elő.

Az álló- és lassú folyású vizekben egyaránt előforduló *Trochospongilla horrida* a paleolimnológiai vizsgálatok alapján a jégkorszakban nem lehetett

Trochospongilla horrida WELTNER. Váztűk és amfidiszkuszok balatoni telepből (Balatonmária, 1955. szeptember 30). Váztűk h = $172\text{—}216\ \mu$, átlagérték = $203\ \mu$, 16 példány; amfidiszkusz, nyél hossz = $14\ \mu$, korong $\varnothing$ = $16\ \mu$. Eau de Javelle, kanada-balzsam

Trochospongilla horrida WELTNER. Macroscleres and birotulate spicules from a Balaton-colony (30. Sept. 1955). Length of the macroscleres = $172\text{—}216\ \mu$, mean $203\ \mu$, 16 specimens. Length of the shaft of the birotulate spicules = $14\ \mu$, $\varnothing$ of the disc. = $16\ \mu$. (Eau de Javelle, balsam.)

1a. kép. Makrosklera, amfidiszkusz, apikális nézet

M. ph. 1a. Macrosclere. Birotulate spicules, apical view

1b. kép. Ua., fáziskontraszt felvétel

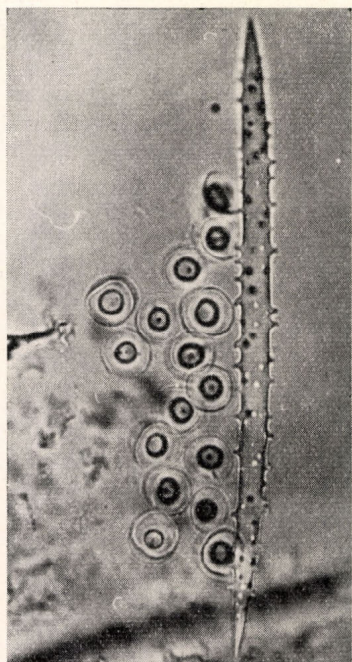
M. ph. 1b. The same, phase contrast

2. kép. Váztű részlete, amfidiszkusz oldalnézetben. Jobb alsó sarokban több amfidiszkusz. Bal felső sarokban *Ephydatia* sp. amfidiszkuszai, apikális nézet

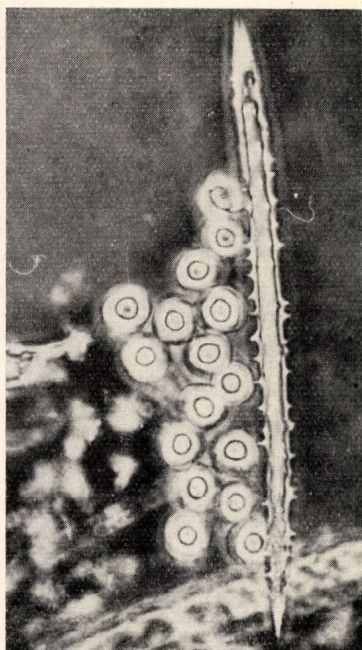
M. ph. 2. Macroscleres, one birotulate spicule, lateral view. More birotulate spicules at the right lower corner. At the left upper corner birotulate spicules of *Ephydatia* sp., apical view

3. kép. Váztű, amfidiszkusz, oldalnézetben

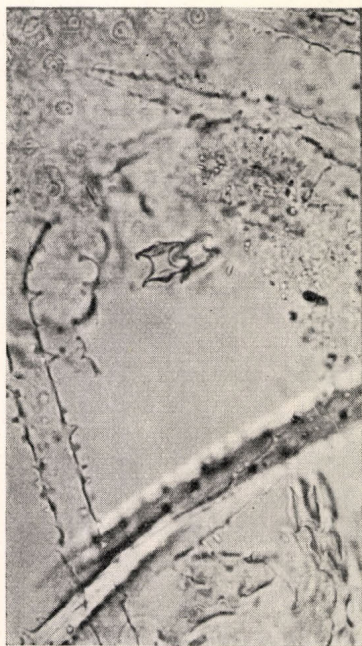
M. ph. 3. Macrosclere and birotulate spicule, lateral view



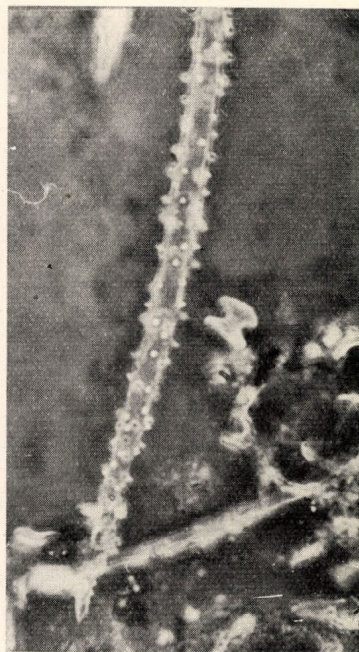
1a



1b



2



3

ritka tavunk mai kiterjedésének megfelelő vízterület egyik részén (vö. SEBES-
TYÉN 1968). A tūmaradványok gyakorisága, fejlettsége és állapota jó szilícium-
és táplálékellátásra, zavartalan környezeti körülményekre utalhat (FREY
1964, 20). A *Trochospongilla horrida* ekológiai igényének ismeretében, más
furatok mintáinak elemzésével további eredmények várhatók a szivacs-
előfordulás tótörténeti értelmezését illetően.

A szubfosszilis édesvízi szivacsmaradványokra vonatkozó összefoglaló
irodalom nem említi a *Trochospongilla horrida* előfordulását tavi üledékekből
(FREY 1964, 20–22). (RAČEK 2 E ábrája emlékeztet a kis balatoni telep tűire.)

A *Spongilla carterire* és a *Trochospongilla horrida* vonatkozó említett
problémák, nézetem szerint, a Balaton élővilága alakulásának, ill. eredetének
problémakörébe sorolhatók, bár elkerülhetetlenül, az ekoszisztéma egészét
érintő vonatkozásaik is vannak.

Összefoglalás

A Balaton élővilágának és a tónak mint ekoszisztémának megismerésére irányuló
törekvések során olyan részletproblémák merülnek fel, melyeket az üledékek makro-
fosszilia adatainak paleolimnológiai értelmezésével lehet megközelíteni.

Ilyen probléma pl. a törpenövés (nanizmus), mely a harmincas években balatoni
vonatkozásban felmerült. E jelenség ok-okozati összefüggésében még nincs feltárva, sem
kellően dokumentálva. Paleolimnológiai kutatások során alkalom nyílhat bepillantani a
mindenkori környezeti körülményekbe, s az élővilág tagjainak maradványai is támogat-
hatnak ilyen kérdésekben.

FREY (1964) rámutat a szubfosszilis szivacsmaradványok faji felismerésének
nehézségeire, de arra is, hogy a kovatúk fejlettségéből a környezeti körülmények kedvező
vagy kedvezőtlen voltára is lehet következtetni.

Magyarország szivacsfaunájának valamennyi tagja (*Spongilla fragilis*, *S. lacustris*,
S. carteri ssp. *balatonensis*, *Ephydatia mülleri*, *E. fluviatilis*, *Trochospongilla horrida*) él a
Balatonban, sőt a *S. carteri* és *Trochospongilla* csak e tóban fordul elő.

A *S. fragilis* gyakran előforduló telepei csenevésznek, gemmuláin a faji jellegzetessé-
geket nem könnyű felismerni. Nem lehetetlen, hogy ez esetben a törpenövés jelenségével
állunk szemben.

Trochospongilla horrida WELTNER szubfosszilis makroszklerák balatoni üledékekből
ZÓLYOMI BÁLINT III. furatának 36. sz. mintájából (350–370 cm), Szigliget–Balaton-
fenyves profil, a tó közepén Glicerín-zselatin genciána-violet

a = normál felvétel; *b* = fázis kontraszt felvétel

Subfossil macroscleres of the sponge, *Trochospongilla horrida* WELTNER, from the sedi-
ments of Lake Balaton, in the middle of the profile Szigliget–Balatonfenyves, core III,
sample 36, depth 350–370 cm

Glycerine gelatine-gentiana violet

a = normal; *b* = phase contrast

4. kép tū hossza 211,5 μ (1250 sz. példány)

M. ph 4. = length 211.5 μ (No. specimen, 1250)

5. kép tū hossza 209,88 μ (1250a sz. példány)

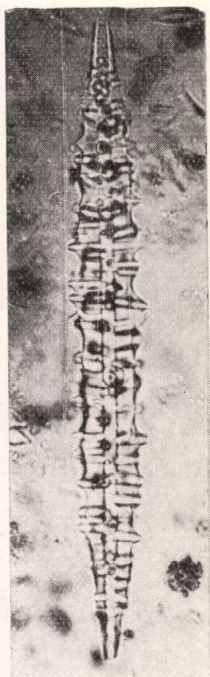
M. ph 5. = length 209.88 μ (No. specimen, 1250a)

6. kép tū hossza 221,54 μ (1251 sz. példány)

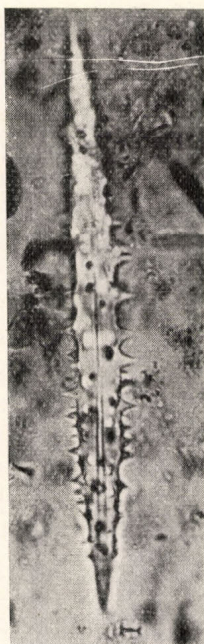
M. ph 6. = length 221.54 μ (No. specimen, 1251)

DR. ZS.-NAGY IMRE felvétele

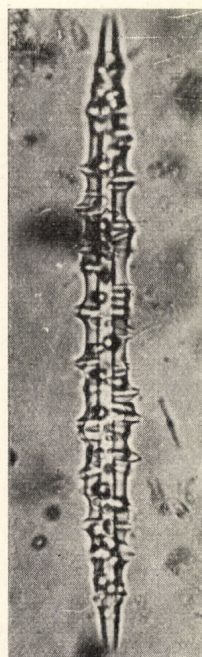
Photo, IMRE ZS.-NAGY M. D.



4a



5a



6a



4b



5b



6b

Nincs kizárva, hogy szubfosszilis vizsgálatok során feleletet lehet kapni a *Spongilla carteri* ssp. *balatonensis* alfaj kialakulásának okára, valamint a faj balatoni betelepülésének idejére, különösen ha gemmulái is előkerülnek.

A *Trochospongilla horrida* körülbelül 7 évtizeden át csak a tó iszapjában fellelhető tüskés makroszklerái képviselték (Traxler). Récens előfordulásának egyetlen bizonyítéka a tó déli partján, egy berekvíz beömlése tájékán talált elgemmulásodott kis telep (Balatonmária, 1955. szept. 30). E fajnak, továbbá a *Heteromeyenia baley* v. *stepanovi* eddigi hazai lelőhelyei kívül esnek határainkon).

A balatoni üledékek mikrofossziliáinak vizsgálata során szivacstűk is előkerültek, közöttük a *Trochospongilla horrida* jellegzetes makroszklerái, melyek — kivételesen — egymagukban is alkalmasak faji meghatározásra (ARNDT). Különböző rétegekből szórványosan került elő egy-egy ilyen kovaelem. A III. furat 36. mintájában (350–370 cm) jól konzervált erőteljes váztűk gyakoriak. Ebből arra lehet következtetni, hogy a *T. h.* a késő jégkorszakban (Late Pleistocene) nem lehetett ritka tavunk mai kiterjedésének megfelelő vízterületen (vö. SEBESTYÉN, 1968. 216. o.).

A túmaradványok gyakorisága, fejlettsége és állapota jó szilícium- és táplálékellátásra és zavartalan környezeti körülményekre utalhat (FREY 1964, 20). Más minták elemzésével további eredmények várhatók e szivacs-előfordulás történeti vonatkozásában.

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ON SOME PROBLEMS OF FRESH-WATER SPONGES OCCURRING IN LAKE BALATON WITH REFERENCE TO LAKE-HISTORY INVESTIGATIONS

Summary

Olga Sebestyén

The fauna of Lake Balaton contains all the six species of the Fam. *Spongillidae* GRAY, which at present occur in Hungary. Both *Spongilla carteri* and *Trochospongilla horrida* are known only from this lake in our country. The list of the sponge fauna of the lake is: *Spongilla fragilis* LEYDI 1851, *S. lacustris* L. 1759, *Spongilla carteri* CARTER 1849, ssp. *balatonensis* ARNDT 1923, *Ephydatia fluviatilis* L. 1759, *E. mülleri* LIEBK. 1856 and *Trochospongilla horrida* WELTNER 1893.

In the course of my studies for several decades now on the sponges of this lake few problems arose which now by means of the interpretation of subfossil material recovered from the various layers of the sediments of Lake Balaton might be investigated. We have to keep in mind, however, the difficulties of the identification at the species level of the spicules, the most common remains of this group (FREY 1964, 20—22) (see also RAČEK 1966, 82).

Up to the middle of the fourtieth of this century fine colonies of *Spongilla carteri*, *S. lacustris* as well as *Ephydatia fluviatilis* could be easily found. Lake Balaton was widely known for the luxuriant growth of *S. carteri*. *S. fragilis* seems to be a common sponge here (GELEI, 1929. 39., 40., 41) but its colonies are small and thin. To discern the characteristic marks on the gemmules meant difficulties in the identification of the species for the beginner. Recently, however, there arose the question that this species might perhaps be enlisted among those inhabitants of the lake on which dwarfgrowth is suspected (SEBESTYÉN, 1943). The problem of dwarfism in general has neither been thoroughly investigated nor satisfactorily documented in Lake Balaton, although the possibility of the presence of this phenomenon has been noticed by several authors independently from each other (SEBESTYÉN, 1943).

W. WUNDER suggested that the small size of the fish, *Abramis brama* L. might be contributed to the insufficient food-supply for the large population of this fish in our lake (WUNDER, 1930, 752). One is inclined to think that the reason for the dwarfgrowth of several free-moving aquatic animals of small size might be looked for in the effects of some environmental factors or combination of these. D. G. FREY suggested the presence of dwarfgrowth in the population of the chydorid Cladocera, *Pleuroxus uncinatus* BAIRD v. *balaticus* DADAY, in combination with gynandromorphism. (FREY, 1965, R 103)

As limnology in general enjoys now new dimensions through the effects of paleolimnology (view points, methods), the approach of problems on some of our sponges and other individual problems of Lake Balaton might be expected.

Besides dwarfgrowth in general and especially on *Spongilla fragilis*, problems in both *Spongilla carteri* ssp. *balatonensis* and *Trochospongilla horrida* might be mentioned.

ARNDT considered the Balaton specimens for a subspecies of *Spongilla carteri* on the ground of some morphological characteristics of the colonies. This author stated also that the age of the differentiation of the Balaton population might be looked for in the geological past (ARNDT, 1923).

The origin of the development of the ssp. *balatonensis* could hardly be investigated by paleolimnological methods because it is characterised by some morphological pattern of the colonies. However, it might be established how long this sponge inhabits our lake,

especially if gemmules could be recovered. (Textfig. 1.) This taxon has an interesting zoogeographical distribution and the center of it has not been established as yet (ARNDT, 1923).

The first and as yet the only alive colony of *Trochospongilla horrida* in Lake Balaton was found on a stone laying at the inflow of a draining canal, off Balatonmária (southern shore of the lake, 30 Sept. 1955. Note by OLGA SEBESTYÉN, *Fauna Catalogue, Balaton, Tihany*). It was a tiny colony full of gemmules, and the identification could be carried out. (*M. ph.* 1-3,)

Previous to this find only occurrence of both the spicules and the amphidiscs were established in the mud along the northern shore of the lake (Badacsony, Révfülöp) by L. TRAXLER (1864-1898), an outstanding Hungarian spongiologist who studied sponges both recent and subfossil in Hungary and from other countries (TRAXLER, 1898).

The first list of sponges in Hungary and Lake Balaton was given by him (TRAXLER, 1889, 1898, SEBESTYÉN, 1940a). The *Pharagmitetum* along the northern shore as searched for the small crustlike colonies of this rare sponge in vain by the author in the thirtieth. It was a surprise to find a tiny colony on stone substratum at the opposite shore of the lake where the spicules were first found more than 50 years ago.

In the course of microfossil studies on samples of different cores from the sediments of Lake Balaton sponge spicules were frequently met being in various conditions in the different samples some of them similar to those of Figs 2, A-E in RAČEK, 81. Frequency of the spicules were put on record but an identification at the species level was not attempted. (FREY, 1964, 20-22. RAČEK, 1966, 82.) One amphidisc of *Ephydatia fluviatilis* (?) was met but one occasion.

In the Late-Pleistocene sample (36. of core III, 350-370 cm, Szigliget-Balatonfenyves) amidst with well conserved and many remains of *Pediastrum* spicules of *Trochospongilla horrida* were frequent (see microphotos 4-6). (Size of subfossil skeleton spicules = 163-244.6 μ , mean = 205.8 μ , 16 data). The layer where this sample originates from, corresponds, on palynological ground, with sample 140, core B 28, 330 cm (middle of the profile, Révfülöp-Boglár) NE from the profile of core III (B. ZÓLYOMI in litt.) (SEBESTYÉN, 1968).

It could be established that in the geological past (Late-Pleistocene) *Trochospongilla horrida* was a member of the biota of a water-body which, however, at that age had probably no connection with waters laying NE from this site (SEBESTYÉN 1968, p. 216 Pre-Balaton period). The frequency of the well developed and intact spicules suggests both adequate supply in food, silica, etc. in the habitat of this sponge and undisturbed environmental conditions in the sediments (FREY, 1964, 20). Knowledge on the ecological demand of this species and more data of subfossil material are needed in order to learn more on the paleolimnological significance of the remains of this sponge in the sediments of Lake Balaton.

This is, perhaps, the first record on the presence of *Trochospongilla horrida* remains in lake sediments. It is not mentioned in FREY's very helpful and inspiring review. (FREY, 1964, 20-22.) However the spiny spicula in Fig. 2. E. in RAČEK's paper (1966) is quite similar to that of *Trochospongilla horrida* in Lake Balaton (*M. ph.* 1.,).

НЕКОТОРЫЕ ВОПРОСЫ ФАУНЫ ГУБОК ОЗЕРА БАЛАТОН В СВЯЗИ С ИЗУЧЕНИЕМ ИСТОРИИ ОЗЕРА

Ольга Шебештен

При изучении животного мира Балатона и озера как экосистемы возникают вопросы, в решении которых полезен палеонтологический анализ ископаемых остатков дна. Одним из них является вопрос о карликовом росте организмов, населявших Балатон в 30-х годах. Это явление до сего времени не исследовано в достаточной мере и не объяснено. Палеонтологические исследования позволяют оценить условия окружающей среды в разные исторические периоды, и индикаторами при этом служат остатки живых организмов.

Фрей (1964), отмечая трудности определения вида по ископаемым остаткам губок, вместе с тем подчеркивает, что по развитию их кремневых иголок можно судить о благоприятных или неблагоприятных условиях среды.

Все виды (*Spongilla fragilis*, *S. lacustris*, *S. carteri* ssp. *balatonensis*, *Ephydatia mul-leri*, *E. fluviatilis*, *Trochospongilla horrida*), характерные для фауны Венгрии, представле-

В составе микроископаемых остатков озерных осадков Балатона найдены характерные иглы губки *Trochospongia horrida*, которые как правило достаточны для определения вида. Особенно много их в образце III/36 на глубине 350—370 см., из чего можно сделать вывод, что в позднем плейстоцене озеро обладало сходной величиной водной поверхности. (Шебештен, 1968.)

Частота нахождения, развитие и состав кремневых губок указывают на хорошую их обеспеченность питанием и на благоприятные условия среды (Фрей, 1964). ны в Балатоне, при чем два из них — *S. carteri* и *Trochospongia* встречаются только в этом озере.

S. fragilis представлены только очень чахлыми колониями, в которых недоразвиты характерные морфологические признаки вида. Не исключено, что это и есть проявление карликового роста. Изучение ископаемых остатков, возможно, прояснит причины возникновения подвида *Spongia* ssp. и время его поселения в Балатоне, — особенно, если будут обнаружены геммулы этих губок. *Trochospongia horrida* в течение 70 лет была представлена в озерном иле только в виде игольчатых макросклеров. Их современное существование было доказано только в одном случае у южного берега озера у устья небольшого ручья (Балатонмария, 30 XI 1955 г.). Этот вид, как и *Heteromeyenia baley* v. *stepanovi* более нигде в Венгрии не обнаруживается.

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 polyvinyl 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. clathra-*

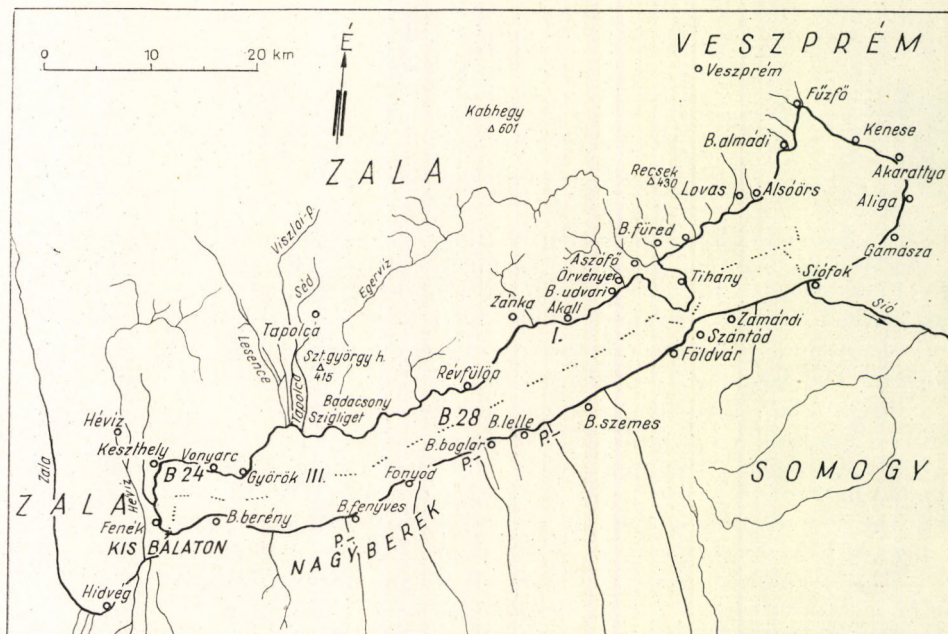


Figure 1. Sketch of Lake Balaton showing the sites of the borings mentioned in the text

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

tum (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).

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).

*

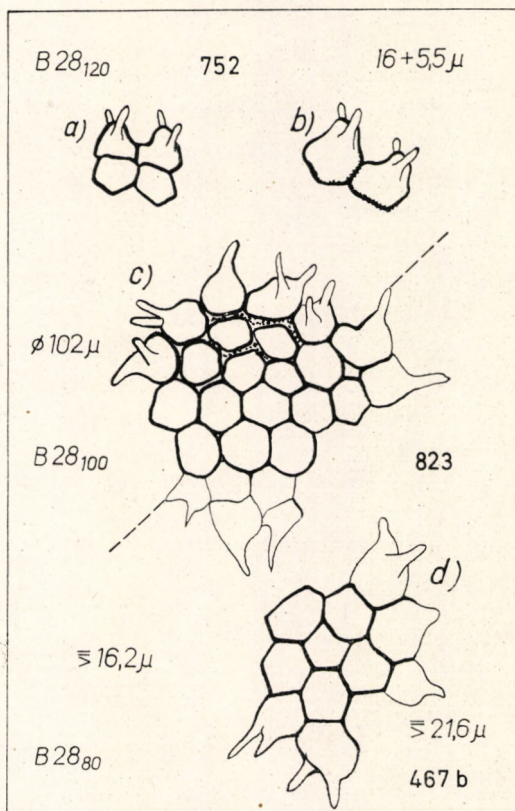


Figure 2. Sketches of *Pediastrum kawraiskyi* remains

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*ről

a-b = a 752. sz. példány peremsejtjei (vö. 1. sz. mikrofelvétellel); *c* = 823. sz. példány a B 28, 100. sz. mintából. Granulált sejtfa. 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

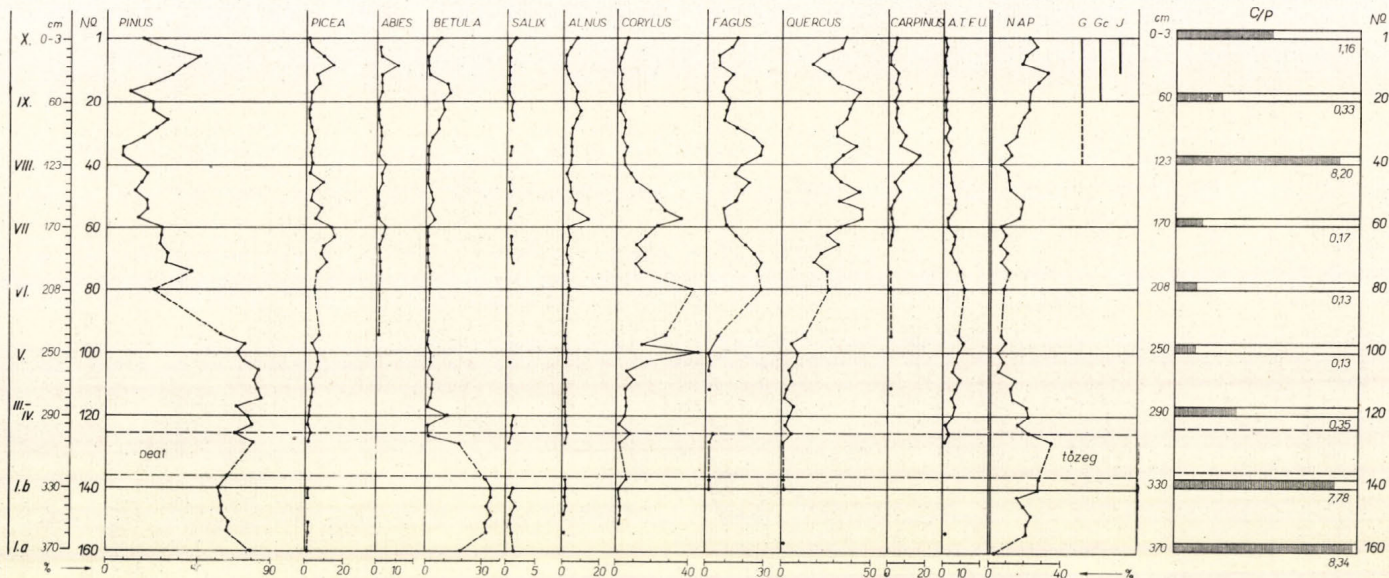


Figure 3. B 28. Pollenspectrum. AP (%), NAP (in % of AP. From ZÓLYOMI's data, 1964, 1965, 2–3 items being united. C/P = Percentage distribution of Cladocera (cross-hatched) and *Pediastrum* (solid white) remains. 1, 20, 40 ... 160. = No. of sample; ATFU = *Acer*, *Tilia*, *Fraxinus*, *Ulmus*; G = graminea,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

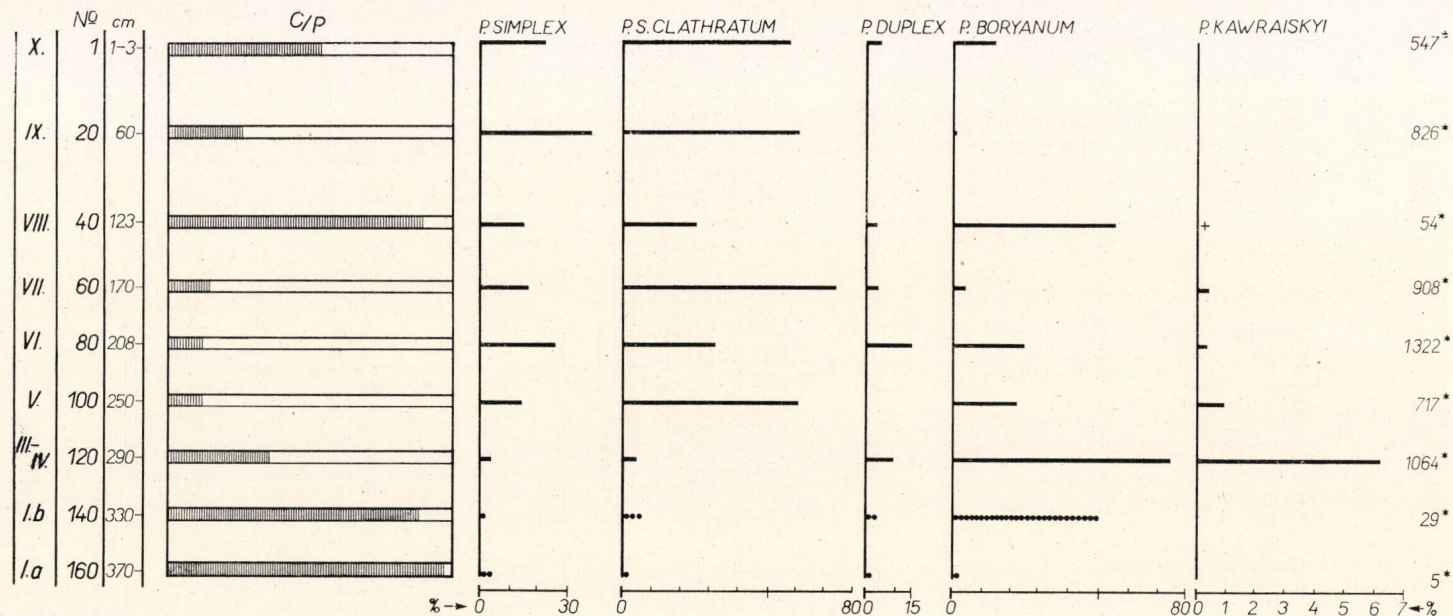


Figure 4. Core B 28. Percentage distribution of *Pediastrum* remains in samples 1–120. For samples 140. and 160. numbers of specimens given. . = * = number of specimens. For other signs see Fig. 3

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

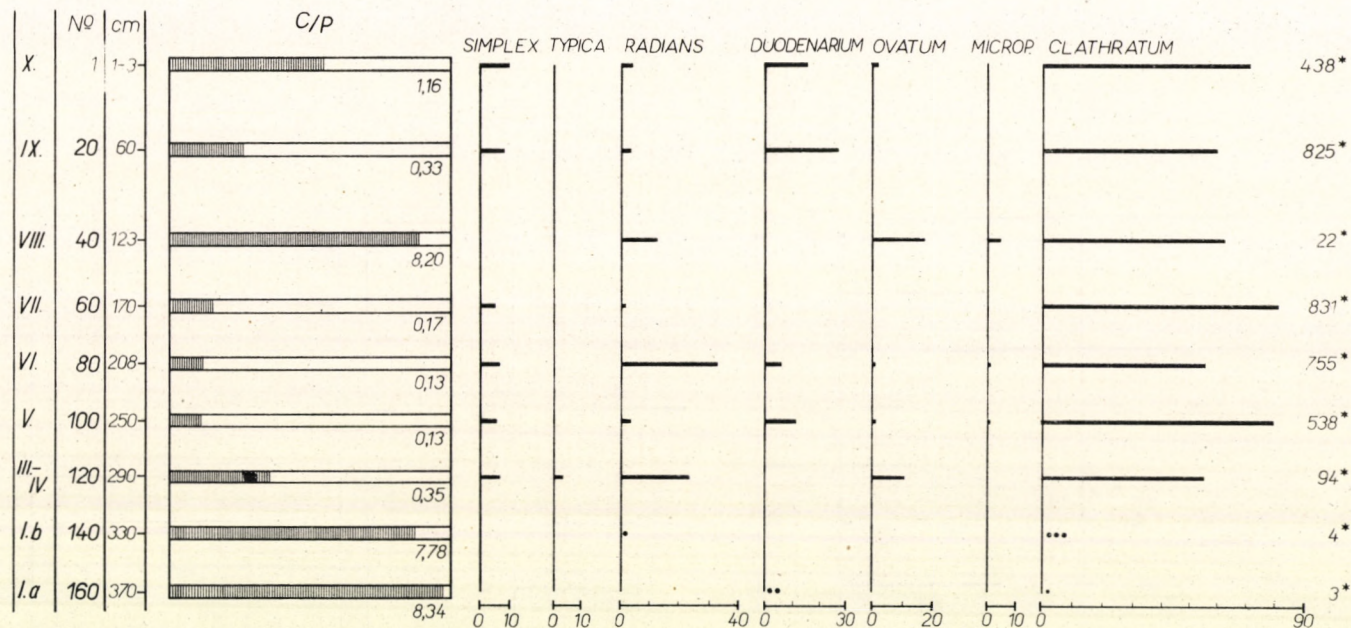


Figure 5. Percentage distribution of *Pediastum simplex* and varieties. B 28., samples 1–120. For samples 140. and 160. numbers of specimens given. For other signs see Fig. 4

5. ábra. B 28. *Pediastum 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. ($\pm 8000 \pm 1000$ 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)

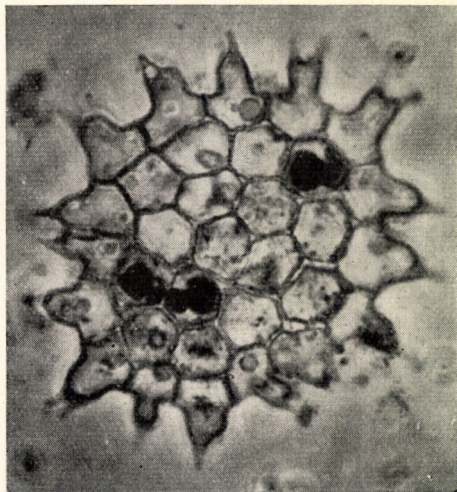
The species was found first by W. SCHMIDLE (1897) in material from a Caucasian lake at high altitude. In the system he placed it between *P. simplex* and *P. braunii* (WARTMANN). BIGEARD in his thorough study on the *P.* species in Europe (1933) enlisted it between *P. simplex* and *P. boryanum* (p. 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. angulosum* 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. FORT's (p. c.) consideration

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

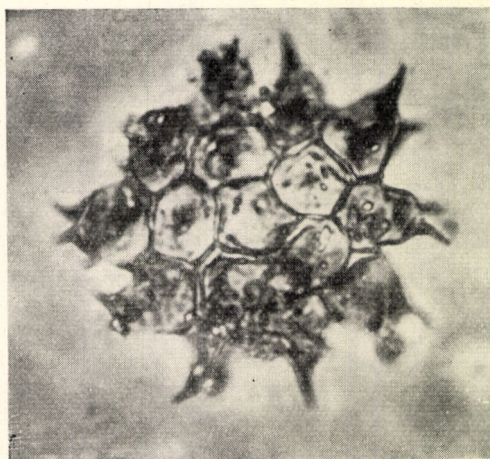
Remains of *Pediastrum kawraiskyi* SCHMIDLE from the sediments of Lake Balaton

Pediastrum kawraiskyi maradványok balatoni üledékekből



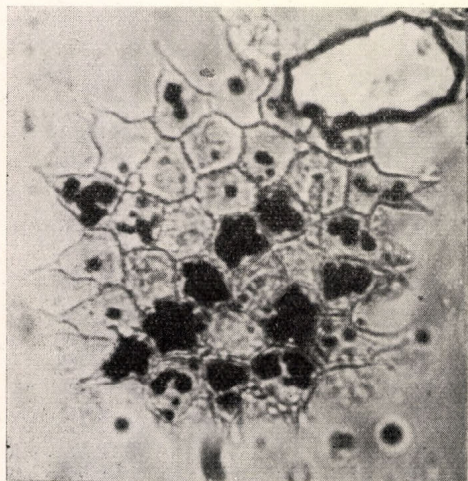
M. ph. 1. — Specimen 752, from sample B 28, 120. Cell wall with granules. Some cells with pyrite (?) crystals. Size, inner cells $11-13\ \mu$, marginal cells $\pm 16 + 5.5\ \mu$. The specimen is flattened under the cover slip. Polyvinil lactophenol-lignin pink. (See Fig. 2.a—b.)

1. B 28, 120. minta, 752. sz. példány. Granulált sejtfa, egyes sejtekben pirit (?) kristályok. Belső sejtek mérete = $11-13\ \mu$, peremsejtek $\pm 16 + 5.5\ \mu$. A példányt a fedőlemez ellapította. Vö. 2a, b ábrával



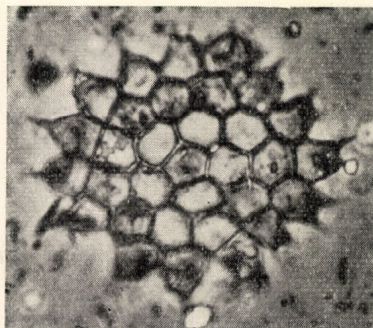
M. ph 2. — Specimen 467b from sample, B 28, 80. Cell wall not granulated. Size, inner cells $\pm 16.2\ \mu$, marginal cells with processes $\geq 21.6\ \mu$. The specimen is not flattened under the cover slip. Glycerine gelatine-gentiana violet. (See Fig. 1d.)

2. B 28, 80. sz. minta 467b példányszám. Sejtfa nem granulált. Belső sejtek = $\pm 16.2\ \mu$, peremsejtek, nyúlvánnyal $\geq 21.6\ \mu$. A cenobium nincs ellapítva. Vö. 1d ábrával



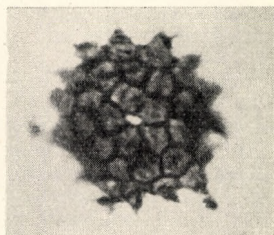
M. ph. 3. — Specimen from sample B 28, 120. Diameter 124 μ . Some cells with pyrite (?) crystals and granules. Granulated cell wall. Polyvinil lactophenol-lignin pink

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



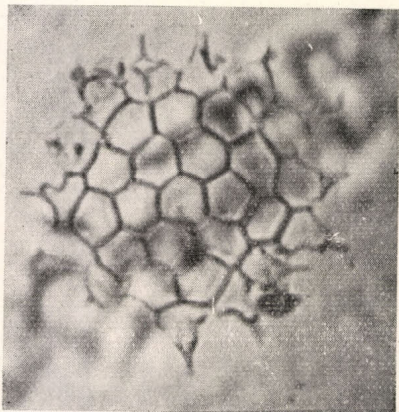
M. ph. 4. — Specimen from sample B 28, 120. Diameter 102 μ . Polyvinil lactophenol-lignin pink

4. B 28, 120. μ minta. Átmérő 102 μ



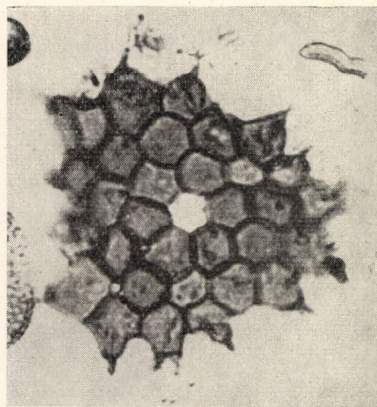
M. ph. 6. — Specimen 1260, sample III 6. Diameter 43.7 μ . Size, inner cells 5.5 μ . Glycerine gelatine-gentiana violet

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 system (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).

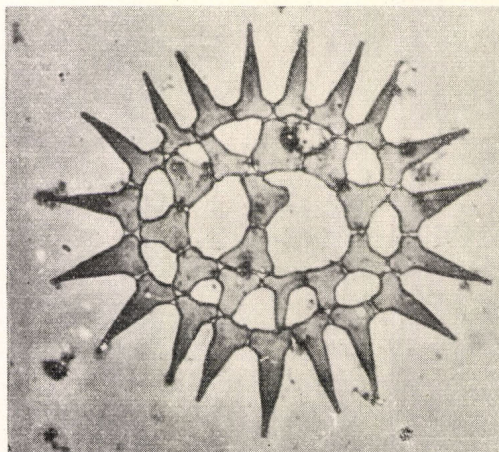
Data on recent occurrences suitable to our aim should include time of sampling, length of the period of occurrences in both the active and resting states.

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 tundra 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)

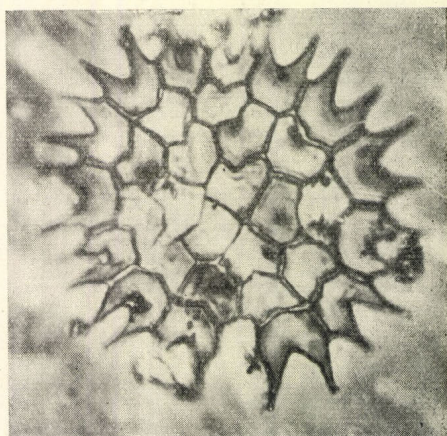
Pediastrum remains from the sediments of Lake Balaton

Pediastrum maradványok balatoni üledékekből



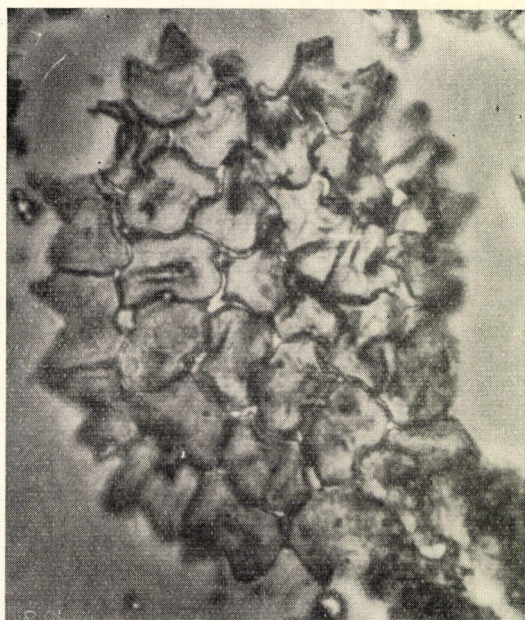
M. ph. 8. — *Pediastrum simplex clathratum*. Specimen 493, from sample B 28, 80. Size of the cenobium $153.45 \times 133.6 \mu$. Polyvinil lactophenol—lignin pink

8. *P. simplex clathratum*. B 28, 80. sz. minta, 493. sz. példány, cenobium = $153.45 \times 133.6 \mu$



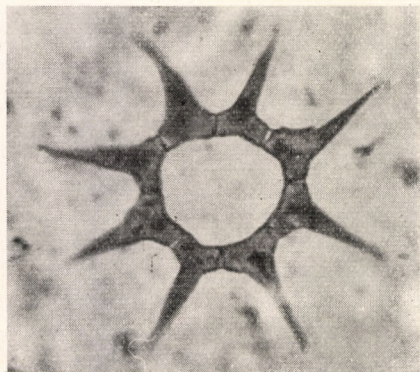
M. ph. 9. — *Pediastrum boryanum* from sample IA, 4. Diameter 118.9μ . Glycerine gelatine-gentiana violet

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



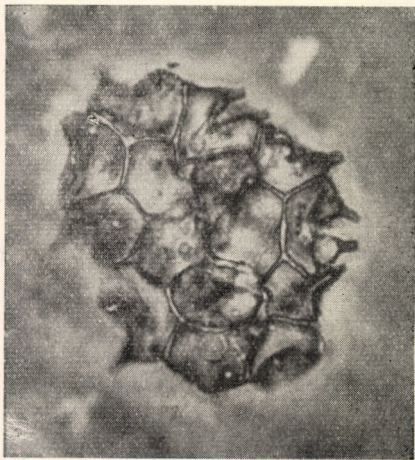
M. ph. 10. *Pediastrum duplex*? Specimen 1142, from sample B 28, 140. length 140μ . Polyvinil lactophenol-lignin pink

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



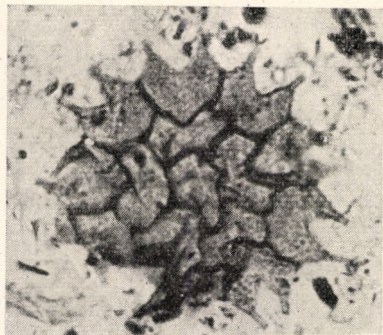
M. ph. 11.—*Pediatrum simplex radians* from sample B 28, 80. Diameter of cenobium $75\ \mu$. Glycerine gelatine-gentiana violet

11. *P. simplex radians* B 28, 80. minta, átmérő $75\ \mu$



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

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



M. ph. 13. — *Pediatrum boryanum* from sample III, 36. Diameter of cenobium, $70.26\ \mu$. Glycerine gelatine-gentiana violet

13. *P. boryanum* III 36. sz. minta. Átmérő $70.26\ \mu$

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 ± 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 stand-points.

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 depths, 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					
<i>Pediastrum</i>	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
<i>kauraiskyi</i>		—	—	+	0.33	0.22	0.97
<i>simplex</i> (v. <i>clathratum</i>)		80.94 (58.03)	99.78 (61.13)	40.73 (25.92)	91.61 (74.86)	59.37 (32.98)	75.03 (60.39)
<i>duplex</i>		4.99	—	3.71	3.85	15.28	0.97
<i>boryanum</i> (<i>biduntulum</i> <i>ornatum</i>)		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 $15 \times 6 \text{ km} \times 6 \text{ m}$, 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 $\pm 110 \text{ ha}$, depth $\pm 3 \text{ m}$, 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 is 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 1 b	Tihany 4 depth
6,29	—	—	11.08	10.72%	+	—
8.82 (4.88)	4 (3)	3 (1)	9.91	All other <i>P.</i> species etc.	—	30.51 (30.51)
9.49	2	1	31.13	89.27%	—	(v. rel) 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 positive 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	<i>Pediastrum</i>				
		<i>kawraiskyi</i>	<i>simplex</i>	<i>duplex</i>	<i>biradiatum</i>	<i>boryanum</i>
Europe	Hungary	Balaton	—	+	+	+
			●	●	●	—
	France	l'étang de Serrant	+	+	+	—
			+	+	+	+
	Sweden	Sä Säbysjön Uppland	+	clath.	v. <i>araneusum</i>	v. <i>brevicorne</i>
		Tämnaren	+			
		Skedviken	+			
		Masnaren	×	+	+	+
U.S.S.R. Asia	Baikal region	Lake Kotokel	+	—	—	+
			●	●	—	●
		Sor Possolsky	+		+	
	Altaj mt.	Lake Zaisan	+	+	v. <i>aspera</i> v. <i>clath.</i> v. <i>retic.</i>	—

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 egyidejűleg előforduló más *Pediastrum* fajoknak előfordulása néhány európai és ázsiai vízben.

- + = recens adat
 ● = szubfossilis adat
 — = negatív adat

<i>angulosum</i>	<i>tetras</i>	<i>braunii</i>	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 Pediastron, Blaualgen, etc.”
				168: „vereinzelt unter zahlreichen anderen Phytoplanktern. 12, 7, 34”
+	+	—	M. B.-FLORIN, 1957	and others, altogether 16 taxa see p. 110 General table
—	—	—	KORDE, 1966	
—	—	—		
	+			
+	+	+ <i>tricornutum</i>	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 accommodate 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 geological 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 planktozone 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 $\pm 8000 - \pm 1000$ 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 analysis 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.

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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 planktoxon 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 $\pm$ 8000 – $\pm$ 1000 i.e.) öt mintájából előkerültek *P. k.* SCH. maradványok, az idők folyamán csökkenő mennyiségben (relatív quantitativ adatok). Hasonló maradványokat más balatoni furatokból is feljegyeztünk, részben mélyebb (korábbi) rétegekből.

Az irodalomban háromféle adatot találunk e faj előfordulására: récents adatok (209. o.), récents 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 szubfosszilisán 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 palynológiai 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 (Зольоми, 1952 и 1953).

Во всех 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 настоящее 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 летнего 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 Балатон 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.

QUANTITATIVE UNTERSUCHUNGEN DES MIKROPHYTOBENTOS AUS DEM EPROFUNDAL DES BALATON-SEES AUF GRUND DER SAMMLUNGEN DES JAHRES 1967

GIZELLA TAMÁS

Biologisches Forschungsinstitut der Ungarischen Akademie der Wissenschaften, Tihany, Ungarn

Eingegangen am 1. März, 1968

Diese Studie schließt sich jenen Arbeiten an, welche in den letzten Jahren Angaben über den Mikrophytobentos des Balaton-Sees machten (TAMÁS 1966, 1967).

Wir hatten eine doppelte Zielsetzung:

a) praktisch zur gleichen Zeit (innerhalb zwei Tagen) eine weitere Orientierung über die quantitative Zusammensetzung der Mikrophytobentosgesamtheit des ganzen Sees in der warmen Jahreszeit zu erhalten,

b) weitere Angaben über die Artzugehörigkeit und -verbreitung der Mitglieder des Mikrophytobentos innerhalb des Sees auf Grund von Probenreihen der Quersegmente zu sammeln.

Ort und Zeit des Sammelns, Aufarbeitung des Materials

Die Schlammprobenentnahmen 1967 geschahen ähnlich wie im vorigen Jahr von April bis Oktober. In dem südwestlichen Teil des Sees haben wir in drei, in dem nordöstlichen Teil in zwei zur Längsachse rechtwinklig stehenden Querschnitten gesammelt. (Die schematische Darstellung der See-Karte des Balatons mit den Querschnitten und den Angaben der Probenentnahmen ist der im Jahre 1967 erschienenen Arbeit von TAMÁS, Seite 234 zu entnehmen.) Bei den Schlammproben haben wir an drei bestimmten Punkten der Querschnitte M, K, G, A, E mit dem modifizierten Craib-Schlammprobenentnehmer (PONYI, BIRÓ und P.-ZÁNKAI 1967) eine 1–2 cm dicke Schicht der Oberfläche entnommen. Nach 48 Stunden Sedimentation wurden im Laboratorium aus der 1 cm dicken Schicht der Oberfläche sämtliche lebenden und abgestorbenen Algen aus einer 5mal 1 cm² großen Schlammprobe registriert. Die so erhaltenen Daten wurden auf eine Oberfläche von 1 dm² umgerechnet. In der zweiten und dritten *Tabelle* haben wir die errechneten Durchschnittswerte der an den drei Punkten der einzelnen Quersegmente erhaltenen Werte dargestellt. Die beim Sammeln erhaltenen Werte enthält die *1. Tabelle*, es sind dies die Durchschnittswerte der Angaben, die an den drei Punkten je eines Quersegmentes aufgezeichnet sind.

Diese Studie gibt lediglich die Mikrophytobentosdaten der Schlammproben von 1967 bekannt. Sie beschäftigt sich weder mit der limnologischen Auswertung der Angaben der drei Jahre, noch mit der Beschreibung des

Umstandes, inwieweit die angewendete quantitative Methode und die Daten der zur Untersuchung vorbereiteten Proben die wirkliche Lage widerzuspiegeln fähig sind. All diese Fragen bilden das Thema einer späteren, zusammenfassenden Studie.

Untersuchungsergebnisse

Die von den 115 Schlammproben der 15 Entnahmestellen bestimmten Algenarten, die mit dem Pilz zusammen in die 6 großen Stämme der Systematik gehören; die Reihenfolge ist nach der Häufigkeit gewählt:

	Art	Varietät
<i>Chrysophyten</i>	54	3
<i>Chlorophyten</i>	13	2
<i>Cyanophyten</i>	8	—
<i>Euglenophyten</i>	3	—
<i>Pyrrophyten</i>	1	—
<i>Mycophyten</i>	1	—
Zusammen:	80	5

Der *Chrysophyten*-Stamm ist mit 57 Arten vertreten (*Xanthophyceae* 2, *Bacillariophyceae* 55). Unter den Schlammbewohnerarten (32) der *Bacillariophyceae*-Klasse haben einige mancherorts — ähnlich wie bei den Angaben des Vorjahres — eine sehr hohe Anzahl erreicht: *Amphora ovalis*, *Diploneis elliptica*, *D. puella*, *Fragilaria pinnata*, *Navicula cryptocephala*, *Nitzschia amphibia* usw. Unter den pelagischen Arten (13) haben die *Cyclotella bodanica*, *C. ocellata*, *Melosira granulata* und ihre Varietät *Nitzschia acicularis*, *Stenopterobia pelagica* eine höhere Individuenzahl/dm² erreicht. Unter den epiphyten Arten (10) kam stellenweise die *Cocconeis placentula* in bedeutender Anzahl vor. Das prozentuale quantitative Vorkommen dieses Stammes schwankte von April bis Oktober stellenweise zwischen 76,8% und 99,7%. Dieser Stamm macht 67,1% der gesamten Algenarten aus.

In Bezug auf die Häufigkeit nimmt der *Chlorophyten*-Stamm mit 15 Arten den zweiten Platz ein. Die Mehrzahl der Arten (12) gehört in die Ordnung der *Chlorococcales*. Die *Zygnematales*-Ordnung wurde durch drei Arten vertreten. Die Angaben über die in den Schlammproben nur mit sehr geringer Zahl/dm² enthaltenen Exemplare sind unbedeutend. Von April bis Oktober lag das quantitative prozentuale Vorkommen an den einzelnen Stellen zwischen 0 und 8,2%. Dieser Stamm macht 17,6% der gesamten Algenarten aus.

Von den Stamm der *Cyanophyten* haben wir 8 Arten gefunden. In sämtlichen Schlammproben, wo andere Arten nur vereinzelt vorkamen, war — ob in lebendem oder totem Zustand — die *Lyngbya circumcreta* vertreten. Die Fadenteile des *Aphanizomenon flos-aquae* var. *klebahnii* haben wir ähnlich wie im vorigen Jahr auch jetzt aufgezeichnet. Das prozentuale quantitative Vorkommen der Blaualgen schwankte von April bis Oktober an den einzelnen Orten zwischen 0 und 17,6%. Der Stamm enthält 9,4% der Zahl der gesamten Algenarten.

In der Häufigkeitsreihe folgt der *Euglenophyten*-Stamm, dessen drei Vertreter sporadisch, in niedriger Anzahl in den Schlammproben vorkommen. Die prozentuale Exemplarzahl/dm² lag stellenweise von April bis Oktober zwischen 0 und 1%. Der Stamm macht 3,5% der Anzahl der gesamten Algenarten aus.

Tabelle 1 — 1. táblázat
Ort und Zeitpunkt der Probenentnahme 1967 und andere Angaben
Az 1967. évi gyűjtések helye, ideje és egyéb adatai

Sammelstellen Gyűjtőhelyek	Zeitpunkt — Időpont	Wassertemperatur Víz hőfok, °C	Lufttemperatur Levegő hőfok, °C	Wassertiefe Víz mélység, cm	Durchsichtigkeit Átlátszóság, cm	Anmerkungen — Megjegyzések
M	IV. 11. 6—9 h	12	16,1	272	61	Windstille — Szélcsend
	V. 16. 6—9 h	19	20	256	43	Windstille — Szélcsend
	VI. 20. 6—9 h	20	20,6	283	91	Trübes Wetter — Borús idő
	VII. 18. 6—8 h	23	20,1	259	61	Brise — Szellő
	VIII. 15. 7—9 h	20	16,6	238	66	Windstille — Szélcsend
	IX. 19. 7—9 h	16,5	14,2	247	92	Windstille — Szélcsend
	X. 17. 6—9 h	16	17,5	256	102	Brise — Szellő
K	IV. 11. 10—12 h	12	20,8	367	54	
	V. 16. 10—13 h	19	20,3	375	49	Nordwind und Regen — Északi szél, eső
	VI. 20. 10—12 h	19,8	23	366	59	Gewitter und Regen — Vihar, eső
	VII. 18. 9—12 h	22	23,1	349	74	Starke Wellenbewegung — Erős hullámozás
	VIII. 15. 10—12 h	20,6	21,6	359	59	Brise — Szellő
	IX. 19. 10—12 h	17	19,8	355	73	
	X. 17. 10—12 h	16,8	21,1	329	57	Starke Wellenbewegung — Erős hullámozás
G	IV. 11. 16—18 h	11,8	19,5	431	67	
	V. 16. 16—19 h	19	20,3	420	50	
	VI. 20. 15—18 h	20	21,5	413	93	
	VII. 19. 8—11 h	23	22,3	402	56	Brise — Szellő
	VIII. 15. 15—18 h	21	24,8	401	55	Brise, trübes Wetter — Szellő, borús idő
	IX. 19. 15—18 h	18	20,1	400	79	Windstille — Szélcsend
	X. 17. 15—18 h	17,8	20,9	396	64	Brise — Szellő
A	IV. 12. 9—12 h	12,1	18,8	366	68	Brise — Szellő
	V. 17. 10—13 h	19	21	401	61	Brise — Szellő
	VI. 26. 9—13 h	24,1	26,6	380	137	Windstille — Szélcsend
	VII. 20. 9—12 h	24	26,5	357	105	Windstille — Szélcsend
	VIII. 16. 9—13 h	21	24,1	372	77	Windstille — Szélcsend
	IX. 20. 9—13 h	17,8	18,3	377	98	Brise — Szellő
	X. 23. 11—13 h	12,6	13,6	374	96	Brise — Szellő
E	IV. 12. 15—18 h	12	18	436	89	Brise — Szellő
	V. 18. 10—14 h	19	22	439	47	Brise — Szellő
	VI. 26. 15—19 h	25	30,3	426	122	Windstille — Szélcsend
	VII. 19. 16—18 h	23,6	26,5	435	67	Windstille — Szélcsend
	VIII. 16. 15—18 h	21,5	24,8	429	64	
	IX. 20. 15—18 h	18	18,5	401	137	Brise — Szellő
	X. 23. 15—17 h	14	15	413	74	Windstille — Szélcsend

Zeichenerklärung — Jelmagyarázat

* Die Werte beziehen sich auf Messungen mit der Secchi-Scheibe — Mérések Secchi-koronggal

Tabelle 2 — 2. táblázat

Quantitative Mikrophytobentos-Untersuchungen aus dem Eprofundal des Balaton-Sees auf Grund der Sammlungen des Jahres 1967 (i/dm² = 1000 Individuen pro dm²)

A Balaton nyíltvízi fenékiszapmintáinak mennyiségi algológiai adatai az 1967. évi gyűjtések alapján (i/dm² = 1000 egyed/dm²)

Sammelstellen und Zeitpunkt des Vorkommens Gyűjtőhelyek, időpont		M		K		G		A		E	
Artenverzeichnis Fajok felsorolása		a	b	a	b	a	b	a	b	a	b
CYANOPHYTA											
<i>Aphanizomenon flos-aquae</i> var. <i>klebahnii</i> ELENK.	V.	—	—	—	—	—	—	—	—	0,2	—
	VI.	—	—	—	—	0,1	—	—	—	—	—
	VIII.	—	0,1	—	—	—	—	—	—	—	—
	X.	—	—	—	—	—	0,1	—	—	—	—
<i>Coelosphaerium kützingianum</i> NAEG.	VI.	—	—	—	—	0,4	—	—	—	—	—
	VIII.	—	—	0,1	—	—	—	—	—	—	—
	X.	—	—	0,1	—	0,1	—	0,2	—	—	—
<i>Gomphosphaeria lacustris</i> CHOD.	VI.	—	—	—	—	0,1	—	—	—	—	—
<i>Lyngbya circumcreta</i> G. S. WEST	IV.	0,1	0,1	0,5	0,3	0,5	1,6	0,9	0,6	1,2	1,7
	V.	—	0,2	0,1	0,5	0,7	0,6	0,8	0,8	1,4	1,3
	VI.	0,3	—	0,2	0,3	0,3	0,7	1,3	1,9	1,7	1,6
	VII.	0,2	0,1	0,1	0,6	0,6	1,8	1,0	3,1	1,1	3,2
	VIII.	0,1	0,5	0,3	0,4	1,9	1,1	2,1	2,3	1,4	3,4
	IX.	0,1	0,1	—	0,3	1,7	1,1	2,0	1,8	3,7	5,0
	X.	0,5	0,1	0,3	0,4	1,6	1,4	3,0	3,1	3,7	5,0
<i>Lyngbya limnetica</i> LEMM.	IV.	—	—	—	—	—	0,1	—	—	0,1	—
	VI.	0,2	—	0,1	—	0,5	—	—	—	0,2	—
	VII.	—	—	—	—	—	—	0,1	—	—	—
	VIII.	—	—	0,1	—	0,2	—	—	—	—	—
	IX.	0,1	—	—	—	—	—	0,3	—	0,3	—
	X.	—	—	—	0,1	0,2	0,2	0,4	0,1	1,2	1,2
<i>Merismopedia glauca</i> (EHR.) NAEG.	VI.	—	—	—	—	1,6	—	—	—	—	—
<i>Oscillatoria</i> sp.	X.	0,2	—	—	—	—	—	—	—	—	—
<i>Pseudanabaena catenata</i> LAUT.	IV.	—	—	—	—	0,1	—	—	—	—	—
	V.	—	—	—	—	—	—	0,4	—	—	—

	VI.	—	—	0,3	—	0,3	—	0,1	—	—	—
	VII.	0,2	—	—	—	—	—	0,7	—	—	—
	IX.	0,8	—	—	—	—	—	—	—	—	—
	X.	—	—	—	—	—	—	0,1	—	—	—
EUGLENOPHYTA											
<i>Phacus acuminatus</i> STOKES	IV.	—	—	0,1	—	—	—	—	—	—	—
<i>Phacus tortuosus</i> ROLL	X.	—	—	—	—	0,1	—	—	—	—	—
<i>Trachelomonas volvocina</i> EHR.	IV.	0,1	—	—	—	—	—	—	—	—	—
	X.	—	—	—	—	—	—	—	—	—	0,1
PYRROPHYTA											
<i>Ceratium hirundinella</i> (O. F. MÜLL) SCHRANK (ZYSTEN)	X.	—	—	—	—	—	—	0,1	—	—	—
CHRYSOPHYTA											
<i>Xanthophyceae</i>											
<i>Botryococcus braunii</i> KÜTZ.	IV.	—	—	—	—	—	—	0,1	—	—	—
<i>Planktonema lauterborni</i> SCHMIDLE	IV.	—	—	0,1	—	—	—	—	—	—	—
	V.	—	—	—	—	0,1	—	—	—	—	—
	VI.	—	—	—	—	—	—	0,1	—	—	—
	X.	—	—	—	—	—	—	—	0,1	—	—
<i>Bacillariophyceae</i>											
<i>Be Amphora ovalis</i> KÜTZ.	IV.	0,2	0,5	0,3	0,8	—	1,8	0,4	1,7	0,5	2,3
	V.	0,6	1,0	0,1	2,8	—	0,6	3,2	2,1	1,9	1,2
	VI.	0,8	1,1	0,4	1,7	4,8	1,3	0,6	1,4	0,5	2,1
	VII.	0,3	0,9	0,8	0,8	3,1	1,7	0,2	1,3	0,9	2,8
	VIII.	1,1	0,7	1,1	0,7	1,8	1,7	0,6	3,0	1,2	4,2
	IX.	1,7	0,7	1,6	2,1	0,3	2,8	2,1	6,0	1,4	2,7
	X.	0,1	0,5	0,1	0,8	0,4	2,1	0,5	3,6	0,5	2,1
<i>Be Amphora ovalis</i> var <i>pediculus</i> KÜTZ	IV.	0,2	0,4	—	0,5	—	1,7	1,0	1,7	0,5	1,0
	V.	0,4	0,6	0,2	2,8	0,1	0,6	1,9	1,7	1,7	0,8
	VI.	0,5	0,9	0,1	2,4	2,9	1,1	0,1	0,8	0,1	0,5
	VII.	0,2	1,2	0,4	0,6	1,3	0,4	—	0,9	0,7	1,1
	VIII.	1,1	0,8	1,0	0,5	1,4	2,0	0,4	2,5	0,4	1,6
	IX.	0,8	0,3	1,1	2,1	—	1,6	1,7	3,4	0,6	1,7
	X.	—	1,1	0,2	0,7	0,1	0,8	0,2	2,2	0,3	1,7
<i>Be Caloneis schumanniana</i> var. <i>biconstricta</i> GRUN.	IV.	0,1	0,1	—	0,3	—	0,4	0,1	0,4	—	0,6
	V.	0,1	—	0,2	—	—	0,1	—	0,3	—	0,2

Tabelle 2 (Fortsetzung) — 2. táblázat (folytatás)

Sammelstellen und Zeitpunkt des Vorkommens Gyűjtőhelyek, időpont		M		K		G		A		E	
Artenverzeichnis Fajok felsorolása		a	b	a	b	a	b	a	b	a	b
	VI.	—	—	—	—	—	0,2	—	0,1	—	0,1
	VII.	—	—	—	0,1	—	0,4	—	0,2	—	0,3
	VIII.	—	—	—	0,1	—	0,2	0,2	0,2	0,2	0,3
	IX.	—	—	—	0,1	—	—	—	0,1	—	0,2
	X.	—	—	—	0,2	0,1	0,1	—	0,5	—	0,1
Be <i>Campylodiscus noricus</i> var. <i>hibernica</i> (EHR.) GRUN.	IV.	—	—	—	—	—	—	1,0	0,2	0,9	0,3
	V.	—	—	—	—	—	—	1,1	0,1	0,9	0,1
	VI.	—	—	—	—	0,1	—	0,1	—	0,2	0,2
	VII.	—	—	—	—	—	—	—	0,4	0,3	0,5
	VIII.	—	—	—	—	0,1	—	1,2	0,1	1,7	0,1
	IX.	—	—	—	—	0,1	—	0,1	0,2	—	0,4
	X.	—	—	—	—	—	—	0,9	0,5	1,4	0,4
Ep <i>Cocconeis placentula</i> EHR.	IV.	2,3	—	1,3	0,2	0,3	—	—	—	—	—
	V.	6,2	0,1	—	—	—	—	0,5	—	2,1	—
	VI.	0,7	—	—	0,3	1,2	—	0,6	0,1	—	—
	VII.	0,2	—	—	—	—	—	0,5	—	2,0	0,1
	VIII.	2,5	—	0,2	—	0,5	—	0,2	—	—	—
	IX.	3,7	—	0,4	—	0,5	—	—	—	1,2	—
	X.	1,4	—	—	0,1	—	—	—	—	—	—
Pl <i>Cyclotella bodanica</i> EULENST.	IV.	0,1	3,1	—	4,9	—	2,8	—	2,1	—	2,2
	V.	—	4,6	—	4,0	—	5,0	—	2,9	—	2,3
	VI.	—	5,9	—	8,2	—	7,4	—	8,6	—	4,2
	VII.	—	9,5	—	9,8	—	10,9	—	5,6	—	1,6
	VIII.	—	7,7	—	7,8	—	5,7	0,1	2,0	—	2,7
	IX.	—	2,8	—	6,9	—	5,4	—	4,8	0,1	1,4
	X.	—	8,8	—	9,8	—	6,7	—	4,1	—	3,9
Pl <i>Cyclotella ocellata</i> PANT.	IV.	—	3,3	—	6,9	—	2,8	—	2,7	—	2,2
	V.	—	4,9	—	3,8	—	6,3	—	3,3	—	1,9
	VI.	—	7,4	—	8,9	—	8,2	—	10,6	—	6,3
	VII.	—	10,3	—	14,9	—	11,6	—	6,9	—	2,5

	VIII.	—	10,4	—	8,7	—	5,5	0,1	1,8	—	2,2
	IX.	—	6,5	—	9,8	—	5,6	—	4,7	—	1,5
	X.	—	11,7	—	12,5	—	6,5	—	3,9	—	4,3
Pl <i>Cymatopleura elliptica</i> (BRÉB.) W. SMITH	IV.	0,9	0,1	0,4	0,2	0,2	0,2	0,6	0,9	0,4	0,8
	V.	0,6	0,1	0,4	0,2	0,6	0,5	1,4	0,4	1,5	0,2
	VI.	0,3	0,3	0,5	—	1,6	0,3	0,3	0,3	0,4	0,7
	VII.	0,8	0,3	1,5	0,5	0,5	0,5	2,3	0,8	1,1	0,6
	VIII.	0,2	0,5	1,3	0,4	0,7	0,8	0,4	1,0	0,9	0,1
	IX.	0,4	0,1	0,7	0,2	0,3	1,0	0,3	1,0	0,3	1,0
	X.	—	0,1	0,1	0,2	—	0,1	0,1	1,1	0,3	0,5
Pl <i>Cymatopleura solea</i> (BRÉB.) W. SMITH	IV.	0,1	0,2	—	—	—	0,1	0,1	0,2	—	0,3
	V.	—	—	—	—	—	—	—	0,5	—	—
	VI.	—	—	—	0,1	—	—	—	0,2	—	0,3
	VII.	—	—	—	—	—	—	—	—	—	0,2
	VIII.	—	0,1	—	—	—	0,2	—	0,5	—	0,4
	IX.	—	—	—	—	—	—	—	0,2	—	—
	X.	—	—	—	—	—	0,1	0,1	0,3	—	0,4
Ep <i>Cymbella affinis</i> KÜTZ.	IV.	—	—	—	0,1	—	—	—	—	—	—
Ep <i>Cymbella ehrenbergii</i> KÜTZ.	IV.	—	—	—	—	—	—	—	0,1	—	—
	V.	—	0,1	—	—	—	—	—	—	—	—
	VII.	—	—	—	—	—	—	—	0,1	—	—
	X.	—	—	—	—	—	—	—	0,1	—	—
Ep <i>Cymbella lancoelata</i> (EHR.) V. HEURCK	VI.	—	0,1	—	—	—	—	—	—	—	—
	VIII.	—	—	—	—	—	—	—	—	—	0,1
Ep <i>Cymbella prostrata</i> (BERK.) CLEVE	VI.	—	—	—	—	—	—	—	0,1	0,3	—
Be <i>Diploneis domblittensis</i> (GRUN.) CLEVE	IV.	—	—	—	—	—	—	0,2	0,4	—	—
Be <i>Diploneis elliptica</i> (KÜTZ.) CLEVE	IV.	0,9	0,1	0,2	1,0	0,3	1,8	3,7	2,6	5,0	2,3
	V.	0,6	0,7	0,7	0,4	0,9	0,9	2,2	2,8	4,2	0,6
	VI.	0,7	0,2	2,6	0,7	2,9	0,4	2,2	2,3	0,5	0,9
	VII.	0,1	0,6	0,1	0,1	2,2	1,1	0,6	3,6	1,0	0,8
	VIII.	—	0,5	0,8	0,6	0,4	1,2	2,4	4,8	1,0	1,5
	IX.	1,6	—	0,5	0,6	1,0	0,9	0,9	3,8	6,9	1,9
	X.	0,8	0,6	0,2	0,2	0,4	0,2	0,2	3,8	0,5	1,8
Be <i>Diploneis puella</i> (SCHUM.) CLEVE	IV.	0,9	0,1	0,2	0,1	0,5	2,0	1,7	1,6	6,4	3,4
	V.	0,9	1,2	0,3	0,5	1,0	0,6	1,7	2,9	13,9	0,9
	VI.	0,5	—	1,5	0,7	2,6	0,8	0,9	1,5	—	1,2

Tabelle 2 (Fortsetzung) — 2. táblázat (folytatás)

Sammelstellen und Zeitpunkt des Vorkommens Gyűjtőhelyek, időpont		M		K		G		A		E	
Artenverzeichnis Fajok felsorolása		a	b	a	b	a	b	a	b	a	b
<i>Ep Epithemia hyndmanni</i> W. SMITH	VII.	0,2	0,4	—	—	2,7	1,0	1,8	3,0	2,3	1,1
	VIII.	0,3	0,3	0,6	0,7	0,7	1,8	1,9	1,8	1,7	2,6
	IX.	2,0	—	1,0	0,5	1,0	2,3	1,6	4,3	11,2	3,5
	X.	0,5	0,9	0,2	0,1	1,0	0,2	0,2	5,5	0,4	1,6
	IV.	—	0,1	—	—	—	0,1	—	—	—	—
	V.	—	0,1	—	—	—	—	—	0,1	—	—
	VI.	—	0,2	—	—	—	—	—	—	—	—
	VIII.	—	0,1	—	0,1	—	—	—	—	—	—
	IX.	—	—	—	0,1	—	—	—	0,1	—	0,1
	X.	—	0,1	—	—	—	0,1	0,1	0,2	—	0,1
<i>Ep Epithemia intermedia</i> FRICKE	V.	—	—	—	—	—	0,1	—	—	—	—
	X.	—	—	—	—	—	—	0,1	—	—	—
<i>Ep Epithemia sorex</i> KÜTZ.	IV.	—	—	—	0,2	—	—	—	—	—	—
	V.	—	0,1	—	—	—	0,1	—	—	—	—
	VI.	—	—	—	0,3	—	—	—	0,1	—	—
	VII.	—	—	—	—	—	0,2	—	0,3	—	—
	VIII.	—	—	—	0,1	—	—	—	—	—	0,1
	IX.	—	—	—	—	—	—	0,1	0,1	—	—
	X.	—	—	—	0,1	—	—	0,1	—	0,1	—
<i>Pl Fragilaria construens</i> (EHR.) GRUN.	IV.	5,3	5,9	4,4	12,6	1,5	—	11,3	11,3	1,5	—
	V.	4,1	3,6	1,0	2,0	6,1	0,5	21,1	5,6	4,6	1,5
	VI.	9,4	5,6	2,5	5,1	—	1,5	22,2	6,1	1,5	—
	VII.	3,3	5,6	6,2	11,3	6,7	1,5	53,7	4,8	3,1	—
	VIII.	4,6	5,1	14,6	15,5	5,8	3,5	5,6	8,7	1,5	1,0
	IX.	4,6	6,4	2,0	13,4	2,5	5,9	2,0	20,4	1,5	1,0
	X.	5,1	9,8	2,0	7,7	—	1,0	4,1	8,7	0,5	2,5
<i>Be Fragilaria pinnata</i> EHR.	IV.	3,5	6,3	3,3	7,9	5,1	1,0	7,9	5,2	2,5	0,5
	V.	2,5	0,5	4,1	0,5	2,5	—	11,3	3,6	3,6	—
	VI.	3,0	1,5	6,7	1,1	3,1	0,5	12,8	0,5	1,5	—
	VII.	0,5	—	—	1,0	1,0	—	6,2	3,5	—	1,0

	VIII.	—	1,2	3,0	8,2	6,6	1,0	7,2	2,5	2,5	0,5
	IX.	2,5	6,6	—	10,8	1,0	2,5	1,5	8,7	0,5	0,5
	X.	—	5,1	2,5	3,0	—	—	14,9	11,3	2,0	0,5
Pl <i>Gyrosigma attenuatum</i> (KÜTZ.) RABH.	IV.	—	0,1	—	—	—	—	0,3	0,1	—	—
	V.	—	—	—	—	—	—	—	0,1	—	—
	VI.	0,2	—	—	—	—	—	—	0,1	—	—
	VII.	0,7	—	—	—	—	—	—	0,1	—	—
	VIII.	—	—	0,1	—	0,8	—	—	0,3	—	—
	IX.	—	—	0,5	—	0,2	0,1	0,1	0,5	0,2	—
	X.	0,2	0,2	—	—	—	—	0,1	0,2	—	0,1
Pl <i>Gyrosigma distortum</i> var. <i>parkeri</i> HARRIS	IV.	0,3	0,4	0,2	0,3	0,7	0,3	0,3	0,2	1,6	1,2
	V.	2,5	0,1	0,5	—	0,8	—	0,8	0,5	3,4	0,5
	VII.	1,7	0,4	0,2	—	1,5	—	1,2	0,5	2,0	0,2
	VIII.	2,3	1,5	0,9	0,2	1,0	0,2	0,3	—	0,8	0,5
	IX.	0,6	0,1	0,1	—	0,1	0,1	—	—	—	0,2
	X.	0,2	0,6	—	—	—	—	0,1	0,2	—	—
Pl <i>Gyrosigma kützingii</i> (GRUN.) CLEVE	IV.	0,8	0,2	0,2	0,3	—	0,2	0,6	0,5	—	0,2
	V.	2,4	0,2	0,5	—	1,0	0,2	1,2	1,0	3,3	0,5
	VI.	1,4	0,4	1,4	0,2	—	0,1	1,5	1,1	1,4	0,9
	VII.	1,0	0,6	0,3	0,2	0,5	0,6	1,2	0,6	1,0	0,5
	VIII.	2,8	1,7	0,5	—	0,6	0,2	1,7	0,6	0,5	0,3
	IX.	1,2	0,4	0,5	0,1	0,1	0,3	0,1	1,3	0,4	0,7
	X.	1,7	1,7	0,3	—	0,1	0,1	2,5	2,7	2,4	0,9
Be <i>Gyrosigma prolongatum</i> (W. SMITH) CLEVE	VIII.	0,1	—	—	—	—	—	—	—	—	—
	X.	0,3	—	—	—	—	—	—	—	—	—
Pl <i>Melosira granulata</i> (EHR.) RALFS	IV.	8,2	12,0	1,3	1,3	2,6	—	2,6	2,6	6,7	7,2
	V.	5,3	8,2	2,0	3,1	2,5	1,0	5,1	4,6	1,5	4,1
	VI.	1,4	7,3	0,7	3,5	1,0	1,0	7,7	10,5	3,3	6,5
	VII.	—	6,1	2,5	1,5	2,5	—	1,0	4,1	1,0	7,9
	VIII.	0,5	4,8	9,2	4,6	3,6	2,5	18,0	29,4	14,4	10,3
	IX.	—	6,7	3,6	4,1	5,1	4,1	11,3	10,3	13,9	13,7
	X.	4,6	7,9	1,5	4,3	3,6	2,5	7,7	10,8	12,4	21,3
Pl <i>Melosira granulata</i> var. <i>angustissima</i> O. MÜLL.	IV.	5,1	10,2	1,8	1,0	1,5	—	0,8	1,3	—	—
	V.	6,7	2,0	—	1,0	—	—	3,0	1,5	—	1,5
	VI.	7,7	10,5	1,5	—	1,0	—	—	—	0,5	0,5
	VII.	3,6	4,5	2,0	4,1	—	—	2,0	—	0,5	—
	VIII.	2,0	2,5	1,0	5,1	0,5	0,5	—	—	1,0	—
	IX.	—	2,0	—	—	—	—	—	—	—	—

Tabelle 2 (Fortsetzung) — 2. táblázat (folytatás)

Sammelstellen und Zeitpunkt des Vorkommens Gyűjtőhelyek, időpont		M		K		G		A		E	
Artenverzeichnis Fajok felsorolása		a	b	a	b	a	b	a	b	a	b
	X.	—	3,0	2,5	0,5	—	1,0	—	—	—	—
Pl <i>Melosira varians</i> C. A. AG.	VII.	—	—	—	—	—	—	—	0,2	—	—
Be <i>Navicula costulata</i> GRUN.	V.	—	—	—	—	—	—	—	—	—	0,2
	VI.	—	—	0,3	—	—	—	—	0,1	—	—
Be <i>Navicula cryptocephala</i> KÜTZ.	IV.	3,6	0,7	2,3	1,0	1,8	0,8	0,4	0,5	—	0,2
	V.	3,1	0,2	5,3	0,4	2,9	0,6	1,4	1,2	6,3	0,1
	VI.	4,1	0,3	13,6	0,3	7,2	0,6	0,5	0,3	1,5	0,2
	VII.	2,8	—	1,0	0,1	1,0	0,4	1,1	0,4	1,4	—
	VIII.	1,6	0,3	0,7	0,6	1,9	0,2	1,0	0,6	0,6	0,1
	IX.	32,2	0,7	5,5	0,3	2,3	0,1	1,3	0,7	1,8	0,3
	X.	0,9	1,7	0,6	0,3	0,5	0,3	2,4	1,6	2,1	1,5
Be <i>Navicula dicephala</i> (EHR.) W. SMITH	IV.	—	0,1	—	—	—	—	0,3	0,1	—	0,1
	V.	—	—	—	—	—	0,1	—	—	—	0,2
	VI.	—	—	—	—	—	—	—	0,1	—	0,1
	VIII.	—	—	—	—	0,2	—	—	—	—	0,2
	IX.	—	—	—	—	—	0,1	—	—	0,1	—
	X.	—	—	—	—	—	—	—	0,1	0,1	—
Be <i>Navicula gracilis</i> EHR.	IV.	0,1	0,1	—	0,2	—	—	—	0,5	—	—
	VI.	0,9	0,1	0,7	—	—	—	—	—	—	—
	VII.	—	—	—	—	—	1,0	—	—	—	—
	X.	—	—	—	—	—	0,1	—	0,4	—	—
Be <i>Navicula hungarica</i> var. <i>capitata</i> (EHR.) CLEVE	IV.	—	0,1	—	0,2	—	—	—	—	—	—
	VI.	—	—	—	—	—	0,1	—	0,1	—	—
	VII.	—	0,1	—	—	—	0,3	—	—	—	—
	VIII.	—	—	—	0,1	—	—	—	0,2	—	0,1
	IX.	—	—	—	—	—	—	—	0,2	—	—
	X.	—	0,1	—	—	—	0,2	—	—	0,1	—
Be <i>Navicula placentula</i> (EHR.) GRUN.	IV.	—	0,3	—	—	—	1,2	—	0,3	—	0,2
	V.	—	0,2	—	—	—	0,7	—	0,1	0,5	0,1

	VI.	0,2	—	1,7	—	3,8	0,3	0,3	0,2	0,1	0,2
	VII.	1,2	—	0,1	0,1	0,3	0,5	0,9	0,4	1,8	0,3
	VIII.	—	0,1	0,1	0,1	0,9	0,6	—	0,7	0,2	0,3
	IX.	0,1	0,3	1,0	0,2	0,5	—	0,4	0,3	0,9	0,5
	X.	—	0,9	—	—	0,1	—	—	0,2	0,1	0,6
Be <i>Navicula reinhardtii</i> GRUN.	IV.	—	0,1	—	—	—	—	—	—	—	—
	V.	—	0,1	—	—	—	—	—	—	—	—
Be <i>Navicula tuscula</i> (EHR.) GRUN.	VII.	—	—	—	—	—	0,2	—	0,1	—	—
	X.	—	0,1	—	—	—	—	—	0,1	—	—
Be <i>Neidium dubium</i> (EHR.) CLEVE	IV.	—	0,1	—	0,1	—	0,4	—	0,1	—	0,4
	VI.	—	—	—	—	—	—	—	—	—	0,1
	VII.	—	—	—	—	—	—	—	—	—	0,1
	VIII.	—	—	—	—	—	0,1	—	—	0,1	0,1
	IX.	—	—	—	—	—	—	—	—	—	0,2
	X.	—	—	—	—	—	0,1	—	0,1	—	0,1
Be <i>Neidium iridis</i> (EHR.) CLEVE	VII.	—	0,1	—	—	—	—	—	—	—	—
Pl <i>Nitzschia acicularis</i> W. SMITH	IV.	1,4	0,3	4,3	0,3	0,1	0,6	1,4	0,8	3,1	1,8
	V.	—	—	0,3	0,3	4,0	1,0	4,0	1,3	9,1	3,6
	VI.	1,9	0,3	4,6	0,6	4,5	1,4	0,9	3,2	1,8	2,2
	VII.	0,3	0,4	0,2	0,1	3,7	0,4	1,3	0,5	1,5	0,5
	VIII.	—	0,1	0,3	—	14,7	0,6	0,4	0,3	0,8	0,1
	IX.	0,6	—	7,1	0,5	0,9	0,2	0,8	0,6	2,7	0,3
	X.	—	0,6	0,5	0,4	0,2	0,5	0,9	1,5	0,1	1,1
Be <i>Nitzschia amphibia</i> GRUN.	IV.	14,2	3,5	14,9	4,8	16,3	3,7	4,9	2,1	23,8	4,5
	V.	29,4	0,7	16,3	2,9	28,9	3,7	17,0	4,3	34,8	5,3
	VI.	9,1	1,8	15,0	0,9	20,1	2,5	6,6	0,5	6,7	1,3
	VII.	17,0	3,0	4,9	2,2	9,8	1,4	8,4	2,5	10,5	2,2
	VIII.	5,6	3,6	5,1	0,9	22,1	0,6	3,2	0,5	6,9	0,6
	IX.	5,9	1,1	16,0	1,2	8,0	0,4	5,0	1,1	18,2	2,8
	X.	4,1	1,8	2,7	2,0	1,3	1,5	3,9	3,1	3,7	3,1
Be <i>Nitzschia sigmoidea</i> (EHR.) W. SMITH	IV.	13,1	4,4	12,1	5,2	16,3	6,4	5,6	2,7	25,2	6,4
	V.	14,9	0,7	6,4	2,1	15,9	2,2	12,8	3,3	31,9	5,6
	VI.	7,7	2,3	18,2	0,9	24,2	2,2	7,1	0,9	4,6	1,9
	VII.	13,1	4,9	6,7	4,8	8,3	2,7	5,3	3,1	4,6	2,3
	VIII.	3,6	5,2	3,7	0,5	26,5	0,8	1,3	1,4	2,6	1,1
	IX.	5,6	1,7	9,7	0,8	0,3	0,6	2,3	1,7	6,6	2,0
	X.	1,5	3,0	2,6	1,2	0,3	1,4	3,6	2,9	2,1	4,9

Tabelle 2 (Fortsetzung) — 2. táblázat (folytatás)

Sammelstellen und Zeitpunkt des Vorkommens Gyűjtőhelyek, időpont		M		K		G		A		E	
Artenverzeichnis Fajok felsorolása		a	b	a	b	a	b	a	b	a	b
Be <i>Nitzschia tryblionella</i> var. <i>debilis</i> (ARNOTT) A. MAYER	IV.	—	—	—	0,1	—	1,0	—	0,2	—	—
	V.	0,2	—	—	0,2	—	—	—	0,1	0,5	0,5
	VI.	—	—	—	0,4	0,2	0,6	—	0,1	—	0,1
	VII.	—	—	0,1	0,2	—	0,2	—	0,1	—	0,1
	VIII.	—	0,1	0,2	0,4	—	—	—	0,1	0,1	0,1
	IX.	—	—	0,1	0,4	—	0,2	0,1	—	—	—
	X.	—	—	—	0,3	—	0,1	—	0,3	—	0,4
	V.	—	—	—	—	—	—	—	—	—	0,1
	IV.	—	—	—	—	—	—	—	0,2	—	—
	VI.	—	0,3	—	—	—	—	—	0,1	—	—
Be <i>Nitzschia tryblionella</i> var. <i>levidensis</i> (W. SMITH) GRUN.	VIII.	—	—	—	—	—	0,1	—	—	—	—
	X.	—	—	—	—	—	0,1	—	—	—	—
	VII.	—	—	—	—	0,1	—	—	—	0,2	—
Be <i>Opephora martyi</i> HÉRIBAUD	VIII.	0,1	—	—	—	—	—	—	0,2	0,2	—
	IV.	—	—	—	0,3	—	—	—	0,2	—	—
	VI.	—	—	—	—	—	0,1	—	—	—	—
Be <i>Pinnularia microstauron</i> (EHR.) CLEVE	VII.	—	—	—	—	—	0,2	—	—	—	—
	VIII.	0,1	—	—	—	—	—	—	0,2	—	—
	IX.	—	—	—	—	—	—	—	—	—	—
Be <i>Pinnularia</i> sp.	X.	—	—	—	—	—	—	—	—	—	—
	IV.	—	—	—	—	—	—	—	—	—	—
	VI.	—	—	—	—	—	0,1	—	—	—	—
	VII.	—	—	—	—	—	0,2	—	0,1	—	—
	IX.	—	—	—	0,1	—	0,1	0,1	0,2	—	—
Ep <i>Rhopalodia gibba</i> (EHR.) O. MÜLL	X.	—	—	—	—	—	—	0,1	—	—	0,1
	VII.	—	—	—	—	—	—	—	0,1	—	—
	X.	—	—	—	—	—	—	0,1	—	—	—
Be <i>Stauroneis smithii</i> var. <i>incisa</i> PANT.	VI.	—	—	—	—	—	—	0,1	—	—	—
Pl <i>Stenopterobia pelagica</i> HUST.	IV.	5,1	0,9	0,9	0,2	3,7	0,7	0,1	0,2	0,4	0,1
	V.	8,6	0,1	0,2	0,1	6,2	0,1	1,2	—	2,2	—
	VI.	1,0	0,5	7,7	—	3,5	0,3	0,3	0,1	—	—
	VII.	3,0	0,1	1,9	0,5	1,3	0,3	0,8	0,5	0,9	0,1
	VIII.	0,1	—	0,2	—	3,1	0,4	—	—	—	—
	IX.	0,5	—	0,5	—	—	0,1	—	—	0,1	—

	X.	—	—	—	—	—	0,1	0,2	—	—	—
Be <i>Surirella biseriata</i> BRÉB.	V.	—	—	—	—	—	—	—	0,1	—	—
Be <i>Surirella elegans</i> EHR.	IV.	—	0,1	—	—	—	—	0,1	0,1	—	—
	X.	—	0,3	—	—	—	—	—	—	—	—
Be <i>Surirella robusta</i> var. <i>splendida</i> (EHR.)	IV.	—	0,1	—	0,4	—	—	0,1	0,7	0,3	0,4
V. HEURCK	V.	—	—	0,7	—	0,2	0,1	0,9	0,2	0,6	0,3
	VI.	—	—	—	—	0,1	—	0,3	0,3	0,5	0,2
	VII.	0,8	—	—	0,2	1,2	—	0,3	1,4	0,3	0,3
	VIII.	0,5	0,2	0,5	0,2	—	—	0,5	0,9	0,6	0,8
	IX.	0,4	0,1	0,3	0,1	—	0,3	—	0,2	0,1	1,1
	X.	0,1	0,3	0,2	0,2	—	—	0,8	1,3	—	0,7
Be <i>Surirella tenera</i> GREG.	VII.	—	—	—	—	—	0,1	—	0,1	—	—
	VIII.	—	—	—	—	—	—	—	0,3	—	0,1
Be <i>Surirella turgida</i> W. SMITH	IV.	—	—	—	—	—	0,1	—	—	0,2	0,1
	V.	—	—	0,3	—	—	—	—	—	—	0,1
	VI.	—	—	0,1	—	0,5	—	0,1	0,1	—	0,1
	VII.	—	—	—	—	—	—	0,2	0,4	—	—
	VIII.	0,1	0,1	0,6	0,1	0,1	0,2	—	—	—	0,1
	IX.	—	—	0,3	—	—	0,1	—	0,1	—	0,2
	X.	—	—	—	—	—	—	0,1	0,2	—	0,4
Ep <i>Synedra parasitica</i> (W. SMITH) HUST.	VI.	—	—	—	—	0,3	—	—	—	—	—
	VIII.	0,1	—	—	—	—	—	—	—	—	—
CHLOROPHYTA											
<i>Ankistrodesmus falcatus</i> (CORDA) RALFS	IV.	—	—	—	—	—	—	0,2	—	—	—
	V.	—	—	—	—	0,1	—	—	—	—	—
	VI.	—	—	—	—	0,2	—	0,1	—	—	—
	VII.	—	—	—	—	—	—	0,1	—	—	—
	VIII.	—	—	0,1	—	0,1	—	—	—	—	—
	IX.	—	—	0,1	—	0,2	—	0,2	—	—	—
	X.	—	—	—	0,1	—	—	—	—	—	—
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i> (A. BRAUN) G. S. WEST	IV.	—	—	—	—	0,1	—	—	—	—	—
	V.	—	—	—	—	—	—	—	—	0,1	—
	VI.	—	—	—	—	0,1	—	—	—	—	—
<i>Ankistrodesmus falcatus</i> var. <i>mirabile</i> W. et G. S. WEST	VIII.	—	—	—	—	—	—	0,1	—	—	—

Tabelle 2 (Fortsetzung) — 2. táblázat (folytatás)

Sammelstellen und Zeitpunkt des Vorkommens Gyűjtőhelyek, időpont		M		K		G		A		E	
Artenverzeichnis Fajok felsorolása		a	b	a	b	a	b	a	b	a	b
<i>Ankistrodesmus setigerus</i> (SCHRÖDER) G. S. WEST	IV.	—	—	—	—	—	—	0,1	—	—	—
<i>Closterium aciculare</i> T. WEST	VI.	—	—	—	—	—	—	0,1	—	—	—
	VIII.	—	—	—	—	0,5	—	—	0,2	—	3,1
	IX.	—	—	—	—	—	0,1	—	0,2	—	—
	X.	—	—	0,1	—	0,1	—	—	—	0,1	—
<i>Crucigenia quadrata</i> var. <i>octogona</i> SCHMIDLE	V.	—	—	—	—	0,4	—	—	—	—	—
	VI.	—	—	—	—	—	—	0,7	—	—	—
	VII.	—	—	—	—	—	—	—	—	0,3	—
	VIII.	—	—	—	—	0,1	—	—	—	—	—
	X.	—	—	—	—	—	—	0,4	—	0,4	—
<i>Dictyosphaerium pulchellum</i> WOOD.	IV.	0,1	—	—	—	—	—	—	—	—	—
	V.	0,1	—	0,1	—	—	—	—	—	—	—
	VI.	—	—	0,1	—	—	—	0,2	—	—	—
	VII.	—	—	—	—	0,1	—	—	—	—	—
	X.	—	—	0,1	—	0,1	—	—	—	0,1	—
<i>Pediastrum boryanum</i> (TURP.) MENECH.	V.	—	—	—	0,1	—	—	—	—	—	—
	VII.	—	0,1	—	0,1	—	—	—	0,1	—	—
	VIII.	—	—	—	0,1	—	0,2	—	0,2	—	—
<i>Pediastrum clathratum</i> (SCHROET.) LEMM.	IV.	—	0,1	—	—	—	—	0,1	—	—	0,1
	V.	—	0,1	—	0,1	—	—	—	0,2	—	0,1
	VI.	—	0,1	—	—	—	0,1	—	0,1	—	0,2
	VII.	—	—	—	0,1	—	0,3	—	—	—	0,1
	VIII.	—	—	—	—	—	0,1	—	0,3	—	0,1
	IX.	—	—	—	0,1	—	0,2	—	0,1	—	—
	X.	—	—	—	—	—	0,1	—	—	—	0,1
<i>Pediastrum duplex</i> var. <i>reticulatum</i> LAGERH.	IV.	—	—	—	—	—	—	—	—	—	0,1
	VI.	—	0,1	—	—	—	—	—	—	—	—
	VII.	—	—	—	0,1	—	—	—	—	—	—

	IX.	—	—	—	0,1	—	—	—	—	—	—
	X.	—	—	—	—	—	—	—	—	0,1	0,1
<i>Pediastrum simplex</i> RALFS	VI.	—	—	—	—	—	—	—	0,1	—	—
	VIII.	—	—	—	0,1	—	—	—	—	—	—
<i>Scenedesmus ecornis</i> (RALFS) CHOD.	IV.	—	—	—	—	0,1	—	—	—	0,1	—
	V.	—	—	—	—	0,1	—	—	—	—	—
	X.	—	—	—	—	—	—	0,1	—	—	—
<i>Scenedesmus quadricauda</i> (TURP.) BRÉB.	IV.	0,2	0,1	—	—	0,1	—	—	—	—	—
	V.	0,2	—	0,3	0,1	—	—	—	—	0,2	—
	VI.	—	—	0,1	0,1	0,3	—	0,1	—	—	—
	VII.	—	—	0,2	—	—	—	—	—	—	—
	VIII.	—	—	—	—	0,3	—	0,1	—	—	—
	IX.	—	—	0,1	0,1	0,1	0,1	—	—	—	—
	X.	0,1	—	0,1	—	0,1	—	—	—	—	—
<i>Staurastrum gracile</i> RALFS	IV.	—	0,1	—	—	—	—	—	—	—	—
	VII.	—	—	—	—	—	0,1	0,1	—	0,2	—
	VIII.	—	—	—	—	—	—	—	0,1	—	—
	IX.	—	—	—	—	—	—	—	—	0,1	—
	X.	—	0,1	0,2	—	0,2	0,2	—	—	0,4	0,2
<i>Staurastrum paradoxum</i> MEYEN	IV.	—	—	—	—	—	—	—	0,1	—	—
MYCOPHYTA											
<i>Dactylosporium</i> sp.	VI.	—	—	0,1	—	0,1	—	0,3	—	0,1	—
	VII.	—	—	—	—	—	—	—	—	0,1	—
	VIII.	—	—	—	—	—	—	0,2	—	—	—
	IX.	—	—	—	—	—	—	0,1	—	—	—
	X.	—	—	—	—	—	—	—	—	0,1	—

Zeichenerklärung: Pl = Planktondiatomeen; Ep = Epiphyten; Be = Benthosdiatomeen; V—XI = Monate; a = lebende Algen; b = abgestorbene Algen.

Tabelle 3

Zusammenfassende quantitative Mikrophytobentos-Untersuchungen aus dem Eprofun-
Individuen

A Balaton nyíltvízi fenékiszapmintáinak összesített mennyiségi algoló-

Sammelstellen Gyűjtőhelyek	Monat Hónapok	Artenzahl Fajszám	Lebende Kieselalgen flökövamoszat i/dm ²	% i/dm ²	Artenzahl Fajszám	Abgestorbene Kiesel- algen Vökövamoszat i/dm ²	% i/dm ²
M	IV.	21	66,4	54,8	30	53,9	44,5
	V.	18	89,1	74,3	23	30,1	25,1
	VI.	19	51,5	52,0	20	47,0	47,3
	VII.	19	50,8	50,6	18	49,0	48,8
	VIII.	19	29,2	37,7	23	47,6	61,4
	IX.	17	64,4	63,1	16	36,5	35,8
	X.	14	21,5	25,8	24	60,9	73,0
K	IV.	16	48,1	47,9	28	51,4	51,1
	V.	18	39,5	61,4	17	23,5	36,6
	VI.	19	79,8	68,0	18	36,3	31,0
	VII.	16	28,9	34,7	20	53,1	63,8
	VIII.	22	45,7	44,3	23	56,2	54,5
	IX.	20	52,5	48,7	21	54,4	50,5
	X.	15	17,2	27,2	20	44,6	70,5
G	IV.	14	51,1	59,6	22	32,1	37,4
	V.	15	73,6	73,2	21	25,0	24,8
	VI.	20	85,6	70,6	21	30,9	25,5
	VII.	18	47,7	54,1	23	37,6	42,6
	VIII.	22	94,0	72,8	24	30,6	23,7
	IX.	17	24,2	38,8	23	34,8	55,7
	X.	12	8,3	21,4	24	25,9	66,9
A	IV.	24	45,5	47,3	34	48,6	50,5
	V.	19	91,8	66,2	26	44,6	32,2
	VI.	20	65,2	54,0	29	50,4	41,8
	VII.	19	89,0	63,2	31	46,6	33,1
	VIII.	20	46,7	40,0	25	64,4	55,2
	IX.	10	31,8	28,5	26	75,0	67,3
	X.	25	44,0	35,7	30	71,5	58,1
E	IV.	17	79,3	65,4	24	38,7	32,0
	V.	20	128,5	77,2	25	34,4	20,7
	VI.	16	25,1	42,0	23	30,8	51,6
	VII.	20	37,1	53,6	23	27,1	39,2
	VIII.	22	39,9	50,0	29	32,2	40,1
	IX.	20	68,7	59,4	23	37,9	32,8
	X.	18	29,1	30,0	26	55,1	56,8

— 3. táblázat

dal des Balaton-Sees auf Grund der Sammlungen des Jahres 1967 — $i/\text{dm}^2 = 1000$ pro dm^2

gial adatai az 1967. évi gyűjtések alapján — $i/\text{dm}^2 = 1000$ egyed/ dm^2

Das Zahlenverhältnis zwischen lebenden und abgestorbenen Kieselalgen Félő és víz kova- moszat aránya	Artenzahl Fajszám	Lebende Algen Félő alga i/dm^2	% i/dm^2	Artenzahl Fajszám	Abgestorbene Algen Víz alga i/dm^2	% i/dm^2	Das Zahlenverhältnis zwischen lebenden und abgestorbenen Algen Félő és víz alga aránya
1,2 : 1	4	0,5	0,4	4	0,4	0,3	1,2 : 1
2,9 : 1	2	0,3	0,3	2	0,3	0,3	1 : 1
1 : 1	2	0,5	0,5	2	0,2	0,2	2,5 : 1
1 : 1	2	0,4	0,4	2	0,2	0,2	2 : 1
1 : 1,6	1	0,1	0,1	2	0,6	0,8	1 : 6
1,7 : 1	3	1,0	1,0	1	0,1	0,1	10 : 1
1 : 2,8	3	0,8	1,0	2	0,2	0,2	4 : 1
1 : 1	3	0,7	0,7	1	0,3	0,3	2,3 : 1
1,6 : 1	3	0,5	0,8	4	0,8	1,2	1 : 1,6
2,1 : 1	6	0,9	0,7	2	0,4	0,3	2,2 : 1
1 : 1,8	2	0,3	0,4	4	0,9	1,1	1 : 3
1 : 1,2	4	0,6	0,6	3	0,6	0,6	1 : 1
1 : 1	2	0,2	0,2	4	0,6	0,6	1 : 3
1 : 2,5	6	0,9	1,4	3	0,6	0,9	1,5 : 1
1,5 : 1	5	0,9	1,0	2	1,7	2,0	1,2 : 1
2,9 : 1	5	1,4	1,4	1	0,6	0,6	2,3 : 1
2,7 : 1	11	4,0	3,3	2	0,8	0,6	5 : 1
1,2 : 1	2	0,7	0,8	3	2,2	2,5	1 : 3,1
3 : 1	6	3,1	2,4	3	1,4	1,1	2,2 : 1
1 : 1,4	3	2,0	3,2	4	1,5	2,3	1,3 : 1
1 : 3,1	8	2,5	6,5	5	2,0	5,2	1,2 : 1
1 : 1	5	1,4	1,5	2	0,7	0,7	2 : 1
2 : 1	2	1,2	0,9	2	1,0	0,7	1,2 : 1
1,2 : 1	9	3,0	2,5	3	2,1	1,7	1,4 : 1
1,9 : 1	5	2,0	1,4	2	3,2	2,3	1 : 1,6
1 : 1,3	4	2,5	2,1	5	3,1	2,7	1 : 1,2
1 : 2,3	4	2,6	2,3	3	2,1	1,9	1,2 : 1
1 : 1,6	7	4,3	3,5	3	3,3	2,7	1,3 : 1
2 : 1	3	1,4	1,1	3	1,9	1,5	1 : 1,3
3,7 : 1	4	1,9	1,1	2	1,4	1,0	1,3 : 1
1 : 1,2	3	2,0	3,4	2	1,8	3,0	1,1 : 1
1,3 : 1	4	1,7	2,4	2	3,3	4,8	1 : 1,9
1,2 : 1	1	1,4	1,7	3	6,6	8,2	1 : 4,7
1,8 : 1	3	4,1	3,5	1	5,0	4,3	1 : 1,2
1 : 1,8	8	6,1	6,3	6	6,7	6,9	1 : 1

Der *Pyrrophyten*-Stamm wurde durch eine einzige Art der *Dinophyceae*-Klasse das pelagische *Ceratium hirundinella* in seiner cystischen Form vertreten (siehe Angaben der *Tabelle 2*). Er macht 1% der Anzahl der gesamten Algenarten aus.

Ebenfalls sporadisch und in unbedeutender Menge haben wir den einzigen Vertreter des *Mycophyten*-Stammes, die *Dactylosporium*-Art aufgezeichnet. Auch diese macht nur 1% der Zahl der gesamten Algen aus.

Unter den 5 Querschnitten war der sich zwischen Balatonfüred und Zamárdi sich befindende Querschnitt im April der reichhaltigste (36), der am spärlichsten etwas aufweisende der zwischen Gyenesdiás und der Mündung des Zala-Flusses entnommene Schlamm in der Zeit von September und Oktober (17). Das Vorkommen von *Gyrosigma prolongatum* hat sich auch jetzt auf die Bucht bei Keszthely und deren Umgebung beschränkt, was die Angaben über das Plankton und die Schlammproben aus dem vorigen Jahr bestätigt.

Aus den algologischen Ergebnissen der Schlammprobenuntersuchungen von 1967 ist ersichtlich, daß die quantitativen Daten über die *Lyngbya circumcreta* — Menge in dem nordöstlichen Teil des Sees — ähnlich den Ergebnissen aus dem Jahre 1966 — eine Erhöhung aufwiesen. In den im August entnommenen Schlammproben aus dem Segment Balatonalmádi — Balatonvilágos war die große Anzahl von abgestorbenen Exemplaren der Grünalge (*Closterium aciculare*) auffallend. Zur gleichen Zeit haben wir ein massenhaftes Vorkommen der lebenden Exemplare in den beiden Segmenten A und E im nordöstlichen Teil des Sees im offenen Wasser und in der Oberflächenmembran (Neuston) gesehen.

Unter den pelagischen Diatomeen waren die Schalen der abgestorbenen *Cyclotella bodanica* und der *C. ocellata* in der ganzen Länge des Sees zu finden, lebende Exemplare haben wir jedoch nur vereinzelt in ganz geringer Anzahl finden können. Die *Fragilaria construens* hat ihre höchsten Werte — ähnlich wie im vorigen Jahr — im Segment zwischen Balatonfüred und Zamárdi im nordöstlichen Teil des Sees erreicht. Das ebenfalls pelagische *Melosira granulata* und ihre Varietät kamen stellenweise und zeitweilig in lebenden und abgestorbenen Zustand — ähnlich den Angaben nach den Schlammproben voriger Jahre — mit hoher Anzahl an Exemplaren vor (siehe die ausführlichen Angaben der *Tabelle 2*).

Unter den schlammbewohnenden Kieselalgen trugen die *Navicula cryptocephala*, *Diploneis elliptica*, *D. puella*, *Fragilaria pinnata*, *Nitzschia amphibia* und die *N. sigmoidea*, die stellenweise und zeitweilig in großer Anzahl vorkamen, erheblich zur Erhöhung der Zahl des Chrysophyten-Stammes bei.

Die Anzahl der lebenden Kieselalgen war im Segment Balatonalmádi — Balatonvilágos in der Schlammprobe vom Mai 1967 die höchste (128 500/dm²), den niedrigsten Wert fanden wir in der Oktoberprobe im Segment Ságpusztá — Balatonszemes (8300/dm²).

Das Verhältnis der lebenden zu den abgestorbenen Kieselalgen ist stellenweise und zeitweise — im Vergleich zu den Angaben von 1965 — ausgeglichener. Eine auffallend große Abweichung haben wir nicht beobachtet. Das Verhältnis der lebenden und der toten Kieselalgen — mit Ausnahme von ein-zwei Fällen — war 1 : 1 (siehe die Angaben der *Tabelle 3*).

Das Verhältnis der lebenden zu den abgestorbenen Algenstämmen ist abgesehen von 2 Ausnahmen zugunsten der lebenden Algen verschoben.

Zusammenfassung

Die Verfasserin hat vergleichende Untersuchungen der von April bis Oktober 1967 entnommenen Schlammproben — ähnlich wie in den vergangenen Jahren — angestellt (siehe *Tabelle 1*). Die von den 115 Schlammproben der 15 Sammelstellen bestimmten 80 Arten und 5 Varietäten gehören zusammen mit dem Pilz in die 6 großen Stämme (siehe *Tabelle 2*). Die an Algenarten reichste war die Schlammprobe von April zwischen Balatonfüred und Zámárdi, die armste die von September und Oktober in der Bucht bei Keszthely.

Die Ergebnisse der algologischen Untersuchungen ähneln teilweise denen der vergangenen Jahre, teilweise weichen sie von ihnen ab. Die Anzahl der Exemplare der lebenden Kieselalgen war in der Probe vom Mai zwischen Balatonalmádi und Balatonvilágos am höchsten, am tiefsten in der Probe im Oktober bei Ságpuszta—Balatonszemes. Das Verhältnis der lebenden zu den abgestorbenen Kieselalgen und anderen Algenarten war stellenweise und zeitweilig — im Vergleich zu den Angaben von 1965 — ausgeglichener. Eine auffallend große Abweichung — mit Ausnahme von ein-zwei Fällen — hat die Verfasserin nicht beobachtet (siehe die zusammenfassenden Angaben der *Tabelle 3*).

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MENNYISÉGI VIZSGÁLATOK A BALATON MIKROFITOBENTOSZÁN AZ 1967. ÉVI GYŰJTÉSEK ALAPJÁN

Összefoglalás

Tamás Gizella

Szerző az 1967. év áprilisától — októberig gyűjtött iszapmintákból — a megelőző évekhez hasonlóan — mennyiségi algológiai vizsgálatokat végzett (1. 1. táblázat). A 15 gyűjtőhely 115 iszapmintájából meghatározott 80 faj és 5 változat a gombával együtt 6 nagy rendszertani törzsbe tartozik (1. 2. táblázat). Algafajokban az 5 harántszelvény közül a leggazdagabb a Balatonfüred—Zámárdi áprilisi, a legszegényebb pedig a Keszthelyi-öböl szeptemberi és októberi iszapmintája volt.

Az algológiai vizsgálatok eredményei részben hasonlóak a korábbi évek adataihoz, részben pedig eltérnek azoktól. Az élő kovamoszatok egyedszáma legmagasabb a Balatonalmádi—Balatonvilágos májusi mintában, a legalacsonyabb a Ságpuszta—Balatonszemes októberi mintában volt. Az élő és elpusztult kovamoszatok és más algafajok aránya helyenként és időnként — az 1965. évi adatokhoz képest — egyenletesebb. Feltűnő nagy eltérést — egy-két esetet kivéve — nem észlelt (1. 3. táblázat összesített adatait).

КОЛИЧЕСТВЕННОЕ ИЗУЧЕНИЕ МИКРОФИТОБЕНТОСА ОЗЕРА БАЛАТОН ПО
СБОРАМ 1967 ГОДА

Г. Тамаш

Проведен количественный анализ водорослей в образцах ила, собранных с апреля по октябрь 1967 г. В 115 пробах, взятых в 15 местах, найдено 80 видов и 7 разновидностей (включая грибы), относящихся к 6 большим систематическим группам (*таблицы* № 1 и 2). Наиболее богаты водорослями пробы ила из района Балатонфюред—Замарди, в апреле, а наиболее бедны пробы Кестхейского залива в сентябре и октябре.

Результаты исследования частично соответствуют данным предыдущих лет, но обнаруживается и некоторое отличие. Наиболее высокое содержание живых кремневых водорослей обнаружено в мае в пробах, взятых между Балатоналмади и Балатонвилагош, а наиболее низкое в пробах, собранных в октябре между Шагпуста и Балатонсемеш. Сравнение данных 1965 и 1967 годов показывает, что отношение между живыми и погибшими кремневыми и другими водорослями стало более равномерным, и теперь не обнаруживается большая разница, как раньше (*см. таблицы* № 3).

ÜBER DIE RÄDERTIEREN- (RATATORIA-) FAUNA DES PLATTENSEES NACH LITERATURANGABEN VON 1897 BIS 1960

NÓRA P.-ZÁNKAI

*Biologisches Forschungsinstitut der Ungarischen Akademie der Wissenschaften, Tihany,
Ungarn*

Eingegangen: 1. Februar, 1968

Die Erforschung der mikroskopischen Tierwelt des Plattensees begann bereits in den achtziger Jahren des vorigen Jahrhunderts (DADAY 1884, 1894, FRANCÉ 1893). Die ersten Sammler haben, um die Lebewelt des Plattensees kennenzulernen, an den verschiedensten Punkten des Sees gesammelt. Die späteren Forscher setzten sich immer mehr ein Ziel, jeweils ein interessanteres Biotop einer gründlichen Untersuchung zu unterziehen und mehrere Jahre hindurch zu beobachten, um so vollkommene Ergebnisse zu erhalten (z. B. Psammon, Cladophora-Bewuchs oder die Untersuchung der Bucht von Aszófő). Die quantitativen Planktonstudien treten in den vierziger Jahren dieses Jahrhunderts immer mehr in den Vordergrund, sie zeigten ein genaues Bild über die Anordnung der Rotatorien in den verschiedenen Tiefen des Sees. Die im Jahre 1936—37—38 begonnenen und 1947—1949—1951 wiederholten quantitativen Untersuchungen haben eine beachtliche Menge an Daten über das vor Tihany gelegene Gebiet des Sees geliefert, auf Grund welcher wir dieses Gebiet als das bekannteste betrachten können.

Die im Jahre 1965 eingetretene massenhafte Fischverendung hat die Wiedereinleitung der Plattenseeforschung notwendig gemacht. Der Vergleich der heutigen Fauna des Plattensees mit den älteren, beinahe 80 Jahre alten literarischen Angaben hat bei der Bearbeitung der Rotatorienarten Schwierigkeiten gemacht. Besonders problematisch war der Vergleich der neueren und älteren ökologischen Beobachtungen zwecks Ermessung und Auswertung einer eventuellen Veränderung des Rotatorienplanktons. Diese Arbeit hat also die Darbietung der Zusammenfassung einer der wichtigsten Lebewesengruppen des Sees und die Erleichterung späterer Forschungen durch die Zusammenstellung der vorhandenen Angaben in der Literatur und durch die Aufzählung der über die einzelnen Arten von verschiedenen Autoren getroffenen ökologischen Bemerkungen zur Aufgabe.

Die Aufführung der einzelnen Arten habe ich nach der alphabetischen Reihenfolge vorgenommen und die verschiedenen systematischen Einordnungen außer Acht gelassen. Ich tat dies erstens darum, weil es so nach meiner Meinung viel übersichtlicher ist, anderseits benutzen die Autoren verschiedene Systeme, was das Aufsuchen der Arten sehr erschwert.

Bei der Benennung der Arten benutze ich die Nomenklatur von VOIGT (1957) und WISZNIEWSKI (1954). In den Fällen, wo die Meinungen dieser zwei

Verfasser voneinander abweichen oder die betreffende Art in der Arbeit des einen oder des anderen fehlt; markiere ich hinter dem Autorennamen mit einem in Klammern gesetzten Buchstaben (VOIGT = V), (WISZNIEWSKI = W) die angewendete Nomenklatur.

Den von der heute gebräuchlichen Nomenklatur abweichenden und in der zitierten älteren Literatur angegebenen Teil des Namens habe ich neben

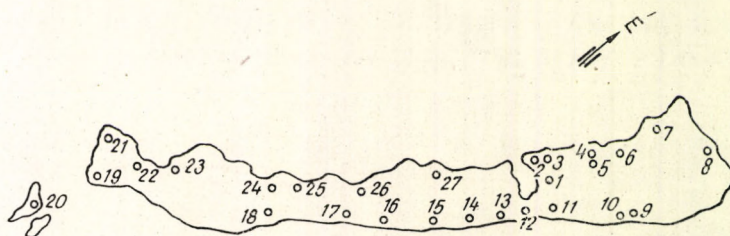


Fig. 1. Die Sammlungsorte im Balaton

- | | |
|-------------------------|--------------------------|
| 1. Tihany | 15. Balatonszemes |
| 2. Bucht von Aszófő | 16. Balatonlelle |
| 3. Balatonfüred | 17. Balatonboglár |
| 4. Csopak | 18. Fonyód |
| 5. Kereked | 19. Die Mündung des Zala |
| 6. Alsóórs | 20. Kis-Balaton |
| 7. Balatonalmádi | 21. Keszthely |
| 8. Balatonkenese | 22. Vonyarc |
| 9. Siófok | 23. Balatongyörök |
| 10. Die Mündung des Sió | 24. Badacsony |
| 11. Zamárdi | 25. Badacsonytomaj |
| 12. Szántód | 26. Révfülöp |
| 13. Balatonföldvár | 27. Balatonakali |
| 14. Balatonszárszó | |

dem nach der modernen Nomenklatur aufgezählten Namen der Art bzw. vor die zitierten Daten aus der Literatur in Klammern gesetzt. Z. B.: *Eosphora najas* EHRBG. (= *E. digitata*) ... (V. 1939)

Bei dem Zitieren der Angaben aus der Literatur habe ich als Grundlage die zeitliche Reihenfolge der Veröffentlichung und nicht die des Sammelns genommen. Hier benutze ich folgende Abkürzungen: DADAY J. = (D.), ENTZ G. = (E.), KOTTÁSZ J. = (K.), SEBESTYÉN O. = (S.), TÖRÖK P. = (T.), VARGA L. = (VA.), NÁDAY L. = (N.).

Bei einigen zusammenfassenden Arbeiten hat der Verfasser es nicht für nötig gehalten, den Zeitpunkt des Sammelns anzugeben, oder er gab das Vorkommen der Arten nur in Jahreszeiten an. In solchen Fällen kann ich selbstverständlich nur die Daten der zitierten Literatur angeben.

Adineta gracilis JANSON. Tihany. Im *Cladophora*-Bewuchs der Steine (VA. 1941).

Adineta vaga (DAVIS). Die Bucht von Aszófő. 3. I. 1936., 19. VII. 1939. Zwischen Wasserpflanzen, im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941).

Anuraeopsis fissa (GOSSE). Kis-Balaton (Kleiner-Balaton). 18. VIII. 1938. Im Plankton und zwischen *Ceratophyllum*. Warmstenotherm (VA. 1944—45).

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- Ascomorpha saltans* BARTSCH. 1930. Im *Cladophora*-Bewuchs. Im Plankton zwischen Algen zufällig (VA. 1941).
- Aspelta circinator* (GOSSE). Die Bucht von Aszófő. 19. VII. 1939. Zwischen *Myriophyllum* (VA. 1939).
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- Brachionus angularis* GOSSE. Révfülöp 17. III. 1926. Nichtpelagisch (VA. 1932). Tihany. III., IV., VIII., X. 1933. In der Uferzone (E.—K.—S. 1937).
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- Brachionus calyciflorus* PALL. Tihany. VI., VIII., IX. 1933. Sommerform? (E.—K.—S. 1937).
- Brachionus quadridentatus* HERMANN. (= *B. brevispinus* EHRBG.) Siófok. 1884. 3. XI. 1893. In der Uferzone (D. 1897a). (= *B. brevispinus* EHRBG.) Am sandigen Ufer (D. 1897b). (= *B. capsuliflorus* PALL.) Tihany. IV., IX. 1933. In der Uferzone (E.—K.—S. 1937). (= *B. capsuliflorus* PALL.) Die Bucht von Aszófő. Zwischen Pflanzen und Detritus (VA. 1939). (= *B. capsuliflorus* PALL.) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Brachionus quadridentatus brevispinus* (EHRBG.) (V). (= *B. capsuliflorus brevispina* EHRBG.) Im *Cladophora*-Bewuchs (VA. 1941). (= *B. capsuliflorus brevispina* EHRBG.) Kis-Balaton. 18. VIII. 1938. Im Plankton und zwischen *Myriophyllum* (VA. 1944—45).
- Brachionus quadridentatus entzi* (FRANCÉ) (V). (= *B. capsuliflorus Entzii*) Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).

- Brachionus patulus balatonicus* VARGA. Kis-Balaton. 18. VIII. 1938. Im Plankton und zwischen *Ceratophyllum* massenhaft (VA. 1944—45).
- Brachionus polycanthus* EHRBG. Tihany. VI., VII. 1933. (E.—K.—S. 1937). Die Bucht von Aszófő. 16. VII. 1935. Zwischen *Myriophyllum* (VA. 1939)
- Brachionus sessilis* VARGA. VI—IX. 1950. Warmstenotherm (VA. 1951).
- Brachionus urceus* LINNÉ (W). (= *B. urceolaris* EHRBG.) Siófok. 1884., 3. XI. 1893 (D. 1897a). (= *B. urceolaris* EHRBG.) Am sandigen Ufer (D. 1897b). Tihany. VI., VII., X. 1933 (E.—K.—S. 1937). Die Bucht von Aszófő. Sommerform (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941).
- Bryceella tenella* (BRYCE). Zamárdi, Balatonlelle, Balatonboglár. 22. VIII. 1936. Im Hygropsammon. Psammobiont (VA. 1938). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938., 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella auriculata* (MÜLL.). Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Hygropsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Eurytherm. Zwischen Pflanzen und an der Schlammoberfläche (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45). Balatonalmádi. 5. VIII. 1938., Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938., 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella catellina* (MÜLL.). Zamárdi, Szántód, zwischen Balatonszemes und Balatonlelle. 22. VIII. 1936. Im Psammon, eurytop. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr. Zwischen Pflanzen (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. An der Unterseite der schwimmenden *Nuphar*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII., 6. IX. 1938. Im Psammon (VA. 1957).
- Cephalodella compacta* WISZN. Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Hygropsammon. Psammobiont (VA. 1938).
- Cephalodella elongata* MYERS (W). Zwischen Balatonboglár und Fonyód. 22. VIII. 1936. Im Hygropsammon. Psammophil? (VA. 1938).
- Cephalodella eva* (GOSSE). Die Bucht von Aszófő. 18. VII. 1935. Zwischen submersen Wasserpflanzen (VA. 1939). Zamárdi. 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella exigua* (GOSSE) (= *Diaschiza*). Révfülöp, Tihany. Im Frühjahr und im Herbst. Nichtpelagisch (VA. 1932). Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Psammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Pflanzen und an der Schlammoberfläche (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Cephalodella forficata* (EHRBG.). Zamárdi, Szántód, Balatonlelle. 22. VIII. 1936. Im Hydro- und Hygropsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im Frühjahr und im Sommer (VA. 1939). Zamárdi, Balatonföldvár. Im *Cladophora*-Bewuchs des sandigen Ufers (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938, Zamárdi. 23. VIII. 1938. Im Psammon (VA. 1957).
- Cephalodella forficula* (EHRBG.). Zamárdi. 22. VIII. 1936. Im Hydro- und Hygropsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im Sommer. Warmstenotherm. Zwischen untertauchten Wasserpflanzen

- und an der Schlammoberfläche (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Cephalodella gibba* (EHRBG.) (= *Diaschiza*). Révfülöp. 10. VI. 1926., IV. 1927., Tihany. IV. 1927. Im Plankton, zwischen Pflanzen der Uferzone, an der Schlammoberfläche (VA. 1932). Tihany. V., X. 1933. Sommerform. Zwischen Pflanzen und an der Schlammoberfläche (E.—K.—S. 1937). Zamárdi, Balatonföldvár, Balatonlelle. 22. VIII. 1936. Im Hydro- und Hygropsammon. Psammoxen. Eurytop (VA. 1938). Die Bucht von Aszófő. Eurytherm, maximales Vorkommen im Sommer (VA. 1939). Im *Cladophora*-Bewuchs. Im Frühjahr und im Sommer (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Balatonalmádi. 5. VIII. 1938., Zamárdi. 6. IX. 1938., 18. II. 1939. Im Psammon (VA. 1957).
- Cephalodella gracilis* (EHRBG.). Zamárdi, Balatonföldvár, Balatonlelle, Balatonboglár. 22. VIII. 1936. Im Psammon. Psammophil (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr (VA. 1939). Siófok. Im *Cladophora*-Bewuchs des sandigen Ufers (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938., 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella hoodi* (GOSSE). (= *C. hoodii*) Die Bucht von Aszófő. Im ganzen Jahr (VA. 1939). (= *C. hoodii*) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Cephalodella megaloccephala* (GLASCOTT). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen (VA. 1939). Tihany. 1938. Sommerform. Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45). Zamárdi. 18. II., 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella sterea* (GOSSE). Balatonalmádi. 5. VIII. 1938., Zamárdi. 23. VIII. 1938., 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella tenuior* (GOSSE). Zamárdi, Szántód, Balatonboglár. 22. VIII. 1936. Im Psammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. In ganzen Jahr. Zwischen Wasserpflanzen, und an der Oberfläche des Schlammes (VA. 1939). Siófok. Im *Cladophora*-Bewuchs des sandigen Ufers (VA. 1941). Zamárdi. 29. VII. 1939. Im Psammon (VA. 1957).
- Cephalodella ventripes* DIXON-NUTTALL. Die Bucht von Aszófő. Im Sommer und im Winter. An der Oberfläche des Schlammes (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Collotheca ambigua* (HUDSON). Die Bucht von Aszófő. VIII. 1936. Zwischen *Ceratophyllum* (VA. 1939).
- Collotheca atrochoides* WIERZEJSKI. Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum*, an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Collotheca balatonica* VARGA. Tihany. VII. 1935 (VA. 1935—36).
- Collotheca campanulata* (DOBIE) (V). (= *C. proboscidea* EHRBG.) Die Bucht von Aszófő. VIII. 1936. Zwischen *Myriophyllum* (VA. 1939).
- Collotheca cornuta* (DOBIE) (W). Die Bucht von Aszófő. Sommerform. An verschiedenen Wasserpflanzen (VA. 1939). Im *Cladophora*-Bewuchs (VA.

- 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Collotheca coronetta* (CUBITT). Die Bucht von Aszófő. VIII. 1936. Zwischen *Myriophyllum* (VA. 1939).
- Collotheca libera* (ZACH.). Tihany. 22. VII. 1929 (VA. 1932).
- Collotheca mutabilis* (HUDSON). Tihany. 8. IX. 1928. Kaltwasserbewohnende, pelagische Art (VA. 1932). Tihany. VIII., IX. 1933. Sommerform? (E.—K.—S. 1937).
- Collotheca ornata* (EHRBG.). Die Bucht von Aszófő. Im Sommer. Zwischen Wasserpflanzen (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. An *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Collotheca pelagica* (ROUSSELET). Tihany. 20. VII. 1929 (VA. 1932).
- Collotheca volutata* SEBESTYÉN—VARGA. Tihany. 19. XII. 1945., 1948. Im Detritus (S.—VA. 1949—50).
- Collotheca volutata sessilis* SEBESTYÉN. Tihany. IX. 1946. Am schlammbewohnenden *Monospilus dispar*. Nur epizoisch (S. 1957).
- Collotheca wiszniewskii* VARGA. Zwischen Balatonszémes und Balatonlelle. Balatonlelle. 22. VIII. 1936. Im Hygro- und Eupsammon. Psammobiont (VA. 1938). Zamárdi. 23. VIII. 1938., 29. VII. 1939. Im Psammon. Psammobiont (VA. 1957).
- Colurella adriatica* EHRBG. Zwischen Wasserpflanzen und Detritus, sowie an der Schlammoberfläche. Nichtpelagisch (VA. 1932). Zwischen Wasserpflanzen und Detritus sowie an der Schlammoberfläche (E.—K.—S. 1937). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen und Detritus (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum*, und an der Unterseite der schwimmenden *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII., 16. X. 1938. Im Psammon (VA. 1957).
- Colurella colurus* (EHRBG.). (= *Monura Colurus*) Siófok, Szántód. 18. VI. 1891., Kereked. 18. VII. 1893. In der Uferzone (D. 1897a). (= *Monura Colurus*) Im sandigen Ufer (D. 1897b). In der Uferzone (E.—K.—S. 1937). Zamárdi, Szántód, Balatonlelle. 22. VIII. 1936. Am häufigsten im Hygropsammon. Psammophil (VA. 1938). Die Bucht von Aszófő. Im Frühjahr, Sommer und im Herbst (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII., 16. X. 1938., 18. II., 29. VII. 1939. Im Psammon (VA. 1957).
- Colurella colurus* f. *compressa* (LUCKS) (V). (= *C. compressa*) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Colurella gastracantha* HAUER. Balatonszémes, Balatonboglár. 22. VIII. 1936. Im Psammon. Psammophil (VA. 1938). Siófok. 8. VIII. 1938., Zamárdi. 16. X. 1938., 29. VII. 1939. Im Psammon (VA. 1957).
- Colurella obtusa* (GOSSE). Zamárdi, Szántód, Szárszó. 22. VIII. 1936. Im Hygro- und Eupsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Sommerform. Zwischen Wasserpflanzen und Detritus (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum*, *Myriophyllum* und an der Unterseite der *Hydrocharis*-

- Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 16. X. 1938., 18. II. 1938. Im Psammon (VA. 1957).
- Colurella tessellata* (GLASCOTT). Die Bucht von Aszófő. 16. VII. 1935. Zwischen Wasserpflanzen (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Colurella uncinata* (MÜLL.) (V). (= *Colurus uncinatus* EHRBG.) Siófok 1884, Szántód. 18. VI. 1891. In der Uferzone. Kis-Balaton. 22. V. 1893. Im Röhricht (D. 1897a). (= *Colurus uncinatus* EHRBG.) In der sandigen Uferzone (D. 1897b). Tihany. 8. IX. 1928. Im Plankton, aber am häufigsten in der Uferzone (VA. 1932). Tihany. VI., VIII., X., XI. 1933. In der Uferzone (E.—K.—S. 1937). Szántód, Szárszó. 22. VIII. 1936. Im Hygropsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im Sommer. Zwischen Wasserpflanzen und Detritus (VA. 1939). *Cladophora*-Bewuchs. 1930. Im Sommer (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938., 18. II. 1939. Im Psammon (VA. 1957).
- Colurella uncinata bicuspidata* (EHRBG.). (= *C. bicuspidata*) Die Mündung des Zala. 30. VI. 1901. Nichtpelagisch (N. 1914). (= *C. bicuspidata*) Révfülöp. IV. 1927. Zwischen Pflanzen der Uferzone und an der Schlammoberfläche (VA. 1932). (= *C. bicuspidata*) Tihany. V., VIII. 1933. Sommerform. Zwischen Pflanzen der Uferzone und an der Oberfläche des Schlammes (E.—K.—S. 1937). (= *C. bicuspidata*) Szárszó, Balatonlelle, Balatonföldvár. 22. VIII. 1936. Im Hygropsammon. Psammoxen (VA. 1938). (= *C. bicuspidata*) Die Bucht von Aszófő. Im ganzen Jahr, maximale Entwicklung im Sommer (VA. 1939). (= *C. bicuspidata*) Im *Cladophora*-Bewuchs. Im Sommer (VA. 1941). (= *C. bicuspidata*) Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Colurella uncinata f. deflexa* (EHRBG.). (V) (= *C. deflexa*) Die Bucht von Aszófő. 3. I. VIII. 1936. (VA. 1939). (= *C. deflexa*) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Conochiloides dossuarius* (HUDSON). Tihany. VIII. 1928. Sommerform. Euplanktisch (VA. 1932). Tihany. 1933. VI., VII. Pelagisch. Sommerform? (E.—K.—S. 1937). Kis-Balaton. 18. VIII. 1938. Im Plankton (VA. 1944—45). Tihany. 11. V. 1937. Eurytherm (S.—T.—VA. 1951).
- Conochilus hippocrepis* (SCHRANK). (= *C. volvox* EHRBG.) Im offenen Wasserspiegel (D. 1897b). Die Bucht von Aszófő. VII. 1939. In dem, von Pflanzen üppig bewachsenen ruhigen Wasser (VA. 1939).
- Conochilus unicornis* ROUSSELET. Tihany. 20. VII. 1929. Im ruhigen tiefen Wasser. Eurytherm (VA. 1932). Tihany. VI., VII. 1933. Pelagisch. Sommerform? (E.—K.—S. 1937). Die Bucht von Aszófő. 3. I. 1936. (VA. 1939). Tihany. 20. IV. 1936. (S.—T.—VA. 1951).
- Dicranophorus capucinus* HARRING—MYERS (W). Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Hygro- und Eupsammon. Psammobiont (VA. 1938).
- Dicranophorus caudatus* (EHRBG.). Die Bucht von Aszófő. Im ganzen Jahr, maximales Vorkommen im Sommer. An der Schlammoberfläche (VA. 1939).

- Dicranophorus forcipatus* (MÜLL.). Tihany. VII., XII. 1929. Im Plankton sehr selten (VA. 1932). Zamárdi, Szántód. 22. VIII. 1936. Im Hygropsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr, maximale Individuenzahl im Sommer. An faulenden Blättern der Wasserpflanzen (VA. 1939). Im *Cladophora*-Bewuchs. Sommerform (VA. 1941). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45). Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Dicranophorus grandis* (EHRBG.) (V). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Dicranophorus hercules* WISZN. Zamárdi. Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Hygropsammon. Psammobiont (VA. 1938). Zamárdi. 18. II., 29. VII. 1939. Im Psammon. Psammobiont (VA. 1957).
- Dicranophorus hercules capucinoides* WISZN. Zamárdi. Zwischen Szárszó und Balatonszemes. Szántód. 22. VIII. 1936. Im Hygropsammon. Psammobiont (VA. 1938).
- Dicranophorus leptodon* WISZN. Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Hygro- und Eupsammon. Psammobiont (VA. 1938).
- Dicranophorus lütkeni* (BERGENDAL). (= *Arthroglena*) Zwischen Detritus, im Plankton sehr selten (VA. 1932). (= *Arthroglena*) Zwischen Detritus (E.—K.—S. 1937). Zamárdi, Balatonföldvár. 22. VIII. 1936. Im Hygropsammon. Psammophil (VA. 1938). Die Bucht von Aszófő. 9. IV. 1936. (VA. 1939).
- Dicranophorus saevus* HARRING—MYERS (W). Zwischen Szárszó und Balatonszemes. 22. VIII. 1936. Im Hygro- und Eupsammon. Psammobiont (VA. 1938).
- Dicranophorus uncinatus* (MILNE). Die Bucht von Aszófő. Im Winter, Frühjahr und im Sommer. Zwischen Wasserpflanzen (VA. 1939). Tihany. Im *Cladophora*-Bewuchs von Steinen (VA. 1941).
- Dissotrocha aculeata* (EHRBG.). (= *Philodina*) Tihany. IV., IX. 1933. Nichtpelagisch (E.—K.—S. 1937). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen und an der Schlammoberfläche (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der schwimmenden *Nuphar*-Blätter (VA. 1944—45).
- Dissotrocha aculeata medioaculeata* (JANSON) (V). Die Bucht von Aszófő. 19. VII. 1939. Im Bewuchs von der *Planorbis*-Schale (VA. 1939).
- Elosa worallii* LORD. Szántód, Balatonboglár. 22. VIII. 1936. Im Hygro- und Eupsammon. Psammobiont (VA. 1938). Zamárdi. 23. VIII. 1938., 29. VII. 1939. Im Psammon. Psammobiont (VA. 1957).
- Encentrum felis* (MÜLL.). Die Bucht von Aszófő. Im Frühjahr und im Sommer. An der Oberfläche des Schlammes (VA. 1939).
- Encentrum grande* (WESTERN). Die Bucht von Aszófő. Im Frühjahr und im Sommer. An der Schlammoberfläche, und im Periphyton an *Phragmites* (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941).
- Encentrum mustela* (MILNE). Zamárdi. 29. VII. 1939. Im Psammon (VA. 1957).
- Encentrum plicatum* (EYFERTH) (V). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Encentrum saundersiae* (HUDSON) (V). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).

- Eosphora najas* EHRBG. Die Bucht von Aszófő. Sommerform. Zwischen Fadenalgen und *Myriophyllum* (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* und an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938. Im Psammon (VA. 1957). (= *E. digitata*) Die Bucht von Aszófő. Im Sommer (VA. 1939). Kis-Balaton. 18. VIII. 1938. Im Plankton und zwischen *Ceratophyllum* (VA. 1944—45). (= *E. digitata*) Siófok. 8. VIII. 1938. Im Psammon (VA. 1957).
- Eothinia elongata* (EHRBG.). (= *Eosphora*) Révfülöp. 5. III. 1926. Im Plankton sehr selten (VA. 1932). Die Bucht von Aszófő. Im Sommer (VA. 1939). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Myriophyllum* und an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Epiphanes brachionus* (EHRBG.). (= *Notops Brachionus*) Badacsonytomaj. 9. VI. 1893., Kereked. 18. VII. 1893., Tihany. 19. VII. 1893., Balatongyörök. 17. VIII. 1893. Im Plankton (D. 1897a). (= *Notops Brachionus*) Im offenen Wasserspiegel (D. 1897b).
- Eretmia trilix* GOSSE? Badacsony. 29. V. 1893 (D. 1897a). An Uferzonentange (D. 1897b). (Vgl. WISZNIEWSKI 1954, p. 127.)
- Erignatha clastopis* (GOSSE). Die Bucht von Aszófő. Vom Frühjahr bis Herbst. Zwischen untertauchten Wasserpflanzen und an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
- Euchlanis deflexa* (GOSSE) (V). Révfülöp, Tihany, Balatonboglár. 1928. Sommerform. Im Plankton (VA. 1932). (= *Dapidia*) Tihany. VII., VIII., IX. 1933. Nichtpelagisch (E.—K.—S. 1937). (= *Dapidia*) Die Bucht von Aszófő. Im Frühjahr und im Herbst. Zwischen *Myriophyllum* (VA. 1939). (= *Dapidia*) Im *Cladophora*-Bewuchs (VA. 1941). (= *Dapidia*) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Euchlanis dilatata* EHRBG. Balaton. 1884., Szántód, Tihany. 18. VI. 1891., Balatonboglár. 19. VI. 1891., Kis-Balaton 1893. In der Uferzone. Alsóörs. 7. VI. 1893., Tihany. 4. VIII. 1893., Balatongyörök. 17. VIII. 1893. 30. IX. 1893. Im Plankton (D. 1897a). Im Plankton und in der sandigen Uferzone (D. 1897b). Im ganzen Jahr. Euplanktisch (N. 1914). Im Plankton häufig (VA. 1932). Tihany. VI., IX. 1933. Sommerform (E.—K.—S. 1937). Zamárdi, Szárszó, Balatonlelle. 22. VIII. 1936. Im Hygropsammon. Psammoxen. Eurytop (VA. 1938). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Maximale Individuenzahl im Sommer. Zwischen Makrovegetation (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton. Zwischen *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45).
- Euchlanis dilatata macrura* EHRBG. (V). (= *E. macrura*) Nur im Plankton. Sommerform (VA. 1932). (= *E. macrura*) Kis-Balaton. 18. VIII. 1938. Im Plankton und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Euchlanis lyra* HUDSON. Die Bucht von Aszófő. 17. VIII. 1936. Zwischen *Ceratophyllum* (VA. 1939).
- Euchlanis oropha* GOSSE. Die Bucht von Aszófő. Im Sommer. Zwischen Pflanzen (VA. 1939). Im *Cladophora*-Bewuchs 1930. Sommerform (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).

- Euchlanis parva* ROUSSELET. Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Pflanzen (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Euchlanis triquetra* EHRLG. (W). Kis-Balaton. 1893. In der Uferzone (D. 1897a). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Pflanzen und Detritus (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen submersen Wasserpflanzen besonders zwischen *Ceratophyllum* (VA. 1944—45). (= *E. pellucida* HARRING) Die Bucht von Aszófő. 9. IV. 1936. (VA. 1939). (= *E. pellucida* HARRING) Kis-Balaton. 18. VIII. 1938. Nur im Plankton (VA. 1944—45).
- Filinia longiseta* (EHRLG.). Kereked. 6. I., IV., 26. V. Im Winter und im Frühjahr. Pelagisch (N. 1914). Révfülöp. 1925—26. Kaltstenotherm. Eupelagisch (VA. 1932). Tihany. III., V. 1933. Kaltwasserbewohnende Art (E.—K.—S. 1937). Tihany. 6., 20. IV., 9. XII. 1936., II., V. 1937. Maximale Individuenzahl in 2 m Tiefe (11. V. 1937.), (11. II. 1938.) (S.—T.—VA. 1951). Nur in eutrophen Wässern (S. 1953).
- Filinia terminalis* (PLATE). (= *F. longiseta terminalis* EHRLG.) Kereked. V. 1902. Sommer und Herbstform (N. 1914). Tihany. III. 1933. Kaltwasserbewohnende Art? (E.—K.—S. 1937). (= *F. longiseta terminalis*) Kis-Balaton. 18. VIII. 1938. Euplanktisch (VA. 1944—45).
- Floscularia conifera* (HUDSON). Die Bucht von Aszófő. 1939. Im Sommer. Zwischen *Myriophyllum* (VA. 1939).
- Floscularia ringens* (LINNE). Keszthely. Zwischen Pflanzen der Uferzone (Potamogeton) (E.—K.—S. 1937).
- Habrotrocha bidens* (GOSSE). Zamárdi. 22. VIII. 1936. In Hygroptammon. Psammoxen (VA. 1938).
- Habrotrocha munda* BRYCE? (V). (= *Callidina elegans* EHRLG.) Die Bucht von Aszófő. Im Bewuchs an *Phragmites* (VA. 1939).
- Habrotrocha roeperi* (MILNE). Die Bucht von Aszófő. Warmstenotherm. An den Zweigen und Blättern von *Myriophyllum* und *Ceratophyllum* und im Detritus (VA. 1939).
- Habrotrocha tridens* (MILNE). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen submersen Wasserpflanzen und an der Schlammoberfläche (VA. 1939). Im *Cladophora*-Bewuchs. Am Ende des Sommers (VA. 1941).
- Habrotrocha* sp. BRYCE (W). (= *Callidina*) Tihany. VIII., IX. 1933. (E.—K.—S. 1937).
- Itura aurita* (EHRLG.). Die Bucht von Aszófő. Im Frühjahr und im Sommer. An den Makrophyten-Blättern, und im Detritus (VA. 1939). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Myriophyllum* (VA. 1944—45).
- Itura viridis* (STENROOS). Die Bucht von Aszófő. 1936. Im Frühjahr und im Sommer (VA. 1938).
- Kellicottia longispina* (KELLCOTT). (= *Notholca*) Révfülöp. 19. VI. 1891., Balatonszentgyörgy, Vonyarc. 20. VI. 1891., Siófok. 20., 24., 30. V. 1893., Keszthely. 22. V., 1. VI. 1893., Siótorok, Szántód. 7. VI. 1893., Balatonakali. 8. VI. 1893., Badaacsonytomaj, Szántód. 9. VI. 1893., Siófok. 22. VI. 1893., Kereked. 18. VII. 1893., Balatonfüred. 28. VIII. 1893., Badaacsony. 29. V. 1893. Im Plankton und in der Nähe des Ufers (D. 1897a). (= *Notholca*) Im offenen Wasserspiegel (D. 1897b). (= *Notholca*) Kereked.

Im ganzen Jahr. Eupelagisch (N. 1914). (= *Notholca*) Im ganzen Jahr. Maximale Entwicklung in kalter Jahreszeit. Pelagisch (VA. 1932). (= *Notholca*) Tihany. 1933. Im ganzen Jahr ausser IX. Monat. Pelagisch. Eurytherm, maximale Entwicklung im Winter (E.—K.—S. 1937). (= *Notholca*) Tihany. 1936. Im ganzen Jahr ausser V. und VII. Monaten. Maximales Vorkommen an der Oberfläche des Wassers (10. X.), in 1 m Tiefe (29. IV.), in 2 m Tiefe (24. II.). 1937. Im ganzen Jahr ausser VI. und VII. Monaten. Maximales Vorkommen an der Oberfläche des Wassers (19. V.), in 1 und 2 m Tiefen (11. V.), in 3 m Tiefe (26. II.). 1938. Im ganzen Jahr ausser VII. und VIII. Monaten. Maximale Individuenzahl an der Oberfläche des Wassers und in allen Tiefen (14. V.) (S.—T.—VA. 1951). Tihany. 2. XII. 1944., 17. V., 20. XII. 1945., IV., VI., VII., XII. 1947. Das Maximum ihres Vorkommens an der Oberfläche des Wassers und in 1 und 2 m Tiefen (3. IV.), in 4 m Tiefe (20. VI.). I—V., VII. 1949. Maximales Vorkommen an der Wasseroberfläche sowie in 2 und 3 m Tiefen (19. I.), in 1 m Tiefe (28. V.). II., III., IV., VI., VIII. 1951. Maximale Individuenzahl in allen Tiefen (17. IV.). Oligosaprob (S. 1953). Glazialrelikte (VA. 1954).

Keratella cochlearis (GOSSE). (= *Anuraea*) Balatonfüred. 20. VII. 1891., Tihany. 11. VII., 30. IX., 3. XI. 1893., Kereked. 18. VII. 1893., Balatonkenese und Alsóörs. 24. VII. 1893., Balatongyörök. 17. VIII. 1893. Im Plankton (D. 1897a). (= *Anuraea*) Im offenen Wasserspiegel (D. 1897b). Im ganzen Jahr. Eupelagisch (N. 1914). Im ganzen Jahr. Die häufigste Art im Balatonsee. Maximale Entwicklung in IV—VII. und VIII—X. Monaten (VA. 1932). Tihany. 1933. Im ganzen Jahr. Eurytherm, in der kälteren Jahreszeit häufiger (E.—K.—S. 1937). Die Bucht von Aszófő. 16. VII. 1935. Euplanktisch, zwischen Wasserpflanzen selten (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Tihany. 1936. Im ganzen Jahr. Maximales Vorkommen an der Wasseroberfläche und in 2 m Tiefe (26. IX.), in 1 m Tiefe (23. X.), in 3 m Tiefe (10. X.) 1937. Im ganzen Jahr. Maximales Vorkommen an der Wasseroberfläche und in 2 m Tiefe (10. XI.), in 1 m Tiefe (4. X.), in 3 m Tiefe (13. IX.). 1938. Im ganzen Jahr. Maximales Vorkommen in 0, 1 und 2 m Tiefen (14. V.), in 3 m Tiefe (25. IX.) (S.—T.—VA. 1951). Diese Angaben der Art *Keratella cochlearis* fassen die verschiedenen Varietäten und Formen. (= *K. stipitata*) Tihany. 2. XII. 1944., 17. V., 20. XII. 1945., IV., VI., VIII., IX—XII. 1947. Maximales Vorkommen an der Wasseroberfläche (12. VIII.), (6. X.) und in 1 m Tiefe (1. IX.), in 2 m Tiefe (3. IV.), in 3 m Tiefe (2. VI.). 1949. Im ganzen Jahr ausser VIII. Monat. Maximales Vorkommen in 1 m Tiefe (19. I.), in 3 m Tiefe (29. VII.). 1951. Im ganzen Jahr. Maximales Vorkommen in 0, 1 und 2 m Tiefen (17. IX.), in 3 m Tiefe (13. VI.). 5. I. 1952. β -meso-, oligosaprob (S. 1953).

Keratella cochlearis hispida (LAUTERBORN). Im Sommer (VA. 1932).

Keratella cochlearis hispida f. *pustulata* LAUTERBORN (V). (VA. 1932).

Keratella cochlearis irregularis (LAUTERBORN). Im Sommer (VA. 1932).

Keratella cochlearis macracantha (LAUTERBORN) (W). Leitform im März (VA. 1932). Diese Form löst den *Keratella cochlearis* in der Winter-fauna ab (S.—T.—VA. 1951).

Keratella cochlearis tecta (GOSSE). (= *Anuraea tecta*) Die Mündung des Sió. 5. XI. 1893 (D. 1897a). (= *Anuraea tecta*) Am sandigen Ufer (D. 1897b).

- Kereked. 18. VI.—23. XI. 1902. Sommer-Herbstform. Eupelagisch (N. 1914). Diese Form löst den *Keratella cochlearis* in der Winterfauna ab. Eupelagisch (VA. 1932). Balatonfüred, Alsóörs, Balatonkenese, Balatongyörök (E.—K.—S. 1937). Im *Cladophora*-Bewuchs (VA. 1941). Sommerform (S.—T.—VA. 1951). (= *K. tecta*) Tihany. 2. XII. 1944., 17. V., 20. XII. 1945., VII—XI. 1947. Maximales Vorkommen an der Oberfläche des Wassers und in 2 m Tiefe (12. VIII.) und in 1 und 3 m Tiefen (1. IX.). I., VI—XII. 1949. Maximales Vorkommen an der Oberfläche des Wassers (27. X.) und (29. XI.) in 1 m Tiefe (20. XII.), in 2 m Tiefe (27. X.), in 3 m Tiefe (29. XI.). III., VI., VII., IX., XI. 1951. Maximales Vorkommen in 0, 1, 2 und 3 m Tiefen (17. IX.) (S. 1953).
- Keratella quadrata* (MÜLL.). (= *Anuraea aculeata* EHRBG.) Siófok. 1884. In der Uferzone. Balatonfüred. 3. XI. 1893., Siófok. 30. V. 1893., Szántód. 7. VI. 1893., Tihany. 4., 17. VII. 1893., Alsóörs. 24. VII. 1893., Kereked. 18. VII. 1893., Balatongyörök. 17. VIII. 1893. Im Plankton (D. 1897a). (= *Anuraea aculeata* EHRBG.) Im offenen Wasser (D. 1897b). Im ganzen Jahr. Eupelagisch (N. 1914). Im ganzen Jahr, in der kalten Jahreszeit häufiger. Eupelagisch (VA. 1932). Tihany. 1933. Im ganzen Jahr. Eurytherm (E.—K.—S. 1937). Die Bucht von Aszófő. Selten (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Tihany. I—IV., VI., IX., X. 1936. Maximales Vorkommen an der Oberfläche des Wassers und in 1 m Tiefen (26. IX.). III—IX. 1937. Die grösste Individuenzahl in 2 m Tiefe (11. V.). IV., V., VI. 1938. Die maximale Individuenzahl in 0, 1, 2 und 3 m Tiefe (14. V.) (S.—T.—VA. 1951). Tihany. 2. XII. 1944., 17. V., 20. XII. 1945., VI., IX., XII. 1947. Die maximale Individuenzahl in 0, 1, 2 und 3 m Tiefen (2. VI.) und (20. VI.). I., II., V., VI. 1949. II., IV., VI., VII., IX. 1951. Die grösste Individuenzahl in allen Tiefen (17. IV.). 5. I. 1952. Nur in eutrophen Wässern (S. 1953).
- Keratella quadrata brevispina* (GOSSE) (W). Im Frühjahr (VA. 1932).
- Keratella quadrata curvicornis* (EHRBG.) (W). (= *Anuraea curvicornis*) Siófok. 1884. In der Uferzone. Tihany. 8. VIII. 1893. Am steinigen Ufer (D. 1897a).
- Keratella quadrata divergens* (V). Im Winter und im Frühjahr. Maximale Individuenzahl in IV. Monat (VA. 1932).
- Keratella quadrata robusta*? In I. Monat (VA. 1932).
- Keratella quadrata testudo* (EHRBG.) (W). (= *Anuraea testudo*) Siófok. 1884. In der Uferzone (D. 1897a). (= *Anuraea testudo*) Am sandigen Ufer (D. 1897b).
- Keratella stipitata* (EHRBG.) (W). (= *Anuraea*) Siófok. 1884. Tihany. 8. VIII. 1893. Am steinigen Ufer (D. 1897a). (= *Anuraea*) In der sandigen Uferzone, zwischen Wasserpflanzen (D. 1897b). Révfülöp. IV. 1927. (VA. 1932). Tihany. VII—IX. 1933. Nur im Sommer? Pelagisch (E.—K.—S. 1937).
- Keratella valga* (EHRBG.). (= *Anuraea*) Kis-Balaton. 1893. In der Uferzone (D. 1897a).
- Lacinularia flosculosa* (MÜLL.). Die Bucht von Aszófő. An den Zweigen und Blättern von *Myriophyllum*, *Ceratophyllum* und von *Hydrocharis* (VA. 1939).
- Lecane aculeata* (JAKUBSKI). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).

- Lecana arcuata* (BRYCE). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Lecane aspasia* MYERS (W). Die Bucht von Aszófő. 16. VII. 1935. Im Detritus an der Oberfläche des Schlammes (VA. 1939).
- Lecane balatonica* (VARGA) (W). (= *Monostyla*) Szárszó, Balatonlelle. 22. VIII. 1936. Im Hygropsammon. Psammobiont (VA. 1938). Zamárdi. 6. IX., 16. X. 1938., 18. II., 29. VII. 1939. Im Psammon. Psammobiont (VA. 1957).
- Lecane bulla* (GOSSE). (= *Monostyla*) Keszthely. 2. VII. 1901. In der Uferzone, aber im Plankton auch (N. 1914). (= *Monostyla*) In der Uferzone (E.—K.—S. 1937). (= *Monostyla*) Die Bucht von Aszófő. Im Frühjahr und im Sommer. Maximale Individuenzahl im Sommer. Zwischen Wasserpflanzen und Detritus. (VA. 1939). (= *Monostyla*) Im *Cladophora*-Bewuchs (VA. 1941). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Im Plankton zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Lecane clara* (BRYCE). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Lecane closterocerca* (SCHMARDA). (= *Monostyla*) Balatonfüred. In der Uferzone. Im seichten Wasser der Röhrichte (E.—K.—S. 1937). (= *Monostyla*) Zamárdi, Szántód, Szárszó. 22. VIII. 1936. Im Hygropsammon. Psammophil (VA. 1938). (= *Monostyla*) Die Bucht von Aszófő. Im ganzen Jahr. Im Winter: an der Oberfläche des Schlammes; im Sommer: zwischen Makrovegetation (VA. 1939). (= *Monostyla*) Im *Cladophora*-Bewuchs (VA. 1941). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der schwimmenden *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII., 6. IX., 16. X. 1938., 18. II., 29. VII. 1939. Im Psammon (VA. 1957).
- Lecane cornuta* (MÜLL.). (= *Monostyla*) Zamárdi, Szántód, Balatonlelle. 22. VIII. 1936. Im Hydro- und Hygropsammon. Psammoxen (VA. 1938). (= *Monostyla*) Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen und im Detritus (VA. 1939). (= *Monostyla*) Im *Cladophora*-Bewuchs. Im Sommer (VA. 1941). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Im Plankton. Zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lecane crenata* (HARRING) (V). (= *Monostyla*) Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen submersen Wasserpflanzen, an der Unterseite der *Hydrocharis*-Blätter, und im Periphyton des *Phragmites* (VA. 1939). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Lecane flexilis* (GOSSE). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen untertauchten Wasserpflanzen (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* und *Ceratophyllum*, sowie an der Unterseite der schwimmenden *Hydrocharis*-Blätter (VA. 1944—45). Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Lecane furcata* (MURRAY). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lecane hamata* (STOKES). (= *Monostyla*) Die Bucht von Aszófő. Im Sommer. Zwischen Wasserpflanzen (VA. 1939). (= *Monostyla*) Kis-Balaton.

18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938. Im Psammon (VA. 1957).
- Lecane ludwigi* ECKSTEIN (V). (= *L. Ludwigii*) Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Lecane luna* (MÜLL.). Die Mündung des Zala. 30. VI. 1901. Im Plankton sehr selten (N. 1914). Révfülp, Tihany. Nichtpelagisch (VA. 1932). Die Bucht von Aszófő. Im Frühjahr und im Herbst. Zwischen *Myriophyllum* und *Ceratophyllum* und im Periphyton des *Phragmites* (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der schwimmenden *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45).
- Lecane luna* f. *balatonica* VARGA. Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Lecane lunaris* (EHRBG.). (= *Monostyla*) Siófok. 1884., 1891. In der Uferzone. Kis-Balaton. 22. V. 1893. Im Röhricht (D. 1897a). (= *Monostyla*) In der sandigen Uferzone (D. 1897b). (= *Monostyla*) Révfülp. Zwischen Pflanzen und im Detritus der Uferzone (VA. 1932). (= *Monostyla*) Tihany. V., IX., XI. 1933. Im Detritus der Uferzone, zwischen Pflanzen (E.—K.—S. 1937). (= *Monostyla*) Szántód, Balatonföldvár, Balatonlelle. Im Psammon, Psammoxen (VA. 1938). (= *Monostyla*) Die Bucht von Aszófő. Im ganzen Jahr (VA. 1939). (= *Monostyla*) Im *Cladophora*-Bewuchs. Im Sommer (VA. 1941). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45). Zámárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Lecane myriophylli* (VARGA). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Lecane nana* (MURRAY). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lecane pyriformis* (DADAY). (= *Monostyla*) Die Bucht von Aszófő. 6. IV. 1936. Im Detritus (VA. 1939). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Myriophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lecane quadridentata* (EHRBG.). (= *Monostyla*) Die Bucht von Aszófő. Im Sommer (VA. 1939). (= *Monostyla*) Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Lecane scutata* (HARRING—MYERS) (V). Zámárdi. 29. VII. 1939. Im Psammon (VA. 1957).
- Lecane stenroosi* (MEISSNER). (= *Monostyla*) Die Bucht von Aszófő. VII. 1939. Zwischen *Myriophyllum* (VA. 1939).
- Lecane sympoda* HAUER (V). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lecane tenuiseta* HARRING. Siófok. 8. VIII. 1938. In Psammon (VA. 1957).
- Lecane unguolata* (GOSSE). (= *Cathypna*) Kis-Balaton. 1893. In der Uferzone (D. 1897a). Die Bucht von Aszófő. 9. IV. 1936. An der Schlammoberfläche (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum*

- und *Myriophyllum*, im Detritus an der Oberfläche des Schlammes (VA. 1944—45).
- Lepadella acuminata* (EHRBG.). Die Bucht von Aszófő. 1935. Sommerform. Euryök. (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Lepadella cristata* (ROUSSELET). Kis-Balaton. 18. VIII. 1938. Nur im Plankton (VA. 1944—45).
- Lepadella ovalis* (MÜLL.). (= *Metopidia Lepadella* EHRBG.) Tihany. 18. VI. 1891. In der Uferzone. (= *L. o.* EHRBG.) Kis-Balaton. 22. V. 1893. In Röhricht (D. 1897a). (= *Metopidia Lepadella* EHRBG.) Zwischen Pflanzen der Uferzone (D. 1897b). Tihany. IV., VI., VIII., IX., X. 1933. Sommerform (E.—K.—S. 1937). Szárszó, Balatonlelle. 22. VIII. 1936. Im Psammon. Psammoxen, eurytop (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr, maximale Individuenzahl im Sommer. An den Zweigen und Blättern der Pflanzen, und an der Schlammoberfläche (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* und an der Unterseite der *Nuphar* Blätter (VA. 1944—45). (= *L. oblonga* EHRBG.) Kereked. 22. II. 1902. Nichtpelagisch (N. 1914). (= *L. oblonga* EHRBG.) Die Bucht von Aszófő. Im ganzen Jahr, maximale Entwicklung im Sommer. Zwischen Makrovegetation, an der Schlammoberfläche, im Tripton, im Periphyton des *Phragmites*, und an der Unterseite der *Hydrocharis*-Blätter (VA. 1939). (= *L. oblonga* EHRBG.) In der Uferzone (E.—K.—S. 1937). (= *L. oblonga* EHRBG.) Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45). (= *L. oblonga* EHRBG.) Siófok. 8. VIII. 1938., Zamárdi. 23. VIII., 6. IX. 1938. Im Psammon (VA. 1957).
- Lepadella patella* (MÜLL.). Szántód, Balatonlelle, Balatonboglár. 22. VIII. 1936. Im Hygropsammon. Psammoxen, eurytop (VA. 1938). Tihany. Im *Cladophora*-Bewuchs der Steine. Im Frühjahr und im Sommer (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII., 6. IX. 1938., 18. II. 1939. Im Psammon (VA. 1957).
- Lepadella patella similis* (LUCKS). (= *L. similis*) Die Bucht von Aszófő. Im Frühjahr und im Sommer. Im Detritus (VA. 1939). (= *L. similis*) Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lepadella quinquecostata* (LUCKS). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Lepadella rhomboides* (GOSSE). Die Bucht von Aszófő. Im Sommer. Zwischen Detritus und an den Blättern von *Hydrocharis* (VA. 1939). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Lepadella triptera* EHRBG. Die Bucht von Aszófő. Im Winter und im Sommer. Maximales Vorkommen im Sommer (VA. 1939). Kis-Balaton. 18. VIII. 1938. Im Plankton, zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Limnias ceratophylli* SCHRANK. Die Bucht von Aszófő. An den Zweigen und Blättern von *Ceratophyllum* (VA. 1939).
- Limnias ceratophylli sphagnicola* ZACHARIAS. Die Bucht von Aszófő. Nur an *Myriophyllum* (VA. 1939).

- Limnias melicerta* WEISSE. Im seichten Wasser der Röhrichte (*Ceratophyllum*) (E.—K.—S. 1937). Die Bucht von Aszófő. Im Sommer. An faulenden Blättern von *Phragmites* (VA. 1939).
- Lophocaris oxysternon* (GOSSE). Die Bucht von Aszófő. Im ganzen Jahr, häufigeres Vorkommen in der kühlen Jahreszeit. Zwischen Wasserpflanzen, im Periphyton des *Phragmites* und im Detritus (VA. 1939). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Lophocaris salpina* (EHRBG.). Die Bucht von Aszófő. Im Sommer (VA. 1939).
- Mniobia tetraodon* (EHRBG.). Die Bucht von Aszófő. 3. I. 1936. Zwischen Wassermoosen. Kaltwasserbewohnende Art (VA. 1939).
- Monommata astia* MYERS. Die Bucht von Aszófő. 19. VI. 1939. Im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
- Monommata grandis* TESSIN. Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen und im Periphyton des *Phragmites* (VA. 1939).
- Monommata longiseta* (MÜLL.). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen, an der Oberfläche des Schlammes, sowie im Bewuchs an einer lebenden *Planorbis* (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum*, an der Unterseite der *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45).
- Mytilina bicarinata* (PERTY) (V). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen *Myriophyllum* und *Ceratophyllum* (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Mytilina mucronata* (MÜLL.). (= *Salpina* EHRBG.) Tihany. 17. VII. 1893. Im Plankton (D. 1897a). (= *Salpina* EHRBG.) Im freien Wasserspiegel (D. 1897b). Révfülöp. IX. 1926. Im Plankton selten (VA. 1932). In der Uferzone (E.—K.—S. 1937). Die Bucht von Aszófő. Frühjahrs- und Sommerform. Zwischen Pflanzen (VA. 1939). Im *Cladophora*-Bewuchs. Im Sommer (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton und an *Nuphar*-Blättern (VA. 1944—45).
- Mytilina mucronata spinigera* (EHRBG.). (= *M. spinigera*) Die Bucht von Aszófő. 19. VII. 1939. Im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
- Mytilina trigona* (GOSSE). Die Mündung des Zala. 30. VI. 1901. In der Uferzone (N. 1914).
- Mytilina ventralis* (EHRBG.). Révfülöp. 10. XI. 1926. (VA. 1932). Die Bucht von Aszófő. Im Sommer und im Herbst. Zwischen Pflanzen und an der Schlammoberfläche (VA. 1939). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Mytilina ventralis brevispina* (EHRBG.). Die Bucht von Aszófő. In Sommer. Zwischen Pflanzen, an der Unterseite der *Hydrocharis*-Blätter und im Periphyton des *Phragmites* (VA. 1939). Kis-Balaton. 18. VIII. 1938. Im Plankton (VA. 1944—45).
- Notholca acuminata* (EHRBG.) (V). Tihany. 30. III. 1893. Im Plankton (D. 1897a). Im freien Wasserspiegel (D. 1897b). (= *N. striata acuminata*) XII—III. Winter-, Frühjahrsform. Eupelagisch (N. 1914). Révfülöp, Kenese, Tihany, Fonyód. Nur in der Wintersaison. Kaltstenotherm. Euplanktisch (VA. 1932). Tihany. I—IV., XII. 1933. Pelagisch. Winter-

- form (E.—K.—S. 1937). Die Bucht von Aszófő. 3. I., 9. IV. 1936. Selten. Kaltstenotherm (VA. 1939).
- Notholca foliacea* (EHRBG.) (W). Kereked. IV. Winter-, Frühjahrsform. Eupelagisch (N. 1914). Révfülöp. IV. 1927. Pelagisch (VA. 1932). Tihany. III., IV. 1933. Im Frühjahr? Pelagisch (E.—K.—S. 1937). Die Bucht von Aszófő. Winter-, Frühjahrsform. Im Detritus pflanzlicher Herkunft, an der Oberfläche des Schlammes (VA. 1939). (= *N. heptodon* PERTY) (W) Die Bucht von Aszófő. 3. I. 1936. Kaltstenotherm.
- Notholca striata* (MÜLL.). (= *N. s.* EHRBG.) II., III., XII. Im Winter und im Frühjahr. Eupelagisch (N. 1914).
- Notholca squamula* (MÜLL.). (= *Notholca striata* (MÜLL.)) Die vorige Art, ist wahrscheinlich ein Synonym mit dieser (VA. 1951, p. 84.). (= *N. striata*) XI—IV. Kaltstenotherm. Eupelagisch (VA. 1932). (= *N. striata*) I—III., XI., XII. 1933. Pelagisch (E.—K.—S. 1937). (= *N. striata*) Die Bucht von Aszófő. Winter- und Frühjahrsform (VA. 1939). (= *N. striata*) Im *Cladophora*-Bewuchs. Im Sommer sehr selten (VA. 1941). Tihany. I—III., X—XII. 1936. Maximale Individuenzahl in 1, 2, 3 m Tiefen (9. XII.). I—III., XII. 1937. Maximale Individuenzahl in 2 m Tiefe (7. I.). II—IV., XII. 1938. Kaltstenotherm (S.—T.—VA. 1951). Tihany. 3. IV., 6. X., 10. XII. 1947., 19. I. 1949., 6. III., 5. XI. 1951., 5. I. 1952 (S. 1953). Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Notommata aurita* (MÜLL.). Die Bucht von Aszófő. Im Sommer. Zwischen untertauchten Pflanzen, und an der Oberfläche des Schlammes (VA. 1939). Tihany. VIII. 1938. Im *Cladophora*-Bewuchs der Steine (VA. 1941).
- Notommata cerberus* (GOSSE). Die Bucht von Aszófő. Im Periphyton an *Phragmites* und im Detritus (VA. 1939). Tihany. In *Cladophora*-Bewuchs der Steine (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* (VA. 1944—45).
- Notommata contorta* (STOKES). Die Bucht von Aszófő. 9. IV. 1936. Im Periphyton an *Phragmites* (VA. 1939).
- Notommata copeus* EHRBG. (= *N. centrura*) Kis-Balaton. 1893. (D. 1897a).
- Notommata cyrtopus* GOSSE. (= *N. c.* EHRBG.) Die Bucht von Aszófő. Im Sommer. Im Detritus an der Oberfläche des Schlammes sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1939). Siófok. Im *Cladophora*-Bewuchs des sandigen Ufers. Tihany. Im *Cladophora*-Bewuchs der Steine (VA. 1941).
- Notommata pseudocerberus* DE BEAUCHAMP. Die Bucht von Aszófő. Im Sommer. Warmstenotherm. Zwischen submersen Wasserpflanzen, an der Schlammoberfläche und im Periphyton an *Phragmites* (VA. 1939). Tihany. Im *Cladophora*-Bewuchs der Steine. Im Sommer (VA. 1941).
- Notommata pygmaea* HARRING—MYERS (W). Die Bucht von Aszófő. An der Oberfläche des Schlammes (VA. 1939).
- Notommata saccigera* EHRBG. Die Bucht von Aszófő. Sommerform. Zwischen Wasserpflanzen (VA. 1939).
- Notommata tripus* EHRBG. Die Bucht von Aszófő. Im Sommer. Zwischen Wasserpflanzen, an der Oberfläche des Schlammes, und an der Unterseite der *Hydrocharis*-Blätter (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Pedalia mira* (HUDSON). Tihany. 28. VII. 1929. Rein planktisch (VA. 1932). Tihany. VII., VIII. 1933. Pelagisch. Sommerform? (E.—K.—S. 1937).

- Philodina citrina* EHRBG. Tihany. Balatonfüred. VII. 1929. Im Plankton selten (VA. 1932). Zamárdi, Balatonlelle, Balatonboglár, Fonyód. Im Eupsammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr, im Sommer häufiger. Zwischen submersen Wasserpflanzen, im Detritus an der Schlammoberfläche sowie an Makrovegetation (VA. 1939). Im *Cladophora*-Bewuchs. Im Frühjahr und im Herbst (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und *Myriophyllum* sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938. Im Psammon (VA. 1957).
- Philodina erythrophthalma* EHRBG. Balatonboglár. 13. VII. 1893. In der Uferzone. Tihany. 16. VIII. 1893. Am röhrigen Ufer. Kis-Balaton. VIII. 1893. (D. 1897a). Im sandigen Ufer (D. 1897b).
- Philodina megalotrocha* EHRBG. Siófok. 1884. In der Uferzone (D. 1897a). Im sandigen Ufer (D. 1897b). Tihany, Balatonfüred. VII. 1929. In der Uferzone (VA. 1932). Tihany. III., VIII., IX. 1933. In der Uferzone (E.—K.—S. 1937). Zamárdi, Szántód, Szárszó, Balatonszemes. Im Psammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. 3. I. 1936 und im Sommer. Im Detritus an der Oberfläche des Schlammes (VA. 1939). Im *Cladophora*-Bewuchs. Sommerform (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Philodina roseola* EHRBG. Litoralbewohner (E.—K.—S. 1937). Szántód, Balatonlelle, Balatonboglár, Fonyód. Im Psammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im Winter und im Sommer. Zwischen untertauchten Wasserpflanzen, an der Schlammoberfläche und an der Unterseite der *Hydrocharis*-Blätter (VA. 1939). Siófok. Im *Cladophora*-Bewuchs des sandigen Ufers. Tihany. Im *Cladophora*-Bewuchs der Steine. Frühjahrs-, Sommerform (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum*, sowie an der Unterseite der *Nuphar*- und *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938., 18. II. 1939. Im Psammon (VA. 1957).
- Platyias quadricornis* (EHRBG.). Kereked. 1. IX. 1901. (N. 1914). Die Bucht von Aszófő. VII. 1935., VII. 1939. Typische Sommerform. Zwischen Wasserpflanzen, im Detritus an der Oberfläche des Schlammes und im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
- Pleurotrocha petromyzon* EHRBG. In der Uferzone. An Zoothamnien-Kolonien (E.—K.—S. 1937). Die Bucht von Aszófő. Im ganzen Jahr. An Wasserpflanzen, sowie im Detritus an der Oberfläche des Schlammes (VA. 1939). Im *Cladophora*-Bewuchs. Im Sommer (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Pleurotrocha robusta* (GLASCOTT) (W). Die Bucht von Aszófő. Nur im Sommer. Zwischen Pflanzen, im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
- Ploesoma hudsoni* (IMHOF) (V) Tihany, Siófok. VII. 1925—26. Eupelagisch (VA. 1932). Tihany. VII—IX. 1933. Sommerform? Pelagisch (E.—K.—S. 1937).
- Polyarthra dolichoptera* f. *aptera* HOOD (V). (= *Anarthra aptera* HOOD) Tihany. 22. VII. 1929. Eupelagisch (VA. 1932). (= *Anarthra aptera* HOOD) Tihany. VII., VIII. 1933. Sommerform? (E.—K.—S. 1937).

- Polyarthra vulgaris* CARLIN. (= *P. platyptera* EHRBG.) Siófok. 21. V., 5. XI. 1893., Tihany. 21. V., 17. VII., 2. VIII. 1893., Balatongyörök. 17. VIII. 1893., Balatonakali. 3. VIII. 1893. In der Uferzone und im Plankton (D. 1897a). (= *P. platyptera* EHRBG.) Im offenen Wasser (D. 1897b). (= *P. trigla* EHRBG.) Im ganzen Jahr. Eupelagisch (N. 1914). (= *P. trigla* EHRBG.) Im ganzen Jahr. Eupelagisch (VA. 1932). (= *P. trigla* EHRBG.) Tihany. Im ganzen Jahr. Eurytherm, maximale Entwicklung im Sommer (E.—K.—S. 1937). (= *P. trigla* EHRBG.) Balatonboglár. 22. VIII. 1936. Im Hydropsammon. Psammoxen (VA. 1938). (= *P. trigla* EHRBG.) Kis-Balaton. 18. VIII. 1938. Im Plankton und zwischen *Ceratophyllum* (VA. 1944—45). (= *P. trigla* EHRBG.) Tihany. IV—XII. 1936. Maximales Vorkommen in 0 und 1 m Tiefen (7. VIII.), in 2 und 3 m Tiefen (26. IX.). 1937. Im ganzen Jahr ausser III. und IV. Monaten. Die grösste Individuenzahl an der Oberfläche des Wassers und in 3 m Tiefe (16. VII.), in 1 und 2 m Tiefen (23. VII.). 1938. Im ganzen Jahr. Maximales Vorkommen an der Oberfläche des Wassers (21. VIII.), in 1 m Tiefe (19. XI.), in 2 m Tiefe (19. VIII.) (S.—T.—VA. 1951). (= *P. trigla* EHRBG.) β -mesosaprob, oligosaprob (S. 1953).
- Polyarthra* sp. Tihany. 17. V. 1945. IV—XII. 1947. Maximale Individuenzahl an der Oberfläche des Schlammes (2. VI.), in 1 und 4 m Tiefen (20. VI.), in 2 m Tiefe (8. VII.). I., V—VIII., X—XII. 1949. Maximales Vorkommen in 1, 2, 3 m Tiefen (20. XII.). VI—IX., XI. 1951. Die grösste Individuenzahl an der Oberfläche des Wassers (21. VIII.), in 1 und 3 m Tiefen (13. VII.), in 2 m Tiefe (17. IX.) (S. 1953).
- Pompholyx complanata* GOSSE. Tihany. 7. VIII. 1893. In der Uferzone. Balatongyörök. 17. VIII. 1893. Im Plankton (D. 1897a). In der Uferzone und im offenen Wasser (D. 1897b). Kereked. 28. IV., 14. XI. 1902. Sommer-, Herbstform. Eupelagisch (N. 1914). Im ganzen Jahr ausser Winter. Eupelagisch (VA. 1932). Tihany. V—X. 1933. Sommerform. Eupelagisch (E.—K.—S. 1937). Die Bucht von Aszófő. VII. 1935. Im Plankton (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Tihany. 17. VI., 28. VIII. 1936., 14. V., 20. VI. 1938. Warmstenotherm (S.—T.—VA. 1951). Mesosaprob (S. 1953).
- Pompholyx sulcata* HUDSON. Tihany. 1893. In der Uferzone (D. 1897a). In der Uferzone (D. 1897b). Révfülöp. Vom Frühjahr bis Herbst, maximales Vorkommen im Sommer. Eupelagisch (VA. 1932). Tihany. IV—X. 1933. Sommerform. Pelagisch (E.—K.—S. 1937). Im *Cladophora*-Bewuchs. 1930 (VA. 1941). Tihany. 1936. Im ganzen Jahr ausser III. und IV. Monaten. Die grösste Individuenzahl an der Oberfläche des Wassers und in 1 m Tiefe (17. VI.), in 2 und 3 m Tiefen (28. VIII.). V—XI. 1937. Maximales Vorkommen in 0, 1, 2 und 3 m Tiefen (16. VII.). 1938. Im ganzen Jahr, ausser I., II. und XII. Monaten. Maximale Individuenzahl 0, 1, 2 und 3 m Tiefen (21. VII.). Warmstenotherm (S.—T.—VA. 1951). Oligosaprob (?) (S. 1953). Zamárdi. 16. X. 1938. Im Psammon (VA. 1957).
- Pompholyx* sp. Tihany. 17. V. 1945., VI., VIII—X. 1947. Maximales Vorkommen an der Oberfläche des Wassers und in 2 m Tiefe (12. VIII.), in 3 m Tiefe (1. IX.). IV—VI., VIII—X. 1949. Maximales Vorkommen in 0, 1, 2 und 3 m Tiefen (3. IX.). VI—IX. 1951. Maximale Individuenzahl in 0, 1 und in 3 m Tiefen (17. IX.), in 2 m Tiefe (21. VIII.) (S. 1953).

- Proales brevipes* HARRING—MYERS. Die Bucht von Aszófő. 17. VIII. 1936., 20. VII. 1939. Zwischen *Ceratophyllum* und an der Oberfläche des Schlammes (VA. 1939).
- Proales decipiens* (EHRBG.). Die Bucht von Aszófő. Im Winter und auch im Sommer. Zwischen Pflanzen (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Proales minima* (MONTET). Balatonlelle. 22. VIII. 1936. Im Hygropsammon. Eurytop. Psammoxen (VA. 1938). Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Proales similis* de BEAUCHAMP. Die Bucht von Aszófő. 1936. Im Sommer. Zwischen Pflanzen (VA. 1939).
- Proales wernecki* (EHRBG.). (= *P. werneckii*) Die Bucht von Aszófő. Im Winter: im Detritus an der Oberfläche des Schlammes; im Frühjahr: zwischen Wassermoosen und im Periphyton an *Phragmites*; im Sommer: zwischen untertauchten Wasserpflanzen (VA. 1939). Tihany. VIII. 1938. Im *Cladophora*-Bewuchs der Steine (VA. 1941).
- Ptygura brevis* (ROUSSELET). Die Bucht von Aszófő. An *Myriophyllum* (VA. 1939). Kis-Balaton. 18. VIII. 1938. An der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45).
- Ptygura crytallina* (EHRBG.). Die Bucht von Aszófő. An *Myriophyllum* und an *Ceratophyllum*. Sowie am Schilfrohr, an der Unterseite der *Hydrocharis*-Blätter und im Detritus (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941).
- Ptygura stygis* (GOSSE). Die Bucht von Aszófő. An Wasserpflanzen meist an den Blättern von *Ceratophyllum* (VA. 1939).
- Ptygura tihanyensis* VARGA. Die Bucht von Aszófő. An *Ceratophyllum* (VA. 1939).
- Rotaria citrina* (EHRBG.). (= *Rotifer citrinus*) Die Mündung des Sió. 1884. In der Uferzone (D. 1897a). (= *Rotifer citrinus*) In der sandigen Uferzone (D. 1897b). Im Plankton selten (VA. 1932). In der Uferzone (E.—K.—S. 1937). Balatonboglár, Balatonlelle, Fonyód. 22. VIII. 1936. Im Psammon, Psammoxen (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr, maximales Vorkommen im Sommer. Zwischen Pflanzen, am Schilfrohr, an der Oberfläche des Schlammes (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Zamárdi. 23. VIII., 16. X. 1938., 18. II. 1939. Im Psammon (VA. 1957).
- Rotaria elongata* (WEBER). Die Bucht von Aszófő. Im ganzen Jahr. An Pflanzen, im Periphyton an *Phragmites* (VA. 1939). Im *Cladophora*-Bewuchs der Steine. Im Frühjahr und im Herbst (VA. 1941).
- Rotaria macroceros* (GOSSE). Die Bucht von Aszófő. 16. VII. 1935. Im Periphyton an *Phragmites* (VA. 1939). Tihany. Im Sommer. Im *Cladophora*-Bewuchs der Steine (VA. 1941).
- Rotaria macrura* (EHRBG.). Die Bucht von Aszófő. 9. IV. 1936., 19. VII. 1939. Im Bewuchs an der Unterseite der *Hydrocharis*-Blätter, sowie an der Oberfläche des Schlammes (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* (VA. 1944—45).
- Rotaria rotatoria* (PALLAS). (= *Rotifer vulgaris* EHRBG.) Siófok. 1884. In der Uferzone., Sió-kanal. 1. VI. 1893., Tihany. 2. VII. 1893. Am röhrigen Ufer., Kis-Balaton. VIII. 1893 (D. 1897a). (= *Rotifer vulgaris* EHRBG.)

- In der sandigen Uferzone (D. 1897b). In der Uferzone (E.—K.—S. 1937). Balaton. 22. VIII. 1936. Im Psammon. Psammoxen (VA. 1938). Die Bucht von Aszófő. Im ganzen Jahr, maximale Individuenzahl im Sommer. Zwischen Makrovegetation, an Blättern der Pflanzen, sowie an der Schlammoberfläche (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum* und an der Unterseite der *Hydrocharis*-Blätter (VA. 1944—45). Siófok. 8. VIII. 1938., Zamárdi. 23. VIII. 1938., 18. II. 1939. Im Psammon (VA. 1957).
- Rotaria tardigrada* (EHRBG.). Im Tripton, zwischen Pflanzen (VA. 1932). Tihany. III., IV., VII—IX. 1933. Am schwimmenden Detritus pflanzlicher Herkunft (E.—K.—S. 1937). Die Bucht von Aszófő. Im ganzen Jahr, maximale Individuenzahl im Sommer. Im Detritus an der Oberfläche des Schlammes (VA. 1939). Im *Cladophora*-Bewuchs. Sommerform (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Ceratophyllum*, *Myriophyllum* und an der Unterseite der *Nuphar*-Blätter (VA. 1944—45). Balatonalmádi. 5. VIII. 1938., Zamárdi. 18. II. 1939. Im Psammon (VA. 1957).
- Scaridium longicaudum* (MÜLL.). Tihany. VIII. 1933. Pelagisch (E.—K.—S. 1937). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Makrovegetation und im Detritus an der Oberfläche des Schlammes (VA. 1939). Tihany. Im *Cladophora*-Bewuchs der Steine (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton. Zwischen *Ceratophyllum* und *Myriophyllum*, sowie an der Unterseite der *Nuphar*-Blätter (VA. 1944—45).
- Sinantherina socialis* (LINNÉ). (= *Megalotrocha alboflavicans* EHRBG.) Die Bucht von Aszófő. 1929. An *Myriophyllum* (VA. 1939).
- Squatinella geleii* VARGA. Balaton. Im Sommer. In der Uferzone. Warmstenotherm (VA. 1933).
- Squatinella lamellaris* (MÜLL.) (W). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Wasserpflanzen, im Detritus an der Oberfläche des Schlammes (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Squatinella longispinata* (TATEM). Die Bucht von Aszófő. 9. IV. 1936. Frühjahrsform (VA. 1939).
- Squatinella mutica* (EHRBG.) (W). Die Bucht von Aszófő. Im Frühjahr und im Sommer. Zwischen Pflanzen, im Detritus und im Bewuchs an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
- Squatinella tridentata* (FRESENIUS) (V). Die Bucht von Aszófő. 9. IV. 1936., 19. VII. 1939. Zwischen submersen Wasserpflanzen und im Periphyton am *Phragmites* (VA. 1939). (= *S. intermedia* BURN.) Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Synchaeta kitina* ROUSSELET. Die Bucht von Aszófő. 9. IV. 1936. Im Plankton (VA. 1939).
- Synchaeta longipes* GOSSE. Die Bucht von Aszófő. 3. I. 1936. Im Plankton. Kaltstenotherm (VA. 1939).
- Synchaeta oblonga* EHRBG. Kühl- und kaltwasserbewohnende Art. Eupelagisch (VA. 1932). Tihany. II—IV., XII. 1933. Im Winter. Pelagisch (E.—K.—S. 1937). Die Bucht von Aszófő. 9. IV. 1936 (VA. 1939). Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Im Plankton (VA. 1944—45). Tihany. 26. IX. 1936., V—VII. 1937., 19. VIII. 1938. In eutrophen Wässern (S.—T.—VA. 1951).

- Synchaeta pectinata* EHRBG. Kereked. IV. 1902. Sommer- und Herbstform. Eupelagisch (N. 1914). Tihany. XII. 1928. Kaltwasserbewohnende Art. Eupelagisch (VA. 1932). Tihany. III., IV., XII. 1933. Winterform (E.—K.—S. 1937). Die Bucht von Aszófő. Im Winter. Im Plankton. Kaltstenotherm (VA. 1939). Tihany. 23. X., 18. XII. 1936. Kaltwasserbewohnende Art (S.—T.—VA. 1951).
- Synchaeta tremula* (MÜLL.). Im Sommer auch häufig. Maximales Vorkommen in IV. Monat. Pelagisch (VA. 1932). Die Bucht von Aszófő. Im Winter und im Frühjahr. Eupelagisch (VA. 1939).
- Taphrocampa annulosa* GOSSE. Die Bucht von Aszófő. 17. VIII. 1936. An der Oberfläche des Schlammes (VA. 1939). Tihany. Im *Cladophora*-Bewuchs (VA. 1941). Kis-Balaton. 18. VIII. 1938. Zwischen *Myriophyllum* (VA. 1944—45).
- Testudinella clypeata* (MÜLL.). Die Bucht von Aszófő. VII. 1935., VII. 1939. Manchmal epizoisch an jungen Asellus und an Aedes-Larven (VA. 1939).
- Testudinella elliptica* (EHRBG.). Die Bucht von Aszófő. Manchmal an Aedes- und anderen Insecten-Larven (VA. 1939).
- Testudinella incisa* (TERNETZ). Die Bucht von Aszófő. Im ganzen Jahr. Zwischen Wasserpflanzen und im Detritus an der Oberfläche des Schlammes (VA. 1939).
- Testudinella mucronata* (GOSSE) (V). Die Bucht von Aszófő. Im Sommer. Im Bewuchs an *Phragmites*, sowie an der Unterseite der *Hydrocharis*-Blätter (VA. 1939).
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A BALATON KEREKESHÉREG (ROTATORIA) FAUNÁJA AZ 1897—1960. ÉV IRODALMI ADATAI ALAPJÁN

Összefoglalás

P.-Zánkai Nóra

A szerző, az 1897—1960. évek között megjelent irodalom alapján összefoglalja a Balatonból kimutatott Rotatoria fajokat. A felsorolt 256 faj, varietas, ill. forma mind-egyikéhez rövid ökológiai és tavi elterjedéssel kapcsolatos megjegyzéseket fűz. A Balaton planktonjában nagy egyedszámban előforduló fajok és formák esetében — melyek hal-táplálék szempontjából is jelentősek — feltünteti a mélységbeli rétegződésre vonatkozó adatokat is.

ФАУНА КОЛОВРАТОК ОЗЕРА БАЛАТОН НА ОСНОВЕ ЛИТЕРАТУРНЫХ ДАННЫХ с 1897 ГОДОВ ПО 1960 ГОДУ

Нора П.—Занкай

Автор перечисляет виды коловраток, найденных в озере Балатон по литературным данным в 1897—1960 годах. Дается краткое описание распространения и экологии всех 256 перечисленных видов, разновидностей и форм. Для наиболее распространенных видов планктона озера Балатон, которые играют роль в питании рыб, приводится также их глубинное распределение.

CHRONICLE

In 1967 two Department functioned in the Institute. The research program is part of a 3 years' research plan. Due to this plan the *Department of Experimental Zoology* performed comparative neurobiological investigations on Invertebrates. Lamellibranchs and Gastropods were investigated with physiological, morphological and biochemical methods following the principle of complexity.

The *Department of Hydrobiology* continued the investigation of plankton and benthos as well as of the problems of nutrition biology and metabolism of different water organisms. These works were carried out in collaboration with other institutions.

Dr. OLGA SEBESTYÉN retired head of the Department of Hydrobiology continued her work on the theme „Lake history studies on microfossils of Lake Balaton sediments”.

Results of the work performed by the scientists of the two Departments were published partly in *Annal. Biol. Tihany* **35**, and partly in different Hungarian and foreign journals. Besides the publications also the meetings held in the Institute provided wide publicity in presenting the scientific endeavours of this institution (see Meetings).

The Institute's permanent staff was in 1967: 54 workers (total), divided as follows: 19 scientific research workers, 20 technical assistants, 6 administrative and 9 other workers.

During the year the following changes took place in the scientific staff: dr. T. PÉCSI scientific research worker left for Tiszántúli Vízügyi Igazgatóság (Debrecen) on the 1st July, 1967; J. JÁRAI electroengineer on the 1st September 1967 for the Laboratory for the Research of Chemical Structures of the Hungarian Academy of Sciences (Szeged). I. KISS biologist-chemist on the 1st August 1967 and M. VÉRO electroengineer on the 15th September, 1967 were posted to the Department of Experimental Zoology.

Inland study trips

K. BIRÓ has been for 2 months in the ELTE Zoological Collection, Budapest,

J. OLÁH stayed for 6 months in the Institute of Soil Research and Agrochemistry, Budapest.

Travels abroad

dr. S.-RÓZSA, K. spent 1 month (March, 1967) in the Soviet Union,
 dr. J. SALÁNKI attended the IX. Conference of the Society for Biological Rhythms, held in Wiesbaden (GFR), in April 1967.

T. FARKAS worked following a private invitation 2 weeks in Berlin in July (GDR).

dr. I. ZS.-NAGY was for 1 month on a study trip in the CSSR in October, 1967.

J. OLÁH left for a 6 months stay in Borok (Soviet Union) in October, 1967.

dr. E. LÁBOS left in November 1967 for 8 months for France.

Visiting scientists from inland and abroad

Also in 1967 several investigators worked for variable length of time in the Institute:

D. A. SAKHAROV, Moscow, Institute for Developmental Biology,
 MARIE LUISE ALBRECHT, Berlin (GDR), Institute für Fischerei,
 J. MÄRILAINEN Finland, Scholarship of the Finn-Hungarian Cooperation,

E. LOZADA, Chile, UNESCO scholarship,

L. RIBAK, Soviet Union,

B. GLAIZNER, England, University of Southampton,

Dr. GY. ÁDÁM, Budapest, Eötvös Loránd University,

Dr. F. BICZÓK, Szeged, József Attila University,

Dr. B. CSILLIK, Szeged, University Medical School,

Dr. M. GARAMVÖLGYI, Pécs, University Medical School,

Dr. Z. KÁDÁR, Debrecen, Kossuth Lajos University,

Dr. I. TÖRŐ Jr. Budapest, University Medical School,

Dr. G. MAKARA, Budapest, Institute for Experimental Medicine,

Dr. L. NAGY, Pécs, University Medical School,

Mrs. KOVÁCS, M. ÉVA, Á. MATSKÁSI, F. MÉSZÁROS, Budapest, ELTE Zoological Collection,

Dr. G. UHERKOVICH, Szeged, Station for Tisza Research,

A. BOTHÁR, Budapest, Station for Duna-Research,

L. NEDELKOVICS, Keszthely, Academy of Agriculture.

Besides the above recounted scientists more than 200 guests from Hungary and from abroad visited the Institute.

During the summer months 8 Hungarian and 2 university students from abroad joined the Institute's work for 3–4 weeks.

Meetings

In the course of 1967 five important meetings were held in the Institute:

1. Between the 28th–31st August, 1967 the *first International Symposium on Paleolimnology* of the SIL Symposia Series. More than 70 participants from 20 countries attended the Symposium. The Chairman of the International Organizing Committee was Prof. D. G. FREY (U.S.A.). The local Chairman of the Organizing Committee was dr. O. SEBESTYÉN, one of the

Vice Presidents of SIL. The proceedings of the meeting will be published in the Mitteilungen series of the International Association of Limnology (T. T. MACAN, Secretary).

2. On the 2nd September *commemoration meeting* at the 40 anniversary of the Institute. Participants were the Vice President of the Hungarian Academy of Sciences, the Biological Department and its Institutes, the invited guests of the public life, former members and friends of the Institute and the present staff. Professor Dr. F. VERZÁR (Institute für Gerontologie, Basel) the first director of the Institute also spoke at this occasion.

3. Between the 4th—7th September the *Symposium on Neurobiology of Invertebrates* with 32 participants from abroad and with 15 scientists from Hungary. The Symposium was sponsored by the Biological Department of the Hungarian Academy of Sciences, presided by Dr. J. SZENTÁGOTHAÍ, academician, and organized by dr. J. SALÁNKI, director of the Institute. The material will be published as a joint addition of Plenum Press (New York) and Akadémiai Kiadó (Budapest) under the title: Neurobiology of Invertebrates.

4. Between 26th—30th September a *Colloquium on the application of modern methods of physics in biological research*, organized by the Biological Department of the Hungarian Academy of Sciences, with 45 participants.

5. Between the 5th—7th October „*Hydrobiological Days*” attended by 37 guests and the Institute’s research workers. The annual meeting is a joint program of the Hydrobiological Section of the Hydrobiological Society and of the Institute’s Department of Hydrobiology.

Improvement in research facilities

The equipment park was improved among others by an EEG (8 channels) and by an Aminco-Bowman Spectrophotofluorimeter.

At the end of 1967 the Library registered 43 169 units. Over 600 different periodicals are being received currently.

The yearbook of the Institute, *Annal. Biol. Tihany*, Vol. 34 (1967) was sent to 567 institutions all over the world, in exchange the Library received about 343 different journals and publications.

In 1967 the renewal of the Institute’s Hotel was completed (14 rooms with bath-rooms and central heating) as well as that of the Institute’s dining-room and club-room.

KRÓNIKA

Az Intézetben 1967-ben két tudományos osztály működött. A kutatási feladat a hároméves kutatási terv része.

Ennek megfelelően a *Kísérleti Állattani Osztály* összehasonlító neurobiológiai kutatásokat végzett gerinctelen állatokon. A Lamellibranchiata és Gastropódák vizsgálatánál a komplexitás elvének megfelelően fiziológiai, morfológiai és biokémiai módszereket alkalmaztak.

A *Hidrobiológiai Osztály* tudományos munkáját plankton és bentosz-kutatás, valamint egyes vízi szervezetek táplálkozás-biológiai és anyagsere vizsgálata képezte. E kutatások több Intézettel kollaborációban folytak.

Dr. SEBESTYÉN OLGA nyugalmazott osztályvezető továbbra is aktív tudományos tevékenységet fejtett ki az Intézetben. Munkáját a „Történelmi tanulmányok balatoni üledék mikrofossziliáin” c. téma keretében folytatta.

A két osztályon dolgozó kutatók tudományos munkáinak egy része az *Annal. Biol. Tihany* 35. kötetében, más része különböző hazai és külföldi folyóiratokban jelent meg (*L. Annal. Biol. Tihany*, 35, 280. oldal.)

A tudományos eredmények széleskörű publicitást kaptak még az Intézet 40. évfordulójáról megemlékező emlékülésen, valamint az ahhoz kapcsolódó két szimpóziumon is (l. rendezvények).

Az Intézet személyi állománya 54 fő, ami a következőképpen oszlott meg: kutató: 19, kutatási segédkutató: 20, adminisztratív: 6, egyéb: 9.

Az Intézet kutatói állományában az alábbi változások történtek: dr. PÉCSI TIBOR tudományos munkatárs 1967. július 1-én a Tiszántúli Vízügyi Igazgatósághoz (Debrecen), JÁRAI JÁNOS elektromérnök szeptember 1-én Szegedre a MTA Szerkezetkutató Laboratóriumába távozott az Intézetből. KISS ISTVÁN biológia-kémia szakos tanár 1967. augusztus 1-től tudományos segédmunkatársi kinevezéssel, VÉRÓ MIHÁLY elektromérnök pedig 1967. szeptember 15-től vezető mérnök beosztással kezdte meg munkáját a Kísérleti Állattani Osztályon.

Belföldi tanulmányutak

BIRÓ KÁLMÁN tudományos segédmunkatárs két hónapot töltött az ELTE Állattárában Budapesten.

OLÁH JÁNOS tudományos segédmunkatárs 6 hónapot dolgozott Budapesten a Talajtani és Agrokémiai Kutatóintézetben.

Külföldi utak

dr. S.-RÓZSA KATALIN tudományos munkatárs III. 6-tól kezdődően egy hónapot töltött a Szovjetunióban.

dr. SALÁNKI JÁNOS igazgató részt vett a Wiesbadenben (NSZK) rendezett „Society for Biological Rhythm” IX. konferencián (ápr. 4–7).

FARKAS TIBOR önköltséges alapon dolgozott (VII. 6–VII. 12) Berlinben (NDK) az „Institut für Binnenfischerei”-ben.

dr. ZS.-NAGY IMRE X. 3-tól kezdődően egyhónapos tanulmányúton volt Csehszlovákiában.

OLÁH JÁNOS X. 2-án kezdte meg féléves tanulmányútját Borokban (Szovjetunió).

dr. LÁBOS ELEMÉR november elején kezdte meg 8 hónapos tanulmányútját Franciaországban.

Vendégkutatók

Az előző évekhez hasonlóan több külföldi és hazai kutató dolgozott az Intézetben.

D. A. SAKHAROV, Moszkva, Fejlődésbiológiai Intézet,

MARIE LUISE ALBRECHT az NDK-ból,

J. MÄRILAINEN Finnországból a Finn–magyar együttműködési szerződés keretében,

E. LOZADA, Chiléből, UNESCO ösztöndíjasként,

L. RIBAK, a Szovjetunióból,

B. GLAIZNER, Angliából, a Southamptoni Egyetemről,

dr. ÁDÁM GYÖRGY, Budapest, Eötvös Loránd Tudományegyetem,

dr. BICZÓK FERENC, Szeged, JATE,

dr. CSILLIK BERTALAN, Szeged, Orvostudományi Egyetem,

dr. GARAMVÖLGYI MIKLÓS, Pécs, Orvostudományi Egyetem,

dr. KÁDÁR ZOLTÁN, Debrecen, Kossuth Lajos Tudományegyetem,

dr. ifj. TÖRŐ IMRE, Budapest, BOTE,

dr. MAKARA GÁBOR, Budapest, KOKI,

dr. NAGY LÁSZLÓ, Pécs, Biofizikai Intézet,

KOVÁCSNÉ, M. ÉVA, MATSKÁSI ÁRPÁD és MÉSZÁROS FERENC, Budapest, Állattár,

dr. UHERKOVICH GÁBOR, Szeged, Tiszakutató Állomás,

BOTHÁR ANNA, Budapest, Dunakutató Állomás,

NEDELKOVICS LÁSZLÓ, Keszthely, Mezőgazdasági Akadémia.

A felsoroltakon kívül több mint 200 hazai és külföldi kutató látogatta meg az Intézetet.

A nyári hónapokban 8 hazai és 2 külföldi egyetemi hallgató kapcsolódott be az Intézet munkájába 3–4 hétre.

Rendezvények

Az Intézetben 1967. év folyamán 5 nagyobb rendezvény került lebonyolításra. Ezek a következők voltak:

1. Augusztus 28–31. Nemzetközi Paleolimnológiai Szimpózium.

A Nemzetközi Limnológiai Társaság és a MTA közös rendezésében 20 ország, több mint 70 kutatójának részvételével. A rendezőbizottság hazai

elnöke dr. SEBESTYÉN OLGA nyugalmazott osztályvezető, a Nemzetközi Lymnológiai Társaság alelnöke volt.

2. Szeptember 1. Emlékezés az Intézet 40 éves jubileuma alkalmából. Az egynapos ülésen a Magyar Tudományos Akadémia alelnöke, a Biológiai Tudományok Osztálya, a Biológiai Tudományok Osztályához tartozó Intézetek, a megyei és járási államhatalmi és társadalmi szervek vezetői, továbbá az Intézet régebbi kutatói és barátai, valamint az Intézet jelenlegi dolgozói vettek részt. Részt vett és felszólalt az emlékülésen dr. VERZÁR FRIGYES nyugalmazott egyetemi tanár, az Intézet első igazgatója, a Básvai Gerontológiai Intézet vezetője is.

3. Szeptember 4–7. Gerinctelen Állatok Neurobiológiája Szimpózium 32 külföldi és 15 hazai kutató részvételével. A szimpózium védnöke a MTA Biológiai Tudományok Osztálya, elnöke dr. SZENTÁGOTAI JÁNOS akadémikus, osztálytitkár volt, rendezője az Intézet igazgatója, dr. SALÁNKI JÁNOS.

4. Szeptember 28–30. Modern fizikai módszerek alkalmazása a biológiai kutatásban c. kollokvium, az MTA Biológiai Tudományok Osztályának rendezésében, 45 résztvevővel.

5. Október 5–7. Hidrobiológus napok, melyen az Intézet dolgozóin kívül 37 kutató vett részt. A Hidrológiai Társaság Hidrobiológiai Szakosztályának és az Intézet Hidrobiológiai Osztályának közös rendezvénye.

Kutatási feltételek fejlődése

Tovább javult az év folyamán az Intézet műszerellátottsága. Jelentősebb új gyarapodás volt az év során beérkezett 8 csatornás electroencephalograph, valamint egy Aminco-Bowman gyártmányú Spektrofotofluorimeter.

Az évvégi összesítés alapján az intézeti könyvtár állománya 43 169 egység. Összesen 610 különböző folyóirat és kiadvány érkezik az Intézetbe, köztük 12 referáló jellegű.

Az Intézeti Évkönyv — *Annal. Biol. Tihany* 34. kötetét 567 címre küldtük meg, melyért cserébe 343 kiadvány érkezett.

Az elmúlt évben befejeződött az Intézeti Szálloda felújítása, melynek kapcsán 14 fürdőszobás, központi fűtéssel ellátott vendégszobát alakítottak ki. Felújításra került az Intézet konyhája, ebédlője, klubszobája és portálakása is.

**List of papers published elsewhere as in Vol. 34 of our Annales
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megjelent dolgozatok jegyzéke**

- B. BARANYAI, J. SALÁNKI: Changes in the secretory activity of the central nervous system of *Anodonta cygnea* upon the action of chemical agents. — *Acta Biol. Hung.* **18**, 93—103.
- HERODEK, S.: The distribution of labeled palmitic acid into the diglycerides and triglycerides of rat adipose tissue. — *Lipids* **2**, 299—302.
- KLEINE, R., J. PONYI: Vorkommen und Eigenschaften der proteolytischen Enzyme des Magensaftes und der Mitteldarmdrüse des Flusskrebse *Astacus astacus* (L), und *Cambarus affinis* (SAY). — *Zeitschr. f. vergl. Physiol.* **55**, 39—50.
- LÁBOS, E.: Strength duration relation in the nerve of the fresh-water mussel. — *Acta Biochem. Biophys.* **2**, 433—449.
- LUKACSOVICS, F., T. PÉCSI: A new occurrence of *Urnatella gracilis* LEIDY (Kamptozoa) in Hungary. — *Opuscula Zoologica* **7**, 221—225.
- PONYI, J., BIRÓ K., P.-ZÁNKAI N.: A Balaton iszaplakó állatainak gyűjtéstechnikája és problémái. — *Állat. Közlem.* **54**, 129—134.
- PONYI, J., L. P.-ZÁNKAI: Untersuchungen über die Endopeptidase-Aktivität des Verdauungs system der Höheren Krebse (Malasostraca). — *Crustaceana* **13**, 31—38.
- S.-RÓZSA, K., I. ZS.-NAGY: Physiological and histochemical evidence for neuroendocrine regulation of heart activity in the snail *Lymnaea stagnalis* L. — *Comp. Biochem. Physiol.* **23**, 373—382.
- ZS.-NAGY, I.: Histochemical demonstration of biogenic monoamines in the central nervous system of the lamellibranch mollusc *Anodonta cygnea* L. — *Acta Biol. Hung.* **18**, 1—8.

List of scientific lectures
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- BIRÓ K., PONYI J., P.-ZÁNKAI N.: A Balaton nyíltvízi iszapjának Nematodái. — *Állattani Szakosztály, IV.* 7.
- FARKAS T.: Lipidek a Balaton táplálékláncában. — *Hidrobiológus Napok, X.* 5–7.
- FARKAS T.: C 3'5'-AMP és jelentősége a hormonok hatásában. — *Magyar Kémikusok Egyesülete Veszprémmegyei tagozata Biokémiai Szekciójának ülése, Tihany, VI.* 14.
- HERODEK S.: A hőmérséklet hatása a planktonrákok zsírsav-összetételére. — *Hidrobiológus Napok X.* 5–7.
- HIRIPI L.: Indoalkilaminok és katalolaminok meghatározásának laboratóriumi módszerei. — *Magyar Kémikusok Egyesülete Veszprémmegyei tagozata Biokémiai Szekciójának ülése, Tihany, VI.* 14.
- LÁBOS E.: On the mechanism of anisotropic properties of excitability for adductor response of glochidia. — *Neurobiol. Szimp., Tihany, IX.* 4–7.
- ZS.-NAGY I.: Histochemical and electron microscopical studies on the relation of dopamine and dense-core vesicles in the neurons of *Anodonta cygnea* L. — *Neurobiol. Szimp., Tihany, IX.* 4–7.
- PONYI J.: Mennyiségi és minőségi vizsgálatok a Balaton nyílt vize iszaplakó rákjain. — *Hidrobiológus Napok X.* 5–7.
- PONYI J., BARON F., CSONTI F.: Pesticidmaradékok vizsgálata különféle hazai vizekből származó szervezeteken. — *Hidrobiológus Napok, X.* 5–7.
- S.-RÓZSA K.: Cyclic 3'5'-AMP as a second messenger of excitatory influences on the heart of *Helix pomatia*. — *Neurobiol. Szimp., Tihany, IX.* 4–7.
- SALÁNKI J.: On the central mechanism of periodic activity in *Anodonta cygnea* (Pelecypoda). — *Society for Biological Rhythm, 9. Intern. Konferenz, Wiesbaden* 6–8. April.
- SALÁNKI J.: Role of cerebral ganglia in the regulation of activity in fresh-water mussel. — *Neurobiol. Szimp., Tihany, IX.* 4–7.
- TAMÁS G.: Horizontális fitoplankton vizsgálatok a Balatonon. — *Hidrobiológus Napok, X.* 5–7.
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- VARANKA I.: Kolinszteráz biológiai szerepe és vizsgálata. — *Magyar Kémikusok Egyesülete Veszprémmegyei tagozata Biokémiai Szekciójának ülése, Tihany, VI.* 14.
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A kiadásért felel az Akadémiai Kiadó igazgatója Műszaki szerkesztő: Merkly László
A kézirat nyomdába érkezett: 1968. VII. 3 — Példányszám: 900 — Terjedelem: 25,2 (A/5) ív

68.65903 Akadémiai Nyomda, Budapest — Felelős vezető: Bernát György

