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QUANTITATIVE INVESTIGATIONS ON MUD-LIVING CRUSTACEANS IN THE OPEN WATERS OF LAKE BALATON

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Two earlier publications (ENTZ et al. 1963; PONYI, 1966) give a preliminary survey on the qualitative and partly quantitative conditions of "micro-crustacea" found in Keszthely Bay and in other sections of Lake Balaton. In want of adequate collecting apparatus, the employed EKMAN—BIRGE type dredger, in the case of small crustaceans, was only suitable for informatory quantitative investigations, for this machine is hardly capable to secure the very soft upper layer of the bottom. Notwithstanding, the data coming to light drew attention to "micro-crustacea" living in abundance in the Lake, therefore, a more accurate method to be worked out to ascertain their number was rather desirable. The results achieved in the field of methodological investigation of the past few years (PONYI et al. 1967) rendered possible the more accurate quantitative measuring of crustaceans living in the mud of open water in Lake Balaton. This study is to give information on the results having achieved so far.

Conditions of collecting, sample taking and working-up.

Mud samples were taken at the South-western part of the Lake (M, K, G) at three points, at the North-eastern part at two (A, E) and at three-three points of the transversal sections being at a right angle to the longitudinal axis of the Lake (cf. TAMÁS, 1967, pp. 233—234). The samples were secured by a modified version of the CRAIB type apparatus (more information in: PONYI et al. 1967). The time of collecting: 14th—15th June, 1966, 26th—27th August, 21st—22nd September, 18th—19th October, 15th—16th November, 11th—12th April, 1967 and 16th—18th May. Data bearing relation to collecting (temperature of water and atmosphere, depth of water, water transparency) and other comments may be found in TAMÁS'S paper (1967, p. 235 and 1968. p. 229).

At each of the 15 collecting sites of the 5 sections 3 samples were taken (total surface was 40 cm^2), which were put into a common container. The samples contained about 300 ml mud and 100 ml water coming from just above the surface of the mud. In the laboratory the sample was carefully stirred, then half of it was divided into equal portions of 20 ml each and were poured into conic No. 25 plancton nets. Into the net thin stream of sieved tap water was allowed to pour in order to eliminate fine mud and colloid-size particles. The prepared material was then transferred into a quadratic-latticed dish and a binocular microscope was used for selection (PONYI et al. 1967).

A survey and some comments on the species found during the investigation

The selected crustaceans of some 4—5 thousand belonged to 29 species, the distribution according to larger taxonomic units is as follows: Cladocera 15, Ostracoda 4, Copepoda 10 species. From ecological and frequency points of view two main groups may be distinguished valid for Lake Balaton:

(a) *mud (partly reed-grass and reed-grass coats) inhabitants:*

Cladocera:

Macrothrix laticornis (JURINE), *Iliocryptus sordidus* LIEVIN, *Alona rectangula* G. O. SARS, *Alona quadrangularis* (O. F. MÜLLER), *Alona affinis* LEYDIG, *Alonella rostrata* (KOCH), *Leydigia leydigii* (LEYDIG), *Leydigia acanthocercoides* (FISCHER), *Pleuroxus uncinatus* var. *balatonicus* DADAY, *Monospilus dispar* G. O. SARS.

Ostracoda:

Candona balatonica DADAY, *Candona* sp. (not *balatonica)*, *Ilyocypris gibba* (RAMDOHR), *Darwinula stevensoni* (BRADY et ROBERTSON).

Copepoda:

Paracyclops fimbriatus (FISCHER), *Acanthocyclops viridis* (JURINE), *Microcyclops varicanas* (G. O. SARS), *Ectinosoma abrau* (KRITSCHAGIN), *Attheyella* (s. str.) *crassa* (G. O. SARS), *Nannopus palustris* BRADY.

(b) *Plankton members (and well swimming littoral inhabitants):*

Cladocera:

Latona setifera (O. F. MÜLLER), *Diaphanosoma brachyurum* (LIEVIN), *Daphnia hyalina* var. *galeata* G. O. SARS, *Daphnia cucullata* G. O. SARS, *Bosmina longirostris* f. *pellucida* STINGELIN.

Copepoda:

Eudiaptomus gracilis (G. O. SARS), *Cyclops vicinus* ULJANIN, *Acanthocyclops vernalis* (FISCHER), *Mesocyclops* (s. str.) *leuckarti* (CLAUS).

Two species, *Attheyella* (s. str.) *crassa* (G. O. SARS) and *Microcyclops varicans* (G. O. SARS), are new to the fauna of Lake Balaton. Both species — excepting one specimen — come from the A and E sections of the Lake. *A. crassa* occurs in different waters (both in stagnant and in running), including even subsoil waters. *M. varicans*, according to the literature, is the inhabitant of the macrovegetation of the littoral zone.

The quantitative distribution in the different regions of the lake

(a) *Mud inhabitants*

From quantitative point of view the majority of species ranged into the group of open water mud inhabitants, in the course of the investigation, seemed to play only a minor role. Although among them were real mud inhabitants

(Iliocryptus sordidus, Pleuroxus uncinatus var. *balatonicus, Leydigia leydigii, L. acanthocercoides,* etc.) we shall disregard them in the following pages of this paper. Likewise shall we dispense with the description of such crustaceans which are rather the inhabitants of the macrovegetation and in a restricted sense of the littoral zone, occurring in the mud of the open water only sporadically. Respective data on them may be found in various papers (PONYI, 1957, 1960, 1962; SEBESTYÉN, 1947, 1948, 1965).

In the view of quantity; the first place is occupied by *Ectinosoma abrau.* Though at different points of the identical sections the number of individual specimens significantly diverged, its ubiquity in the whole of Lake Balaton seems to be certain. Section K is the poorest in any month of sample taking, showing an increase of number towards Tihany (G—E) and Keszthely (M). The greatest population was observed in early spring months *(Fig. 1)*; the numbers given indicate a distribution in 20 cm² per exemplars:

M	*K*	*G*	*A*	*E*
13 ± 2	7 ± 2	34 ± 9	16 ± 7	19 ± 7

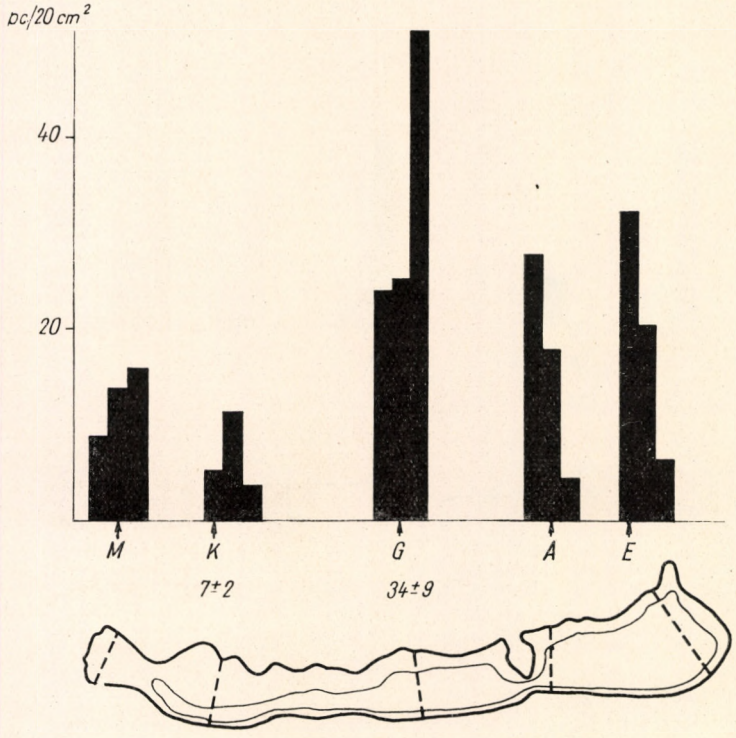

Fig. 1. The quantitative conditions of *Ectinosoma abrau* in June 1966 in the different sections of Lake Balaton.
† = samples from the axis of depth.
The numbers below the abscissa mean the average of the three samples and the deviation from the average

where it is readily observable that K and G significantly differ from each other calculated as means on the basis of three sample taking points. The quantity decreased in July, the biggest values were found in sections M and E. The smallest number of individuals was detected in August *(Fig. 2)*, however, no

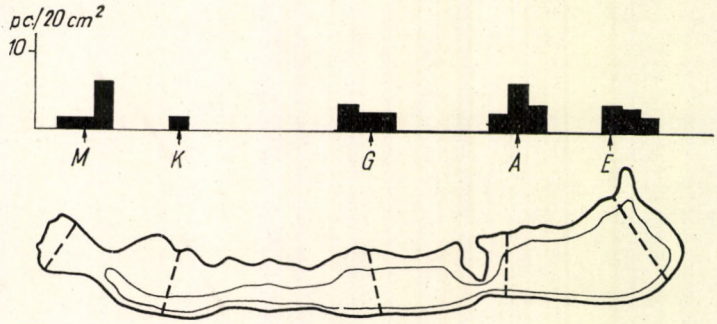

Fig. 2. The quantitative conditions of *Ectinosoma abrau* in August 1966 in the different sections of Lake Balaton.
↑ = samples from the axis of depth

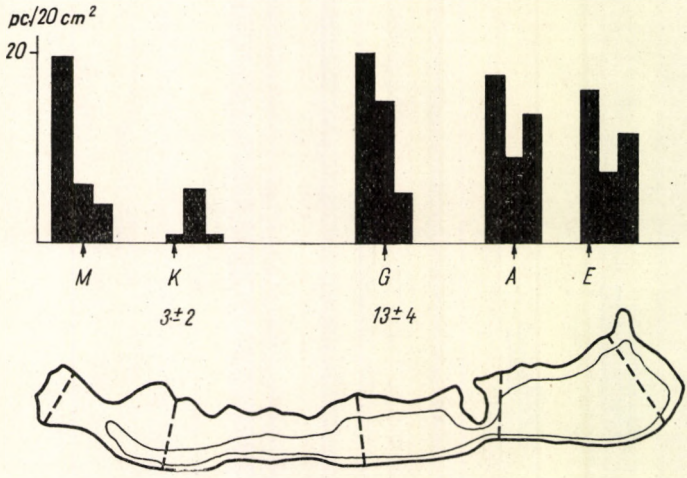

Fig. 3. The quantitative conditions of *Ectinosoma abrau* in November 1966 in the different sections of Lake Balaton.
↑ = samples from the axis of depth

quantitative differentiation could be ascertained. Starting from September, in the course of October and November *(Fig. 3)* section K strikingly differs from all the other sections. The same phenomenon also occurs in April and May.

The highest number of specimens with eggs (on an average in respect of all sections) was found in April, their number gradually decreased until July,

only sporadically appearing in August and September, while in October and November examples with eggs were not found. In respect of sectional distribution A and E proved to be the richest.

The monthly mean calculated from the transversal sections is as follows (exemplars per dm^2):

1966						1967	
June	July	Aug.	Sept.	Oct.	Nov.	Apr.	May
89	38	10	21	47	51	47	18

The data indicate that the greater population of *Ectinosoma* falls on the early summer period.

As respect of quantity the second place is occupied by *Paracyclops fimbriatus*. Its distribution is very uneven within the individual sections *(Fig. 4)*. However, the significant values always come from samples of the axis of depth. The fluctuation of monthly values calculated from all sections shows that the highest number of individuals in the early summer period (47 specimens per dm^2) suddenly decrease by August (5 specimens per dm^2), then from September a gradual increase sets in (13—23 specimens per dm^2).

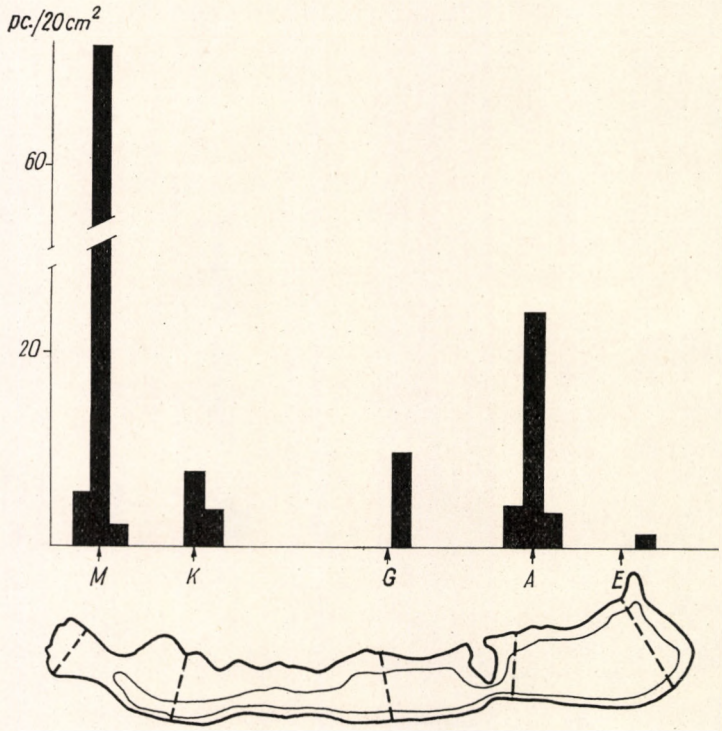

Fig. 4. The quantitative conditions of *Paracyclops fimbriatus* in June 1966 in the different sections of Lake Balaton.
↑ = samples from the axis of depth

Darwinula stevensoni occurs in small number of individuals, though its distribution is rather even in every section and even in sectional points. The 13—14 specimens per dm^2 in the months of June and July by September decrease to 5 specimens per dm^2, then showing rise in number in October nearly reaching the summer level.

A *Candona* sp., whose identification could not yet be accomplished for in the last few years only juvenile exemplares have been collected, may also be mentioned here as quantitatively significant. Great numbers (7—14 specimens per dm^2) were found in summer months and in September. It should be noted here, that this Ostracoda is not synonymous with *Candona balatonica*. This latter was found only in October and November within the period of investigation, mainly in sections M, K and E, and even here only very sporadically.

The quantitative distribution according to collecting points of *Alona quadrangularis* and *Alona affinis* is rather uneven. It came to light that these two species bear less significance beside the aforementioned species in respect of quantity, taking into account the whole of the investigational period, calculated separately on the basis of the five sections both in the warm and cold water period (June—September and October—May). Both species were found in the greatest number in June, near the middle of the Lake (G section) in less towards the shores in greater numbers. By August their number drastically decreased showing a rise only in autumn. *A. quadrangularis* both in the warm and cold water period produced an average of 11 specimens per dm^2 and 4 specimens per dm^2, respectively. *A. affinis*, on the other hand, occurred in an average of 9 specimens per dm^2 and 2 specimens per dm^2, respectively. While in the littoral zone and in its vegetation generally *A. affinis* appears more frequent as compared to *A. quadrangularis* (Sebestyén, 1947, 1948, 1965; Ponyi, 1962;

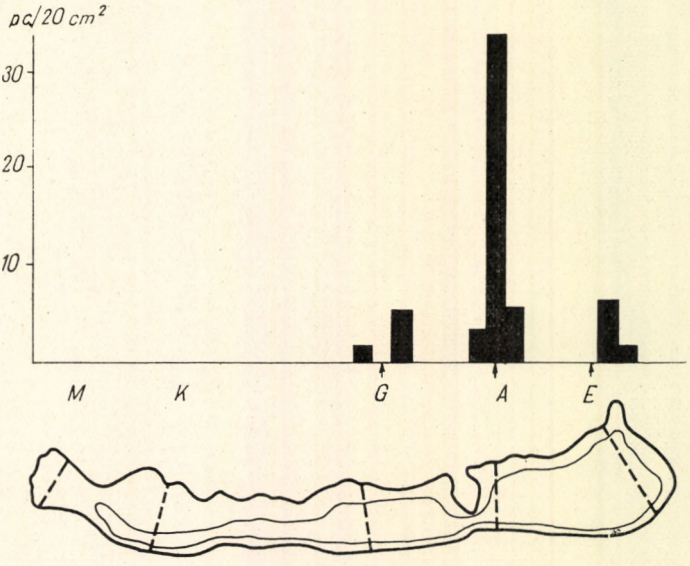

Fig. 5. The quantitative conditions of *Monospilus dispar* in October 1966 in the different sections of Lake Balaton.
† = samples from the axis of depth

data of other habitats: BERG, 1929; FLÖSSNER, 1962, 1964, etc.), in the mud of open water, taking into consideration all five sections — it seems — that this proportion is inverted. It is to be noted, that during the period of investigation *A. affinis* occurred in sections A and E with greater frequency than in sections K and M.

The mosaic-like distribution of *Monospilus dispar* in Lake Balaton has been known some time (SEBESTYÉN, 1965) which has been nowproved with greater certainity by these quantitative investigations *(Fig. 5)*. The results further show that in the period of investigation the North-eastern basin (A, E) both in the warm (June—September) and cold period (Oct.—Nov., Apr.—May)

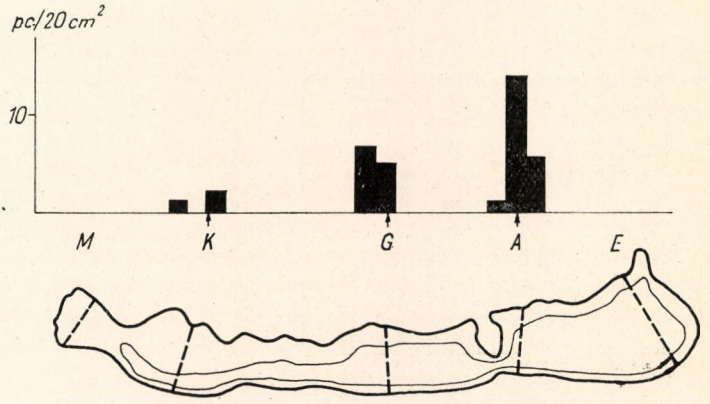

Fig. 6. The quantitative conditions of *Nannopus palustris* in June 1966 in the different sections of Lake Balaton.
↑ = samples from the axis of depth.

possesses a higher number of individuals than does the South-western. While the former produces for both periods 12—16 specimens per dm², the other only 0.5—1 specimen per dm². Whether this quantitative distribution is stable for the two basins or has only been characteristics for the year when the experiment was carried out is uncertain, and only future research of the question may decide unambiguously.

The distribution of *Nannopus palustris* in the Lake has been very similar to that of *Monospilus (Fig. 6)*. Quantitatively it was only notable in June and July (2—7 specimens per dm²).

(b) *Notes on plankton members found in the mud samples*

In the mud, on its surface and on the border of water and mud considerable quantity of plankton crustaceans were found. Out of the 4—5 thousand animals which were selected out some 35% were plankton organisms (juveniles of *Mesocyclops* (s. str.) *leuckarti*, *Eudiaptomus gracilis* and *Cyclops vicinus)*. During the 8 months in each of the five sections the plankton members appeared with a frequency of above 50%:

M	*K*	*G*	*A*	*E*
3	6	2	1	1

These data indicate, especially in the South-western basin of the Lake, that the juvenile forms of planktonic copepods play an important role in the mud surface. The frequency distribution of *Mesocyclops* and *Eudipatomus* genera seems to be proportional to the relative quantity of planktons. For the benthic distribution of *Cyclops vicinus* see an other paper (PONYI, 1968).

The comparison of quantitative data between 1965 and 1966

Although the previous quantitative investigations (PONYI, 1966) were only informative in nature, their comparison with the present results offers to be profitable for two reasons *(Table 1)*. The number of individuals per dm^2 of the collected mud inhabiting crustaceans from the same period and sections of the two years increased 3—4 times by employing the method just described. This number most probably is nearer to the real values than the earlier ones, although we should not disregard the damaging effect of chlorinated carbon hydrogen remmants (cf. PONYI et al. 1968, p. 185).

Table 1.

The quantitative distribution of mud inhabiting "micro-crustaceans" in the open water mud of Lake Balaton (specimens per dm^2)

Sections	*M*		*K*		*G*		*A*		*E*		
Dates	specimen per dm^2	%	specimen per dm^2	%	specimen per dm^2	%	specimen per dm^2	%	specimen per dm^2	%	%
1965. VI—X.	46	30.1	14	9.1	25	16.3	34	22.2	34	22.2	
1966. VI—X.	148	24.1	43	7.0	118	19.2	148	24.1	158	25.1	

In spite of the difference between the two methods of collecting the relative "micro-crustacean" values in per cent in respect of the same sections show great similarity. On the basis of this it may be expressed with certainty that the distribution of mud inhabiting crustaceans of the open water is heterogeneous. The richest regions are the North-eastern basin and Keszthely Bay (section M), while the middle region of the Lake is the poorest, meaning that the mud of open water in the Lake, taking into account other qualitative characteristics, may be devided at least into three great units.

Summary

1. Author established, in respect of the mud of open water, that from quantitative point of view the following species are most important: *Ectinosoma abrau*, *Pracyclops fimbriatus*, *Darwinula stevensoni* and a *Candona* sp. The species of *Alona* and *Monospilus* mainly play a more significant role in the, North-eastern basin.

2. The fry forms of Copepoda plankton members appear in greater quantities in the mud, especially in section K, therefore their activity should not be neglected.

3. On the basis of comparative examinations carried out in 1965 and 1966 it became evident that the mud of open water of great extent may be devided into three large units.

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MENNYISÉGI VIZSGÁLATOK A BALATON NYÍLTVÍZI ISZAPJÁBAN ÉLŐ RÁKOKON

Ponyi Jenő

Összefoglalás

1. A tó nyíltvízi iszapjára vonatkozóan a szerző megállapította, hogy mennyiségi szempontból az *Ectinosoma abrau*, *Paracyclops fimbriatus*, *Darwinula stevensoni* és egy *Candona* faj a legjelentősebb. Az *Alona* és *Monopsilus* fajok elsősorban az ÉK-i medencében látszanak jelentősnek.

2. A tó iszapjában, különösen a „K"-val jelzett területen, a juvenilis Copepoda-planktontagok jelentős mennyiségben fordulnak elő, így azok tevékenysége nem elhanyagolható.

3. Az 1965. és 1966. évi vizsgálatok összevetése alapján bizonyossá vált, hogy a nagyterületű nyíltvízi iszap 3 nagyobb részre tagolódik.

КОЛИЧЕСТВЕННЫЕ ИССЛЕДОВАНИЯ РАКОВ, ЖИВУЩИХ В ИЛЕ ОТКРЫТОЙ ВОДЫ ОЗЕРА БАЛАТОН

Й. Поньи

1. Было установлено, что в иле открытой воды озера в наибольшем количестве обнаруживаются *Ectinosoma abrau*, *Paracyclops fimbriatus*, *Darwinula stevensoni* и один вид *Candona*. Виды *Alona* и *Monopsilus* найдены в значительном количестве в северно-востокном бассейне.

2. В иле озера особенно в области «К» обнаруживается значительное количество недорозвитых Copepoda— планктонов, так что их деятельность надо принимать во внимание.

3. Сравнивая исследования 1965 и 1966 годов доказывают, что ил открытой воды разделяется на 3 больших составных части.