A STUDY OF PALINGENIA LONGICAUDA OLIV. IN THE ZOOBENTHOS OF THE TISZA AND MAROS (EPHEMEROPTERA)

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Abstract

Zoobenthic studies carried out on the environmental reaches of Szeged (Tisza: 170 river km, 171,5 river km; Maros: 1 river km, 2 river km) are reported. The more important taxonomical groups of these regions are described, taking into account the effects of some abiotic and biotic factors; the coenoses of the areas termed *Palingenia* biotopes by the authors are discussed.

We should like to become acquainted with the ecology of the larva of *Palingenia longicauda* OLIV.; this larva is of relatively restricted spread, and it has a characteristic way of life. Our data referring to this are extremely limited (UNGER 1927, SCHOENEMUND 1929, RUSSEV 1957, BERETZK et al. 1958), although the imago, and particularly the larvae, are important as fish-food.

Some of our studies would extend for several years, while others would presume a certain ecological knowledge regarding the species, and thus we set ourselves the aim of discovering the biocoenosis of the larvae of this species, its seasonal variation, and also the effects of several abiotic factors.

These observations were considered to be of importance since zoobenthic research in the Tisza and Maros is rather sparse (BERETZK et al. 1958, BÁBA et al. 1961, HORVÁTH 1966, FERENCZ 1968, 1969), and its results can provide useful assistance towards the solution of certain hydrobiological problems.

Materials and Methods

The material for our studies was collected in part from the Tisza (170 river km and 171,5 river km), in part from the Maros (1 river km and 2 river km). The collection was repeated monthly from October 1970 until November 1971, with the exception of the winter months, because of the breaking-up of the rivers and the very high water-lebels.

For the clarification of the first question to arise (the nature of the fauna characterizing the above biotopes), it was necessary to carry out certain comparative studies, and for this purpose we used the data of our exploratory collections (1963—64). These sampling sites were at 171,2 river km on the Tisza, and 0.3 river km on the Maros.

The sampling was performed with a bagger 16 cm in diameter. In each case 2000 cm³ of surface soil was excavated. From each site 3—5 samples were taken in general, at distances of 20—30 cm from each other, and the combined values for these are given in the Tables.

Our studies, which extended to the examination of the effects of the depth of the water and the distance from the bank on the distribution of the number of individuals, required the application of a certain "square net" sampling method. Thus, on 21 May 1971 collecting was carried out at 171.5 km in the Tisza and 1 km in the Maros in the following way: the samples were taken at 10 m intervals in a 100 m stretch of the bank, at 1 m intervals from the bank towards the bed (up to 5 m). Those samples which revealed a non-clayey section (sandy, and thus not containing *Palingenia*) denoted the limits of these biotopes.

After appropriate cleaning and selection operations, the collected material was preserved, partly in alcohol, partly in 4% formalin.

The publications of ANDRÁSSY (1955), BRINKHURST (1963), DAHL (1929) and HRABE (1934, 1941, 1962, 1966) were used to determine the Oligochaeta.

Resutlts and discussion

From the data of the systematic collections and certain comparative studies, an attempt was made to form a picture by means of the description of the characteristics of the biotopes containing the *Palingenia longicauda* OLIV. larvae.

The holes bored by the *Palingenia* larvae can be well seen in the steep, broken clayey sections of the bank. The compact surface soil, which well maintains the passages, permits the animals to dig their way in. The animal ecosystem of such biotopes is the argillorheophilous biocoenosis (SHADIN 1940).

Table 1. *Comparison of Palingenia and non-Palingenia biotopes in the Maros (spring)*

Taxonomical group	Non-*Palingenia*		*Palingenia*	
	A	D	A	D
Ephemeroptera	— — 1 — —	0,94	7 7 2 7 12	6,7
Oligochaeta	1 2 8 1 38	47,6	10 166 34 9 202	81,4
Mollusca	— — — 25 —	23,8	— 9 3 2 5	3,6
Diptera	1 0 17 5 4	25,6	1 23 1 5 5	6,7
other	— 1 — — 1	1,9	— 6 — — 1	1,3

In the river sections investigated the above areas are relatively extensive (150—200 m or longer), and above them the water-movement is stronger because of the various eddies.

The surface of the topsoil is rich in detritus, in some places completely grey, and

Table 2. *Comparison of Palingenia and non-Palingenia biotopes in the Tisza (spring)*

Taxonomical group	Non-*Palingenia*		*Palingenia*	
	A	D	A	D
Ephemeroptera	— — — — —	—	— 4 3 4 11	6,7*
Oligochaeta	8 12 7 1 14	15,9	29 94 5 7 18	46,9
Mollusca	96 — — — —	36,5	2 6 — 49 53	33,7
Diptera	34 6 30 — 16	32,6	— 17 — 1 —	5,5
other	— 5 30 3 1	14,8	2 11 1 2 6	7,05

* One of the given specimens was non-*Palingenia*.

greasy. On the basis of the particle-study* of the soil samples taken from the two Tisza and the two Maros collection sites, it can be stated that this soil should be characterized as a sandy, clayey rock flour.

The question arises of whether there is a difference, and if so to what extent, between the fauna compositions of the biotopes charcaterized above and those differing from these. Any biocoenosis whatever can be discussed only if the ecology of the components is known. As the first step towards this, our main task is the clarification of the autecology of *Palingenia longicauda* OLIV., one of the typical representatives of the argillorheophilous biocoenosis. Assistance in this is provided by the study of Oligochaeta species which occur most frequently together with it, and whose ecologies are already more or less well known.

A deeper causative disclosure of the biocoenological relations of the individual species in the habitats we have named *Palingenia* biotopes may possibly confirm our assumption that they are in fact characterized by a certain degree of individuality, and are distinguished thus from the other, non-*Palingenia* biotopes.

For this purpose the results of corresponding collections in the two reaches were compared. These results are given in Tables 1 and 2.

It is clear from the Tables that the main taxonomical groups in the two types of

* The particle-size analysis was carried out in the Department of Geology, Attila József University.

biotope are the same (Ephemeroptera, Oligochaeta, Mollusca, Diptera and others [Nematoda, Odonata, Trichoptera]). Thus, the Oligochaeta occur in a very high proportion in the *Palingenia* biotopes in the Maros, and then follow the Diptera (mainly Chironomida and Ceratopogonida), the Mollusca (mainly Gastropoda) and the other (Nematoda, Odonata, Trichoptera) groups. The Oligochaeta are similarly dominant in the Tisza, followed by the Mollusca, other (Nematoda, Odonata, Trichoptera, Amphipoda, Polychaeta) and Diptera categories. The clear-cut dominance of the Oligochaeta group is evident in both biotopes in both rivers. Only one case was observed when this did not hold, and in this case the Mollusca became dominant (Table 2).

As regards the most important taxonomical groups the biocoenoses of the two types of soil exhibit a considerable agreement, differing only in their abundance and dominance. Our observations were next restricted to these areas, which in our view are special, by studying the changes produced as a result of the abiotic and biotic factors (Figs. 1—4).

The dominance values of the Ephemeroptera in the Maros, and within this of the *Palingenia* larvae, attain a maximum in August-September (Figs. 1—2). This value (even in the case of absolute values) coincides with the minimum of the other taxo-

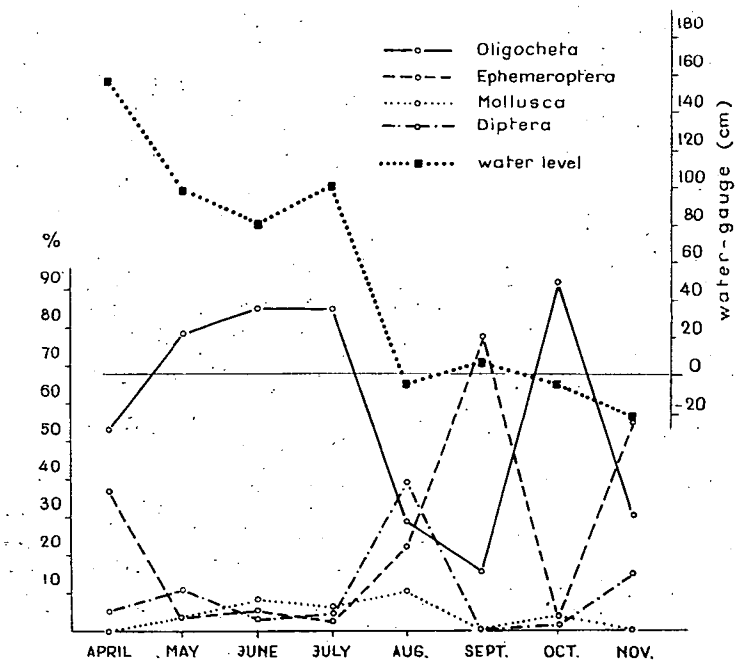

Fig. 1. Variation of the monthly dominance values of the main taxonomical groups (Maros 1 river km).

nomical group. This can be seen particularly nicely in the case of the Oligochaeta, where the D values on the other hand form a curve with two maxima (June—July and September—October). This is certainly related to a large extent with the periods of reproduction of the individual species (PODDUBNAJA 1959). The entire annual quantitative change of this group is practically a mirror-image of the change in dominance of the *Palingenia* and the Ephemeroptera. The Diptera, Mollusca and other taxonomical groups do not exhibit such regular variations.

The Tisza collections (Figs. 3—4) do not give such a clear-cut picture. The graphs in the two Figures differ considerably, not only from each other, but also, and even more so, from the graphs for the Maros collections (Figs. 1—2).

It is a most striking difference between the two collecting sites that at the 170 km site (Fig. 3) the Mollusca (and in particular the Gastropoda) dominate, and at the 171.5 km site (Fig. 4) the Oligochaeta. This latter is the taxonomic group which is the most characteristic and occurs in the greatest numbers as regards the annual distribution too. Autumnal maxima can be observed at both sites, although this does not mean a dominance of the number of individuals in an absolute sense.

The summer maximum is not so clear-cut, and the curves have several maxima and minima. In our view this can be explained by possible errors in the sampling, and perhaps also by other, mainly abiotic factors. Of the effects of these, mention should first be made of the water-level fluctuation. It is assumed that the effect of

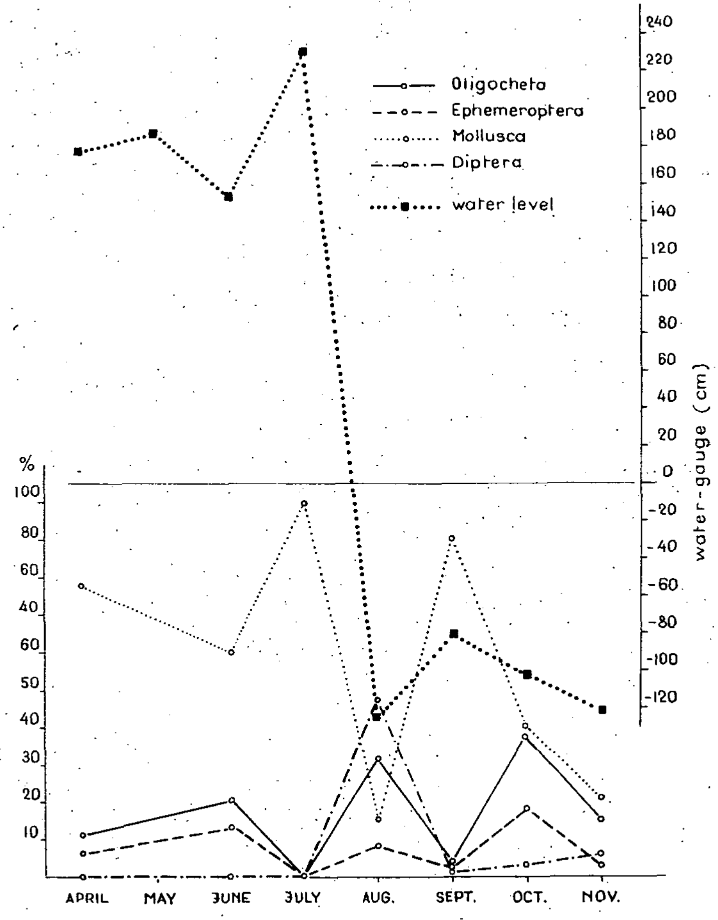

Fig. 2. Variation of the monthly dominance values of the main taxonomical groups (Maros 2 river km.)

this factor is felt mainly at the Maros collection sites, since factors significantly modifying the pH, the pollution, and the ionic composition of the water need not be considered as there were no sewage discharges in the vicinity of our study areas. These findings are based on the results of the analysis of the water.*

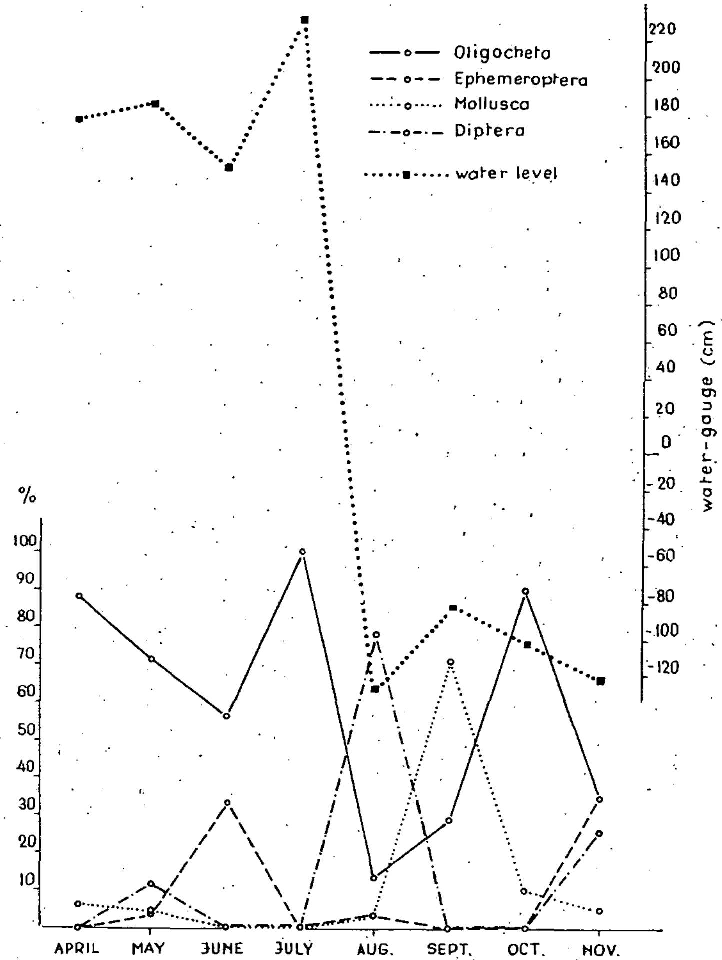

Fig. 3. Variation of the monthly dominance values of the main taxonomical groups (Tisza 170 river km).

It is an observed fact that the *Palingenia* larvae require a variation of the water-level. If the area of the given soil becomes partially dry, the larvae initially occur more concentratedly in the area covered by water, and if the majority or the whole of the area becomes dry, then the larvae leave their passages, and seek favourable conditions by means of active and passive movement. This is supported by observations at the

* We should like to express our thanks to the staff of the Szeged Water Conservancy Board, who made available to us the results of analyses of the waters of the Tisza and Maros.

two Tisza collection sites. At the 171.5 km site the trough-like depression in the river-bed is the habitat of the *Palingenia* larvae (ca. 100 m above it is the New Szeged sewage discharge). In the case of a high water-level the sewage flows towards the middle of the bed, meanwhile becoming well mixed with the water-mass of the river. When the water-level is low the majority of the sewage accumulates in this depression. If the otherwise low water-mass, which produces a concentration of the *Palingenia* larvae into a small area (this can explain the higher value observed in June [Fig. 4]) is subjected to a more pronounced pollution, then the larvae either partially or totally leave this area.

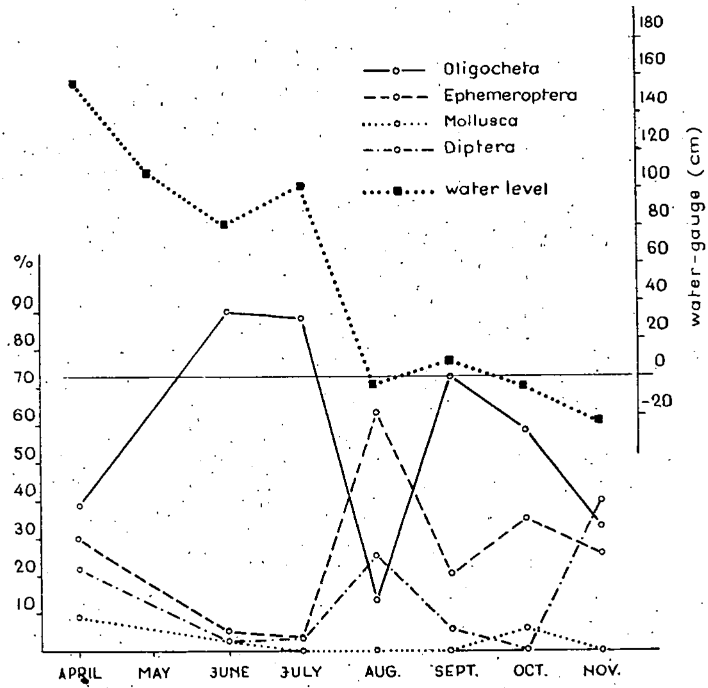

Fig. 4. Variation of the monthly dominance values of the main taxonomical groups (Tisza 171,5 river km).

In the 170 km reach of the Tisza the sewage effects are not exerted so directly. Even at a low water-level the larvae can still readily find a favourable topsoil region where sufficient food and ample oxygen are available to them. Those larvae which leave their habitat at the 171.5 km site establish themselves in part here, and in part elsewhere. This is responsible for a certain increase in the values of the curves at these collection sites.

After we had obtained answers to the questions of the natures of the more important taxonomical groups and the effects of the abiotic factors exerted in the study areas, our observations were extended to the distribution of these groups according to the depth of the water. The highest values of the zoobenthic production were found at sites 1—4 m deep in the Tisza, and 1—2 m deep in the Maros. All these data, broken down into the individual taxonomic groups, are depicted in the graphs of Figures 5 and 6.

The "square net,, method described in the section "Material and method,, was used for the depth studies; at the same time this also provided a base on which to carry out calculations referring to the average individual density within the given area, and also on which to chart those places where the individual groups occur in the greatest numbers. This method was used at the 1 km site in the Maros, and the 171.5 km site in the Tisza.

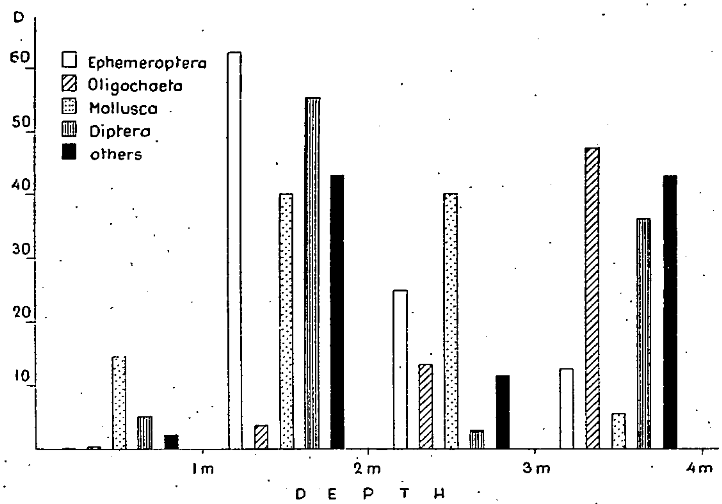

Fig. 5. Distribution of the dominance values of the more important taxonomical groups as a function of the water-depth (Maros 1 river km).

Of the taxonomic groups mentioned above, the individual density calculation was carried out with regard to the *Palingenia*, as the characteristic group, and to the Oligochaeta which occur most frequently with it. It was found that the average individual density of the *Palingenia* larvae in the Maros was 89.74 per m², and of the Oligochaeta was 738.4 per m², and at the same time the total production was 1774 per m². The corresponding values for the *Palingenia*, the Oligochaeta and the total production in the Tisza were 17.5 per m², 672.5 per m², and 975 per m², respectively.

The three "squares" richest in *Palingenia* were excavated from each of these areas, in order to obtain information about the composition by species of the condominant Oligochaeta too.

A total of 17 Oligochaeta were found in the Tisza samples; of these, 2 were undefined and the distribution of the remaining 15 according to individual species was the following:

Isochaetides newaensis HRABE	6	(40%)
Limnodrilus hoffmeisteri CLAP.	5	(33,3%)
Limnodrilus claparedeanus RATZ.	3	(20%)
Limnodrilus michaelseni LAST.	1	(6,6%)

We are unaware of the dominant European occurrence of the *Isochaetides newaensis* HRABE species, with the exception of the Soviet Union, where it is frequent in the various brooks, rivers and lakes, mainly in muddy or sandy-muddy topsoil (MALEVICH 1956, 1958, SHADIN 1940). Its optimum living conditions are probably found in the sites of medium depth in reaches of rivers where the current is not too strong. Its characteristic external appearance, connected with its digging-boring mode of life, makes the sexually immature individual readily recognizable.

The studies of PODDUBNAJA (1961) indicate that this species lives on the grey muddy-sandy topsoil, in contrats to *Limnodrilus hoffmeisteri* CLAP. and *Limnodrilus udekemianus* CLAP., which can be found on topsoils of various types.

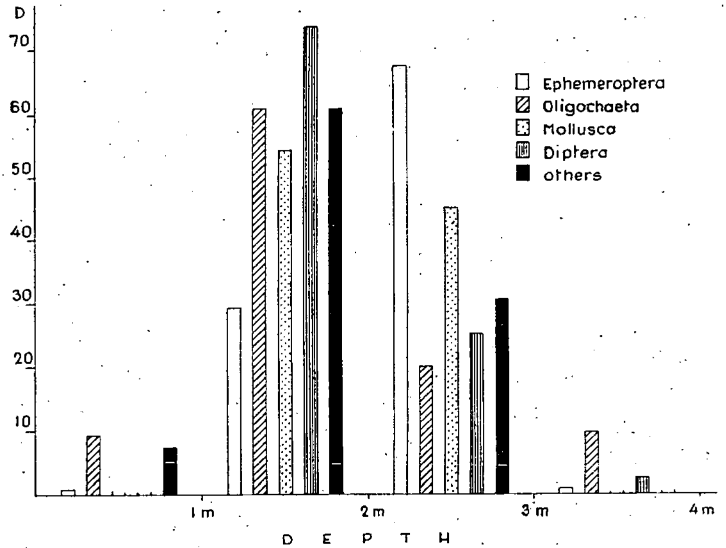

Fig. 6. Distribution of the dominance values of the more important taxonomical groups as a function of the water-depth (Tisza 171, 5 river km).

Of the total of 62 Oligochaeta in the Maros samples, 22 were undefined, and the distribution of the remaining 40 according to individual species was the following:

Limnodrilus hoffmeisteri CLAP.	16 (40%)
Psammoryctes moravicus HRABE	13 (32,5%)
Limnodrilus claparedeanus RATZ.	7 (17,5%)
Limnodrilus udekemianus CLAP.	4 (10%)

In the unanimous opinion of the research workers (SHADIN 1940, KENNEDY 1965, etc.), the ecological valency of the dominant *Limnodrilus hoffmeisteri* CLAP. is very broad, and accordingly it is widespread. It is characteristic of it that even in the case of its joint occurrence with some other species of the genus (*Limnodrilus claparedeanus* RATZ., *Limnodrilus udekemianus* CLAP.), it is always this which is the dominant, while the monospecific occurrence too is characteristic only of this (KENNEDY 1965). The results of our investigations to date are also in agreement with these findings (mainly with the first).

The *Limnodrilus hoffmeisteri* prefers the muddy topsoil in parts of rivers where the current is slight, and here it digs itself in to a depth of 4—6 cm. The species can be regarded as pelophilous or pelorheophilous.

The following emerge for the Oligochaeta ecosystems of the two rivers: in addition to the higher production in general characteristic for the Maros, the considerable similarity in the dominance relations and in the number of the species; the 60% (Tisza) and 67,5% (Maros) predominance of the *Limnodrilus* genus, and within this of the *Limnodrilus hoffmeisteri.*

The main aim of our studies, the possible establishment of the individual specific natures of the *Palingenia* biotopes, is naturally not considered to have been unambiguously achieved on the basis of such few data. Our above findings, however, do permit the conclusion that they have been more or less well elucidated.

In the next stage of our research it appears reasonable to study further just these *Limnodrilus* species (in particular as regards the abiotic factors), for according to KENNEDY (1965) the abiotic factors limiting the spread of the *Limnodrilus* species are not characteristic, and these should be sought among the biotic factors rather.

The abiotic factors controlling the qualitative and quantitative distribution of the zoobenthos in the rivers to the greatest extent are generally held to be the topsoil types, the fluctuation of the water-level and the current, which, together with the chemical factors, can in their complexity induce the effects of several other factors in a positive or negative direction. In the action-interaction sense, however, the zoobenthos can be evaluated as a sensitive indicator of the hydrobiological processes at the river-bed.

Summary

A study was made of the zoobenthic fauna and synecologies of the 170 and 171.5 river km reaches of the Tisza and the 1 and 2 river km reaches of the Maros, and the dependence of these on some abiotic (water-level fluctuation, water-depth, pollution) and biotic (nature, quantity and distribution of the coenosis components) factors. The extents of the modifying effects of pollution and water-level fluctuation in these reaches were determined. It is considered that the factors decisively affecting the distribution of the coenoses are biotic.

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