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AQUATIC OLIGOCHAETA

Proceedings
of the Fourth All-Union Symposium
Tbilisi, 5-7 October

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The Proceedings contain data on the origin, phylogenesis, fauna and ecology of the aquatic Oligochaeta. The papers included deal with their reproduction, development, productivity, life cycle, parthenogenesis, daily activity, population structure, and importance in increasing the standing crop of fish in water bodies. 2*

The book is intended for specialists in the fields of hydrobiology and ichthyology.

Editor: B.E. Kurashvili, corresponding member of the Academy of Sciences of the Georgian SSR

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* The figures in the right-hand margin indicate page numbers of the original (Tr.).

3

OPENING ADDRESS

by

B.E. Kurashvili

Director of the Institute
of Zoology of the Academy of Sciences
of the Georgian SSR, corresponding member
of the Academy, professor

Dear Comrades!

The holding of all-union symposia on aquatic Oligochaeta seems to have become a tradition: here we are together again for what is already a fourth such symposium, being held this time in Tbilisi, as was proposed at the preceding symposium which took place in Togliatti. At our Institute research on aquatic oligochaetes is carried out as part of a program of comprehensive hydrobiological and ecological studies of Georgia's inland water bodies: its reservoirs, lakes and rivers. I think it would be correct to describe this research as being basically ecological and faunistic in character; by now it has already yielded enough data to give us a sufficiently clear understanding of such matters as the species composition of the oligochaete populations in the inland water bodies of the Georgian Republic, the ecological and geographical distribution and the distinguishing ecological characters of individual species, the ecological groupings of species and their relative quantities in different biotopes.

The study of aquatic oligochaetes is arousing more and more interest among biologists everywhere; this is made evident by both the growing number of publications on this subject and by the fact that the first International Symposium on Aquatic Oligochaeta Biology was held recently in Sidney, Canada.

This interest is quite understandable, considering the role that oligochaetes play as an important component of aquatic ecosystems and, in particular, as valuable food for fish.

Thus, the study of aquatic oligochaetes is important in that it forms an integral part of the study of aquatic ecosystems and of the biological production processes that take place in them. There can be no doubt, therefore, that the country-wide research on aquatic oligochaetes is bound, from the taxonomic, faunistic, zoogeographical and ecological points of view, to have not only theoretical but also practical significance to the fishing industry in its efforts to increase the rate of exploitation of the various water bodies. 4

The agenda of the present Symposium corresponds, in general, to what has just been said since it includes papers covering a wide range of subjects connected with the study of aquatic oligochaetes, namely their taxonomy, phylogenesis, fauna, geography, biology and ecology.

We hope that the Fourth All-Union Symposium on Aquatic Oligochaeta, which is about to start its work, will help the specialists taking part in it to get to know each other's work and to exchange their experience, that it will lead to closer and more successful cooperation and to more effective research in this field.

It gives me great pleasure to state that present at this Symposium are scientists from Moscow, Leningrad, Kiev, Borok, Frunze, Odessa, Volgograd, Krasnoyarsk, Togliatti, Tartu, Tomsk, Magadan, Vilnius, Chelyabinsk, Kharkov, Yaroslavl, Dnepropetrovsk and Tbilisi.

I shall not read out the agenda of the present Symposium because its copies, as well as copies of the general plan of our work, have been distributed among all the participants.

Dear friends, let me greet you all on behalf of the Organizing Committee of the Symposium and wish you successful work, so
that the Tbilisi Symposium could make a significant contribution 5
to the study of aquatic oligochaetes.

The session is declared open.

SPATIAL DISTRIBUTION OF AQUATIC OLIGOCHAETES

by

T.L. Poddubnaya and A.J. Bakanov
(Institute of the Biology of Inland Waters, Academy of Sciences of the USSR, Borok)

It is well known that the quantitative distribution of oligochaetes over their biotope is practically never uniform. Some representatives of the Tubificidae (_Tubifex tubifex_ Mull., _Limnodrilus hoffmeisteri_ Clap., _L. ukedemianus_ Clap.) are capable of forming dense masses ranging in size from 10-12 cm^2 to several square meters. Alsterberg (6) described such masses as "local aggregations", while I.I. Malevich (5) called them "pillows". They consist of enormous numbers of worms packed tightly together. Such dense aggregations are formed either under unfavorable conditions, in which case they perform a protective function, or whenever an inflow of water rich in organic matter creates an abundance of food (4, 7). At such high densities, the distribution of oligochaetes in samples taken from inside the aggregations must be nearly uniform. A few very rare instances have been reported of oligochaetes being uniformly distributed over the entire area of a water body.

Normally, the distribution of oligochaetes, determined empirically from quantitative estimates of the degree of aggregation, is described by the negative binomial or lognormal statistical distributions, which is indicative of the existence of aggregations (9). 6

We distinguish several levels of aggregation - from macro- to microaggregation (1). On Lake Pleshcheevo we studied the macroaggregation of the oligochaetes (aggregation over the entire area of the lake) and their microaggregation (aggregation over a relatively homogeneous part of the biotope).

To study the macroaggregation and its seasonal dynamics, samples were taken at 50 stations distributed in an unrestricted random manner (completely random sampling). The samples were obtained by means of a DAK-250 grab sampler (1). The data provided by the samples were used to compute Lloyd's "patchiness index" C_L (8) and to estimate its standard error by moments (3). The degree of aggregation of the oligochaetes was estimated both in terms of number of individuals, which is important for a better understanding of their ecology, and in terms of biomass, which is necessary in order to give us a correct notion of their role as a source of food supply for benthophagous fish. Throughout the year, all the individual species and the oligochaete population as a whole showed a definite aggregated distribution. In spring and summer, when the worms get ready for breeding, copulate, and then, a little while later (in June-July), begin to lay cocoons, the degree of aggregation in terms of numbers is nearly the same for all of the different species. In autumn, when the young worms are hatched and when there is a rise in the total abundance of each species, the degree of aggregation of *P. hammoniensis* and *I. newaensis* also rises, while that of *Ps. barbatus* declines. Overall, toward autumn, the degree of aggregation of the oligochaetes decreases, the decrease in terms of number of individuals being more pronounced than the decrease in terms of biomass.

As is known, there are three basic factors that can induce animals to show a tendency toward aggregation: non-uniform conditions over the biotope, behavioral responses (herd instinct), and, finally, random density fluctuations. As a rule, the three factors operate 7
simultaneously, so that it may be very difficult to say which of them is playing the dominant role in a specific instance, particularly if the investigations are being conducted under natural conditions and not as part of a fully controlled experiment. To be able to explain the peculiarities of the aggregative behavior of individual species, it is necessary to make detailed studies of such fine traits of their biology as their responses to microvariations in the environment and to other organisms.

To determine the microaggregation, a homogeneous biotope was selected in the open littoral at a depth of 0.5 m. The lake bed in that area is composed of fine yellow sand. A 7-meter transect was sampled from the shore toward the center of the lake, with 102 samples, immediately adjacent to each other, taken by means of a square tube covering an area of 50 cm^2 and having a penetration depth of 20 cm. In studying this series of samples we made use of the index C_L, which enabled us to estimate the statistical distribution of the organisms, and also of the method of spectral analysis of stochastic processes (I0), which makes it possible to characterize quantitatively the spatial distribution of the oligochaetes. The peaks of the curve on the density function plot show how many samples separate each recurring density variation characterized by a specific amplitude. Thus, the general variability is resolved into a series (3-4) of periodic components. This suggests the presence of a multilevel hierarchy of aggregations, in which large aggregations consist of smaller ones, which are in their turn composed of still smaller ones, etc., all these aggregations being regularly, and not randomly, distributed in space.

The littoral biotope transect yielded I2 oligochaete species: 7 tubificid species, and 5 naidid species. The following species occurred particularly often: *L. hoffmeisteri* (6I%), *L. udekemianus* (6I%), *P. hammoniensis* (30%), *I. newaensis* (I6%). *Ps. barbatus* occurred less frequently. Among the naidids, the most frequently occurring species was *Uncinais uncinata* (I7%). The data we have given show 8
that the oligochaete population as a whole and the individual species are definitely microaggregated. The aggregation coefficient is lowest for *L. udekemianus* (C_L - I.8), and highest for *Ps. barbatus* (C_L - 43.4) and *Is. newaensis* (C_L - I.3). Our data demonstrate that patchiness recurs regularly every 20, 50 and I30 cm. Each species is characterized by its own specific aggregation recurrence frequency. Thus, aggregations of the species *L. udekemianis*, characterized by the lowest aggregation coefficient, occur rather frequently - every 20 cm, which creates the impression that the species is the least aggregated one.

Aggregations of L. hoffmeisteri (C_L - 2.9) occur every 50 cm. The same aggregation recurrence frequency is characteristic of P. hammoniensis, although its C_L = II.9. The lowest degree of patchiness - aggregations recurring every I30-I50 cm - is found in the case of Is. newaensis and Ps. barbatus. These species have the highest coefficient of aggregation. Analysis of the age structure of the population of almost every species shows that the adult clitellar individuals, which are in the process of breeding or which have already laid their cocoons, are massed in the central part of the aggregation, while the young worms occupy its peripheral zone. A general big aggregation of oligochaetes recurs every I20-I30 cm. Weak positive correlation (with P = 95%) is reliably known to exist among the species forming part of such an aggregation.

Reliably known interspecific correlations (with P = 95%)

L. hoffmeisteri - Is. newaensis 0.2I ± 0.I

P. hammoniensis - Is. newaensis 0.43 ± 0.09

P. hammoniensis - Ps. barbatus 0.66 ± 0.08

Is. newaensis - Ps. barbatus 0.29 ± 0.I

This points to the absence of antagonistic interspecific interactions 9
within the aggregations.

Analysis of the microstructural patterns in the distribution of the littoral community enables us to make the following conclusions. Among the bottom-dwellers of the littoral, L. udekemianus and L. hoffmeisteri show a particularly uniform distribution. These species, like the chironomid species *Ch. plumosus* and *Stictochironomus*, are characterized by a I00% frequency of occurrence in the biotope. These tubificid species form family groups, which are organized in such a way that in each microaggregation the adult individuals occupy the central part, while their young surround them in the peripheral zone. The small distances of I5-20 cm separating the groups suggest that worms belonging to these species are sufficiently well adapted to the substratum and are capable of finding suitable conditions for life at practically any point in the littoral zone. Nor are they adversely affected by the presence of other species. Considerably greater densities are found in aggregations of *Is. newaensis*, *Ps. barbatus* and *P. hammoniensis*, which means that these species are more demanding with regard to their habitat.

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BIOLOGY OF *POTAMOTHRIX HAMMONIENSIS* (MICH.) (TUBIFICIDAE, OLIGOCHAETA) IN WATER BODIES OF DIFFERENT TYPES

by

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P. hammoniensis is a species which is widespread in the stagnant and nearly stagnant water bodies of the Paleoarctic, where it plays an important role in the production processes of the bottom biocenoses. This role has of late attracted to the species the attention of specialists, who have studied it from various points of view.

The present paper discusses the results of research into 11 some of the aspects of the biology of P. hammoniensis, which was conducted in the following three water bodies of the Upper Volga basin: the mesotrophic Ivankovo and Rybinsk reservoirs and the eutrophic Lake Nero. The aspects studied included the relative importance of the oligochaetes in the community, the size and age composition and the generative structure of the population, the breeding season, the fecundity, and the duration of the embryonic development period.

In the Rybinsk reservoir, systematic observations were carried out from 1971 to 1977. They were conducted in the Volga reach over a biotope of gray muds in the former channel of the Volga at depths of 9-15 m. Reconnaissance observations were made in the Ivankovo reservoir during the growing season of 1978 and 1979 on the gray muds of the former channel of the Volga in the Lower Volga reach at depths of 9-14 m. Similar investigations were performed on the sapropel muds of the north-western part of Lake Nero at depths of 0.5-4 m.

In the Rybinsk reservoir samples were taken weekly during the growing season and one or two times a month while the reservoir was frozen over; in the other water bodies sampling was done once a month. The work was performed by means of a small box-type Ekman-Berge grab sampler with a cross-section of 1/25-1/40 m^2 (2-5 hauls). The material was washed through silk gauze sieves No. 21-23. The samples were processed by methods generally accepted in hydrobiology.

In the Rybinsk reservoir P. hammoniensis is one of the dominant species that form a stable tubificid community; in abundance and biomass it is inferior only to Limnodrilus hoffmeisteri Clap.

and *Isochaetides newaensis* (Mich.). In the Ivankovo reservoir this species is a subdominant form, the dominant role being played by *L. hoffmeisteri*. In Lake Nero *P. hammoniensis* predominates among the tubificid species and is found throughout the lake. 12

In all of the three water bodies the biology of *P. hammoniensis* is similar in many respects. The species has lived in the reservoirs for no less than three years. The population consists of young worms, one- or two-year-old individuals (the core of the population), and old worms of uncertain age, including those with a segment VIII diameter of 0.625-0.925 mm. The population always includes individuals which are at different stages of generative development. In the Rybinsk reservoir the ratio between the number of sexually mature worms with clitella and the total number of worms in the population remains constant from year to year. Mature worms with clitella account for 0-39%, the maximum percentage being reached in May. The same ratio is characteristic of the *P. hammoniensis* population in the Ivankovo reservoir. Young worms 2-5 mm long, and juvenile and adult individuals whose sexual system is in the process of development or being resorbed account for 7-71% and 20-68%, respectively, in the Rybinsk reservoir, and for 14-83% and 13-74% in the Ivankovo reservoir. The worms begin to reproduce in May, when the bottom temperature rises to 6-7°C. The first to start reproducing are the large individuals with a segment VIII diameter of 0.625-0.925 mm. At the end of May and in June they are joined by a growing number of smaller one-year-old worms with a segment VIII diameter of up to 0.225-0.3 mm. The reproductive period lasts 2-3 months. Active reproduction goes on for 1-1.5 months. Very few individuals reproduce in July and in August.

In Lake Nero sexually mature worms with clitella account for
up to 50% of the total abundance. The worms get ready to reproduce
and reach their maximum abundance already during the winter months
and are, therefore, able to start reproducing somewhat earlier (as
soon as the mud grows sufficiently warm) than in the reservoirs. The 13
period, the duration and the character of the reproduction process
are the same as in the reservoirs. In the open part of the lake re-
production ceases in June, while in the flowing water area (the head
of the Veksa river) it comes to an end in July-August.

One individual lays from 2 to 32 cocoons. Cocoons containing the largest number of embryos occur at the beginning of the growing season. In June and July, when the small-sized worms start reproducing, the number of embryos in the cocoons decreases. The range of variations in the number of embryos per cocoon is nearly the same in the different oligochaete populations: 3-20 embryos in the Rybinsk reservoir, 2-20 in the Ivankovo reservoir, and 4-14 in Lake Nero.

Active reproduction of P. hammoniensis takes place at temperatures of 6-18°C. The high bottom water temperature in July hampers maturation and reproduction. The incubation period lasts about a month. In different years, depending on when the worms start to reproduce and on the temperature conditions during the period of embryonic development, the young begin to emerge between the last days of May and the second half of June. In the open part of Lake Nero hatching ended in June; in the Ivankovo reservoir, in 1978, it was over in July, and in the Rybinsk reservoir young worms continued to hatch

till July, August, sometimes till September. In 1977 the hatching period in the lake and the main hatching period in the Rybinsk reservoir came to an end at the same time. Following reproduction, a certain number of individuals die; in those that remain alive the sexual system undergoes resorption and regeneration. During the second half of summer and in autumn, the sexual system is formed in worms which are to reproduce in the following year. In the reservoirs, the ovaries of some of the individuals begin to function in September and October. From January to March eggs are accumulated and undergo development in the ovisacs. The worms copulate and lay cocoons in 14
spring as soon as the water body is free from ice. The lake in winter contains mature worms with eggs in the ovisacs and sperm in the spermathecae. No cocoons were found,

The life cycle of *P. hammoniensis* is largely determinated by temperature conditions. In water bodies with sharp seasonal variations in temperature the population breeds in the spring and summer months: Lake Disnai (1), Lakes Saad"yarv and Vyrts"yarv (2), Lake Esrom (5-8), the water bodies of the upper Volga basin (our data). Prolonged exposure to low temperatures results in a longer reproductive period. Thus, in the profundal of Lake Mergozzo, where the temperature remains practically constant (4.5-6°C), sexually mature worms, cocoons and young worms are found throughout the year (4). In the lake of Lesser Sevan three reproductive periods are distinguished at a depth of 60 m: the winter, the summer, and autumn periods. The worms start reproducing at a temperature of 2.6°C (3). The rate at which the bottom sediments grow warm and the temperature conditions which in different years develop in the water body and in its various parts determine the time of the onset and the length of the breeding season, the fecundity, the amount of time needed for the embryonic development and sexual maturation of the worms, and the total duration of their life.

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ON THE RELATIONSHIP BETWEEN THE MICROFLORA AND THE HABITAT OF THE TUBIFICIDAE

by

A.V. Balykin

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The method of utilizing animal farm effluent for breeding tubificids to be used as food for fish by fish-farms has lately become widespread. Two tubificid species - *Tubifex tubifex* and *L. udekemianus* - have become well adapted to the natural effluent-polluted ecosystems of the Chu valley in the Kirghiz SSR. The tubificids have been able to adjust themselves quite well to their extreme conditions and have retained a high reproductive capacity. Laboratory studies have shown that the effluents and the bottom muds are rich in organic matter and abound in all kinds of microflora (Balykin, 1976; Balykin *et al*., 1979). Our data indicate that in terms of abundance microorganisms surpass all other organisms both in the muds and in the effluents. The purpose of our investigation was to determine the nutritive value of bacteria to the tubificids and to study the ecological relationship between them; we also wanted to find out if the worms accumulated those species of bacteria that serve as sanitary condition indicators.

The few existing publications on the microflora of the Tubificidae do not discuss any of the important aspects of the above-mentioned problem; the instances of tubificids feeding on bacteria that are mentioned involve totally different ecological conditions (Coler, Gunner, Zuckerman, 1967, Warve, Brinkhurst, 1971, Whitli, Thomas, Seng, 1976). For our study, worms were collected in ditches carrying the effluents of large animal farms and milk factories. They were extracted from the substratum composed of a muddy sediment, thoroughly washed and placed in flowing water, where they were kept for 5 days. 17
Prior to bacterial inoculation, the worms were placed for three minutes in 96° ethyl alcohol, following which they were repeatedly washed in sterile physiological salt solution. After this, the worms were exposed for 60 seconds to the rays of a germicidal lamp (OBP-450) in order to destroy completely the remaining surface microflora.

An adequate amount of tubificids was ground in sterile porcelain mortars filled with sterile water and the suspension thus prepared was introduced onto an appropriate nutrient medium. The work was carried out in accordance with procedures used in sanitary, aquatic and medical bacteriology.

First of all, we studied the composition of the microflora present in the bottom muds that served as a nutrient substratum for the tubificids. It was found that the bottom mud microflora included a wide variety of species and that its species composition remained stable throughout the year.

The detected microflora was, for the purpose of our study, divided into two categories: bacteria serving as sanitary condition indicators, and heterotrophic bacteria. In terms of abundance, particularly prominent among all the groups of bacteria in the inoculations were coliform bacilli, pseudomonades, and representatives of the *Proteus*. The strains were identified as *E. coli*, *E. coli communior*, *Proteus vulgaris*, *P. mirabilis*, *Pseudomonas aeruginosa*, *Ps. fluorescens*, *Achromobacter* sp.

Also present were microorganisms from the genera *Micrococcus*, *Bacterium*, *Bacillus*, *Streptococcus*. In addition to bacteria, we often found yeast, fungi and actinomycetes but did not try to identify their species. The above-mentioned groups of microorganisms form the principal microflora background in the bottom muds and in the animal farm effluent. According to our data, the coli titer of the effluent was as high as 1×10^{-10}, while that of the muds reached 1×10^{-9}. The total number of bacteria in one gram of mud was 10 billion cells. 18
In analyzing the microflora isolated from the tubificids, we were able to establish that it bore a distinct relation to the microflora of the substratum and the effluent. Precisely as in the case of the muds, the microflora found in the tubificids showed a numerical predominance of the group of bacteria serving as sanitary condition indicators. It should however be noted that the tubificid microflora also contained an increased proportion of other microorganisms, including, among others, coccal and bacillic species. The worms yielded largely the same species as the muds, although the qualitative and quantitative composition of the microflora was not quite so rich. Thus, the total number of bacteria in one gram of tubificids reached 120 million cells, while the coli titer amounted to 1×10^{-5}. This is se-

veral orders of magnitude below the corresponding figure for the substratum.

Our analysis showed a direct relationship between the numbers of microorganisms in the substratum and in the worms. The less pollution there was in the water and in the mud, the more microorganisms were found in the tubificids. Some researchers (R.A. Coler, H.B. Gunner *et al*. 1967) have demonstrated experimentally that *Limnodrilus* and other tubificids feed on coliform bacilli. They believe that under natural conditions worms themselves fashion the microflora around them by having a preference for a particular species. Our preliminary data, obtained under simulated conditions, support this hypothesis. Thus, specimens of sewage water inhabited by tubificids increased their coli titer by comparison with the control specimen, which means that the quality of the water improved to a certain extent with respect to the presence of microorganisms serving as sanitary condition indicators. We were also able to isolate from the tubificids certain species of symbiotic bacteria which are found only in worms and which seem to play an important role in the physiological processes of assimilating the organic substances contained in the food. These are various vibrio-type microorganisms, streptococcal species, and species belonging to the genus *Bacillus*. 19
The importance of symbiotic microorganisms is emphasized in the works by E. Shteinkhauz (1950) and Ya. Vaizer (1972). Considering the wide variety of biochemical and physiological processes in which microorganisms are involved, we thought it necessary to study the characteristics of the strains isolated from the tubificids. In the bacterial

cenoses of the worms, we identified species producing hydrogen sulfide, ammonia and urease, and having proteolytic, amyolytic and nitrate-reducing properties.

Altogether we studied the physiological and biochemical parameters of 120 strains. Of these, 90 strains were found to produce hydrogen sulfide, 15 strains produced indole, and 90 strains produced ammonia. 40 cultures were capable of producing urease, and the proteolytic property was established in 80 cultures. The data obtained make it possible to conclude that the bacterial cenoses of the tubificids contain microorganisms which are physiologically and biologically active. These microorganisms appear to play an important role in the trophic decomposition processes that transform the organic substances which the tubificids consume as food after extracting them from the substratum.

Thus, our investigations show that the microflora of the tubificids consists of an association of various species. Our studies of the microflora point quite clearly to the existence of an intimate ecological relationship between the habitat (substratum) and the tubificids. This relationship was studied particularly well in the case of the coliform bacillus E. coli. We have every reason to believe that the microorganisms of the substratum (bottom muds) constitute an important component of the food consumed by the tubificids; these microorganisms also play a significant role in the physiological processes taking place in the worms' bodies. However, tubificids living in effluent-polluted waters can accumulate certain
pathogenic microorganisms and bacteria serving as sanitary condition 20

indicators. The tubificids which we analyzed yielded 25 species of microorganisms.

CRAYFISH OLIGOCHAETES IN THE WATER BODIES OF THE UKRAINE

by

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Oligochaetes of the family Branchiobdellidae are constant members of the crayfish symbiotic cenosis, which also includes infusorians, rotifers, nematodes and copepods. Over 40 branchiobdellid species of the genera Branchiobdella, Bdellodrilus, Cambarincola, Pterodrilus, Xironodrilus and Xironogiton have been described from the crayfish inhabiting the water bodies of Europe. However, Pop's detailed investigations (Pop, 1965) into the crayfish branchiobdellids of the water bodies of Rumania, as well as his studies of collections accumulated by other researchers, led him to the conclusion that in Europe the crayfish served as hosts to only four species of the genus Branchiobdella described in the XIXth century: B. astaci Odier, 1823; B. parasita (Braun, 1805) Henle, 1835; B. pentadonta Whitman, 1882; B. hexadonta Gruber, 1883. Pop declared all the branchiobdellid species described from the crayfish in this century to be synonyms of one or another of the above-mentioned four species.

Later, Karaman (Karaman, 1970) reaffirmed the independent status of the species Branchiobdella italica Canegallo, 1928 and B. balcanica Moszynski, 1937, and in 1978 Subchev (Subchev, 1978) described a new branchiobdellid species - *B. kozarovi*.

In addition to the oligochaetes of the family Branchiobdellidae, a representative of the family Aelosomatidae - *Hystricosoma chappuisi* Michaelsen, 1926 has also been described from the crayfish.[21]

In the Soviet literature, the works published before our studies were made mention the occurrence on crayfish of four species of the genus *Branchiobdella*: *B. astaci* (in the Russian and Baltic Republics), *B. parasita* (in the Russian Republic and the Estonian SSR), *B. pentadonta* (in the Russian and Baltic Republics), *B. hexadonta* (in the Russian Republic).

In 1975-1980 we studied about 1500 crayfish in different water bodies in the Ukraine. The long-clawed crayfish *Astacus leptodactylus* Eschsch. was studied mainly in the Dnieper basin (in the Dnieper-Bug liman, in the Kakhovka, Kremenchug, Kanev and Kiev reservoirs, and in the Dnieper tributaries: the Ingulets, Olshanka, Seym, Sluch, Sula and Udai rivers) and also in some of the water bodies of the Danube basin (Lake Katlabukh) and the Southern Bug basin (near the towns of Nikolayev and Uman). The broad-clawed crayfish *Astacus astacus* L. (30 specimens) was studied in some of the lakes of the Lvov region.

The crayfish of the Ukrainian water bodies were found to serve as hosts to three species of the family Branchiobdellidae (*Branchiobdella kozarovi*, *B. pentadonta*, *B. balcanica*) and to one species of the family Aelosomatidae (*Hystricosoma chappuisi*).

B. kozarovi was found on the long-clawed crayfish of the Dnieper, Danube and Southern Bug basins. It occurred mostly on the

surface of the body and, far less frequently, in the gill cavity. Large numbers of cocoons of these oligochaetes were found on the limbs and on the gill filaments. In some water bodies, such as the Kakhovka reservoir and the Dnieper-Bug liman, the incidence of *B*. 22
kozarovi reached 90.0-100.0%. The number of worms carried by one host varied between 5 and 180.

The specimens of *B*. *kozarovi* which we studied differed by a number of morphological characters from the first description of this species. They reached 3 mm and over (up to 4 mm) in length, while according to Subchev (Subchev, 1978), their bodies are 1.1-1.7 mm long; the maximal width of the head is always considerably greater than the width of the first trunk-like segment; there are 18 pharynx papillae, and not 16 as indicated by Subchev; at the distal end of the spermatheca pouch there is a small appendage. We found worms not only on the surface of the crayfish's bodies but also in their gill cavities; according to Subchev's data, worms occur only on the outside of their hosts.

When studying the broad-clawed crayfish in the lakes of the Lvov region, we found representatives of two more branchiobdellid species - *B*. *pentadonta* and *B*. *balcanica*. *B*. *pentadonta* was found on 12 of the 20 crayfish that were investigated. The number of worms per host varied from 3 to 44. *B*. *balcanica* was discovered on one of the ten crayfish we investigated. The crayfish carried 39 worms. The cocoons and the worms themselves were found only on the surface of the crayfish's bodies.

A representative of the family Aelosomatidae - *Hystriosoma* *chappuisi* was found on long-clawed crayfish in all the water bodies which we investigated. These are small worms, not exceeding 1.7 mm in length, which normally form chains consisting of two zooids. In the worms that we studied the maximum number of setae in the dorsolateral bundles was 8, while other researchers (Michaelsen, 1926; Kasprzak, 1976) mention 12-15 setae. The maximum length of the setae is 145 mkm according to our data, and 100 mkm according to the data of other authors.

The incidence of *H. chappuisi* is particularly high (90.0- 23
100.0% among the crayfish of the Kakhovka reservoir, the Dnieper-Bug liman and the Ingulets and Volshanka rivers. The number of worms present in the gill cavity of a single crayfish usually varied between 100 and 500, sometimes exceeding 1000, and in certain cases reaching 7000.

Studies of the seasonal population dynamics of *B. Kozarovi* and *H. chappuisi* show that the former species occurs in crayfish throughout the year. *H. chappuisi* was found on crayfish only during the warm months - from April to November. In the summer months worms of the genus *Hystricosoma* reproduce asexually by paratomy; in autumn they begin sexual reproduction and the laying of cocoons.

Among the stenotopic members of the crayfish symbiotic cenosis, worms of the genera *Branchiobdella* and *Hystricosoma* are distinguished for their frequency of occurence and abundance. In addition to these oligochaetes, we found the following other forms in the gill cavity of the crayfish we examined: *Aelosoma hemprichi*, *A. quaternarium*, *A. tenebrarum*, *A. variegatum*, *Dero obtusa*, *Nais barbata*, *Pristina aequiseta*, *Stylaria lacustris*, *Vejdovskiella comata* and some others which are not commonly associated with crayfish and get into their gill cavities merely by chance.

The presence of epibiotic oligochaetes on crayfish does not result in any appreciable and immediate harm to the host. However, when occurring in large numbers, the worms and their cocoons may have a detrimental effect by damaging and deforming the gill filaments.

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PRESENT-DAY CONDITION OF THE OLIGOCHAETE POPULATION IN THE ZAPOROZHYE RESERVOIR AND IN ITS INLETS

by
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The existing literature provides data on the Dnieper oligochaetes obtained before the formation of the Zaporozhye reservoir (1), in the course of its formation (2), during the period when, after the destruction of the Dnieper power station dam, the reservoir reverted to its original river status (3), during the restoration of the reservoir (4), and during the first several years of its existence under regulated flow conditions (5).

Over the last 10 years, the influence of the Kremenchug and Dneprodzerzhinsk reservoirs, situated farther upstream, has reduced the fluctuations in the water level resulting from the use of the water in the production of electric power. This, in its turn, has led to a decrease in the area of the littoral which periodically became dry before the flow was finally regulated.

As a result of the general and partial changes in the hydrobiological conditions that occurred in the Zaporozhye reservoir following the formation of a series of reservoirs on the Dnieper, the bottom fauna cenoses have become less varied as compared with the cenoses that appeared in the reservoir after it was formed. Sand-inhabiting biocenoses no longer play an important role in the reservoir and include *Isochaetides michaelseni* Last., *I. newaensis* Mich., and *Propappus volki* Mich.

A considerable part of the littoral bottom in the reservoir is composed of loess. In the past, the erosion of the banks and the transport of the erosion products affected the development of the benthos in the littoral zone. The abundance of the bottom macrofauna 25
in this zone did not exceed 200 ind/m^2. In the course of the last ten years the proliferation of emergent and submersed higher aquatic plants along the banks of the reservoir has brought the bank erosion process to a halt, with the result that the bottom fauna has become more varied and abundant. Data gathered in 1978 show that the loess macrozoobenthos was represented at the time by oligochaetes, polychaetes, leeches, mollusks, gammarideans and insect larvae, their total abundance being as high as 2000 ind/m^2 and their biomass reaching 170 g/m^2 (with the mollusks). *I. newaensis*, *I. michaelseni*, and *Stylaria lacustris* L. accounted in this zone for only 3% of the abundance and for 8% of the biomass of the above-mentioned groups of invertebrates, exclusive of the mollusks.

Under the conditions now existing in the Zaporozhye reservoir higher aquatic plants grow in large numbers both near the banks of the main reach and in the inlets, some of which are several kilometers long. We made collections of invertebrates among very thickly growing submersed macrophytes, which are widespread throughout the littoral zone. These are, for the most part, clasping-leaved, fennel-leaved and various-leaved pondweeds, as well as spiked milfoil. To characterize quantitatively the fauna of the thickly overgrown areas, we calculated the number of the detected invertebrates per kilogram of raw plants.

The oligochaete fauna is particularly varied in areas overgrown with clasping-leaved pondweed. This fauna is represented by *Nais communis* Piguet, *N. barbata* Müll., *N. simplex* Piguet, *Uncinais uncinata* (Oersted), *S. lacustris*, *Ophidonais serpentina* (Müll.), and more seldom by *Chaetoganter diaphanus* (Gruithuisen). The dominant invertebrates in these areas are chironomid larvae - up to 1.5 million ind/kg in terms of abundance and up to 25.0 g/kg in terms of biomass; 26
the phytophilous oligochaetes constitute only 2-3% of the abundance of the chironomid larvae and no more than 0.5% of their biomass. The same oligochaete species, although in much smaller numbers, inhabit areas overgrown with fennel-leaved and various-leaved pondweed. There they account for no more than 1% of the total number of all the organisms living on the plants. No oligochates were found among spiked milfoil plants.

The decrease in the speed of the current in the Zaporozhye reservoir has resulted in the formation of a layer of silt in some parts of the sandy bottom. The silted areas of the reservoir are characterized by a bottom fauna which includes various groups of organisms, such as leeches, mollusks, chironomid, mayfly and dragonfly larvae. However, the oligochaetes inhabiting those areas (*Limnodrilus hoffmeisteri* f. tipica Clap., *L. claparedeanus* Ratzel, *Tubifex tubifex* (Müll.), *Limnodrilus udekemianus* Clap., *Potamothrix hammoniensis* (Mich.) constitute no more than 50% of the total abundance of the macrozoobenthos, whereas formerly they accounted for 75-80%.

The profundal zone of the reservoir, at depths of over 10 m, is inhabited mostly by pelophylous oligochaetes - *L. hoffmeisteri*, f. tipica, *L. udekemianus*, *L. claparedeanus*, *T. tubifex*. Although represented by a small number of species, they constitute up to 97-99% of the total abundance of the macrozoobenthos. In the silted parts of the profundal zone the abundance of the oligochaetes increases from the higher to the lower areas up to depths of 20-25m. Thus, along the section line between the villages of Kodak and Lyubimovka (at depths of up to 10 m) the abundance is as high as 1500 ind/m^2; along the section line between the village of Zvonetskoe and the Voronoi inlet (at depths of up to 15 m) it amounts to 4000 ind/m^2; near the village of Petrovo-Svistunovo (at depths of up to 25 m) it is 6000 ind/m^2. As one moves closer towards the dam of the Lenin power station, the depth of the reservoir increases, while the abun- 27
dance of the oligochaetes decreases: along the section line between the Vil'nyi and Vil'nyanka inlets (at a depth of 33 m) it reaches 1800 ind/m^2 and in the Kichkas-Yama depression (over 50 m deep) it amounts to 1150 ind/m^2.

In an earlier paper (5) it was reported that in the areas polluted by industrial and domestic effluent the number of oligochaetes reached one million ind/m^2. The presence of large numbers of individuals of the species *L. hoffmeisteri* f. tipica, *L. claparedeanus*, *T. tubifex* indicated that, from the ecological point of view, conditions in the water body were nearly saprobial. Also present in the same areas was the species *Peloscolex ferox* (Eisen), which numbered 280 ind/m^2.

At present, with some of the indusrtial enterprises beginning to use closed water recycling systems, the sanitary condition of the polluted areas in the reservoir has improved. The structure of the benthos communities is changing, with new dominant groups emerging in them: the detrivorous species L. hoffmeisteri f. tipica and I. newaensis are being replaced by filter feeders (mollusks, gammarideans). Oligochaetes are becoming scarce, their abundance not exceeding 120 ind/m^2.

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STRUCTURAL AND FUNCTIONAL CHARACTERISTICS OF THE OLIGOCHAETE POPULATIONS IN THE KRASNOYARSK RESERVOIR

by

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In the present paper we shall analyze the oligochaete fauna of the Krasnoyarsk reservoir on the basis of data collected in 1975-1980. We shall distinguish two separate periods within this interval of time (I - 1975-1978, II - 1979-1980), taking into account the redistribution of polluted areas and the impact of the Sayano-Shushenskoe reservoir which is now in the process of formation. The data were processed with the help of G.N. Skoptsova and B.E. Anninskii.

As regards the number of species by which they are represented in the bottom communities of the Krasnoyarsk reservoir, the oligochaetes are second only to the chironomids. During the above-mentioned period of study we were able to identify 35 oligochaete species, of which 18 belong to the family Naididae and 14 to the family Tubificidae. Sufficiently widespread in the reservoir are Uncinais uncinata (140 ind/m^2)* (which are, however, absent from the areas receiving domestic and industrial effluents), as well as Stylaria lacustris (73 ind/m^2), Tubifex tubifex (880 ind/m^2), Limnodrilus hoffmeisteri (600 ind/m^2) and Aulodrilus limnobius (1200 ind/m^2). Present mainly in the upper part of the reservoir, up to the zone polluted 29
by industrial effluent, are Nais Bretscheri (30 ind/m^2), Arcteonais

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* The abundance (ind/m^2) and biomass (g/m^2) figures given in this paper represent average values.

Lomondi (40 ind/m^2), Limnodrilus udekemianus (72 ind/m^2), Peloscolex ferox (36 ind/m^2), Propappus volci (12 ind/m^2).

The area which earlier received domestic effluent and where Dero (220 ind/m^2) was the dominant genus among the naidids has of late been constantly yielding representatives of Nais simplex (67 ind/m^2) and Nais pardalis(56 ind/m^2). At the same time, the population of tubificids has greatly declined in this part of the reservoir.

Of considerable interest is the oligochaete fauna in two adjacent regions of the reservoir - the Mokhovskii and Krasnoturanskii reaches. The former is inhabited by a larger number of species - 17, but these are characterized by low population densities: 51 ind/m^2, 45 mg/m^2. The latter, which in summer time experiences extensive algal bloom, had 11 species by 1980 (it used to have 7), but the abundance and biomass of its oligochaete population, dominated to a considerable extent by tubificids, amounted, respectively, to 262 ind/m^2 and 1.3g/m^2. The species Potamothrix bedoti had grown in abundance from 70 to 1600 ind/m^2.

The overall proportion of oligochaetes in the bottom fauna of the Krasnoyarsk reservoir varies within the following limits: in terms of abundance - 59% in the upper part of the reservoir, 62% in the middle part, and 52% in the lower part; in terms of biomass - 29% in the upper part, 56% in the middle part, and 38% in the lower part.

The distribution of oligochaetes with depth in the benthic zone follows characteristic patterns, which are dissimilar in different regions of the reservoir. In the Krasnoturanskii reach, in the upper part of the reservoir, at depths of 20 m and over, the proportion of oligochaetes in the specific composition reaches 97-100%, their abundance and biomass being also fairly high: up to 1960 ind/m^2 and up to 5 g/m^2. Samples taken in the benthic zone at all depths normally contain Slavina appendiculata, Specaria josinae, Uncinais uncinata, Potamothrix bedoti, and Tubifex tubifex. 30

In the deeper and less eutrophic Primorskii reach, the predominance of oligochaetes (namely Limnodrilus hoffmeisteri and T. tubifex) becomes evident at depths of 35 m and over (92%, 600 ind/m^2, 0.2 g/m^2), the three characteristics reaching their maximum values at depths of 50-60 m (100%, 2200 ind/m^2, 1.5 g/m^2). Below 60 m, the bottom communities contain only Tubifex tubifex, whose abundance is very low - 70 ind/m^2.

Table 1

Production and decomposition characteristics of the oligochaetes of the Krasnoyarsk reservoir (1976-1978) J/m^2

Part of the reservoir	Average value for the growing season				
	B	P	P*	A	P/B
Above the effluent discharge	22	8	3	6	0.13
Domestic effluent discharge	556	130	55	185	0.09
Industrial effluent discharge	116	28	12	40	0.10
Mokhovskii reach	208	27	11	38	0.05
Krasnoturanskii reach	580	67	29	95	0.05
Novoselovskii reach	257	36	15	51	0.05
Primorskii reach	146	50	18	59	0.10
Reach immediately above the dam	119	19	8	27	0.06
Average value for the reservoir	251	45	19	63	0.08

The production and decomposition characteristics of the oligochaetes show considerable variations in the different regions of the

* Production was calculated by the physiological method with $K_2 = 0.3$.

Krasnoyarsk reservoir due mainly to hydrobiological and anthropogenic factors (Table 1).

The gross and net production and decomposition values are 31
lowest in the steady-flow region of the upper part of the reservoir, in the zone of industrial effluent discharge, and in the deep reach immediately above the dam. These values are highest in the zone of domestic effluent discharge, and in the eutrophic Krasnoturanskii reach.

The role of the oligochaetes (calculated on the basis of the decomposition, assimilation, suspended organic meterial content and current speed values) in oxidizing the suspended organic material present in the Krasnoyarsk reservoir is insignificant - no more than one per cent. Of much greater importance is the role they play in mineralizing the assimilated food through the process of decomposition: the oligochaetes mineralize daily an average of 334×10^5 J of organic material in the upper part of the resrvoir, 108×10^5 J in the middle part, and 15×10^5 J in the lower part.

Thus, at the present time, the oligochaete fauna of the Krasnoyarsk reservoir comprises 35 species, after the emergence of 7 new species during the years 1974-1980; the abundance of the oligochaetes in the reservoir has grown, on average, from 32 ind/m^2 to 98 ind/m^2, the actual rate of growth varying greatly in the different regions; the benthic zone, starting from depths of 20-30 m, is inhabited mainly by oligochaetes; the mineralization activity of the oligochaetes is particularly intensive in the upper part of the reservoir, which receives considerable amounts of effluent and experiences extensive algal bloom.

LAKE BOTTOM SEDIMENTS AS THE MOST IMPORTANT FACTOR IN THE DISTRIBUTION AND DEVELOPMENT OF AQUATIC OLIGOCHAETES

by

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The specific composition and distribution of the benthic organisms are determined by the temperature of the water and by its che- 32
mical and physical properties, by the sediments, by the bottom microflora, by the vegetation present in the lake, and by a number of other factors.

Our investigations were conducted over a part of Lake Lushyai, one of the lakes in the National Park of Lithuania. The area investigated, although not very large, was characterized by great variety in its bottom sediments and thermal conditions.

Lake Lushyai is a deep subglacial channel lake of the thermal type with pronounced thermal stratification. The longitudinal axis of the lake (6.2 km) is directed from east to west (Fig. 1).

The epilimnion is 6-7 m thick. The hypolimnion is characterized by a high concetration of dissolved oxygen (2-7 mg/l), by a low and constant water temperature, which at a depth of 37 m varied between 6.4 and 6.6°C (Zhukaite, 1980), and a low concetration of biogenic matter. The highest concentrations of biogenic matter are found at a depth of 10 m (Grigyalis et al., 1982) (in the press).

Transect AB, which lies at a distance of 320 m from the deepest area (37 m) (Fig. 1), contains a large variety of bottom sediments. 33

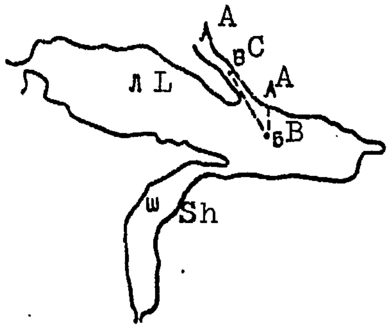

Рис.I. Схема озер Лушяй (Л), Шакарвай (Ш) и приток в озера Асалнай (А). Разрезы АБ и БВ.

Fig. 1. Map of Lake Lushyai (L), Lake Shakarvai (Sh) and the channel leading to Lake Asalnai (A). Transects AB and BC.

We find sand near the bank, up to depths of 1.0-1.5 m; gray mud - far- 33
ther down, at depths from 1.5-2.0 to 6.0 m; gray mud with gravel - at depths of 6.0 - 10.0 m; light-colored gray mud - at depths from 10 to 24 m; carbonate mud - at depths of 24-27 m; and dark mud - below 27 m (27-37 m).

At transect BC, at a depth of 15 m (Fig. 1), we found lumps of ferruginous material in the form of pellets 2-4 mm in diameter.

Particularly badly affected by wave action at transect AB of Lake Lushyai is the sandy biotope extending from the bank up to a depth of 1.5 m. The littoral sand zoobenthos is dominated by oligochaetes of the species Lumbriculus variegatus and Psammoryctes barbatus, which vary from 160 to 1280 individuals per m^2 in abundance and from 1.72 to 5.42 g in biomass. This constitutes 80-90% of the total abundance and 91.5-94.1% of the total biomass of the zoobenthos. The next most abundant species are *Stylaria lacustris* and *Ophidonais serpentira*.

The most varied biotope at transect AB of Lake Lushyai is the area of bottom sediments intermediate between the sand and the mud. This area, which is 1.5-6.0 m deep, is inhabited mainly by *Potamothrix hammoniensis* but also contains *L. variegatus*, *Stylaria lacustris* and others from the family Naididae.

In the metalimnion zone (at depths of 6-10 m) the bottom is composed of gray muds. They are inhabited exclusively by *P. hammoniensis*.

At depths from 10 to 24 m there are gray muds with a large proportion of carbonates, containing patches of red mud and blue clay with red mud. The carbonate mud biotope, situated at a depth of 15 m, is dominated by oligochaetes of the species *Ps. barbatus*. Their abundance was 240 ind/m^2 and their biomass amounted to 2.8 g or to 51.5% of the total biomass of the zoobenthos. The abundance and biomass of *P. hammoniensis* are 160 ind/m^2 (13.8%) and 0.24 g (4.4%), respectively. No oligochaetes were found in the red mud. Farther down, at depths
of 18-19 m, the biotope of blue clay and red mud is inhabited by *Ps.* 34
barbatus, whose abundance and biomass amount to 280 ind/m^2 (35% of the total abundance of the zoobenthos) and to 0.28 g (48%), respectively.

The biotope of gray muds at a depth of 23 m is inhabited by *Ps. barbatus* (85 ind/m^2; 1.3 g) and *P. hammoniensis* (140 ind/m^2; 0.56g). One meter deeper we found only *P. hammoniensis*, whose abundance amounted to 290 ind/m^2 and whose biomass was 2.0 g (90%).

Below 15 m, i.e. in the hypolimnion of Lakes Lushyai and Shakarvai, conditions are not very favorable for the reproduction and existence of oligochaetes, the temperature of the bottom layers of water being 6.4-6.6°C. According to N.R. Arkhipova (1980), *P. hammoniensis* begin reproducing only when the bottom water temperature reaches 6-7°C.

Under low temperature conditions *P. hammoniensis* grows slower and fails to reach the size of those individuals that live closer to the metalimnion in Lakes Lushyai and Shakarvai and in the channel leading to Lake Asalnai.

In the channel of Lake Asalnai the maximum abundance and biomass in 1977-1980 were 560 ind/m^2 and 4.92 g, while in the deep-water zone of Lake Lushyai, which is practically never visited by warm-water fish and where there are no bottom-feeding whitefish, these characteristics amounted to 680 ind/m^2 and 3.68 g/m^2.

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ECOLOGICAL AND FAUNISTIC DESCRIPTION OF THE OLIGOCHAETES INHABITING THE BROOKS AND SPRINGS OF THE EASTERN UKRAINE

by

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The present paper is a fragment of a study entitled "Hydrobiological investigations of the brooks and springs of the eastern Ukraine", which was prepared by the Department of Zoology and Darwinism of the Kharkov Zooveterenary Institute. The investigations were begun in 1969 at the suggestion and under the direction of Professor E.I. Lukin.

Several reasons make investigations of brooks and springs necessary: they are very numerous and widespread, they exert a marked influence on the conditions which develop in rivers and lakes, they are of considerable economic importance, and yet the literature provides no data on the hydrology and the hydrobiological characteristics of these water bodies in the Ukrainian lowlands.

Material used in the investigations before 1972 was collected within the Kharkov region during one- or two-day trips; later, seven expeditions were organized by the Department for that purpose: in 1972 - to the southern part of the Kharkov region, in 1973 - to the Sumy region and the adjacent Belgorod and Kursk (Russian SSR) regions, in 1974 - to the Belgorod region and the northern part of the Kharkov region, in 1976 - to the Dnepropetrovsk and Zaporozhye regions, in 1977 - to the Donetsk and Zaporozhye regions, in 1978 - to the 36
Chernigov and Sumy regions, and in 1979 - to the Chernigov region.

Our investigations covered the territory of three geographical and climatic zones: the steppe, forest-steppe and forest zones. The material - 1469 samples of benthos and plankton - was collected by universally adopted hydrobiological methods from 92 springs and 132 brooks.

The oligochaetes living in the brooks and springs were found to form, together with the chironomids, the dominant group of aquatic organisms. They were present in all of the investigated brooks, including those that dried up as early as June or the first days of July. Altogether, 44 oligochaete species were found: fam. Aelosomatidae - Aelosoma hemprichi Ehrnb. 1828, Ae. niveum Leyd., 1865, Ae. variegatum Vejd., 1884, Ae. tenebrarum Vejd., 1884; fam. Naididae - Stylaria lacustris (L., 1767), Slavina appendiculata (Udek., 1855), Dero digitata (Mull., 1773), Nais barbata Pig., 1906, N. simplex Pig., 1906, N. communis Pig., 1906, N. elinguis Mull., 1773, N. variabilis Pig., 1906, N. pardalis Pig., 1906, N. pseudoobtusa Pig., 1906, Ophidonais serpentina (Mull., 1773), Paranais litoralis (Mull., 1784), Amphichaeta leydigi Taub., 1879, Chaetogaster diastrophus (Gruith., 1828), Ch. diaphanus (Gruith., 1828), Ch. langi Bretsch., 1896, Ch. setosus Sv., 1925, Ch. limnaei Baer, 1827, Pristina longiseta Ehrenb., 1828, Pr. bilobata (Bretsch., 1903), Pr. rosea (Pig., 1906); fam. Tubificidae - Aulodrilus limnobius Bretsch., 1899, Au. pluriseta (Pig., 1906), Rhyacodrilus coccineus (Vejd., 1875), Potamothrix hammoniensis (Mich., 1901), P. bavaricus (Oeschm., 1913), Isochaetides newaensis (Mich., 1902), Limnodrilus udekemianus Clap., 1862, L. hoffmeisteri Clap., 1862, L. claparedeanus Ratz., 1868, Psammoryctides albicola (Mich., 1901), Tubifex tubifex (Mull., 1774), Peloscolex ferox (Eisen, 1879); fam. Enchytraeidae - *Fridericia* sp., *Enchytraeus* sp., fam. Haplotaxidae - *Haplotaxis gordioides* (Hartm., 1821), fam. Lumbriculidae - *Lumbriculus variegatus* (Mull., 1774), *Stylodrilus heringianus* Clap., 1862, *Rhynchelmis tetratheca* Mich., 1920, fam. Lumbricidae - *Lumbricus terrestris* L., 1758.

From the ecological point of view, the fauna in the water bo- 37
dies we investigated is not homogeneous. On the basis of their tolerance to water temperatures, all of its species can be divided into two unequal groups: cold-loving stenotherms and eurytherms. The stenotherms include *N. elinguis*, *P. ferox*, *H. gordioides*, *L. variegatus*, *St. heringianus*, *Rh. tetratheca*.

It is significant that well-heated brooks in the steppe zone contained no worms belonging to these species. *N. elinguis* and *H. gordioides* occurred in the steppes only in large limnokrene-type springs with a constant water temperature of 8-9°C. The eurytherms include all the other species. These can occur both in the upper course of a brook, where the water temperature is low, and in its middle and lower course, where the water temperature experiences wide seasonal fluctuations.

In relation to the speed of the water flow, the vast majority of the species are limnophilous - they occur mostly in areas of slack water, and it is there that their abundance is particularly high. Only *N. barbata*, *N. pardalis*, *N. Pseudobtusa* and *Pr. rosea* can be described as rheophiles, since they occur, for the most part, in biotopes where the current is relatively strong.

In relation to the substratum, the phytophilous Aelosomatidae and Naididae and the pelophilous Tubificidae are the dominant families.

The species *N. barbata*, *N. variabilis*, *N. pardalis*, *Au. pluriseta*, *Ps. albicola*, and *Is. newaensis* prefer sandy areas. Such species as *Pr. rosea* and *Rh. ceccineus* occur in maximum numbers on a slightly silted stony substratum.

Of the relatively large number of species discovered in the water bodies under investigation, only eight can be said to be typical of them: *N. elinguis*, *N. communis*, *S. lacustris*, *Oph. serpentina*, *L. hoffmeisteri*, *L. udekemianus*, *T. tubifex*, *L. variegatus*. These species occur particularly often, forming massive populations.

It is quite natural that the above-mentioned species should be dominant in the brooks of the eastern Ukraine. The habitats provided by the water bodies we have studied are much less favorable than those found in the rivers and lakes. Most of the brooks freeze through in winter and cease to exist as a water flow, while in summer they lose much of their water, drying up completely in the steppes and in the southern part of the forest-steppe zone. It is obvious that under such extreme conditions it is only the most tolerant and ecologically pliable eurythermic and eurytopic species that can develop to a sufficiently significant extent. The only species to which this does not apply are the cold-loving stenothermic *N. elinguis* and *L. variegatus*, but, as we said above, they occur only in the ice-free upper parts of brooks and in springs. Thus, the fauna of the water bodies we investigated consists essentially of eurythermic, limnophilous mud-dwellers and of phytophilous species, which makes the oligochaete fauna of the brooks similar to that of the lakes and the slow rivers of the Ukranian lowlands. This similarity results from some of the characteristic features

of the brooks of the eastern Ukraine: the slow current in most areas, the predominance of mud on the bottom and the presence of abundant 39
aquatic vegetation. None of the discovered oligochaete species can be described as being peculiar exclusively to brooks.

It follows from what has been said that brooks and springs serve, in a sense, as widely distributed faunal reserves which help replenish similar lake and river faunas partly destroyed as a result of man's economic activities. The data obtained are also necessary for developing a scientific classification of the brooks flowing in the differnt geographic and climatic zones of the Ukranian SSR and for compiling a cadastre of the animals found in the USSR. The need for such a cadastre is emphasized in the new Soviet law "On the protection and use of the fauna" passed on June 28, 1980.

SOME TRENDS IN THE CONSUMPTION OF OLIGOCHAETES BY THE RYBINSK RESERVOIR BREAM

by

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The Rybinsk reservoir is one of the largest in the USSR. Each of its four reaches differs from the other three by the specific physical, chemical and biological characteristics of its water masses (Butorin, 1969). The bottom sediments in the reaches have not yet been fully formed. Gray muds, which are particularly productive in terms of benthos biomass, occupied 8% of the reservoir area in 1955, and 37% in 1965 (Butorin, Ziminova, Kurdin, 1975).

The bream is the principal commercial fish in the reservoir; 5-15-year-old individuals at the J_2 (5-8-year-old) and K (9-15-year-old) stages of development spend their foraging periods mostly in the drowned river channels (Zhiteneva, 1962). 40

In 1978 and 1979, investigations were conducted into the feeding habits of the bream on a gray mud biotope in the Volga reach and in the north-western part of the Main reach. The contents of the intestines of 600 fish were subjected to quantitative analysis using the methods developed by T.S. Zhiteneva (1971, 1980).

Oligochaetes are easily distinguishable in the contents of the bream's intestines (with the aid of a MBS-I binocular stereomicroscope designed for reflected light work), provided their biomass in the mud of the foraging biotope is over 2 g/m^2. In the above-mentioned years, the biomass of the gray-mud oligochaetes amounted to 10 g/m^2 in the Volga reach (1978) and to 3 g/m^2 in the Main reach (an average figure for July, August and September, 1979). In both reaches the intestines of the bream at the J_2 and K stages of development contained similar food: chironomid larvae, oligochaetes and mollusks mixed with a considerable amount of gray mud and slime. Oligochaetes were present in the intestines of most of the foraging bream: their frequency of occurrence in fish at the K stage of development varied from 74 to 94% in the Volga reach and from 44 to 89% in the Main reach. The percentage of worms by weight in the bream's food was high in the Volga reach and somewhat lower in the Main reach. In the Volga reach, in June, July and September, oligochaetes served as the "principal" item of food for the bream at the K stage of development, accounting for 55-80% of the weight of the animal food; in May and August their index of importance was lower, amounting to 39-44%.

In the Main reach, oligochaetes constituted the "principal" food of the bream only in September (75%), while during the rest of the year their percentage by weight was low - 10-22% of the weight of the animal food. The low proportion of oligochaetes in the food consumed by the bream of the Main reach in July, August and September, reflected also in the values of the specific indices of fullness (7.3-9.70/000), is accounted for by the low biomass of the oligochaetes 41 in the given area. In May and June, the oligochaete-specific indices for the bream of the Main reach were higher (26.7-36.60/000) than during the rest of the summer and in the autumn; by weight, the worms served as "additional" food for the fish.

In the Volga reach the biomass of the oligochaetes was three times as high as in the Main reach, which affected the ration of the bream at the K stage of development: the value of the oligochaete-specific indices of fullness was high throughout the foraging season - 27.0-43.70/000. Thus, in the gray mud biotope, the rate of consumption of oligochaetes by the bream at the K stage of development varies from one reach of the reservoir to another because of the differences in the biomass of the oligochaete populations. What exactly causes these differences is unclear. They may be due to the specific nutritive properties of the gray mud in the individual reaches, which, as has already been indicated, differ in the physical, chemical and biological characteristics of their water masses. The differences in those characteristics are probably responsible for the differences in the properties of the upper "active" layer of mud.

The consumption of oligochaetes by younger fish at the J_2 stage of development showed the same trends as in the case of bigger fish: in the Volga reach it was more intensive than in the Main reach. But in either reach, the younger bream at the J_2 stage of development consumed smaller quantities of oligochaetes during each month of the foraging season than did the mature bream at the K stage of development. This is due to certain anatomical features of the bream, as well as to the fact that worms are more readily accesible to mature fish than to young ones (Zhiteneva, 1962). The role of the big mature fish in consuming the production of the oligochaetes inhabiting the channel areas of the reservoir is greater than that of the young fish for yet another reason: the latter migrate periodically to the flood- 42
plain areas, so that some of the food they consume probably comes from the benthos present in those parts of the reservoir. Thus, the rate of consumption of oligochaetes by the bream in the gray mud biotopes of the different reaches of the reservoir is determined by: a) the biomass of the worms in the foraging biotope, b) the accessibility of oligochaetes to fish at different stages of development. The role of oligochaetes in producing the ichtyomass of the 5-15-year-old bream in the Rybinsk reservoir is very important since in certain months they constitute the fish's "principal" or "additional" food.

OLIGOCHAETE FAUNA INHABITING THE OUTER PART OF PETROZAVODSK BAY IN LAKE ONEGA

by

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Descriptions of the oligochaete fauna of Lake Onega have already been given in a number of publications (Gerd, 1949, 1950; Hrabe, 1962; Chekanovskaya, 1965; Slepukhina, 1972, 1975; Kaufman, 1980; Polyakova, 1980, and others).

Our investigations were carried out in the outer part of Petrozavodsk Bay. The area covered extends from Cape Sal'nov along the south-western shore to the Pukhtinskie Islands. What follows is the first description of the oligochaete fauna of this area.

Sampling was conducted from April through July, 1981. Altogether, 53 samples from 21 stations were analyzed, yielding 39 species from 24 genera and 4 families: Naididae - 22 species, Tubificidae - 11, Enchytraeidae - 4, Lumbriculidae - 6. Six species of Naididae had never before been found in Lake Onega (_Stylaria fossularis_ Leidy, _Vejdovskiella intermedia_ Bretsch., _Nais elinguis_ Müll., _Homochaetea naidina_ Bretsch., _Amphichaeta leydigi_ Tauber, _Pristina menoni_ Aiyer). 43

Thirty one species were identified from depths of over six meters. Representatives of Lumbriculidae and Tubificidae occur particularly often; they also predominate in abundance, accounting for 40-80% of the oligochaete population. The dominant species include _Lamprodrilus isoporus_ f. var. Svetl., _Stylodrilus heringianus_ Clap., _Peloscolex ferox_ Eisen.

Relatively less frequent are representatives of the Naididae. Comparison of the coefficients of biocenological similarity (K_b) (Vainstein, 1967) reveals a high degree of similarity among the biocenoses of most of the profundal and littoral stations (K_b = 25-43%).

Substantially different from all other regions are the effluent discharge area and the area adjacent to the mouth of the Orzega river (K_b = 0-9%). They are characterized by the highest population densities (3058 ind/m^2 and 3 g/m^2). The dominant role in these areas belongs to representatives of the Tubificidae. *Tubifex tubifex* predominate in the first of the two areas (1560 ind/m^2), sharing the littoral zone with another abundant species: *Nais variabilis* (1364 ind/m^2). The second area is dominated by *Potamothrix hammoniensis* and *Limnodrilus hoffmeisteri* (95%).

Samples taken from stones in the littoral zone were found to contain 18 oligochaete species belonging mostly to the family Naididae. At some of the stations (the mouth of the Uya river) the dominant species *Nais barbata* Müll. and *Chaetogaster diaphanus* Gruith. form aggregations of up to 3000 ind/m^2. The average population density on the stones in the littoral zone amounts to 1000 ind/m^2, while the maximum population density is 8747 ind/m^2 (the mouth of the Uya river). Such high densities are the result of large amounts of organic matter being discharged in the waters of this region. Thus, as regards the nature of their oligochaete fauna and their other limnetic features, the deepwater areas of the outer part of Petrozavodsk Bay appear to be similar to the profundal zone. In the littoral zone, however, the presence of 44
discharged organic matter creates fairly large eutrophic areas.

Considering the present rates of industrial development along the shores of this region, it seems likely that the eutrophic areas will continue to expand, and this makes us feel justly concerned about the future of Lake Onega.

Table

Specific composition of the oligochaetes inhabiting the outer part of Petrozavodsk Bay in Lake Onega

a НАЗВАНИЕ ВИДОВ	b Биотоп	
	прибрежные камни c	Дно озера d
I	2	3
Naididae		
Stylaria lacustris L.	+	-
S. fossularis Leidy	+	-
Arcteonais lomondi Martin	-	+
Vejdovskyella comata Vejd.	+	+
V. intermedia Bretsch.	-	+
Nais pseudobtusa Piguet	+	-
N. barbata Müll.	+	-
N. simplex Piguet	+	-
N. behningi Mich.	+	-
N. communis Piguet	+	+
N. elinguis Mull.	+	+
N. variabilis Piguet	-	+
N. sp.	+	+
Specaria josinae Vejd.	+	+
Piguetiella blanci Piguet	-	+
Uncinais uncinata Oersted	-	+
Homochaeta naidina Bretsch.	-	+
Amphychaeta leydigi Tauber	-	+
Chaetogaster diaphanus Gruith.	+	-

a - Name of species; b - Biotope; c - littoral stones; d - lake bottom

Table (contd.)

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I	2	3
Pristina rosea Piguet	+	+
P. menoni Aiyer	+	-
Naididae gen. sp.	+	+
Tubificidae		
Isochaetides newaensis Mich.	-	+
Limnodrilus udekemianus Clap.	-	+
L. hoffmeisteri Clap.	-	+
L. sp.	-	+
Potamotrix hammoniensis Mich.	-	+
Tubifex tubifex Mull.	+	+
T. smirnovi Last.	+	+
T. sp.	-	+
Peloscolex ferox Eisen	+	+
Alexandrovia onegensis Hrabe	-	+
Tubificidae gen. sp.	+	+
Enchytraeidae		
Marionina glandulosa Mich.	+	+
M. sp.	+	+
Henlea sp.	+	+
Enchytraeidae gen. sp.	-	+
Lumbriculidae		
Lumbriculus alexandrovi Popch.	-	+
L. sp.	-	+
Lamprodrilus isoporus f. var. Sv.	-	+
Stylodrilus heringianus Clap.	-	+
Trichodrilus sp.	-	+
Lumbriculidae gen. sp.	-	+

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YEAR-TO-YEAR CHANGES IN THE OLIGOCHAETE FAUNA OF THE UTULIK-MURINO AREA BIOCENOSES

by

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In order that the objectives of hydrobiological monitoring might be successfully achieved, it is important to choose and establish model testing grounds characterized by varying degrees of changes in the communities under the effect of anthropogenic factors.

One of such testing grounds, where monitoring is conducted at all times, has been established on Lake Baikal in the region affected by the effluent of the Baikal pulp and paper mill (Izrael' et al., 1981). Particularly thorough monitoring is being carried on in the area immediately adjacent to the effluent discharge point. Samples are collected at transects opposite the discharge pipes, 50 and 100 m to the east, and 50 m to the west of the disharge transect. Each transect consists of a number of stations situated in zones of different depths, i.e. over different biotopes. Control transects I-II-III lie outside the region affected by the effluent.

The study of the benthos takes account of the vertical zonality of the communities and of the composition of the bottom substrata.

In analyzing hydrobiological material in the region adjacent to the Baikal pulp and paper mill, O.M. Kozhova distinguishes three groups of bottom substrata according to their content of anthropogenic sludge (Kozhova, 1974).

Group I includes substrata containing a more or less thick layer of slime (0.5-4 cm) and floc. Group II includes substrata with odor; group III comprises apparently pure substrata.

Since the mill was commissioned, the macrozoobenthos of Southern Baikal has been found to include essentially the same groups of animals as before commissioning: gammarideans, mollusks, oligochaetes, planarians, polychaetes, chironomids, nematodes, caddisworms and leeches, with the first three groups predominating in biomass.

Data accumulated over the entire period of monitoring show that in all of the different biotopes the biomass has undergone natural biological fluctuations induced, apparently, by some ecological factors. It is only in the area where the substratum contains a layer of sludge that the decraase in the biomass is particularly significant, indicating the influence of anthropogenic factors (Fig. 1). The accumulation of poorly oxidizable substances on the bottom has resulted in the formation of a patch of pollution, which has remained practically unchanged in size during the last ten years. 48

Comparison of all the communities that have been studied shows that the anthropogenic influence manifests itself in and around the patch of pollution, which has an area of 0.1 km^2 and which lies beyond the littoral zone in the region where anthropogenic sludge is accumulating. In that region the total biomass of the zoobenthos and the proportion in the biomass of each of the dominant groups of animals - gammarideans, mollusks and oligochaetes - are quite different. Thus, at depths of 5-20 m a community consisting of mollusks, oligochaetes and gammarideans is replaced in this biotope by a community of gammarideans and oligochaetes. In the zone of depths ranging from 20 to 100 m the biomass of the oligochaetes decreases, and what was an oligochaete community turns into a community of gammarideans. The biomass of the gammarideans does not change as significantly as that of the other bottom-dwellers, but like the other groups of animals, they are represented by a smaller number of species. The most resistant to the effects of pollution are *Asprogammarus rhodophtalmus*.

Little information on the oligochaete fauna was available before the pulp and paper mill was put into operation. In 1961, M.M. Kozhov handed over the material which was in his possession to Dr. Grab'e for species identification. As a result, a list of 25 oligochaete species was published in 1970 (Kaplina, 1970).

We have received specimens of oligochaetes and used them to study the oligochaete fauna and its distribution patterns in the Utulik-Murino area since 1977. We have been able to determine the species of the worms contained in benthos samples taken in July 1973, 1976 and

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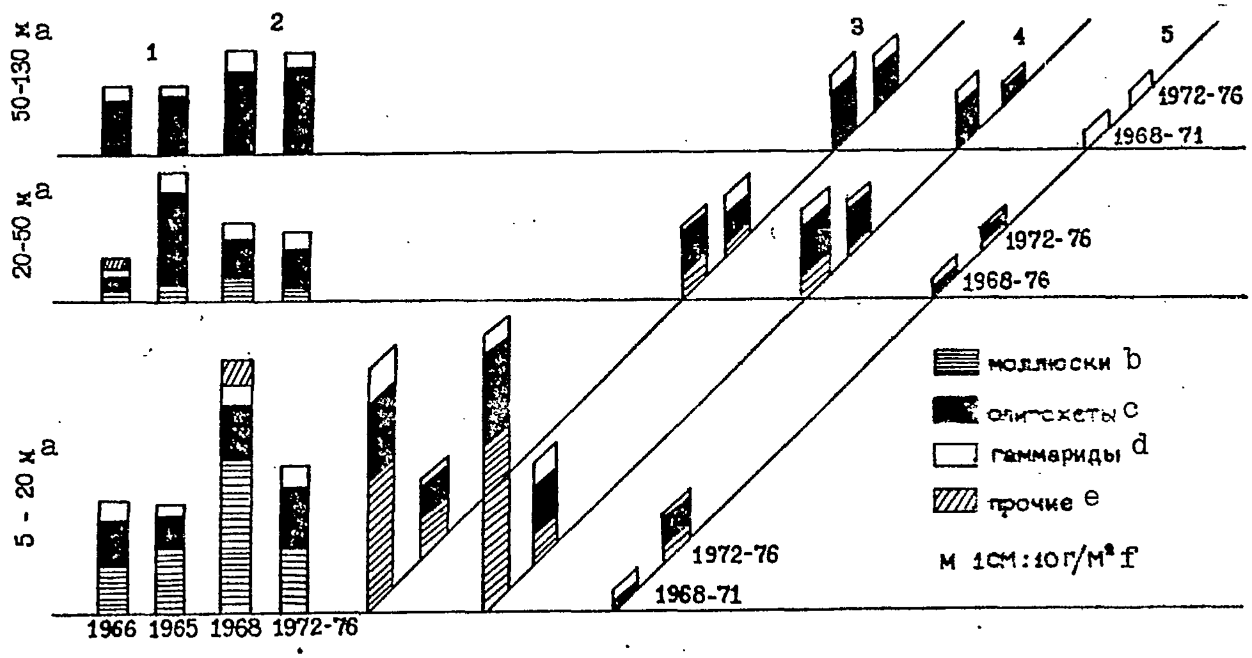

Рис.I. Биомасса макрозообентоса в районе сточных вод БЦБК
I – до пуска; 2 – контрольные разрезы после пуска; 3 – визуально чистый грунт; 4 – грунт с запахом; 5 – грунт с осадком.

Fig. 1. Biomass of the macrozoobenthos in the region where the effluents of the Baikal pulp and paper mill are discharged:
1 - before commissioning; 2 - control transects after commissioning; 3 - apparently pure substrata; 4 - substrata with odor; 5 - substrata with sludge

a - m; b - mollusks; c - oligochaetes; d - gammarideans; e - others; f - scale 1 cm : 10 g/m²

1977. Altogether, 57 oligochaete species from 6 families have been 48
identified (including those already described in the literature): Lumbriculidae (19 species), Tubificidae (29), Enchytraeidae (3), Haplotaxidae (1), Lycodrililidae (5). The family Naididae is poorly represented on the soft substrata of the area under study; the few individuals that were encountered belong to the species *Nais baicalensis*,
N. bekmani, *Neonais elegans*. The dominant families, superior to all 50
others both in the number of species and in abundance, are the Lumbriculidae and the Tubificidae. We shall therefore base our analysis on the relative percentages of these two families.

Let us consider the distribution of oligochaetes at the transects. Control transects I and II lie 6-14 km to the west of the discharge pipes. As the effluent drifts in the north-eastern direction, these transects are not exposed to any anthropogenic influence.

The abundance of the oligochaetes at the transects was particularly high at all depths in 1977, with the highest densities recorded in the littoral zone. The ratio between the lumbriculids and the tubificids is identical at all of the transects (Fig. 2). The samples were found to contain 29 oligochaete species from 5 families. Particularly frequent among the lumbriculids are *Stylodrilus heringianus*, *S. asiaticus*, *Lamprodrilus achaetus*, *Rhynchelmis brachycephala*. Numerically dominant among them are immature worms of the genus *Stylodrilus*. The tubificids are represented by *Isochaetides arenarius* and *Peloscolex velutinus*. Less frequent were the occurences of *Rhyacodriloides abissalis*, *Svetlovia maculata*, *Tubifex* sp. "*kessleri* group". The lycodrilid species present in the samples include *Lycodrilus dybow*-

skii, L. schizochaetus, L. sp. The family Enchytraeidae is represented by the species Propappus volki, P. glandulosus and Enchytraeidae sp. juv.

Control transect III is situated 0.5 km to the east of the discharge pipes. The abundance of the worms there is higher than at the western control transects, and the year-to-year variations are

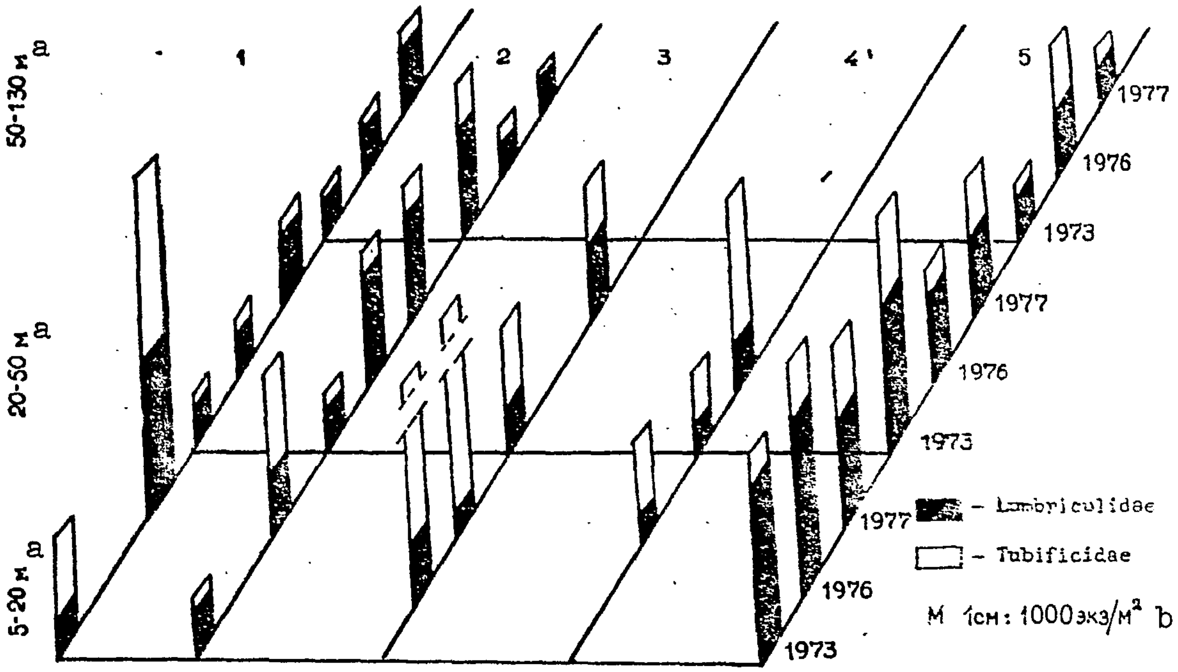

Рис.2. Распределение олигохет в районе Утулик-Мурино за 1973-77 гг. I - контрольные (I-II) разрезы; 2 - визуально чистый грунт; 3 - грунт с запахом; 4 - грунт с осадком; 5 - контрольный (Ш) разрез.

Fig. 2. Distribution of oligochaetes in the Utulik-Murino area in 1973-1977. 1 - control (I-II) transects; 2 - apparently pure substrata; 3 - substrata with odor; 4 - substrata with sludge; 5 - control (III) transect

a - m; b - scale 1 cm : 1000 ind/m^2

less pronounced. The abundance shows a tendency to decrease from the 50
sublittoral towards the supraabyssal, which is generally typical of Lake Baikal. The lumbriculids are more abundant in this area than the tubificids (64% over the entire transect). The number of species
present at the transect is 33. They include such seldom found forms as 52
Rhyacodrilus isossimovi, Rh. multispinus multiovata, Rh. abissalis, Peloscolex malevichi, S. maculata.

The polluted region covers four transects lying near the discharge pipes, 50 m to the west and 50-100 m to the east. We consider them together as the area of effluent discharge and distinguish three groups of substrata according to their content of anthropogenic sludge: substrata containing a layer of slime and sludge, substrata with odor, and apparently pure substrata.

The lowest numbers of oligochaetes are found in the zone where the bottom is covered with sludge. Samples taken at all depths from the layer of sludge contain mostly tubificids, the proportion of lumbriculids being as low as 24%. Altogether, 16 species have been found in this zone. The accumulation of effluent reduces the abundance of the oligochaetes, affecting the lumbriculids with particular severity. The tubificids appear to be more resistant to the adverse changes in the amounts of oxygen and other gases in the water around them.

Higher abundance figures characterize the oligochaetes living on the substratum with odor. In 1976-1977 they reached a particularly high density in the littoral zone - up to 20,000 ind/m^2; 90% of that number were tubificids. It seems that the extra amount of organic matter in the given concentration is having a favorable effect on the tubificids of the genus Isochaetides. Also present in the area are worms of the species Tubifex sp. "kessleri group".

The apparently pure substrata in the effluent discharge region are similar in abundance and variety of species to the western control transects. The proportion of lumbriculids increases with depth. The number of species present is 29.

In the region of effluent discharge as a whole, regardless of the degree of bottom pollution, the abundance of the oligochaetes is highest in the littoral zone, where it reached its maximum in 1976. In the sublittoral and suprabyssal zones the year-to-year variations in the abundance of the oligochaetes are insignificant. 53

The investigations carried out after the commissionong of the pulp and paper mill in the region where the Baikal biocenoses are affected by its effluents have made it possible to establish that the effluents exert a fairly distinct effect on the condition of the bottom biocenoses without, however, causing any irreversible changes in them.

The following persistent tendency is observed at all of the transects: as the depth increases from 5-20 to 130 m, the biomass of the entire macrozoobenthos decreases regardless of the degree of bottom pollution, this being characteristic of Lake Baikal as a whole. It is also obvious that at all depths the area where the bottom is covered with a layer of sludge has the lowest average value of the macrozoobenthos biomass. In that area it was 5 times as low as at the control transects at depths of 5-20 m, 3 times as low at depths of 20-50 m, and 10 times as low at depths of 50-130 m.

The effect of the effluents on the oligochaete fauna is particularly noticeable wherever these tend to accumulate. Samples containing sludge and pulp floc yield the lowest number of species. The accumulation of decomposition products, such as organic acids and phenols, in the substratum produces a harmful effect on the oligochaetes, particularly on the lumbriculids.

Samples with odor contain more species, but the tubificids are still dominant in them.

The apparently pure substrata in the region of effluent discharge are similar in their species composition to the western transects, with the lumbriculids predominating in abundance over the tubificids.

THE ROLE OF OLIGOCHAETES IN THE BOTTOM FAUNA OF SMALL RIVERS FLOWING THROUGH AREAS OF INDUSTRIAL LIVESTOCK-RAISING FARMS 54

by

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The present paper is based on hydrobiological material collected by the author on some of the small rivers of the Belgorod region in 1978-1979.

The Lipovyi Donets and Erik rivers flow through an area of industrial livestock-raising farms; in dry years the Erik river partially dries up.

The hydrobiological material was collected by conventional methods in spring, summer and autumn. Samples were taken above and below animal farms and fields irrigated by treated animal farm effluents.

Simultaneously, samples of river water were taken for hydrochemical analysis.

The qualitative composition of the benthos in the two rivers was represented by 52 taxa belonging to 13 different phyla. Paricularly many species were found among the chironomids and oligochaetes[1].

The Lipovyi Donets river. The samples taken in the river contained varying numbers of chironomids, water sowbugs, dipterous insect larvae and leeches. 55

Considerable differences were observed in the distribution of the benthos depending on the season and on how far the particular part of the river lay from the nearest animal farm.

Above the animal farm, in June and July, the bottom biocenoses are dominated by large chironomid larvae of the genera Chironomus and Cryptochironomus, which have an average abundance of 480 ind/m^2. Only slightly less abundant are the oligochaetes, whose dominant species is Tubifex tubifex. In August the bottom fauna was represented by T. tubifex and Asellus aquaticus, both numbering 560 ind/m^2, and by a small number of leeches. In September the structure of the biocenosis undergoes another change: the dipterous insect larvae become predominant again, while the oligochaetes are represented in the samples by rare and isolated individuals.

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[1] I would like to express my sincere gratitude to T.E. Timm for the constant help she has been giving me in my work.

Below the animal farm the gray muds of the Lipovyi Donets river were inhabited in June and July by a bottom fauna consisting essentially of oligochaetes of the species *T. tubifex*, *Limnodrilus hoffmeisteri* and *Limnodrilus udekemianus*, which had an average abundance of 360 ind/m^2. In August and September the dominant species was *T. tubifex*, whose abundance varied from 2000 ind/m^2 in August to 360 ind/m^2 in September.

Such changes of the dominant species are probably brought about by irregularities in the supply and distribution of the nutrients in the river water. One of the years during which our studies were conducted had a very wet summer, which resulted in a considerable increase in the amount and concentration of the surface run-off from the agricultural land and from the territory of the farm.

Table 1 shows the distribution of nutrients in the surface and bottom layers of water and in the mud. The biogen content in the bottom water layer and in the mud is dozens and even hundreds of times
as great as in the surface water layer, which suggests that the bio- 56
gens are being accumulated in the bottom sediments.

The availability of sufficient amounts of food and dissolved oxygen (10.2 - 11.3 mg/l) creates favorable conditions for the development of the oligochaetes, but the presence of leeches and chironomids checked the growth of the oligochaete population.

Seasonal investigations of the bottom fauna carried out in 1979 in the Lipovyi Donets river revealed further changes in the qualitative composition and quantitative characteristics of the benthos, particularly in the part of the river situated above the animal farm, where the abundance of the oligochaetes did not exceed 520 ind/m^2.

In the river biotopes below the farm the benthos was represented exclusively by oligochaetes. The dominant species was T. tubifex,

Table 1

Total content of nitrogen, phosphorus and potassium in the water (mg/l) and in the mud (mg/100g) of the Lipovyi Donets river in August 1978

Sampling area	Surface layer of water			Bottom layer of water			Mud	
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus
Above the farm	0.2	0.2	5.0	25.9	3.8	7.0	389.2	56.2
Below the farm	0.2	0.2	5.0	35.7	5.8	14.0	263.2	134.3

which in some of the samples reached 20,000 ind/m^2 in abundance and 31.5 g/m^2 in biomass. Two other species - L. profundicola and L. hoffmeisteri - occur in varying numbers in the same biotopes.

The oxygen concentration levels were favorable for the oligochaetes: 4.7 mg/l above and 6.7 mg/l below the animal farm. The nitro- 57
gen and phosphorus content of the mud was also high; the amounts of these elements in the surface layer of water had also increased since 1978. The increased concentration of nitrogen and phosphorus was due to long periods of heavy rain and to the resulting surface run-off.

The Erik river. In 1979 the bottom fauna of the Erik river (a tributary of the Lipovyi Donets) consisted mainly of oligochaetes, whose dominant species was L. profundicola, and of chironomids, most of which belonged to the species Chironomus plumosus. Small numbers of mollusks of the species *Lymnaea stagnalis* were also present in some of the samples taken above the animal farm. The qualitative and quantitative changes observed in the benthos of the Erik river were similar to those taking place in the Lipovyi Donets.

From late May to early June, before the first flight of the chironomid imagoes, the abundance of the oligochaetes in the samples does not rise above 400 ind/m^2, while the abundance of *Chironomus plumosus* and *Ch. thummi* reaches 4000 ind/m^2. In August and September, with very few chironomids occurring in the samples, the abundance of the oligochaetes is as high as 5200 ind/m^2. The presence of *Chironomus* larvae produced an adverse effect on the oligochaete population. Our observations are confirmed by data found in the literature (Popchenko, 1972; Brinkhurst, Kennedy, 1965).

It can be concluded from the above that the oligochaetes play a very important role in the bottom fauna of small rivers flowing through areas of industrial livestock-raising farms. During the different seasons *Tubifex tubifex*, *Limnodrilus hoffmeisteri*, *Limnodrilus udekemianus* and *Limnodrilus profundicola* accounted for 30-80% of the abundance and biomass of the benthos in the river biotopes above the animal farm and for up to 100% in the biotopes below the animal farm.
The factors contributing to the mass development of the tubificids 58
included the slow current in the Lipovyi Donets and Erik rivers, the availability of sufficient amounts of nutrients and the high dissolved oxygen content of the river water. Owing to their peculiar ecological properties and to their feeding habits, the oligochaetes play the role of a natural biofilter by consuming saprophytic bacteria and the eggs

of some helminths, thus restoring the water of small rivers to its original purity.

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THE ROLE OF OLIGOCHAETES IN THE TROPHIC STRUCTURE OF THE BENTHIC BIOCENOSES OF THE TSIMLYANSK RESERVOIR

by

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The invertebrate members of the benthic biocenoses (communities) of the Tsimlyansk reservoir can be classified, on the basis of their feeding habits, into seven trophic groups: non-motile seston-eaters, motile seston-eaters, seston-and-detritus-eaters, detritus-eaters picking up particles of food from the surface of the bottom, mud-eaters (detritus-eaters swallowing mud together with the food it contains), carnivores (active predators), omnivores (facultative predators). In determining these groups and in assigning the various organisms to them, we used a large body of data available
from the literature (Borodich, 1952; Konstantinov, 1958, 1959; Mor- 59
dukhai-Boltovskii, 1963; Poddubnaya, 1963; Yablonskaya, 1971; Sokolova, 1973; Monakov, 1974; Aristova, 1975; Kuznetsov, 1980). The energy

characteristics of the populations in the communities and biocenoses of the benthos as a whole were calculated by means of the procedures proposed by G.G. Vinberg (1969); the production of organisms was evaluated by the physiological method.

As regards their feeding habits, the vast majority of the oligochaetes present in the benthos are detritus-eaters. They are the only members of the group of mud-swallowing detritus-eaters and form a large proportion (up to 92% of the biomass) of the detritus-eaters that pick up their food from the surface of the bottom. They play, therefore, an important role in the trophic structure of the communities (Table 1). Very few oligochaetes form part of the group of seston- and detritus-eaters, and no oligochaetes have been found among the members of the other groups (non-motile and motile seston-eaters, carnivores and omnivores).

The biotic community in whose trophic structure the oligochaetes play the least significant part is the Monodacna colorata (Echv.) - Dreissena polymorpha Pall. biocenosis confined to the sandy littoral zone, which periodically becomes dry. With a biomass of 5.4 kJ/m^2 (or 2.2 g/m^2), the oligochaetes provide one tenth (44 kJ/m^2) of the actual production of the community, and spend as much on metabolism (101 kJ/m^2). The dominant species among the mud-eaters are Isochaetis michaelseni (Last.) (274 ind/m^2 and 0,8 g/m^2) and Limnodrilus hoffmeisteri (Clap.) (222 ind/m^2 and 0.3 g/m^2). The detritus-picking oligochaetes are represented mainly by the species from the family Naididae, their total abundance and biomass being 87 ind/m^2 and 0.1 g/m^2. The seston- and detritus-eaters include practically no oligochaetes.

Table 1

The role of oligochaetes in the trophic structure of the benthic biocenoses of the Tsimlyansk reservoir, kJ/m^2 per season

Т.г. T.g.	а Биоценозы M.colorata -D.polymorpha			D. polymorpha -M. colorata			D. polymorpha			D. polymorpha -P. lacustris			L. hoffmeisteri -Ch. plumosis			Бентос в целом		
	B	P	R	B	P	R	B	P	R	B	P	R	B	P	R	B	P	R
I	52	65	152	92	240	559	241	1034	2404	162	439	1021	54	160	373	156	575	13
II	106	171	397	85	252	587	153	534	1242	125	544	1265	35	94	219	107	387	9
III	10	25	58	21	72	168	39	180	418	86	284	660	65	220	512	43	164	3
III($_I$)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
IV	I	6	14	1	5	10	1	5	12	4	25	59	5	41	95	2	14	
IV($_I$)	I	I	2	1	1	2	1	3	8	1	9	22	5	39	90	1	8	
V	5	43	99	8	74	172	25	199	463	25	179	415	137	1155	2685	36	277	6
VI	1	1	2	1	2	5	1	7	15	2	9	21	1	8	18	1	6	
VII	20	90	208	23	206	480	34	257	597	64	493	1147	8	87	203	32	248	5
VIII	195	396	930	231	845	1981	494	2188	5151	468	1936	4588	305	1733	4105	376	1647	38
VIII($_I$)	5	44	101	8	75	175	25	202	471	26	186	437	142	1194	2776	37	285	6

Примечание: Т.г. – трофические группировки: сестонофаги неподвижные, II – сестонофаги подвижные, Ш – сестоно-детритофаги, Ш($_I$) – в том числе олигохеты, IУ – детритофаги собирающие, IУ($_I$) в том числе олигохеты, У – грунтоеды (олигохеты), УI – плотоядные, УП – всеядные, УШ – бентос в целом, УШ($_I$) – в том числе олигохеты; В – биомасса, Р – продукция, R – траты на обмен

Note: T.g. - trophic groups: I - non-motile seston-eaters, II - motile seston-eaters, III - seston- and detritus-eaters, III($_I$) - oligochaetes in this group, IV - detritus-picking organisms, IV($_I$) - oligochaetes in this group, V - mud-eaters (oligochaetes), VI - carnivores, VII - omnivores VIII - benthos as a whole, VIII($_I$) - oligochaetes in the benthos; B - biomass, P - production, R - metabolic expenditure; a - biocenoses, b - benthos as a whole

In the trophic structure of the Dreissena polymorpha Pall. - Monodacna colorata (Echv.) biocenosis, which develops on hard unsilted substrata, the absolute value of the oligochaetes, although greater than in the biocenosis mentioned earlier, is still rather low. They account for 3.5% (8kJ/m^2 or 3.2 g/m^2) of the total biomass, and for no more than 8.9% of the production and metabolic expenditure (75 and 175 kJ/m^2, respectively). The oligochaetes are represented mainly by mud-eaters, whose most abundant species are L. hoffmeisteri (805 ind/m^2 and 1.4 g/m^2) and Potamothrix hammoniensis Mich. (760 ind/m^2 and 0.7 g/m^2). The total abundance of detritus-picking oligochaetes is as low as 40 ind/m^2, while their biomass amounts to 0.1 g/m^2.

Distinctly more prominent is the role played by the oligochaetes in the trophic structure of the Dreissena polymorpha Pall. biocenosis, which is found in silted areas. In this biocenosis they make up not only the entire group of mud-eaters but also a large proportion (50-63%) of the detritus-picking organisms. As a result, their percentage in the total biomass of the community increases to 5.1% (25 kJ/m^2 or 10.2 g/m^2), while their part in the actual production and metabolic expenditure remains almost unchanged (9.2 and 9.1%, respectively). The mud-eaters are represented by a larger number of very abundant species. These include L. hoffmeisteri (2557 ind/m^2 and 3,6 g/m^2), L. udekemianus Clap. (258 ind/m^2 and 2.3 g/m^2), L. claparedeanus (Ratz) (793 ind/m^2 and 1.4 g/m^2), I. michaelseni (680 ind/m^2 and 1.0 g/m^2), P. hammoniensis (545 ind/m^2 and 0.6 g/m^2) and others.

Similarly significant is the role of the oligochaetes in the trophic structure of the Dreissena polymorpha Pall. - Paramysis lacus-

tris Czern. biocenosis, which occurs on clayey and sandy silts. Their relative importance in the energy balance of the biocenosis is almost the same as in the community just discussed (5.5% of the total biomass, 9.7% of the actual production and 9.5% of the total meta- 62
bolic expenditure). Certain differences are found only in the group of detritus-picking organisms. The proportion of oligochaetes in this trophic group is twice as low, while their absolute numbers are three times as high. Among the mud-eaters, particularly abundant are *L. hoffmeisteri* (2384 ind/m^2 and 4,1 g/m^2) and, to a lesser extent, *P. hammoniensis* (1068 ind/m^2 and 1.8 g/m^2) and *L. claparedeanus* (650 ind/m^2 and 1.6 g/m^2).

A dominant role is played by the oligochaetes in the trophic structure of the *Limnodrilus hoffmeisteri* Clap, - *Chironomus plumosus* L. biocenosis, found on clayey silts and silty clays. With a biomass of 142 kJ/m^2 (56.8 g/m^2), which amounts to 46.6% of the total biomass, the oligochaetes provide over half (68.9% or 1194 kJ/m^2) of the entire actual production of the community, which constitutes 67.6% of the total metabolic expenditure. Of particular importance in the trophic structure of the biocenosis are the mud-swallowing oligochaetes, especially *L. hoffmeisteri* (13,234 ind/m^2 and 25,5 g/m^2), *P. hammoniensis* (13,658 ind/m^2 and 15.6 g/m^2), *L. udekemianus* (650 ind/m^2 and 5.4 g/m^2), *Tubifex tubifex* Mull. (9,083 ind/m^2 and 5,3 g/m^2), and *L. claparedeanus* (825 ind/m^2 and 1.9 g/m^2). These species account for 82.4% of the abundance and 35.3% of the biomass of all the animals in the community. The group of detritus-picking organisms is almost entirely (92-95%) made up of oligochaetes. Dominant among them are the species *Rhyacodrilus coccineus* (Vejd.) (1,231 ind/m^2 and 1.3 g/m^2), *Dero digitata* (Mull.) (2,730 ind/m^2 and 0.3 g/m^2) and others. The members of these trophic groups find abundant food in the biotopes which they inhabit. The food, in the form of organic detritus, is contained in the substratum or is present on its surface and on the microflora.

The peculiar trophic structure of the *L. hoffmeisteri* - *Ch.* 63
plumosus biocenosis, which occupies one fifth of the bottom area, affects the composition of the benthos of the entire reservoir. It is to a certain extent determined by the oligochaetes, which account for 9.8% of the total biomass (37 kJ/m^2 or 14.7 g/m^2), produce 285 kJ/m^2 (17.3% of the actual production) and spend 665 kJ/m^2 on metabolism (17.1% of the total metabolic expenditure). In the trophic structure of the reservoir the oligochaetes make up the entire group of mud-swallowing detritus-eaters, half and over half of the group of detritus-picking organisms, and a small proportion of the group of seston- and detritus-eaters. The importance of the oligochaetes in the benthos of the reservoir is increasing from year to year.

PARTHENOGENESIS IN *LIMNODRILUS UDEKEMIANUS* AND *TUBIFEX TUBIFEX* (OLIGOCHAETA)

by

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Parthenogenesis is fairly common among representatives of the oligochaetes; for many of them it is the most common type of reproduction. However, some tubificid species reproduce sexually and have never been observed to reproduce parthenogenetically. These species include *Tubifex tubifex* and *Limnodrilus udekemianus*. Thus, according to T.E. Timm (1972), an individual of *L. udekemianus* was kept under laboratory conditions for 8 years but never produced any progeny.

In August 1979, in the Kirghiz SSR, in a suburb of Frunze, a
large number of small cocoons, containing 1-2 eggs, were found in 64
ditches in which the two above-mentioned tubificid species are artificially cultivated. The cocoons were of unusual shape: slightly conical or oval, covered with a thick leathery opaque shell. On some of the cocoons the shell had four longitudinal folds (Fig. 1). Also present in the ditches were small worms up to 20 mm long but with a fully formed clitellum (Fig. 2). Worms and cocoons of the same kind were also found in an irrigation ditch polluted by the effluent of a pig farm.

Analysis of the data collected as a result of these observations has enabled us to make the following assumptions: 1. the worms and cocoons which were discovered in the ground ditches and which are unusual for the tubificid species inhabiting them represent the parthenogenetic forms of *L. udekemianus*. 2. In June, July and August the mean daily temperature of the mud in the ground ditches was 22-23°C, which must be what caused the emergence of the parthenogenetic forms.

To test this hypothesis, we have conducted a series of expe- 65
riments; one of their objectives was to obtain parthenogenetic worms under laboratory conditions and to study their development cycle.

Experiment 1. Identification of the species of the cocoons. Cocoons found in the ditches were placed in a Petri dish, which was

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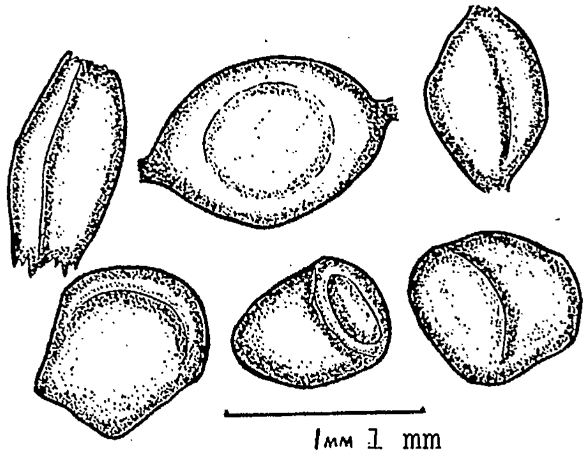

Рис.I. Партеногенетические яйца L.udekemianus из природы и лабораторной культуры

Fig. 1. Parthenogenetic eggs of *L. udekemianus* laid under natural conditions and in a laboratory culture

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then installed in an incubator at a temperature of 22°C. The substratum the cocoons were placed on consisted of clay sifted through a 1-mm meshed sieve. The clay was covered with a thin layer of water. From the fifth through the eleventh day of observation the 17 cocoons yielded 15 young worms, which were identified as *L. udekemianus*. The newly-hatched worms were active and good at locating food; they quickly found the lumps of silt placed on the dish and burrowed into them. Thirty days after being hatched the worms were 15-25 mm long, and most of them had well-developped clitella. They deposited small cocoons of unusual shape containing 1-2 eggs.

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Experiment 2, Incubation of the parthenogenetic form of *L. udekemianus*. Five one-day-old worms obtained from cocoons that had come from

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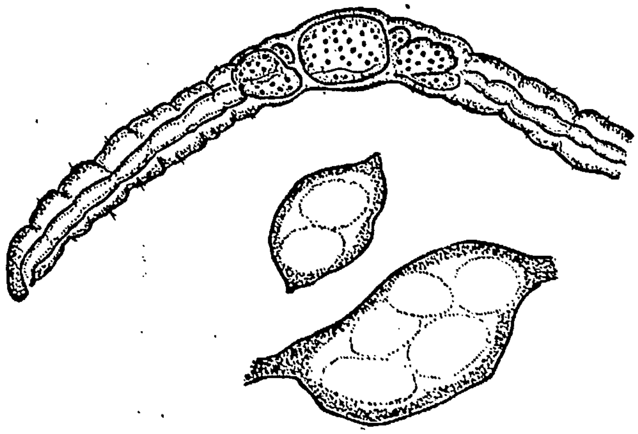

Рис.2. Половозрелая особь и кокон партеногенетической формы в сравнении с обычным коконом

Fig. 2. Sexually mature individual and a cocoon of the parthenogenetic form shown next to an ordinary cocoon

a laboratory culture of worms grown in pans, were placed in separate 66
Petri dishes, which were then installed in an incubator at a temperature of 23°C. The substratum was composed of sifted clay. On the eighth-tenth day the worms began to be fed on silt: a pea-sized lump of silt was placed in each dish. Whenever the substratum became silted, or the water grew turbid, or a bacterial film formed on its surface, both the substratum and the water were replaced.

On the 63rd day three of the five worms were still alive. One of the dishes was found to contain four parthenogenetic cocoons. In the other two dishes the worms had developed clitella, and six days later they laid cocoons which produced young worms. Altogether, the experimental individuals yielded 42 young worms in the first dish, 27 in the second, and 22 in the third one. These grew into adult parthenogenetic worms with developing clitella, ranging in weight from 1.6 to 3.2 mg. The worms in the laboratory culture at this stage of development weighed 13-16 mg.

Altogether, three generations of parthenogenetic worms *L. udekemianus* have been obtained under incubator conditions. It has been established that the period of development of individuals before sexual maturation (i.e., as our observations indicate, before the moment when the clitellum begins to form) is 20-50 days long. The period of formation of a cocoon before it is deposited is 7-12 days long. It takes an embryo 5-8 days to develop in the egg before the young worm is hatched. Thus, the duration of the development cycle in parthenogenetic individuals of *L. udekemianus* is 32-70 days.

Experiment 3. Incubation of the parthenogenetic form of *T. tubifex*. In the middle of September 10 young worms were taken out of a ground ditch, placed in separate Petri dishes and installed in an 67
incubator at a temperature of 23°C. At the beginning of October, the worms started to develop their clitella; this was followed shortly after by the appearance of cocoons and young worms in some of the dishes. Not all of the worms taken from the ditch were equally fertile. The largest number of cocoons laid by one worm is 19; the others laid from 2 to 10 cocoons. Four of the worms failed to lay cocoons altogether, although two of them had fully-formed clitella, which were later resorbed for some unknown reasons.

In early November, 10 individuals were selected from among the 1-2-day-old worms which had emerged from the cocoons in the incubator. The 10 worms (the 2nd series) were placed in separate Petri dishes and again installed in the incubator at a temperature of 23°C. Three worms died during the experiment. The remaining individuals began to develop their clitella between the 25th and 40th day of incubation. The laying of the first cocoons began on the 40-55th day. Observation of the laying of cocoons, of the development of the embryos and of the emergence of young worms from the eggs continued till early January. By that time the worms with clitella had reached 4.2-7.2 mg in weight. The cocoons measured 0.6-0.8 x 1.0-1.2 mm. The maximum number of eggs in a cocoon was four. It should be noted that the cocoons of the parthenogenetic *T. tubifex* individuals were no different in appearance from ordinary cocoons produced by individuals of a sexual generation.

In December, a 3rd series of worms - ten 1-2-year-old individuals - were selected. They began to develop clitella on the 30-45th day of their life and started to lay cocoons on the 35-50th day. The embryo completed its development in the egg within 6-8 days. The entire development cycle lasted 41-58 days. But in some cases this process took as many as 70-80 days. The same results were obtained for the 4th series of worms - the 3rd generation of parthenogenetic individuals.

In the control experiments, which involved the incubation 68
of isolated worms of either species at temperatures of 17-21°C, no reproduction took place. Parthenogenetic individuals, when kept at these temperatures, stopped reproducing. In adult, sexually mature worms incubation at high temperatures resulted in the resorption of

their sexual organs.

Conclusions:

1. The tubificid species L. udekemianus and T. tubifex are capable of parthenogenetic reproduction.

2. The emergence of parthenogenetic individuals becomes possible when the ambient temperatures reach the upper limit zone of the optimum temperature range.

3. Parthenogenetic individuals appear when embryos and young, developing worms are exposed to relatively high temperatures. Adult, sexually mature individuals, which have developed under normal conditions, cease reproducing when the temperature rises to 22-23°C.

ON THE DAILY ACTIVITY OF TUBIFEX TUBIFEX MÜLLER

by

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In the process of incubating two tubificid species - Tubifex tubifex and Limnodrilus udekemianus - under laboratory conditions, it was observed that the food distributed among the worms in the morning was consumed actively and rather fast. The daily dosage of food had been calculated on the basis of the metabolic rate in the worms, which had been determined experimentally through studies of their
breathing rate as a function of the temperature. Normally, the tubi- 69
ficids, which were kept in pans, would quickly find the food placed

on the surface of the substratum and would vigorously devour it. The food distributed at 10-11 o'clock in the morning was always gone by 4-5 p.m., after which the worms would scatter all over the pan. Conversely, whenever the food was given at 4-5 p.m., remnants of it could still be found in the pans the next morning. Also in this case the worms would stay longer near the lumps of food and would eat them with less vigor.

Our observations led us to suppose that the behavior of the worms was probably related to the existence in them of some daily biological rhythms. Therefore, in undertaking the present study, we set ourselves the task of determining the effect of changes in the ambient temperature on the metabolic rate in _T. tubifex_ and of finding out if this species had any circadian rhythms. Respiration was used as an index characterizing these processes. The amount of oxygen consumed by the worms was recorded hourly throughout the day from the readings of a microrespirometer pressure gauge. At the end of the observation period the experimental animals were weighed and the amount of oxygen they had consumed was calculated in ml/g per hour. The worms used in the experiments were all adult individuals without clitella, having an average weight of 4-5 mg. They had been picked out of the pans in the laboratory and out of ground ditches used for cultivating oligochaetes. Prior to the experiment the selected worms were kept in water for 12 hours. The work was carried out in July and August 1981.

In the experiments conducted out of doors, where the temperature experienced natural variations (15-25^{o}C), the breathing rate was

observed to change noticeably, the changes in most cases coinciding with the variations in the temperature. The period of particularly high temperatures (up to 23-25°C) between 2 and 9 p.m. was characterized by an increase in the breathing rate with occasional peaks of up to 0.5-0.6 ml/g per hour. An increase in oxygen consumption was 70
also observed between 7 and 12 a.m. when the temperature rose from 15 to 20°C. A relative decline in the breathing rate occurred when the temperature went down betweem 9 p.m. and 6 a.m.

To determine the relationship between the breathing rate and the temperature variations, we performed a series of experiments in which, during the first half of the observation period (12 hours), the ambient temperature was maintained at a level corresponding to the reference temperature for the given season (20-21°C). During the second half of the observation period (12 hours), the temperature was maintained at 25-26°C. The temperature was raised to that level in the course of two hours (an interval of 5-6°C). This process was not accompanied by any changes in the behavior of the worms - the experimental animals in the incubator chamber exhibited the usual level of slow activity, waving the posterior ends of their bodies. The experiments began at different hours during the day: 2, 6, 10 a.m. and 2, 6, 10 p.m.

The results of our observations indicate that the breathing rate of the worms during the first half of the experiment differed from their breathing rate during the second half. Regardless of the time of day, the breathing rate increases with an increase in the temperature. Often, a rise in the temperature is not immediately followed by an increase in the in the rate of breathing. This increase comes later, the response being delayed by 2-4 hours. Sharp increases in the breathing rate were observed at the start of the experiments; it is possible that they were caused by the closed chamber effect.

Conclusions:

1. Oligochaetes of the species *T. tubifex* have circadian rhythms related to the daily temperature variations.

2. Changes in the ambient temperature during the day are accompanied by corresponding changes in the breathing rate of the worms.

3. In experiments conducted under natural temperature con- 71
ditions the worms were observed to be particularly active between 8-9 a.m. and 5-8 p.m., which explains why the food was devoured with particular vigor in the morning and in the afternoon.

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AQUATIC OLIGOCHAETA

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BIOLOGY AND ECOLOGY OF THE GENUS LIMNODRILUS (OLIGOCHAETA) 71

by

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Oligochaetes of the genus Limnodrilus are widespread in the water bodies of the Ukraine. However, despite their wide distribution and relatively high abundance, not enough research has yet been done on their different species. Almost no data are available on the biology of L. claparedeanus, and very little is known about L. hoffmeisteri.

The proposed construction of the Lower Dnieper and Lower Dniester reservoirs, which will be formed when the Dnieper-Bug and Dniester lagoons have been isolated from the sea by dams, is expected to allow the oligochaetes of the genus Limnodrilus to expand their range still further. So far the oligochaetes of this genus have been unable to spread to the lagoons because the salinity in these bodies of water is higher than in the lower reaches of the rivers.

We have carried out several sets of experiments in order to study the life cycle of the oligochaetes, their actual and potential fecundity, their life span, their reproduction period and the variations in the time of its onset and duration depending on the salinity, temperature, the age of the worms, and the seasons.

For use in the experiments, sexually mature worms were col- 72
lected from natural water bodies or were grown to maturity from eggs. The worms were kept in 100-ml jars containing silt, which had been

washed to remove all other organisms from it. Each jar contained 10 worms. The jars were kept in an aquarium at room temperature, or in an incubator at constant temperature, or in holding nets on the bottom of the Dnieper. Every week the silt in the jars was renewed. During the weekly washing, the worms were counted and the cocoons picked out. After being removed from the jars, the cocoons were measured, opened, and the eggs they contained were counted. A certain number of cocoons were left to hatch. The experiments involved two species: *L. claparedeanus* and *L. hoffmeisteri*.

We shall now describe each of the two species separately. *L. claparedeanus* is particularly widespread and abundant in the lower reaches of the Dnieper and Danube, especially in their branches, where the current is slow and the bottom is for the most part covered with a layer of mud. The species is represented by relatively large worms, dark-red at the anterior end and a lighter shade at the posterior end. The prostomium is blunt; the 2-5 anterior segments have two annuli. The body, which consists of 70-200 segments, is 20-40 mm in length and 3-7 mg in weight, although some individuals vary in weight from 1 to 17 mg. The number of setae varies from 6 to 8 in the anterior segments, and from 2 to 3 in the segments of the posterior part. The distal end of the setae is in most cases longer than the proximal end. The penial tube is long and straight, tapering at the end; the ratio between its length and its width at the base is 16-23:1 in most cases, but in some individuals can be 11:1. The worms live for no less than two years.

Changes in abundance during the reproduction period were observed in all of the groups of worms exposed in the course of the experiments to different temperature conditions. Two sets of experiments were performed: one between August 1978 and August 1979, and the other one between April 1980 and April 1981. 73

The observed changes in the abundance of the worms used in the experiments indicate that during the reproduction period mortality, both in the holding nets on the river bottom and in the incubator, conformed to a certain pattern. Most of the worms that die belong to the older age-groups, while the young worms, which hatched in the spring and began to reproduce in the early summer, usually survive the reproduction period and hibernate till the next spring. The mortality rate during the period of rest is extremely low.

Under natural conditions, the onset, intensity and duration of the reproduction period of this species are directly dependent on the variations of the mean daily temperatures. Reproduction starts between late March and early April at a water temperature of 5-6°C, reaches its maximum in June and July, and then begins to decline, coming to an end in the winter months (early December) at a temperature of 3-3.5°C. No reproduction was observed when the water temperature dropped to 0.2-0.6°C. The worms that were kept indoors and were not exposed to low temperatures showed the same reproduction tendencies as those that were kept in holding nets on the river bottom: a decline in reproduction during the winter months, but with no interruption, and a peak in June and July.

The cocoons of this species are relatively big, light-colored, shaped like an elongated lemon, opaque at first, but later becoming transparent so that the eggs can be easily seen through the shell. The cocoons vary in length from 1.0 to 2.65 mm and in width from 0.75 to 1.30 mm. The biggest cocoon was 4 mm long and 1.9 mm wide.

The fecundity depends on the temperature, the age of the 74
worms, and the quality of the food; it also varies greatly from one individual to another. Thus, in the holding nets on the river bottom one worm lays an average of 20-30 cocoons and produces 200-250 young worms during the reproduction period; in the incubator the corresponding figures are 40-70 and 300-800.

To determine the number of eggs in the cocoons, 4081 cocoons were opened and examined. Over 67% of them were found to contain 2-10 eggs. The number of eggs in a cocoon varied widely depending on the condition in which the worms had been kept and on their age. Cocoons laid in the holding net on the river bottom contained 2-6 eggs, while those deposited in the incubator had 3-10 eggs. Young worms normally lay cocoons with a larger number of eggs than old worms. Worms kept in jars with silt of low nutritive value often lay empty cocoons.

Newly-hatched worms weigh 0.05-0.08 mg and have a considerable average daily gain. At temperatures of 20-30°C the worms begin to reproduce 2 or 3 months after hatching. At water temperatures of 18-22°C young worms emerge from the cocoons 10-14 days after these were laid.

Experimental studies into the effect of salinity on the vital activities of worms of this species have shown that in different habitats they may have different degrees of salinity resistance and can endure a certain rise in the level of salinity; increased salinity, however, produces a detrimental effect on their reproductive activity.

The behavior of *L. hoffmeisteri* in the experiments was very similar to that of *L. claparedeanus*. Its representatives showed the same trends in reproduction, in post-reproduction mortality, in the length of the sexual maturation period, and in their response to 75
temperature variations. However, unlike the latter species, *L. hoffmeisteri* does not reproduce in the incubator during the winter months and is also less prolific. Thus, the average number of cocoons which the worms used in the experiments laid during the reproduction period and the average number of young worms that emerged from these cocoons were 80-100 and 100-150, respectively, in the holding nets on the river bottom, and 150-200 and 200-250 in the incubator. The average number of eggs per cocoon was 1-2 (the maximum number being 6).

Both species are characterized by a marked homeostatic capacity during the reproduction period, which makes them somewhat less dependent on the water temperature. This capacity is more pronounced in *L. hoffmeisteri* than in *L. claparedeanus*. *L. hoffmeisteri* begins to reproduce later (at a water temperature of 7-8.5°C) and stops reproducing earlier, when the water temperature is still high (16-17°C). The reproduction period of this species is six months long (from April to September), while that of *L. claparedeanus* extends over 8-9 months. These two species exhibit genotypic differences in relation to temperature, which suggests that they are of different zoogeographic origin: *L. hoffmeisteri* comes from regions lying farther north, while *L. claparedeanus* is a southern species. This accounts for the fact that the former species is more prolific than the latter.

In the conditions of the southern Ukraine both species develop in populations consisting of two full generations, i.e. they mature and start reproducing in the first year of their life. Our laboratory experiments have shown that L. claparedeanus reproduces well, grows fast, matures early and responds positively to constant optimal temperatures. This species can therefore be bred under artificial conditions and used as food for fish at fish hatcheries.

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OLIGOCHAETE FAUNA OF THE BIG RIVERS IN THE BALTIC SEA BASIN

by

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In 1977-1980, the Laboratory of General Hydrobiology of the Institute of Biology of the Academy of Sciences of the Latvian SSR carried out comprehensive investigations of some of the big rivers in the Baltic region with the aim of determining their present hydrobiological condition.

An understanding of the most important biological processes that take place in bodies of water is impossible without a study of the entire complex of the hydrobionts which inhabit them. Of particular interest among these hydrobionts are the members of the bottom fauna because the benthos (including the oligochaetes) reflects the sanitary condition of the bottom over long periods of time.

The oligochaetes play a very important part in the zoobenthos

Table 77

Distribution of oligochaete species in the rivers of the Baltic Sea basin

	Свирь	Волхов	Нева	Луга	Нарва	Пярну	Гауя	Дауга-ва	Лиелу-пе	Вента	Неман	Прего-ля	Муха-вец
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Aeolosoma hemprichi Ehrenb.	-	-	-	-	-	-	-	•	-	-	-	-	-
Ae. variegatum Vejd.	-	-	-	-	-	-	-	•	-	-	-	-	-
Ae. tenebrarum Vejd.	-	-	-	-	-	-	-	•	-	-	-	-	-
Rheomorpha neisvestnoyae (L.)	-	-	-	-	-	-	-	-	•	-	-	-	-
Stylaria lacustris (L.)	+	+	+•	+	+•	+	+	+•	+•	+	+•	+	+
Arcteonais lomondi (Martin)	-	+•	•	-	•	-	-	•	-	-	-	-	-
Ripistes parasita (Schmidt)	+	•	•	+	-	-	-	•	-	-	-	-	-
Vejdovskyella comata (Vejd.)	-	-	•	-	-	-	-	-	-	-	-	-	-
V. intermedia (Bretscher)	-	-	•	-	-	-	-	•	-	-	-	-	-
Slavina appendiculata (Udekem)	+	-	•	-	•	+	+	•	-	-	+•	-	-
Dero digitata (Müller)	-	•	-	-	+	-	-	+•	•	-	-	+	+
D. dorsalis Ferr.	-	-	-	-	-	-	-	•	•	-	-	-	-
D. obtusa Udekem	-	-	-	-	-	-	-	•	•	+	+	+	-
Aulophorus furcatus (Müller)	-	-	•	-	-	-	-	-	-	-	-	-	-
Nais pseudoobtusa Piguet	-	-	•	-	•	-	+	•	+•	-	+	-	-
N. barbata Müller	-	-	•	+	+•	-	+	•	+•	+	+	+	+
Nais simplex Piguet	-	-	-	-	•	-	-	•	+•	-	-	-	-
N. behningi Mich.	-	-	•	-	+	-	+	+•	-	-	-	-	-

2 - Svir; 3 - Volkhov; 4 - Neva; 5 - Luga; 6 - Narva; 7 - Pyarnu; 8 - Gauya; 9 - Daugava; 10 - Lielupe; 11 - Venta; 12 - Neman; 13 - Pregolya; 14 - Mukhavets

Table (contd.) 78

1	2	3	4	5	6	7	8	9	10	11	12	13	14
N. communis Piguet	-	-	.	-	+	-	-	.	.	-	+	+	-
N. elinguis Müller	-	-	.	+	-	-	+	.	.	-	+	-	+
N. variabilis Piguet	-	-	-	-	.	+	+	.	-	-	+	-	-
N. pardalis Piguet	-	-	-	-	+.	+	+	.	.	-	+	-	-
N. bretscheri Mich.	-	-	.	-	+.	-	+	+.	.	-	+	-	-
Specaria josinae (Vejd.)	+	-	+.	-	+	+	+	+.	.	+	-	+	+
Piguetiella blanci (Piguet)	-	-	.	-	+	+	-	+	-	+	-	-	-
Ophidonais serpentina (Müller)	-	+	.	-	+.	+	+	+.	.	+	+	-	-
Uncinais uncinata (Oersted)	+	+.	+.	+	+.	+	+	+.	.	+	+	-	+
Paranais litoralis (Müller)	-	-	-	-	-	-	-	.	.	-	-	-	-
P. friči Hrabě	-	-	-	-	-	-	-	.	.	+	+	-	-
Amphichaeta leydigi Tauber	-	-	-	-	-	-	-	.	.	-	-	-	-
A. sannio Kallst.	-	-	-	-	-	-	-	.	.	-	-	-	-
Chaetogaster diastrophus (Gr.)	-	-	.	-	-	-	-	.	.	-	+	-	+
Ch. diaphanus (Gr.)	-	-	.	-	+	-	-	.	.	-	+	-	-
Ch. crystallinus Vejd.	-	-	-	-	-	-	-	.	.	+	-	-	-
Ch. langi Bretscher	-	-	-	-	-	-	-	.	.	-	-	-	-
Ch. limnaei Baer	-	-	-	-	-	-	-	.	.	-	-	-	-
Pristina foreli Piguet	-	-	.	-	-	-	-	.	-	-	-	-	-
P. longiseta Ehrenb.	-	-	-	-	-	-	-	+.	.	-	-	-	-

Table (contd.) 79

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pristina aequiseta Bourne	-	-	-	-	-	-	-	.	.	-	-	-	-
P. amphibiotica Lastočkin	-	-	-	-	-	-	-	.	-	-	-	-	-
Aulodrilus limnobius Bretscher	-	-	.	-	-	-	-	+.	.	-	-	-	+
Au. pluriseta (Piguet)	-	-	.	-	+.	+	-	+.	.	+	+	-	+
Au. pigueti Kowalevski	-	-	-	-	-	-	-	-	-	-	-	-	+
Rhyacodrilus coccineus (Vejd.)	-	-	-	-	-	+	+	-	-	-	-	-	-
Isochaetides newaensis (Mich.)	+	+.	+.	+	+.	-	-	+.	+.	-	+	-	-
Limnodrilus udekemianus Clap.	-	+	+.	-	+.	+	-	+.	.	+	+.	+	+
L. helveticus Piguet	-	-	+.	-	+.	-	-	+.	.	-	+	+	+
L. hoffmeisteri Clap.	+	+.	+.	+	+.	+	+	+.	+.	+	+.	+	+
L. claparedeanus Ratzel	-	-	-	-	.	-	+	+.	.	-	+.	+	+
Potamothrix bedoti (Piguet)	-	-	-	-	-	-	-	-	.	-	-	-	-
P. hammoniensis (Mich.)	+	+.	+	+	+.	+	+	+.	+.	+	+.	+	+
P. bavaricus Oeschmann	-	-	-	-	-	-	-	.	.	-	-	-	-
P. vejdovskyi Hrabě	-	-	-	-	-	-	-	+	-	-	+	-	+
P. heuscheri Bretscher	-	-	-	-	-	+	-	.	+.	+	-	-	-
P. moldaviensis Vejd.	-	+	-	-	+.	-	+	+.	.	+	+	+	+
Psammoryctides albicola (Mich.)	-	-	.	-	+.	-	-	+.	+.	+	-	-	+
P. barbatus (Grube)	-	-	.	-	+.	+	+	+.	+.	+	+.	-	+
P. moravicus Hrabě	-	-	-	-	+.	-	-	+.	.	-	-	-	+
Tubifex ignotus (Štolc)	-	+	.	-	+.	-	+	+.	.	+	-	-	-
T. tubifex (Müller)	-	+.	+.	-	+.	+	+	+.	+.	+	+.	+	+
T. costatus (Clap.)	-	-	-	-	-	-	-	-	.	+	-	-	-

Table (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Tubifex smirnovi Lastočkin	-	-	-	-	.	-	-	-	-	-	-	-	-
T. templetoni Southern	-	-	-	-	-	-	-	+.	-	-	-	+	-
Peloscolex ferox (Eisen)	-	+.	.	-	+.	+	-	+.	.	+	+.	+	+
Propappus volki Mich.	-	+	.	-	+.	-	+.	+.	-	-	+	-	-
Enchytraeus albidus Henle	-	-	.	-	-	-	-	-	-	-	-	-	-
Enchytraeus sp.	-	-	.	-	.	-	+	+.	.	-	+	-	-
Fridericia sp.	-	-	.	-	-	-	-	.	.	-	+	-	-
Lumbriculus variegatus (Müll.)	-	-	.	+	+.	+	+	+.	+.	+	-	-	-
Stylodrilus beringianus Clap.	-	+	.	+	.	-	+	+.	+.	-	-	-	-
Rhynchelmis tetratheca Mich.	-	-	-	-	-	-	-	.	-	-	-	-	-
Rh. limosella Hoffm.	-	-	.	-	.	-	-	.	.	-	-	-	-
Criodrilus lacuum Hoffm.	-	-	-	-	-	-	-	+.	+.	+	+.	-	+
Eiseniella tetraedra (Savig.)	-	-	-	-	-	-	-	.	.	-	+	-	-
Eisenia foetida (Savig.)	-	-	-	-	-	-	-	.	-	-	-	-	-
a Всего:	8	16	39	10	37	18	24	66	52	23	32	15	23

a - Total

of the Baltic region rivers - both in terms of species composition 76
and in terms of abundance. The present paper is based on materials collected in the course of the field work and on data found in the literature. The investigations were carried out during the growing season on the rivers Svir, Volkhov, Neva, Luga, Narva, Pyarnu, Gauya, Daugava, Lielupe, Venta, Neman, Pregolya and Mukhavets. Sites for analyses were selected above and below major population centers and in the estuaries of the rivers. Samples of benthos organisms were obtained by means of Petersen and Ekman-Berge grab samplers and were analyzed using universally accepted procedures.

Analysis of 187 samples of zoobenthos organisms obtained from the above-mentioned rivers made it possible to identify 52 oligochaete

species; the total number of species, together with those reported in the literature, is 76 (see the Table). The literature used includes the works by I.I. Gasyunas, E.A. Parele, T.E. Timm, N.P. Finogenova 81
and O.V. Chekanovskaya.

The results of our investigations indicate that the rivers of the Baltic Sea basin are inhabited predominantly by widespread species. The dominant role is played by the families Naididae (36 species) and Tubificidae (24 species).

The species composition and population dynamics of the oligochaetes in the rivers of the Baltic region that were investigated suggest that most of them are polluted to a greater or lesser degree; no biologically pure reaches were found. It can be assumed that the presence of background pollution is now characteristic of all the big rivers in the given region.

FORMATION OF AN OLIGOCHAETE FAUNA IN THE KUMISI RESERVOIR

by

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The Kumisi reservoir has been in existence for a relatively short period of time. It was formed in 1962 in the basin of the salt lake Kumisi. This was done by emptying the salt water from the lake, washing the basin and then refilling it with fresh water.

The reservoir was created for irrigation purposes. It is supplied with water from the Kura river by means of a series of pumping stations.

In 1966, the floor of the reservoir was again washed, and the reservoir, after being refilled with Kura river water, was stocked with commercial fishes. As a result, the Kumisi reservoir has become a highly productive body of water, yielding annually over 700 kg of high-quality fish per hectare of its area.

The reservoir was designed to have a maximum depth of 3.7 m 82
and an area of 540 ha. In the years 1969-1979, the maximum depth varied from 1 m to 2.8 m, while the area of the reservoir never exceeded 450 ha.

The climate in the region is moderately warm, dry, with little precipitation, with moderate winters and hot summers, and with a large number of windy days.

The water temperature varies in winter from 0.3°C to 0.6°C and in summer from 20.4°C to 26.4°C. In cold winters the reservoir freezes over (from December to February), the ice reaching 20 cm in thickness.

The oxygen content of water in the reservoir is quite favorable. The active reaction of the water is weakly alkaline. The salinity was 8.9 % in 1967 and has since been decreasing with slight variations; it reached 2.42%-3.20% in 1973 and 1979.

The bottom of the reservoir is covered with black mud, which has the characteristic odor of hydrogen sulfide. The mud was deposited in the former saltlake. It is liquid at the top but grows denser with depth. At low temperatures the density of the mud may increase in the opposite direction.

Studies of the oligochaetes inhabiting the reservoir were carried out in 1969-1973 and in 1977-1979.

During the first period of study it was found that, due, probably, to the high salt content of the mud, most of the oligochaetes were concentrated in the top 5 cm of the upper layer, with very few worms occurring as deep down as 10 cm below its surface. A Petersen grab sampler was, therefore, used to obtain quantitative zoobenthos samples.

In the very first year of our studies (1969) the oligochaete fauna in the reservoir was represented by only one species - *Paranais friči*, whose numbers and biomass were very low. It should be noted that the salt lake Kumisi also contained small numbers of oligochaetes of only one species, identified as *Paranais litoralis*. We believe, 83
however, that, for reasons discussed below, these oligochaetes must be assigned to the species *Paranais friči*.

At the end of 1970, several individuals representing three oligochaete species - *Dero obtusa*, *Potamothrix bavaricus* and *Limnodrilus claparedeanus* - were found in the area where the Kura water enters the reservoir. The dominant species was still *Paranais friči*, but in 1972 it disappeared altogether from the oligochaete fauna of the reservoir.

In 1972, several individuals of the species *L. hoffmeisteri* were for the first time discovered in the area where the Kura water enters the reservoir. In 1973, this species again disappeared from the reservoir. Later, in 1977, the benthos of the reservoir still included worms of the species *D. obtusa* and *P. bavaricus* and also representatives of *P. friči* and *L. hoffmeisteri*, which had by then reappeared in the reservoir, while *L. claparedeanus* had disappered and was never found again during the second period of our investigations. The same species composition characterized the oligochaete fauna of the reservoir in 1978 and 1979, with only one more species - *N. elinguis* - discovered in the winter and spring of 1978.

Thus, summing up what has been said before, we can point out the following stages in the development of the oligochaete fauna of the reservoir: *P. friči* was the only oligochaete species present in the reservoir in 1969 and 1970; in 1972 and 1973 it disappears but emerges again in 1977 and remains in the reservoir throughout the second period of our studies. *D. obtusa* and *P. bavaricus* have been present in the reservoir since late 1970. *L. claparedeanus*, a few individuals of which were found between 1970 and 1973, was never again encountered in the course of our studies.

L. hoffmeisteri was first discovered in 1972, only to disappear for a few years. It was found again in 1977 and was present throughout the second period of our studies. The species grew rapidly 84
in abundance, reaching fairly high population density and biomass values in 1978 and 1979. Together with *P. bavaricus*, it constitutes the dominant oligochaete form of the Kumisi reservoir (Table 1).

The population density and the biomass of the Kumisi reservoir oligochaetes, which were very low in 1969, increased in the years that followed and reached their maximum values in 1979 (Table 2).

It must be concluded from the above data that the oligochaete fauna of the reservoir is characterized by a qualitatively limited

Table 1

Seasonal population density of the oligochaete species (ind/m^2)

	1977	1978				1979	1979
	autumn	winter	spring	summer	autumn	winter	spring
N. elinguis	-	6	414	-	-	-	-
D. obtusa	56	32	6752	108	3265	3441	682
P. friči	502	2319	2328	-	-	78	78
Pot. bavaricus	670	1091	8476	31683	26722	43474	75708
L. hoffmeisteri	788	3187	17971	7285	13590	17769	29003

Table 2

Quantitative characteristics of the oligochaetes in the different years

Years	1969	1970	1972	1973	1977	1978	1979
Month	VII	VII	VIII	VII	X	VII	IV
Population density (ind/m^2)	62	82	130	3951	2016	39075	105471
Biomass (mg/m^2)	8.0	9.5	23.8	1037.8	635.0	9975.0	58502.0

species composition and a slow rate of development. High quantitative characteristics were reached only in the 16-17th year after the reservoir was formed.

To determine how the different species of oligochaetes had 85
found their way into the Kumisi reservoir, we collected qualitative samples in some other water bodies situated in the same area. The samples yielded representatives of the species N. pardalis, N. elinguis, D. obtusa, P. friči, L. udekemianus, L. claparedeanus, Pot. bavaricus, as well as some worms belonging to the families Enchytraeidae and Lumbriculidae. We also conducted a series of experiments with some of the oligochaete species obtained from fresh and brackish water bodies in

the vicinity of the Kumisi reservoir. Some of the live oligochaetes were lowered onto the bottom of the Kumisi reservoir, while the rest were placed in Petri dishes and kept in a laboratory (on the bank of the reservoir).

Some of the oligochaetes were lowered onto the bottom inside cylindrical glass containers open on one side; the rest were put in cylindrical containers which were open on either side. All the containers were covered with gauze No. 66. Both the Petri dishes and the glass cylinders contained mud taken from the bottom of the reservoir and washed in a dip net. The water temperature on the bottom of the reservoir (near the containers) and in the Petri dishes was measured three times a day.

During the entire period of observation the temperature of the water on the bottom of the reservoir varied between $13^{\circ}C$ and $24^{\circ}C$, and in the Petri dishes between $14.2^{\circ}C$ and $22.8^{\circ}C$.

The experiment resulted in the death of some of the oligochaetes: N. pardalis died 11 days, P. frici 17 days and L. udekemianus 65 days after it was begun. The death of these species was, we believe, caused by exposure to salt water and to frequent variations in its salt content.

No representatives of P. bavaricus and L. claparedeanus died during the experiment. Yet, L. claparedeanus was no longer present in the reservoir. It is possible that a prolonged (over 65 days) stay in a salty substratum is fatal to this species.

The above data show that the species N. pardalis, N. elin- 86
guis, D. obtusa, L. udekemianus, L. hoffmeisteri, L. claparedeanus

and P. bavaricus come to the Kumisi reservoir with the Kura water.

Most of these oligochaete forms perish sooner or later in the saline water of the Kumisi reservoir, with only three species being able to survive: D. obtusa, P. bavaricus and L. hoffmeisteri.

We believe that only one species, P. friči, is of local origin. This form lived in the former salt lake and is regularly found in all of the brackish water bodies in the vicinity of the reservoir. When the concentration of salt in the water of the Kumisi reservoir decreases, P. friči dies out, but when the concentration rises again above the level of 3.5-4%, the species reappears among the inhabitants of this water body.

The process of formation of the oligochaete fauna in the Kumisi reservoir is not yet over. Only one thing is certain: the species D. obtusa, P. bavaricus and L. hoffmeisteri live permanently in the reservoir owing to their apparent ability to tolerate variations in the salinity within the range of 2.8-3.30%.

LONGITUDINAL AND ZONAL DISTRIBUTION OF OLIGOCHAETES IN THE KURA RIVER WITHIN THE BOUNDARIES OF GEORGIA

by

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The Kura river can be divided into three parts: the upper course - from the source (2741 m above sea level) to the Borzhomi gorge, the middle course - from the Borzhomi gorge to Mingechaur, and the lower course - from Mingechaur to the Caspian Sea. Thus, two of the three parts of the river, its upper and middle courses, whose total length is about 400 km, lie within the boundaries of Georgia.

For the purposes of our study, we established permanent stations in the upper course of the river near Khertvisi, in the middle course near the town of Gori, below Tbilisi, below Rustavi, and near the Red bridge.

At each station quantitative samples were obtained by means of a benthos sampler (0.1 m^2). One sample was taken near the bank at a depth of 10 cm, and a second sample at a depth of 50 cm. Sampling was done on a seasonal basis. In the course of three seasons a total of 30 quantitative and 25 qualitative samples were obtained.

Laboratory analysis of the material thus obtained revealed the presence of representatives of six oligochaete families in the Kura river. The naidids head the list as a family represented by the largest number of species - 26, followed by the tubificids, which are represented by 9 species.

Altogether, the Kura river was found to be inhabited by 40 species of oligochaetes. Particularly frequent and dense are the populations of Stylaria lacustris, Nais barbata, N. elinguis, N. iorensis, Limnodrilus sp. (iuv.), L. hoffmeisteri and Tubifex tubifex.

Very infrequent and represented by isolated individuals are the species Specaria josinae, Uncinais uncinata, Aulodrilus pluriseta, A. pigueti and some species of the families Lumbriculidae and Lumbricidae.

In terms of the number of species and frequency of occurrence, the oligochaete fauna of the Kura river is dominated by phytophilous forms. None of the 40 oligochaete species that we identified from the samples had ever been found in the river before. Six of these species (*Stylaria fossularis*, *Specaria josinae*, *Amphichaeta leydigi*, *Pristina bilobata*, *Pr. menoni* and *Pr. foreli*) had been reported from some other water bodies in Transcaucasia.

All of the species we identified can be found in areas of slack water, very close to the bank (at a depth of 10 cm); 37 forms 88
occur in areas where the current is strong (at a depth of 50 cm).

The average density of the oligochaete populations is 15873 ind/m^2 at a depth of 10 cm, and twice that number at a depth of 50 cm (31050 ind/m^2). The biomass is 5536.4 mg/m^2 and 4403.8 mg/m^2, respectively.

Our studies show that both in summer and autumn there were 38 oligochaete species in the river, while in winter their number stood at 26. The presence of so many oligochaete species in summer and autumn was probably made possible by the abundance of algae, the stable water level and the optimum water temperature in the river during these two seasons. Thus, the water temperature fluctuated in summer between 19.8°C and 25.6°C, and in autumn between 12°C and 19.6°C. The significant drop in the number of oligochaete species in winter must be due to the decrease in the abundance of algae and to the decline in the water temperature during the winter months. For example, the water temperature was 3.4°C near Khertvisi and near Gori, and 5.8°C below Tbilisi.

Figures showing the seasonal variations in the population density and biomass of the Kura oligochaetes are given in Table 1. As can be seen, the population density is lowest in summer, increases threefold in autumn, and reaches its maximum value in winter. Similarly, the biomass is lowest in summer, grows 13-fold in autumn, but declines slightly in winter.

The figures given in the Table show the quantitative characteristics of the oligochaetes to be the lowest in summer. We believe, however, that they must be still lower in spring when the high water and the torrential flow result in the death of a large number of organisms, including oligochaetes.

Table 1 89

Seasonal variations in the abundance and biomass of the Kura oligochaetes

Year / Season	1974		1975	Mean annual value
	summer	autumn	winter	
Population density (ind/m^2)	5603	21326	85362	37427
Biomass (mg/m^2)	612.9	7997.8	6299.7	4770.1

The importance of oligochaetes as the best kind of food for benthophagous fish depends on the density and biomass of the oligochaete population. It should be noted in this connection that in terms of biomass the oligochaetes play a dominant role in the zoobenthos of the Kura river. Thus, the oligochaetes account for 9.93% of the total biomass of the zoobenthos in summer, for 83.15% in autumn and for 32.05% in winter (an annual average of 42.07%).

The qualitative and quantitative distribution of oligochaetes along the course of the Kura river within the boundaries of Georgia is represented in Table 2. As can be seen from the Table, the number

of species, the population density and the biomass are lowest in the upper course of the river, near Khertvisi. At the beginning of the middle course, near the town of Gori, the quantitative characteristics are already much higher, while below Tbilisi they reach their maximum values. Below Rustavi the oligochaete fauna is reduced by 5 species, the abundance declines by 3.2 times and the biomass by 8.9 times. Near the Red bridge the quantitative characteristics begin to increase again. In and around Tbilisi the Kura river is very heavily polluted with organic wastes. Thus, within the city limits, the river receives 4 m^3/sec of untreated domestic and industrial sewage. Such gross pollution creates favorable conditions for the extensive development of the oligochaete population. It is this pollution that must be responsible for the fact that the highest quantitative characteristics 90
are observed precisely below the city of Tbilisi.

Table 2

Longitudinal and zonal distribution of the quantitative characteristics of the oligochaete fauna in the Kura river

Area	Number of species	Density (ind/m^2)	Biomass (mg/m^2)
Khertvisi	19	8380	303.3
Gori	28	9989	1141.0
Below Tbilisi	33	73688	16277.7
Below Rustavi	28	22917	1810.8
Red bridge	29	67292	7317.8

The significant decline in the abundance of the oligochaetes below Rustavi must be attributed to the toxic effect of the effluents being discharged into the river by a number of industrial enterprises operating in that area. Living material samples obtained in winter below Rustavi yielded 69 oligochaete cocoons. The cocoons were found to contain individuals with two heads and tails. Some of them could be seen moving actively inside their cocoons but, being two-headed and two-tailed, were unable to pass through the openings. We opened some of the cocoons and extracted 23 of those deformed individuals. Despite the good conditions in which they were kept, all the deformed individuals, both those that had and those that had not been extracted from their cocoons, died within 74 days from the start of the observation.

It is obvious that the same thing happens under natural conditions in the river, so that below Rustavi most of the oligochaetes 91
die quickly on being exposed to the effect of the chemical wastes, while in some of them the chemicals produce various abnormalities resulting in their death later on. Only a small number of oligochaetes manage to survive.

Thus, the effluents which the chemical factories and the steel mills of Rustavi discharge into the Kura river cause a mass mortality among the aquatic organisms and a significant drop in the density and biomass of the oligochaete population.

ZOOGEOGRAPHY OF THE AQUATIC OLIGOCHAETES IN THE NORTHERN PART OF EUROPEAN USSR

by

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The water bodies of the northern part of European USSR have a very rich oligochaete fauna. This is the conclusion one is bound to draw upon comparing this fauna with the faunas of the adjacent areas and of other large regions of the world. The North European water bodies of this country are inhabited by 140 oligochaete species, which account for 50% of all the genera and about one quarter of all the species of aquatic oligochaetes known to exist in the world.

Zoogeographic analysis of the North European oligochaete fauna has shown it to be genetically heterogeneous and composed of six groups:

1. Species with a particularly vast range (cosmopolitan or inhabiting different widely-separated parts of the Northern and Southern Hemispheres);

2. Holarctic species;

3. Palearctic species;

4. Species found only in Europe;

5. Species that have so far been found only in the water bodies of northern Europe;

6. Species with a discontinuous range. 92

Most of the oligochaete species (about 70%) in the area under discussion have a very wide range: these are cosmopolitan or bipolar, holarctic and palearctic forms. Particularly abundant among them are *Stylaria lacustris*, *Nais communis*, *N. simplex*, *N. barbata*, *Ophidonais serpentina*, *Chaetogaster diaphanus*, *Limnodrilus hoffmeisteri*, *Tubifex tubifex*, *Peloscolex ferox*, *Lumbriculus variegatus* and some others.

Far less important is the role played by the European species with a narrow range. These species, confined to a small part of Europe and occurring sporadically, include *N. alpina*, *Ch. setosus*, *T. smirnovi*, *Alexandrovia onegensis*, *Tatriella slovenica*, *Rhynchelmis tetratheca*, as well as species with Mediterranean and Pontic-Caspian ranges (the genera *Isochaetides*, *Potamothrix*, *Psammoryctidea* and the species *S. parvus*). The species of the genera *Isochaetides* and *Potamothrix* have greatly expanded their ranges, spreading northward and eastward mainly along shipping routes. Many of the European species are very poorly represented in the North European water bodies, while some of them (*N. alpina*, *Ch. setosus*, *A. onegensis*, *T. slovenica*) are confined to one or a few bodies of water, where they form small populations.

A very small proportion (12%) of the North European oligochaete fauna is made up of species which so far have been found only in the northern part of European USSR: *T. kessleri*, *Lumbriculus karelicus*, *L. alexandrovi*, *Trichodrilus oporophorus*, *Tatriella longiatriata*, *Arcteonais elenae*, *Pristina palmeni*, *Umbadrilus saamicus*, etc. These species have not been discovered in any other basins and zoogeographic regions, but it would still be premature to describe them as being endemic.

The geographic distribution of species with a discontinuous 93
range (*Lamprodrilus achaetus*, *L. isoporus*) is connected with the deep ancient water bodies of Eurasia scattered between Macedonia and Baikal: lakes Ohrid, Onega, Ladoga, Baikal, etc.

Twenty species of the North European oligochaete fauna are particularly evenly distributed throughout the area - these are, in the main, its most abundant and widespread representatives. The species Isochaetides michaelseni, I. newaensis, Potamothrix moldaviensis, P. bedoti, Propappus volki and others, which are widespread in other basins, are seldom encountered in the inland water bodies of the region under discussion. This is probably due to the fact that they are relatively recent arrivals in this region, their presence in it being connected with the giant lakes (Ladoga, Onega), the big rivers and their basins, and also with the man-made water bodies (reservoirs).

According to the mollusk-based system of zoogeographic regionalization of continental water bodies proposed by Ya.I. Starobogatov (1970), the northern part of European USSR lies within the Palearctic region and occupies a considerable portion of the European-Siberian subregion, which includes the Lapland, Dvina and Pechora provinces.

The distribution of the North European oligochaete fauna is quite distinctly affected by latitudinal and zonal factors which involve the specific temperatures and the hydrological and hydrochemical regimes of the water bodies, the origin of the lake basins and river channels, and also a variety of historical processes. In this connection, we distinguish within this area three districts as part of the European-Siberian subregion.

The northern district, which lies to the north of 65° N., is 94
characterized by a relatively poor oligochaete fauna (comprising 55% of all the North European oligochaete species), which is dominated by the species (P. ferox, T. tubifex, S. heringianus, L. variegatus and others) of the northern oligochaete complex (Lastochkin, 1947) and includes almost no European and Palearctic forms. Some rare oligochae-

te species are well represented in this district.

The middle district, which lies between 63° and 65° N., has a mixed fauna consisting of species that penetrated into this area from the water bodies of three basins - those of the White, Baltic and Pechora Seas. This district is inhabited mostly by cosmopolitan, Holarctic and Palearctic forms, as well as by a certain number of European species.

The southern district lies to the south of 63° N. It is characterized by a particularly rich oligochaete fauna (comprising about 90% of all the species), by the presence of all the European and many "southern" faunistic forms, and by the high total abundance of the widespread species. The oligochaete fauna of the Dvina and Pechora provinces of this district shows clear signs of being related to that of the Volga basin. The fauna of the district as a whole consists almost entirely of widespread species.

The oligochaete fauna grows poorer not only in the latitudinal direction - from south to north, but also longitudinally - from east to west, i.e. the general trend is from south-east to north-west. In this direction the fauna gradually loses its European and Palearctic groups, retaining only those forms that have a wider range. Towards the north the fauna is characterized by a gradual increase in the proportion of the stenothermal cold-loving species of the family Lumbriculidae, while towards the north-east (the Pechora river basin) a very prominent role in the fauna is assumed by S. fossularis, a fairly common fresh-water species of the Far East.

The zoogeographically complex structure of the North European 95 olgochaete fauna and the diverse and mixed nature of its constituents are due not only to the diversity of the landscapes and the patchiness of the natural conditions in the area but also to the historical trends that have characterized the development of its natural complexes.

The oligochaete fauna of the northern part of European USSR is relatively young. It has developed during the post-glacial period over the last 13-15 thousand years. The first to arrive were probably the cold-loving stenotherms from the family Lumbriculidae, which penetrated into the area from sufficiently cold high-mountain water bodies of Europe following the retreat of the continental glaciers. As the climate grew warmer, the oligochaete fauna gradually spread northward - mostly from south-western Europe, but partly also from the east. This process is still going on, as is evident from the fact that many of the species are expanding their ranges. It is quite likely that in the near future the northern part of European USSR will see the arrival of some other oligochaete species (P. heuscheri, P. bavaricus and others) that are known to inhabit the water bodies of the adjacent provinces.

The natural penetration of many of the South European oligochaete species into the northern part of European USSR is being hampered by the severe climate of the area with its long winters, by the low degree of mineralization and the relatively high degree of humification of the water bodies, and also by the salt-water White Sea, which separates the Kola peninsula from the areas to the east and south, blocking the spread of fresh-water immigrants (Timm, Popchenko, 1978).

However, the ships which sail in increasing numbers between the north and south are instrumental in enriching the northern oligochaete fauna by transporting oligochaetes from the southern regions.

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EFFECT OF THE AMBIENT TEMPERATURE ON THE METABOLISM IN LIMNODRILUS UDEKEMIANUS (OLIGOCHAETA)

by

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The capacity of poikilothermic organisms and their isolated tissues to maintain within a certain range of ambient temperatures a constant level of life activities - metabolism - has come to be known as metabolic ambient-temperature compensation (Bullock, 1955).

This phenomenon, observed at the cellular and subcellular levels, as well as at the level of the body and of its various organs, involves a number of biochemical processes discovered by several researchers (Precht, 1964; Prosser, Nagai, 1968; Behrisch, 1971; Wieser, 1973; Khochachko and Somero, 1977). Most often it characterizes organisms inhabiting the littoral zone (Newell, Pye, 1970), soil-dwelling organisms exposed to cyclic temperature variations (Byzova, 1977), and fresh water organisms living in the type of extreme continental climate that is characteristic of the Kirghiz SSR (Prasolova, 1980).

Studies on the growth and reproduction of oligochaetes in a natural body of water (Vasil'eva et al., 1977) show that these worms reproduce actively throughout the year and that their biomass is high

(4-5 kg/m^2) even in winter, when the ambient temperatures are low (2-3°C). On the basis of this fact we assumed that, in the conditions of the Kirghiz SSR, the activity of some other functions in oligochaetes, including respiration, must be equally high. Worms of the species *L. udekemianus* were collected for our study once a month during 1977-1980. The samples were obtained from an open water body, and the worms they contained were identified to species under the temperature conditions of their habitat. Measurements of the oxygen consumption by the worms were taken *ex tempore* at a temperature corresponding to that of the mud at the moment when the worms were pulled 97
out from it, and also during a sharp change in temperature from 13°C to 23°C. The total uptake of oxygen was determined by means of two techniques: by Winkler's iodometric method, and by manometric measurements in a Warburg flask; both methods were used at the body and tissue levels.

The Table below contains the following data: the ambient temperature at the moment of taking the sample; the rate of oxygen consumption by the worms at the ambient temperature; the respiration rate during sharp temperature changes, and the respiration rate of tissue homogenates; the respiration rate Q_{10} values calculated for 13°C and 23°C.

The results of our study show that the two methods used to determine the total oxygen consumption by *Limnodrilus udekemianus* produce nearly identical values. When the ambient temperature in a natural water body rises from 2-3°C to 18-21°C, the respiration rate, measured at the ambient temperature at the moment of taking the sam-

Table 98

Relationship between the metabolic rate and the ambient temperature in <u>Limnodrilus udekemianus</u>

e При T°C обитания	a Общее потребление кислорода, мл O_2/г.ч b Методом Винклера		c Методом Варбурга		d Дыхание гомогенатов Методом Варбурга	
	I3°C	23°C	I3°C	23°C	I3°C	23°C
2-3°C 0,087 ±0,003	0,I35 ±0,0I9	0,I43 ±0,003	0,I68 ±0,0I4	0,I62 ±0,0I0	0,I46 ±0,026	0,I54 ±0,033
	O_{IO}-I,06		O_{IO}-0,96		O_{IO}-I,05	
5-7°C 0,089 ±0,005	0,I36 ±0,009	0,I49 ±0,005	0,I49 ±0,0I2	0,I42 ±0,0I4	0,206 ±0,028	0,234 ±0,039
	O_{IO}-I,09		O_{IO}-I,0I		O_{IO}-I,I4	
8-I0°C 0,I00 ±0,0I8	0,II8 ±0,006	0,I24 ±0,0I4	0,I24 ±0,004	0,I58 ±0,003	0,II9 ±0,0I0	0,I45 ±0,007
	O_{IO}-I,05		O_{IO}-I,27		O_{IO}-I,39	
I2-I5°C 0,II6 ±0,008	0,I44 ±0,0II	0,I76 ±0,0I6	0,I23 ±0,0,0I0	0,I67 ±0,007	0,I05 ±0,008	0,I59 ±0,008
	O_{IO}-I,22		O_{IO}-I,36		O_{IO}-I,5I	
I6-I7°C 0,I30 ±0,005	0,I23 ±0,005	0,I76 ±0,008	0,I22 ±0,005	0,I70 ±0,008	0,I75 ±0,0I3	0,309 ±0,0II
	O_{IO}-I,43		O_{IO}-I,39		O_{IO}-I,77	
I8-2I°C 0,I63 ±0,006	0,I34 ±0,0I5	0,229 ±0,0I2	0,I04 ±0,006	0,I74 ±0,009	0,I52 ±0,0I2	0,25I ±0,0II
	O_{IO}-I,7I		O_{IO}-I,67		O_{IO}-I,65	

a - Total oxygen consumption, ml O_2 per gram per hour; b - by Winkler's method; c - by Warburg's method; d - Respiration in homogenates by Warburg's method; e - at an ambient temperature

ple, shows only a twofold increase. The low Q_{10} values (1.15-1.20) 97
observed in nature are evidence of the stability of the metabolic processes within the temperature range of 2-21°C.

When the ambient temperature changed from low to high and vice

versa, the worms were observed to respond to these changes in different ways. Thus, when exposed in the course of our experiment to temperatures of 13-23°C, worms taken from a low temperature environment maintained the total oxygen consumption at a nearly stable level and showed low Q_{10} values - 0.96-1.26 as determined by Warburg's method and 1.06-1.49 according to a measurement made by Winkler's method. In the same kind of experiments worms taken from a natural water body at a time when the temperature of the mud was high exhibited a tendency to increase the temperature coefficient to 1.71 98
as the ambient temperature rose. The rise in the Q_{10} value of the oxygen consumption was detected through measurements of the respiration rate taken both by Winkler's method and in a Warburg flask.

Similar results were obtained in our studies of respiration in tissue homogenates taken from oligochaetes. The respiration Q_{10} 99
was low (1.06-1.14) in the winter oligochaete populations (2-7°C) and high (1.59-1.77) in oligochaetes living under more favorable temperature conditions (8-21°C). As our study shows, exposure to sharp temperature changes produces different changes in the metabolic rate of aquatic oligochaetes. The following tendency is clearly evident: the metabolic rate in oligochaetes is high at low temperatures, these having a peculiar homeostatic effect on the metabolic processes.

Our studies show that in the natural and climatic conditions of Central Asia and, in particular, of the Kirghiz SSR oligochaetes of the species L. udekemianus are capable of maintaining their own specific type of metabolic homeostasis. This is evidenced by the fact that in the course of our experiments a particularly great compensatory capacity was observed during the winter months in individuals picked out from a natural body of water and exposed to high temperatures.

SPECIES COMPOSITION AND DISTRIBUTION OF OLIGOCHAETES IN THE ABYSSAL ZONE OF LAKE BAIKAL

by
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One of the most remarkable features of Lake Baikal is its abyssal zone, which lies at depths prevailing over the greater part of the lake: from 200 m down to 1620 m.

Faunistic investigations of this zone of Lake Baikal have been conducted for nearly a hundred years, and yet our knowledge of the species composition, distribution, ecology and quantitative characteristics of the oligochaetes in the bottom communities of the abyssal zone is very far from being complete. The little that is known about the abyssal zone oligochaetes is contained in a few separate descriptions of some new species (Michaelsen, 1901; Michaelsen, 1905; Izosimov, 1962; Chekanovskaya, 1975). These publications, however, fail 100
to indicate the location of the species they describe, which makes it impossible to understand how the different species are distributed throughout the abyssal zone.

The present paper summarizes the results of our own study into the species composition, distribution and ecology of the abyssal zone oligochaetes. The study was based on material collected in 1968-1970 by groups of researchers, headed by M.Yu. Bekman, from the Institute of Limnology of the Siberian Branch of the Academy of Sciences of the USSR. The material consists of oligochaetes from 55 zoobenthos samples covering almost the entire abyssal zone at depths ranging from 250 to 1615 m. The samples were taken by means of an "Okean" bottom sampler, a toothed trawl, and a beam trawl with a nylon net. The last-mentioned gear proved to be particularly effective.

The purpose of the study was to determine as fully as possible the species composition of the oligochaete fauna represented in the samples. Species identification was performed through the examination of complete specimens, fragments, and dissected sexual systems of the worms. Altogether, nearly 10 thousand worms were examined.

As a result of our study, we were able to identify 28 species whose presence in Lake Baikal had been established in earlier investigations, and 9 forms which will be described in a separate publication as species previously unknown to science. Representatives of the family Enchytraeidae were not identified to species but were assigned to a general group.

Until recently, the abyssal zone of Lake Baikal was known 103
to be inhabited by 20 oligochaete species. Our study has more than doubled that number. Of particular interest is the discovery of a species representing the genus Nais at a depth of 700 m. Analysis of the presently known composition of the abyssal oligochaete fauna in Lake Baikal shows it to be non-specific in its general character: almost all the species discovered to date in the abyssal zone have also been found at relatively small depths in the littoral and sublittoral zones of the lake. At present, it is still too early to discuss the

Table 100

Species composition and distribution of the oligochaetes in the abyssal zone of Iake Baikal

№№ п/п a	b Виды	Глубины c	Местонахождение (район: м-мыс, б-бухта, кв-квадрат, р-река) d	
I	2	3	4	a - Item No.; b - Species; c - Depths; d - Location (region: C. - cape; B. - bay; sq - square; R.- river); e - family
e	Сем. Naididae			
I.	Nais sp.	700	б.Болоадей	1. Bolsadei B.
e	Сем. Tubificidae			
2.	Rhyacodrilus multispinus (Mich.)	350-850	м.Курла, б.Черемшанка	2. C.Kurla, Cheremshanka B.
3.	Rh. isossimovi Čekanovskaja*	225-I600	м.Курла, м.Болоадей, м.Валукан, м.Крестовый, м.Котельниковский, м.Кр.Яр, м.Крестовый, м.Ухан, м.Солонцовый, б.Сосновка, м.Береговой, против р.Осиновки, кв.кв.24, 86, I0I, I04a, IIIa, I76, I82a	101 3. C.Kurla, C.Bolsadei, C.Valukan, C.Krestovyi, C.Kotel'nikovskii, C.Kr.Yar, C.Krestovyi, C.Ukhan, C.Solontsovyi, Sosnovka B., C.Beregovoi, opposite R.Osinovka, sq.24, 86, 101, 104a, 111a, 176, 182a
4.	Rh. sp.	820	б.Заворотная	4. Zavorotnaya B.
5.	Rhyacodriloides abissalis Ček.*	2I0-500	м.Валукан, м.Бирокан, б.Сосновка, б.Болоадей, Слюдянка	5. C.Valukan, C.Birokan, Sosnovka B., Bolsadei B., Slyudyanka
6.	Tubifex taediosus Ček.*	250-I600	м.Курла, б.Сосновка, б.Заворотная, кв.кв. 24, 60, IIIa, I04, 85a, I27, 35, 89	6. C.Kurla, Sosnovka B., Zavorotnaya B., sq.24, 60, 111a, 104, 85a, 127, 35, 89
7.	T. bazikalovae Ček.*	305-II45	м.Валукан, б.Сосновка, б.Солонцовая, кв.кв.60, IIIa, I60, I28, I76, I27	7. C.Valukan, Sosnovka B., Solontsovaya B., sq.60, 111a, 160, 128, 176, 127
8.	T. minutus Ček.*	250-700	м.Курла, м.Болоадей, б.Сосновка	8. C.Kurla, C.Bolsadei, Sosnovka B.
9.	T. kessleri Hr. baikalensis Sem.	350-I4I0	м.Курла, м.Кадильный, м.Сытый, м.Береговой, кв.I3, кв.20	9. C.Kurla, C.Kadil'nyi, C.Sytyi, C.Beregovoi, sq.13, sq.20
I0.	T. kessleri Hr. variabilis Sem.	290	м.Бирокан	10. C.Birokan
II.	T. speciosus Hr. vetus Sem.	2I0-840	Слюдянка, м.Болоадей, кв.I76	11. Slyudyanka, C.Bolsadei, sq.176
I2.	T. sp.	350	м.Курла	12. C.Kurla
I3.	Pelosoolex inflatus (Mich.)	305-I400	б.Солонцовая, б.Сосновка, против р.Осиновки, кв.26	13. Solontsovaya B., Sosnovka B., opposite R.Osinovka, sq.26
I4.	Baikalodrilus digitatus Holmq.	350	м.Солонцовый	14. C.Solontsovyi
I5.	Pelosoolex werestschagini Mich.	800	б.Солонцовая	15. Solontsovaya B.
I6.	P. kozovi Hr.	345	б.Сосновка	16. Sosnovka B.
I7.	Isochaetides sp.	250-480	м.Валукан, б.Сосновка	17. C.Valukan, Sosnovka B.
I8.	Svetlovia maculata Ček.*	305-I400	м.Курла, о.Ушканьи, м.Солонцовый, б.Сосно-	18. C.Kurla, Ushkan'i Is., C.Solontsovyi, Sosnovka B., sq.20, 60, 101a, 111a, 170

I	2	3	4	
			вка,кв.кв.20,60, IOIа,IIIа,I70	
	e Сем. Enchytraeidae			
I9.	Propappus glandulosus Mich.	820	б.Заворотная	19. Zavorotnaya B.
20.	Enchytraeidae gen. sp.	305–I600	м.Курла,м.Солонцовый,кв.I04,I60,I28,I76	20. C.Kurla,C.Solontsovyi,sq. 104,160,128,176
	e Сем. Haplotaxidae			
2I.	Haplotaxis ascaridoides Mich.*	250–I6I5	м.Болсадей,м.Валукан,м.Солонцовый, о.Ушканьи,кв.85а, 89а,89,I04,I27,I28	21. C.Bolsadei,C.Valukan,C.Solontsovyi,Ushkan'i Is.,sq.85a, 89a,89,104,127,128
22.	H. gordioides (Hartmann)*	900	о.Ушканьи	22. Ushkan'i Is.
	e Сем. Lumbriculidae			
23.	Lamprodrilus wagneri Mich.*	250–580	м.Валукан,м.Болсадей,б.Сосновка	23. C.Valukan,C.Bolsadei,Sosnovka B.
24.	L. achaetus Jsoss.	225–900	м.Курла,м.Бирокан, м.Солонцовый,м.Валукан,б.Сосновка, б.Заворотная,м.Болсадей,кв.I76	24. C.Kurla,C.Birokan,C.Solontsovyi,C.Valukan,Sosnovka B., Zavorotnaya B.,C.Bolsadei,sq.176
25.	L. pigmaeus Mich.	520–I400	м.Бирокан,м.Болсадей	25. C.Birokan,C.Bolsadei
26.	L. inflatus Mich.*	290–440	м.Бирокан,м.Болсадей	26. C.Birokan,C.Bolsadei
27.	L. bythius Mich.*	400–700	м.Бирокан,м.Болсадей,б.Солонцовая, б.Сосновка	27. C.Birokan,C.Bolsadei,Solontsovaya B.,Sosnovka B.
28.	Stylosoolex ohorioidalis Mich.	850	б.Черемшанка	28. Cheremshanka B.
29.	St. sp.	II45–I4I0	м.Кадильный,кв.60	29. C.Kadil'nyi,sq.60
30.	Teleuscolex sp.	250–880	м.Болсадей,м.Солонцовый,б.Сосновка, б.Заворотная	30. C.Bolsadei,C.Solontsovyi, Sosnovka B.,Zavorotnaya B.
3I.	Rhynchelmis brachycephala Mich.*	250–I400	м.Курла,м.Береговой,б.Солонцовая, б.Сосновка,б.Черемшанка,о.Ушканьи, кв.20,24,60,I82.	31. C.Kurla,C.Beregovoi,Solontsovaya B.,Sosnovka B.,Cheremshanka B.,Ushkan'i Is.,sq.20, 24,60,182.
32.	R. sp. N 1	350	м.Курла	32. C.Kurla
33.	R. sp. N 2	900–I245	против р.Осиновки, кв.III	33. opposite R.Osinovka,sq.111
34.	Stylodrilus opisthoannulatus (Jsoss.)*	250–I400	м.Валукан,м.Болсадей,б.Сосновка, б.Заворотная,б. Солонцовая,кв.20, 60	103 34. C.Valukan,C.Bolsadei,Sosnovka B.,Zavorotnaya B.,Solontsovaya B.,sq.20,60
35.	S. crassus (Jsoss.)	420–I4I0	м.Валукан,м.Бирокан,м.Береговой, б.Солонцовая,кв. 24,60,IOIа	35. C.Valukan,C.Birokan,C.Beregovoi,Solontsovaya B.,sq.24,60, 101a
36.	S. asiaticus (Mich.)*	250–950	м.Болсадей,м.Солонцовый,б.Заворотная,б.Сосновка,кв.I3	36. C.Bolsadei,C.Solontsovyi, Zavorotnaya B.,Sosnovka B.,sq. 13
37.	S. sp.	700	б.Солонцовая	37. Solontsovaya B.
	e Сем. Lycodrilidae			
38.	Lycodrilus schizochaetus Mich.	225–850	м.Б.Черемшанка, м.Валукан	38. C.B.Cheremshanka,C.Valukan

f <u>Примечание</u>: виды, отмеченные звездочкой, были ранее известны для абиссали

f – <u>Note</u>: the species marked with an asterisk were previously known to be present in the abyssal zone geographical distribution of the abyssal oligochaetes and the distribution patterns of their individual species in Lake Baikal. It can nevertheless be assumed that the most varied oligochaete fauna is to be found in the abyssal zone of the central part of Baikal since it is probably in that area that the most ancient oligochaete populations emerged and developed.

Particularly abundant and varied are the oligochaete popu- 104
lations in the areas where the bottom is covered with a layer of mud (samples from those areas were taken by means of a beam trawl with a fine-meshed nylon net). One biocenosis of mud-dwelling organisms may include up to 14 species of oligochaetes. Very widely distributed are representatives of the genera *Stylodrilus* and *Rhyacodrilus*; slightly less widespread are worms belonging to the species *Svetlovia maculata* and to the genus *Tubifex* (*minutus* and *taediosus*). The 22 samples taken by means of the "Okean" bottom sampler (0.1 m^2) show that the abyssal zone oligochaetes are characterized by a relatively low population density, not exceeding 800 ind/m^2, and that the density of the individual species is distributed rather evenly, varying between 10 and 80 ind/m^2). There was only one sample, taken near Cape Krestovyi at a depth of 1600 m, in which two out of the ten species present (*Rh. isossimovi* and *Rhynchelmis* sp.) had densities of 250 and 300 ind/m^2, respectively.

The general trend characterizing the bottom communities of the abyssal zone in Lake Baikal and in other water bodies is toward the presence of more varied and more abundant oligochaete populations wherever the bottom is covered with mud containing large amounts of organic detritus and sufficient amounts of oxygen.

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GENUS PELOSCOLEX LEIDY IN LAKE BAIKAL

by

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In 1978-1979, the Swedish researcher Ch. Holmquist undertook a new and particularly drastic revision of the genus Peloscolex Leidy, 1850, as a result of which she divided the genus into eight genera: Peloscolex; Spirosperma Eisen, 1879; Embolocephalus Randolph, 1892; Orientodrilus Holmq., 1978; Baikalodrilus Holmq., 1978; Edukemius Holmq., 1978; Haber Holmq., 1978; Tubificoides Holmq., 1937. Naturally, the representatives of the genus Peloscolex in Lake Baikal were also involved in this revision. Moreover, Holmquist included in the second part of her work (1979) a description of a new Baikal species, *Baikalodrilus digitatus*, previously unknown to science, which we (V.P. Semernoi) described in 1978 under the name of *Peloscolex echinoideus*. Our description of this and of some other species was submitted for publication in the series "Novoe o faune Baikala" (New facts about the fauna of Lake Baikal), issue 3, but, unfortunately, it has not yet been published. The extensive and painstaking investigation carried out by Ch. Holmquist has, in our view, but one flaw - excessively fine division of the genus *Peloscolex*.

The purpose of our own study, which is the subject of the present paper, was to analyze the distribution, abundance and other characteristics of a group of species belonging to the former genus *Peloscolex* from Lake Baikal.

The material used in the study included numerous specimens of "*Peloscolex*" worms from our collection of oligochaetes gathered over the entire area of Lake Baikal. Of particular interest are our specimens of small-sized worms from the mezobenthos of southern Baikal; in the past such worms were often lost in the process of handling the macrozoobenthos samples. We studied complete worms, fragments of worms, and dissected sexual systems.

At present, six species of the genus *Peloscolex* are known
to occur in Lake Baikal: *ferox* (Eisen), *velutinus* (Grube), *inflatus* 106
(Mich.), *werestschagini* Mich., *kozovi* Hr., *malevichi* Cek., and the new species *Baikalodrilus digitatus* Holmq.

P. ferox normally occurs in the littoral zone of Lake Baikal, in the bays and in the estuaries of the rivers and streams flowing into the lake, mainly along the northern and north-eastern shores (Okuneva, 1970, 1972; Snimshchikova, 1977). It is a typical representative of the Siberian faunistic complex and is not found below the littoral zone in Lake Baikal.

P. velutinus does not have a wide distribution in Lake Baikal (according to unpublished data). Its presence in the lake was first reported by W. Michaelsen (Michaelsen, Vereshchagin, 1930). The setal apparatus of the Baikal worms is characterized by considerable variability. According to Holmquist (1979), P. velutinus is distinguished by the absence of flabellate setae and the predominance of unidentate setae in the ventral bundles. Our collection contains worms of the following three types: 1) those that have only bidentate setae in the ventral bundles and regular bidentate setae in the dorsal bundles; 2) those that have setae with rudimentary distal denticles or unidentate setae together with bidentate ones in the ventral bundles, and deformed (pectinate) setae in the dorsal bundles; 3) those with unidentate (acuminate) setae in the ventral bundles, and acicular ones in the dorsal bundles. Always present are trichoid setae, which are mainly of the plumed (downy) variety. Representatives of the second type are particularly widespread in Eastern Siberia. The sexual system is typical.

P. inflatus is a species often found in Lake Baikal, mostly at great depths. Sexually mature worms have a characteristic white porous clitellum on segments X-XIII. Our collection includes worms with bidentate setae in the ventral bundles, but a sexual system fit- 107
ting the diagnosis particularly well is found only in worms with uni-

dentate setae. M.M. Kozhov and G.L. Okuneva (1969) distinguish two forms, an "early" one and a "late" one, which differ in the time of reproduction and in the character of their integument: the "late" form has no epidermal papillae. Sexually immature individuals and those at early stages of maturation are almost indistinguishable from P. velutinus.

P. werestschagini has a limited distribution in Lake Baikal. It is easily identifiable by the presence of four rows of oval tubercles, which are light in color (when there is no secretion adhering to them) and are situated among the bundles of setae (Michaelsen, 1933) on the solid lorica. The sexual system is, on the whole, similar to that of P. velutinus and P. inflatus.

P. kozovi is another species that is not widespread in Lake Baikal, although in some of the samples it was represented by very large numbers of individuals. It has a characteristic barrel-like shape. The integument is usually clean and smooth. Our material included worms whose atrium is not tubular, as reported by S. Hrabě (1969) and Holmquist (1979), but about twice as wide as the penial sac. This seems to indicate considerable individual variability depending on the size and the condition of the worms at the time of fixation.

P. malevichi was described by O.V. Chekanovskaya (1975) from the abyssal zone of the lake, but the specimens which we have in our collection were obtained at different depths in the littoral zone of northern and southern Baikal. The species is distinguished by long unidentate setae with a proximal node and plumed (downy) trichoid setae. The diagnosis of the species describes the dorsal bundles as consisting of acicular setae, but in the specimens we have the setae are of the flabellate type.

Baikalodrilus digitatus is a species widely distributed throughout the lake. It is interesting to note that, until recently, 108 specialists in the zoology of Lake Baikal mistook it for *P. werestschagini*. It is under this name that a few specimens of these oligochaetes were sent to Ch. Holmquist by G.L. Okuneva (BGNII, Irkutsk University). In the first part of her work (1978) Ch. Holmquist published a photograph of the specimens giving their name as *P. werestschagini*. Later, after realizing her mistake, Ch. Holmquist described *B. digitatus*, on the basis of the specimens that had been sent to her, as a species not yet known to science. We came across worms of this species as early as 1975 in samples obtained near the town of Baikal'sk and, later, in samples taken in Barguzin Bay. In 1977 we gave them the name of *Peloscolex echinoideus*. The species is mentioned under this name in definitions proposed by V.I. Lazareva, L.N. Snimshchikova and T.V. Akinshina (unpublished). Worms of the species are distinguished by the presence of very long epidermal papillae on the dorsal surface; the papillae grow smaller on the lateral surfaces, and are almost totally absent from the ventral surface. The sexual system is similar to that of the preceding species.

We are at present aware of the existence of several forms which differ significantly from the above-mentioned species in the structure of their integument and setal apparatus, while showing only slight differences in the structure of their sexual system. It is possible that, after further study, some of these forms will be described as new species. At the same time, it can be assumed 1) that all of them, as well as *P. kozovi*, *P. malevichi* and *B. digitatus*, are life forms of *P. werestschagini*; or 2) that all the species of the "*Peloscolex*" complex in Lake Baikal are specific life forms of the Palearctic species *P. velutinus*. We use the term "life form" in the same morphoecological sense in which it is used by I.Kh.Sharova (1981).

We believe it unnecessary to divide the genus *Peloscolex*. The 109
complex of "loricate" oligochaetes should be left undivided or else this group of genera should be given the status of a tribe. In the latter case the genus *Haber* should be excluded from it as having no morphological analogues among the other members of the group.

ON THE ORIGIN AND PHYLOGENESIS OF THE AQUATIC OLIGOCHAETES

by

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The genealogical tree of the Oligochaeta, which we propose in the present paper (Fig. 1), is based mainly on the structure of their sexual and setal apparatus (with the principle of oligomerization of homologous organs taken duly into account), as well as on ecological, zoogeographic and paleographic data.

The oligochaetes are believed to have evolved from polychaetes which, in the latter half of the Paleozoic, migrated from the sea to inland bodies of water. The bundles of setae in the oligochaetes are thought to be the remnants of the parapodia. In fresh-water habitats these worms lost their pelagic larva and acquired cutaneous glands (clitellum) capable of secreting a cocoon serving to protect the embryos. The acquisition of the clitellum resulted in the condensation of the entire sexual system. These changes developed convergently in the ancestors of the present-day oligochaetes and in the Aelosomatidae. The members of the last-mentioned family have trichoid setae in all of their bundles; they have testes before and behind the ovaries, a pulvinate clitellum next to the female gonopore, which has no genital duct, and unicellular spermathecae.

The ancestors of the present-day oligochaetes were fresh-water worms that had a variable number of setae per bundle, with trichoid setae present only in the dorsal bundles; they had four pairs of gonads in segments X-XIII (the testes being located anteriorly to the ovaries); the gonoducts penetrated the septum behind the funnel; the clitellum was muff-like in shape. This group of oligochaetes
developed during the cold Permian period. Hence their tendency, par- 110
ticularly characteristic of the aquatic families, to reproduce at low environmental temperatures.

As early as during the Permian period the oligochaetes split into the Naidomorpha and the Lumbricomorpha. The former continued to live in aquatic habitats; they still had a variable number of setae per bundle, but the number of gonads decreased to two pairs in segments XI-XII. Following the breakup of the supercontinent of Pangaea and the emergence of warmer climatic conditions along the equator, the Naidomorpha separated into the southern and northern branches. In representatives of the southern branch the spermathecae are located behind the male gonoducts, while in those of the northern branch these organs are arranged in the opposite order. In the northern branch the sexual system was also shifted forward, initially by one segment. In both hemispheres the oligochaete fauna separated into ecologically different forms: relatively cold-loving benthic oligochaetes and asexually reproducing phytophilous oligochaetes capable of inhabiting tropical water bodies (respectively, the Phreodrilidae and Opistocystidae in the south, and the Tubificidae and Naididae in the north). A third branch, the Enchytraeidae, left the water and moved into the soil. Their setae became simpler in shape (convergently with the Lumbricomorpha) but remained variable in number.

The ancestors of the Lumbricomorpha, closely related to the present-day Haplotaxidae, left the open water bodies during the Permian and penetrated first into the ground water and the swamps, and then into the soil. In the process of this transition they acquired a typically lumbricid set of bristles (two hook-like setae per bundle), which has been retained by almost all of their descendants (some of the eartworms have developed a perichaete arrangement of the setae, without bundles). The position of the gonads did not change. On the different continents the principal line of the soil oligochaetes, the order Haplotaxida, split into different families, some of them becoming adapted to hot climatic conditions. The presence of the lumbricid set of bristles in *Acanthobdella* suggests that the leeches are also descended from the ancient Lumbricomorpha. 112

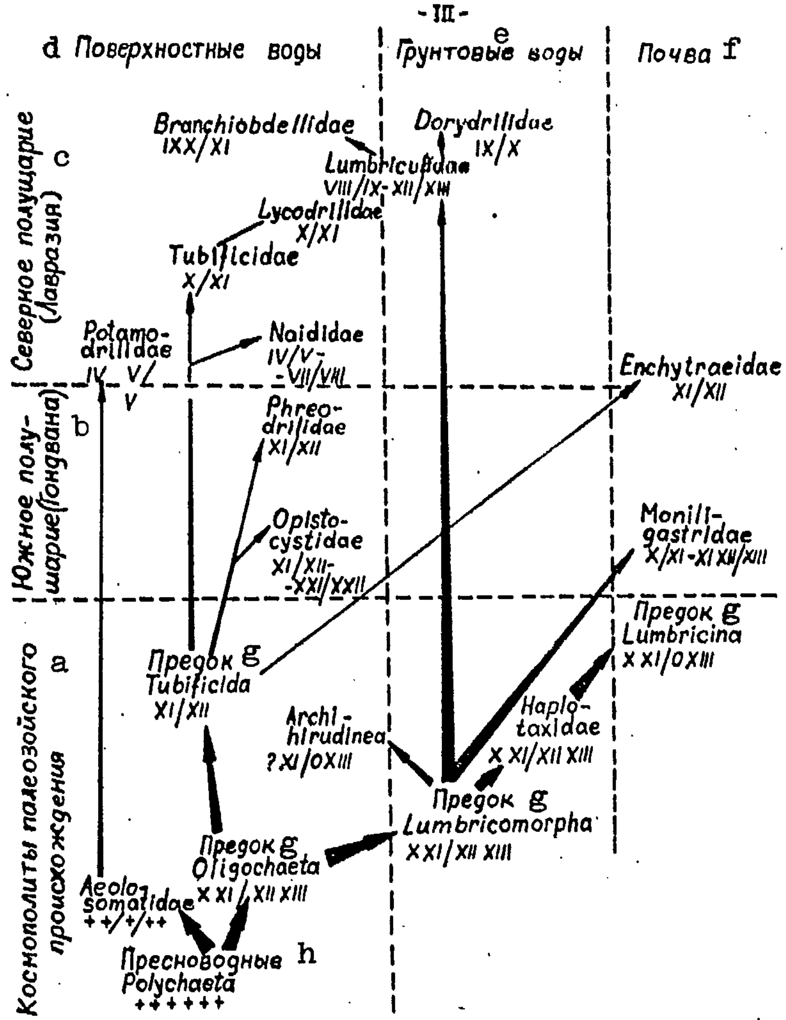

Рис.I. Дополненная схема эволюции водных олигохет и близких групп. Римские цифры обозначают фертильные сегменты типичных представителей групп. + + + - неопределенные сегменты с гонадами; о - стерильный сегмент; / - диссепимент, отделяющий семенники от яичников

Fig. 1. Expanded chart of the evolution of the aquatic oligochaetes and related groups. Roman figures indicate the fertile segments in typical representatives of the groups. + + + stand for unnumbered segments with gonads; o stands for a sterile segment; / denotes the septum separating the testes from the ovaries. a - Paleozoic cosmopolites; b - Southern Hemisphere (Gondwanaland); c - Northern Hemisphere (Laurasia); d - Surface water; e - Ground water; f - Soil; g - Ancestor; h - Fresh water

Two side branches with a highly variable, unstable sexual system morphology broke away from the primordial Lumbricomorpha at a very early stage. The male gonoduct orifice in those oligochaetes was characteristically shifted forward into the testicular segment. The oligochaetes in question were the Lumbriculidae in the cold underground and open water bodies of the Holarctic region and the Moniligastridae in the soils of India.

The Dorydrilidae resemble the Lumbriculidae in every respect, except for the location of the male gonoduct in the segment. This is, in our view, one of the possible manifestations of the tendency toward the simplification of the sexual system in the Lumbriculidae, while the similarity between the gonoducts of the Dorydrilidae and Tubificidae must be purely coincidental. There can be no doubt, however, that the Lycodrilidae are, indeed, closely related to the Tubificidae. The two simple setae which they have in each bundle represent a character they have evolved convergently with the Lumbricomorpha. The young families Dorydrilidae and Licodrilidae, as well as the aberrant genus Kurenkovia from the family Lumbriculidae, provide evidence of a new increase in the rate of evolution of the cold-loving aquatic oligochaetes during the Neogene and Pleistocene under climatic conditions basically similar to those that existed during the Permian period.

The structure of the sexual system of the parasitic oligochaetes Branchiobdellidae shows them to be descendants of the Lumbriculidae.

We would like to propose the following phylogenetic system for the Oligochaeta and the related groups (of the class Clitellata):

Subclass Aphanoneura

Order Aelosomatida (families Aelosomatidae, Potamodrilidae)

Subclass Oligochaeta

Superorder Naidomorpha

Order Tubificida (families Tubificidae, Lycodrilidae, Naididae, Phreodrilidae, Opistocystidae, Enchytraeidae) 113

Superorder Lumbricomorpha

Order Haplotaxida (families Haplotaxidae, Alluroididae and the various "earthworms" in the broad sense of the word)

Order Moniligastrida (family Moniligastridae)

Order Lumbriculida (families Lumbriculidae, Dorydrilidae)

Order Branchiobdellida (family Branchiobdellidae)

Subclass Hirudinea (the leeches, not considered any further).

Among the orders listed above only the Aelosomatida and Tubificida are truly primordial and paleolimnetic. The aquatic representatives of the Haplotaxidae, as well as the Lumbriculidae, Dorydrilidae and, possibly, Lycodrilidae are ecologically similar to mesolimnetic organisms, which must be due to the fact that they have arisen from ground water dwellers and not from marine animals.

ON THE POTENTIAL AGE OF THE OLIGOCHAETES

by

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Academy of Sciences of the Estonian SSR)

For a number of years small cohorts of oligochaetes of various species were kept by the present author in aquariums under different temperature conditions. The worms lived on a layer of lake silt, from which their progeny was regularly removed.

Representatives of sexually reproducing species normally lived for several years (Table 1). This is also true of many other forms that did not reproduce in the aquarium. Certain intraspecific differences were observed in the duration of life of individual oligochaetes. Individuals died at different ages, sometimes perishing as early as during the first year of life (Fig. 1). Therefore, the duration of life of half of the individuals is more representative of a species (strain, cohort) than the life span of the most long-lived worm. Low tempera- 114
tures proved to be conducive to longevity at all times or during certain seasons. Oligochaetes which were mature when taken out of natural water bodies often lived longer in the aquarium than those born in captivity.

The Naididae did not fare very well in the aquarium. Only one paratomy clone of *Nais communis* lived there for up to six years, but without reaching maturity. Architomy clones of some of the Tubificidae prospered in the aquarium for long periods of time: *Potamothrix bedoti* (no less than 14 years) and *Bothrioneurum vejdovskyanum* (no less than 7 years).

Thus, at least some of the individuals of the species belonging to the families Tubificidae, Lumbriculidae and Oriodrilidae can attain the ages of 5-15 years, and some can live even longer. Among the Naididae, a clone lives for less than a year if there is a normal yearly alternation of generations, while individuals stay alive for a few weeks or months. If incapable of sexual maturation, their clones can live for as long as several years.

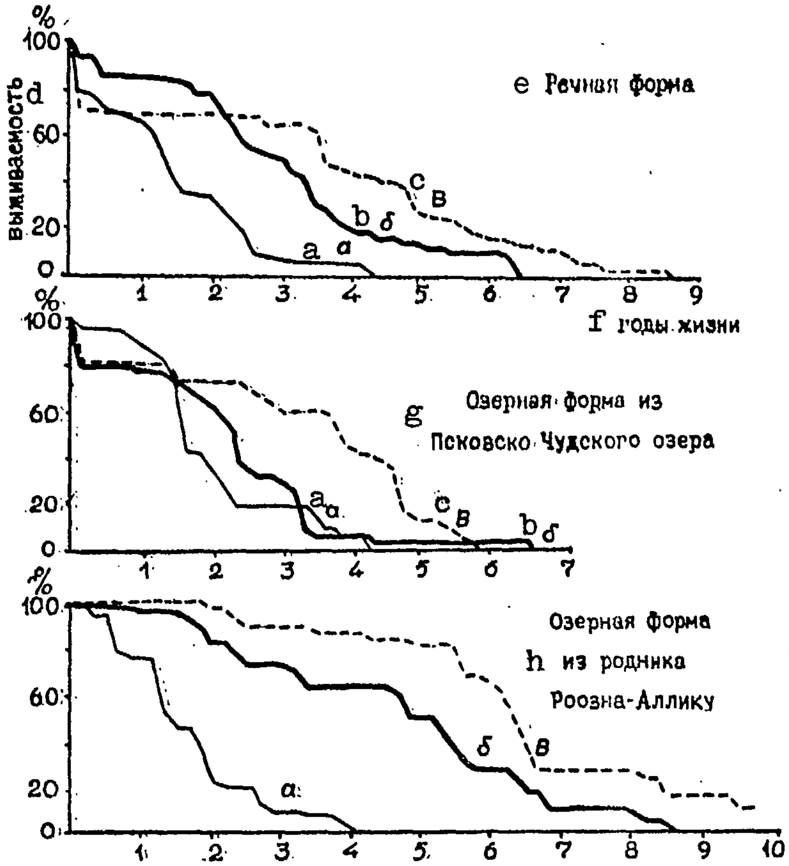

Рис.I. Продолжительность жизни разных форм в различных условиях температуры. а - постоянная т-ра +25°С, б - комнатная т-ра, в.- сезонная т-ра. 100% соответствует 30-60 экз.

Fig. 1. Life span of the different forms under different temperature conditions:
a - constant temperature of +25°C, b - room temperature, c - seasonal temperature; 100% represents 30-60 individuals;
d - survival rate;
e - river form;
f - years of life;
g - lake form from Lake Peipus;
h - lake form from Roozna-Alliku Spring Brook

Table 1 116

Individual life spans of certain oligochaetes in the aquarium, in years
(Figures in brackets refer to worms which were mature when taken out of natural water bodies)

Вид, форма	Максимальная a			b Половины особей		
	При сезонной темпер.	При комнатной темпер.	При 20–25°	При сезонной темпер.	При комнатной темпер.	При 20–25°
I	2	3	4	5	6	7
Tubifex tubifex, речная форма c	$8^{I}/2$	$6^{I}/2$	$4^{I}/3$	$3^{2}/3$	2	~2
Tubifex tubifex, озерная форма из Псковско-Чудского озера d	$6^{I}/2$	$5^{2}/3$	$4^{I}/6$	$3^{2}/3$	$2^{I}/2$	$I^{I}/2$
Tubifex tubifex, озерная форма из родника Роозна-Аллику e	$>I0^{I}/2$	$9^{I}/2$	$3^{5}/6$	$6^{I}/3$	$5^{I}/6$	$I^{I}/3$
Tubifex tubifex, озерная форма из родника Норра f		$I^{I}/4$			I/4	
Tubifex ignotus		<I(>5)				
Ilyodrilus templetoni	8	5	3	6	2^{I}–2	$2^{3}/4$
Potamothrix hammoniensis	3–6	$2^{I}/2$–4	$3^{I}/2$	I–2	~2	$I^{I}/2$
Potamothrix moldaviensis	$3^{I}/2$	$4^{I}/2$	$2^{I}/2$	$2^{I}/2$	$2^{I}/2$	I
Limnodrilus hoffmeisteri из реки Суур-Эмайыги g	$>I0^{I}/2$	8		I0	3–>6	

1 - Species, form
a - maximum
b - of half of the individuals
2 - at seasonal temperatures
3 - at room temperature
4 - at 20-25°C
5 - at seasonal temperatures
6 - at room temperature
7 - at 20-25°C
c - river form
d - lake form from Lake Peipus
e - lake form from Roozna-Alliku Spring Brook
f - lake form from Norra Spring Brook
g - from the river Suur-Emaiygi

Table 1 (contd.) 117

I	2	3	4	5	6	7
Limnodrilus hoffmeisteri из сублиторали Псковско-Чудского озера h		$I^{I}/2$(>7)			~I	
Limnodrilus udekemianus		9			$4^{I}/2$	
Isechaetides newaensis	8(>I4)	7	I	5–6	5	<I
Isochaetides michaelseni		(>I0)			$(>I^{I}/2)$	
Psammoryctides barbatus	$>II^{I}/2$	8(>I0)	3–5	4	5	I–2
Psammoryctides albicola		$(>I\text{–}>2^{I}/2)$				
Spirosperma ferox	>II(>I4)	>II(>I4)	8	>II(>I4)	6(>II)	6
Rhyacodrilus coccineus	>I0(>I4)			>I0		
Stylodrilus heringianus	$>II^{I}/2$	7(>I4)	$3^{I}/2$	$3^{I}/2$	4	$2^{I}/2$
Lamprodrilus isoporus	<I(>I)					
Rhynchelmis limosella	$(>6^{I}/2)$	(>3)				
Rhynchelmis tetratheca	$9^{I}/2$(>II)			$3^{I}/2$		
Lumbriculus variegatus		(>3)				
Criodrilus lacuum		$>I3^{I}/2$(>I6)			(>5)	

h - from the sublittoral zone of Lake Peipus

OLIGOCHAETE FAUNA OF THE SEAS OF THE USSR

by

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The oligochaete fauna of the seas comprises several different forms: marine, brackish-water, fresh-water and amphibious species. The present paper discusses those species whose range is chiefly confined to the sea, i.e. species of the brackish-water and marine origin. Until recently, it was believed that the oligochaetes had evolved mainly in bodies of fresh water and in the soil, with only a limited number of genera becoming, at a later stage, adapted to life in the sea, mostly within the confines of the littoral zone. In his large monograph published in 1930, Stephenson names representatives of 14 oligochaete genera among sea-dwellers, while describing only four of them as being purely marine (Michaelsena Ude, Phallodrilus Pierant., Heterodrilus Pierant, Limnodriloides Pierant.). However, the extensive investigations carried out in the seas over the last 10-15 years have resulted in the discovery of a rich original marine fauna with and without analogues in the fauna of the fresh-water bodies. During these years researchers have described 15 tubificid genera and over 120 tubificid species, about 80 enchytraeid species, and several species from the families Naididae, Aelosomatidae and Megaloscolecidae. The composition of the sea-dwelling oligochaete fauna is given in Table 1. As can be seen from the Table, the family Tubificidae is particularly widely represented in the sea. Most of the sea-inhabiting tubificid genera seem to be of marine origin, while several genera are found in both

Table 1 119

Composition of the marine oligochaete fauna

a Семейства	b Число родов	
	Чисто морские c	Смешанные (имеются морские, пресноводные, почвенные виды) d
Aeolosomatidae		I
Naididae	I	3
Tubificidae	23	5
Enchytraeidae	I	3
Glossoscolecidae		2
Megascolecidae		6

a- Families; b - Number of genera; c - Purely marine; d - Mixed (including marine, fresh-water and soil species)

fresh-water and marine habitats. The phylogenetic relations among 118 the marine tubificids themselves, and among the marine and fresh-water tubificids are not yet completely understood. Not enough data have been accumulated so far to allow any serious generalizations to be made. We do, however, agree to the idea of distinguishing the marine 119 subfamily Phallodrilinae Brinkhurst, Jamieson, 1971. This family comprises a number of morphologically related genera which are distinctly different from all other tubificids. On the other hand, we believe that there are no reasons other than purely formal ones that could justify the inclusion of the genera Aulodrilus Bret. and Limnodriloides Pierant. in one subfamily - Aulodrilinae Brinkhurst, Jamieson, 1971. Some of the peculiar characters of Aulodrilus, similar to those found in the naidids (for example, the location of the testes in segments IV-VI), make it appear to stand by itself among the rest of the tubificids. The marine

genera *Limnodriloides* Pierant, *Thalassodrilides* Br., *Bohadshia* Hr., *Marcusaedrilus* Righi a. Kanner and *Kaketio* Righi a. Kanner undoubtedly form a single group, but it is still too early to say which taxonomic category this group corresponds to. Developing a classification of the marine oligochaetes is a job for future researchers. In the other families only *Wapsa* Marcus (Naididae) and *Crania* South. (Enchytraeidae) can be regarded as truly marine. The other genera of the
families Aelosomatidae, Naididae, Enchytraeidae, Megascoledidae and 120
Glossoscolecidae include sea-, fresh-water-, and also soil-dwellers. Most of the marine and brackish-water oligochaetes inhabit the littoral zone and the upper regions of the sub-littoral zone. However, over 20 species from 8 genera are known to occur in the lower parts of the shelf at depths of 50-400 m. And a few species of the genera *Phallodrilus* Pier., *Bathydrilus* Cook and *Peloscolex* Leidy have been discovered in the abyssal zone of the seas and oceans at depths of 1100-3750 m. One species - *Bathydrilus hadalis* Erseus - has been found in the Aleutian Trench at a depth of 7298 m.

The seas of the USSR have not yet been studied in a sufficiently comprehensive and thorough manner. The species making up the marine and brackish-water oligochaete fauna of these seas are listed in Tables 2-5 (based on data from the literature and on our own material).

Investigations in the seas of the Far East were begun only in the 1960's. At about the same time research was considerably intensified in the Baltic Sea and in the seas of the southern part of the country. Practically nothing is known yet about the oligochaetes of most of the northern seas (the Kara, Laptev, East Siberian and Chukchi

Table 2 121

The marine oligochaete fauna of the Far Eastern seas of the USSR

Виды	Япон-ское море	Берин-гово море	Охот-ское море	Тихий океан у Курил. о-вов и Кам-чатки
I	2	3	4	5
Nais borutzkii Sok., 1964	+			+
Paranais orientalis (Sok.,1964)	+		+	+
Monopylephorus rubroniveus iturupi Finog.*			+	
M.irroratus orientalis Finogenova*			+	+
Rhizodrilus pacificus kurilensis Finog.*			+	
Aktedrilus longitubularis Finog., Shurova, 1981	+			
Ainudrilus oceanicus Finogenova*				+
Phallodrilus timi Finog.*				+
Tubificoides shurovae sp. n.*			+	
Clitellio saxosus sp. n.*				+
Enchytraeus albidus Henle, 1837				+
E. bonus Shurova, 1978		+		
E. cryptosetosus Tynen, 1969	+			
Marionina subterranea (Kn., 1935)	+			+
M.spicula (Leuckart, 1847)	+			
M. limpida Shurova, 1979	+			+
M. magnifica Shurova, 1978		+		
M. subachaeta Shurova,1979				+
M.miniampullacea Shurova, 1978				+
Lumbricillus annulatus Eisen, 1904		+		+
L.nipponicus (Yamag.,1937)	+			+
L.mirabilis Tynen, 1969			+	+
L.corallinae Shurova, 1977	+			
L.ignotus Shurova, 1974	+			
L.ochotensis Shurova, 1979			+	
Lumbricillus parabolus Shurova, 1978		+	+	
L. pinquis Shurova, 1977			+	
L. taisiae Shurova, 1978		+	+	+
L. alaricus Shurova, 1974			+	+
L.kurilensis Shurova,1974		+	+	+
L.lentus Shurova, 1978		+		
L. orientalis Shurova, 1977		+		+
L.sapitus Shurova, 1979		+		
L. rufulus Shurova, 1974				+
L. similis Shurova, 1974				+
Grania pacifica Shurova, 1979			+	

1 - Species
2 - Sea of Japan
3 - Bering Sea
4 - Sea of Okhotsk
5 - Pacific Ocean near the Kurile Islands and the Kamchatka Peninsula
* - Descriptions of these species have not yet been published

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Seas). Several enchytraeid species reported from the coasts of the Siberian seas are either members of the soil fauna or must be reinvestigated. Studies in the seas of the Far East and in the White and Barents Seas have so far been confined almost exclusively to the littoral zone. The deep-water zones of the Black Sea remain largely unexplored. Only the Baltic Sea can be said to have been studied to an adequate extent. And yet the research that has been carried out over this short period of time has yielded a great deal of new and interesting information about the oligochate fauna of the seas of the USSR. The fauna of the littoral and, in part, of the sublittoral zones of the Far Eastern seas has proved to be almost entirely original. Of the 36 species recently discovered in these seas, 27 species and one genus (Ainudrilus) have been found to be new to science (Table 2).

An exceedingly interesting oligochaete fauna has been disco- 122
vered in the Black Sea (Table 3). Representatives of the genera that

Table 3

Marine and brackish-water oligochaete fauna
of the seas in the southern part of the country

Виды	Черное море	Азов-ское море	Каспи-йское море	Аральское море
1	2	3	4	5
Paranais litoralis (Müll.,1784)	+			
Clitellio arenarius (Müll.,1776)	+			
Phallodrilus minutus Hr., 1973	+			

1 - Species; 2 - Black Sea; 3 - Sea of Azov; 4 - Caspian Sea; 5 - Aral Sea

Table 3 (contd.)

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1	2	3	4	5
Limnodriloides agnes Hrabě, 1967	+			
L. fragosus Finogenova, 1972	+			
Adelodrilus kiselevi (Finogenova, 1972)	+			
A. borceai (Hrabě, 1973)	+			
Monopylephorus rubroniveus ponticus (Hr.,1967)	+			
Bacescuella pontica Hrabě, 1973	+			
Bohadshia pierantonii Hrabě, 1971	+			
Thalassodrilides gurwitschi (Hr.,1971)	+			
Peloscolex svirenkoi (Jar.,1948)	+	+		
P. euxinicus Hrabě, 1966	+			
P. maritimus (Hr.,1973)	+			
P. benedeni (Udekem.,1855)	+			
Aktedrilus monospermathecus Kn.,1935	+			
Tubifex costatus (Clap.,1863)	+			
Lumbricillus lineatus (Müll.,1771)	+			+
Marionina mica Finogenova, 1972	+		+	
M. brevis Finogenova, 1972	+		+	
M. spicula (Leuckart, 1847)	+			
M. subterranea (Kn., 1935)	+			
Enchytraeus albidus Henle, 1837	+			
Amphichaeta sannio Kallst., 1892	+			

form part of this fauna - *Clitellio* Sav., *Limnodriloides* Pier., *Adelodrilus* Cook., *Bacescuella* Hr., *Bohadshia* Hr., *Thalassodrilides* Br., *Aktedrilus* Kn. - are native to highly brackish and sea water habitats and are not known to occur in bodies of fresh water. Some of the species (*Limnodriloides fragosus* Hr., *Adelodrilus kiselevi* (Fin.), *A. borceai* (Hr.), *Peloscolex euxinicus* Hr., *P. svirenkoi* (Jar.), *P. maritimus* (Hr.), *Phallodrilus minutus* Hr., *Bohadshia pierantonii* Hr.) were found at considerable depths (85-150 m). The sea of Azov and the Caspian and Aral Seas, which are characterized by low salinity levels and, in the case of the two last-mentioned seas, by a peculiar ionic composition of the water, are inhabited by very few marine forms. Only a 124

Table 4

Marine and brackish-water oligochaete fauna
of some of the northern seas

Виды	Белое море	Баренцово море
I	2	3
Amphichaeta sannio Kallst., 1892	+	
Paranais litoralis (Müll.,1784)	+	+
Clitellio arenarius (Müll., 1776)	+	+
Peloscolex benedeni (Udek.,1855)	+	+
Tubifex costatus (Clap.,1863)	+	
Enchytraeus albidus Henle, 1837	+	+
Marionina subterranea (Kn., 1935)	+	
Lumbricillus lineatus (Müll., 1774)	+	+
L. rivalis Lev.,1883 augm. Ditl., 1904	+	+
L. murmanicus finog., Strelzov, 1978		+
L. pagenstecheri (Ratzel, 1869)		+
L. semifuscus (Clap.), Steph., 1911		+
L. rubidus Finogenova, Strelzov, 1978		+

1 - Species; 2 - White Sea; 3 - Barents Sea

handful of marine and brackish-water oligochaete species have been discovered in these seas. We would like to emphasize that we are not discussing here the rich complex of Pontic-Caspian relict species because, apart from a few of its members, this complex cannot be regarded as a true marine fauna. A small number of naidid, tubificid and, in particular, enchytraeid species have been found in the White and Barents Seas, mainly within limited areas of the littoral zone (Table 4). Most of these species are widespread in the seas of the northern and temperate latitudes. The fact that so few species are known to occur in the White and Barents Seas is clear evidence of the inadequate amount of research carried out so far in this region. In

Table 5

Marine and brackish-water oligochaete fauna of the Baltic Sea

Виды	Западная часть	Центральная часть	Восточная часть (Финский и Рижский заливы)	Северная часть (Ботнический залив)
I	2	3	4	5
Aeolosoma litorale Bunke, 1967	+			
Paranais litoralis (Müll.,1784)	+	+	+	+
P. botniensis Sperber, 1948				+
Amphichaeta sannio Kallst.,1892	+		+	
Phallodrilus prostatus (Kn.,1935)	+		+	
Spiridion insigne Kn., 1935	+			
S. scrobiculare Last., 1937			+	
Clitellio arenarius (Müll.,1776)	+	+	+	
Tubifex costatus (Clap.,1863)	+	+	+	+
T. nerthus Mich., 1908	+		+	
Isochaetides pseudogaster (Dahl., 1960)	+			
Peloscolex benedeni (Udekem., 1855)	+	+	+	
P. heterochaetus (Mich.,1924)	+	+	+	
Aktedrilus monospermatheous Kn., 1935	+		+	
Monopylephorus rubroniveus Lev., 1884	+	+		
Monopylephorus irroratus (Verril, 1873)	+			

1 - Species

2 - Western part

3 - Central part

4 - Eastern part (the Gulf of Finland and the Gulf of Riga)

5 - Northern part (the Gulf of Bothnia)

Table 5 (contd.)

I	2	3	4	5
Lumbricillus lineatus (Müll., 1771)	+	+	+	
L. pagenstecheri (Ratzel, 1869)	+			+
L. rivalis Lev., 1883	+		+	+
L. balticus Bülow, 1957	+			
L. semifuscus (Clap.), Steph., 1911	+	+	+	+
L. arenarius (Mich.,1889)	+		+	
L. eudioptus (Bülow, 1955)	+			
L. knöllneri Niels., Christ., 1959	+	+		
L. kaloensis Niels., Christ., 1959			+	+
L. fennicus Nurminen, 1964			+	
L. tuba Steph., 1911				+
L. bülowi Niels., Christ., 1959	+			
L. helgolandicus Mich., 1934	+			
Marionina apicula (Leuckart, 1847)	+	+	+	+
M. southerni (Cern., 1937)	+		+	
M. subterranea (Kn., 1935)	+			
Grania postclitellochaeta (Kn., 1935)	+			
Enchytraeus albidus Henle, 1837	+	+	+	+
Cernosvitoviella immota (Kn., 1935)	+	+	+	

the Baltic Sea, as in all other seas, a particularly varied and 125
abundant fauna is found in the littoral and in the upper part of the sublittoral zones (Table 5). The littoral zone abounds in enchytraeids. The interstitial fauna is unusual and relatively diverse. The ground waters are known to be inhabited by several tubificid species (*Phallodrilus prostatus* (Kn.), *Spiridion insigne* Kn. and *Aktedrilus mono-* 126
spermathecus Kn.) and enchytraeid species (*Cernosvitoviella immota* (Kn.), *Marionina subterranea* (Kn.) and others). The oligochaete fauna of the eastern part of the Baltic Sea (the Gulf of Finland), which has a very low salinity, is little different in its species composition from the oligochaete fauna of the western part of the sea (Kiel Bay), where the salinity is noticeably higher. Many of the oligochaete species of the Baltic Sea have been found in the North Atlantic near the coasts of Europe and North America.

Altogether, 73 species of marine and brackish-water oligochaetes are now known to be present in the seas of the USSR. They belong to the families Naididae (4 species), Tubificidae (27 species) and Enchytraeidae (42 species). Of all of these forms, 2 naidid species, 15 tubificid species and 24 enchytraeid species have been described during the last 20 years. There can be no doubt that further research on the oligochaete fauna of the seas of the USSR will add 127
many more new species to the existing list.

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EXPERIMENTAL STUDIES INTO THE SELECTIVE FEEDING OF CERTAIN OLIGOCHAETE SPECIES ON EGGS OF HELMINTHS (*OPISTHORCHIS FELINEUS* AND *TAENIARHYNCHUS SAGINATUS*)

by

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Oligochaetes inhabit different types of substratum and in some biotopes predominate over all other animals (1,2,3).

Moreover, they are capable of feeding on a fairly wide variety of nutrients, and some of their species (Tubificidae) are known to be selective with respect to the food they ingest (4).

Some interesting data on this question are provided by K.E. Chua and R.O. Brinkhurst (5), and M. Warve and R.O. Brinkhurst (6), the latter paper dealing with the digestion by *Tubifex tubifex* and *Limnodrilus hoffmeisteri* of different species of bacteria. According to the authors of this paper, certain species of bacteria are not only unaffected by digestion in the intestine of *T. tubifex* and *L. hoffmeisteri* but even remain capable of reproducing.

It can be assumed, therefore, that oligochaetes are not capable of selective food ingestion. Different species of oligochaetes (*T. tu-* 128
bifex and *L. hoffmeisteri*) ingest *Ascaris suum* eggs at an equal rate (7,8). However, the eggs that pass through the intestine of *T. tubifex* show no structural changes and in a pendent drop develop to the stage of an active larva. At the same time, *L. hoffmeisteri* breaks up some of the eggs it ingests.

We decided in this connection to find out how digestion in *T. tubifex* and *Aelosoma* sp. affects the structure and embryogeny of eggs of *Opisthorchis felineus* and *Taeniarhynchus saginatus*.

Methods. The experimental worms, *T. tubifex* and *Aelosoma* sp., were taken from aquariums kept at the Institute. The helminth eggs were obtained from live, sexually mature individuals.

The oligochaetes were placed in Petri dishes (15-20 individuals per dish), each containing 10000-20000 helminth eggs. Twenty four hours later some of the worms were picked out, washed in pure water and examined under a microscope, while the rest of the worms (mainly *T. tubifex*) were put in small jars, from which their feces were collected for subsequent analysis. The helminth eggs extracted from the feces were placed in pendent drops in order to study the development of the embryos. Each set of experiments was accompanied by check experiments. To determine the effect produced by *T. tubifex* on the structure of eggs of *T. saginatus*, two sets of experiments (5 repetitions) and two sets of check experiments were conducted. In the first set of experiments 15 individuals of *T. tubifex* were kept in water, to which eggs of *T. saginatus* had been added, while during the second set of experiments the worms (20 individuals) were placed in soil also containing eggs of *T. saginatus*. The check experiments involved the same conditions but no oligochaetes.

Results. The worms began to ingest the eggs on the fourth 129
day after the start of the experiment. The number of ingested eggs in the intestine of the oligochaetes varied from 1 to 4. Altogether, the experimental worms were found to have ingested 380 eggs. However, after passing through the intestine of the worms, all those eggs showed no visible morphological changes.

The experimental worms also exhibited a slow motor reaction. They were inactive, pale and died on the 31st day of the experiment. At the same time, in the presence of eggs of Ascaris suum T. tubifex lived for 3-4 months (7,8).

Some interesting data were obtained in the experiments designed to determine the effect of T. tubifex and Aelosoma sp. on eggs of O. felineus.

We found 284 eggs in the alimentary canal of 80 individuals of T. tubifex. The number of ingested eggs in each oligochaete varied between 2 and 10. The eggs displayed no visible structural changes. T. tubifex showed itself incapable of selective digestion of O. felineus eggs. The same trend was observed in the case of Aelosoma sp. Opisthorchis eggs were found in the intestine of 197 individuals. The number of ingested eggs in the intestine of the oligochaetes varied between 8 and 18. The structure of the eggs that had passed through the intestine of the worms and their embryonic development were compared to those of the controls. No deviations from the norm were detected.

At the same time, Aelosoma sp. shows a different digestive reaction to eggs of Ascaris suum. As already indicated (7,8), these oligochaetes are capable of digesting A. suum eggs which are protected by three shells. There is reason to believe that Aelosoma sp. has digestive enzymes that can dissolve A. suum eggs but has no enzymes 130
that could cause the lysis of the shells of Opisthorchis eggs.

The results of our experiments enable us to conclude that, while capable of selective feeding on A. suum eggs, Tubifex tubifex and Aelosoma sp. have no such capacity with respect to eggs of O. felineus and T. saginatus.

Thus, oligochaetes of the species T. tubifex and Aelosoma sp. do not produce any effect on the structure and embryogeny of the eggs of O. felineus and T. saginatus which they ingest. For that reason, T. tubifex and Aelosoma sp. should be regarded as disseminators of eggs of O. felineus and T. saginatus and as a factor promoting helminth invasions in nature.

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