On drift and diel vertical migration of bottom invertebrates of the Amur. O.A. KLYUCHAREVA (1963). Zool.Zh. 42, 1601-12.

Translated by J.E.M. Horne

Our investigations in 1957 and 1958 in the body of the Soviet Chinese Ichthyological division of the ~~Complex~~ Combined Amur Expedition, conducted in connection with future hydro development, give the possibility of introducing some additions to the concept of "Hydrobiological Characteristics of Rivers of the Amur type". The hydrobiological characteristics of a river or a group of rivers, are expressed primarily in the concrete forms of adaptations of different categories of hydrobionts to the specific abiotic and biotic conditions existing in this river or group of rivers. To the demonstration of one of these adaptations in the benthos of the Amur we dedicate the present work.

Planktobenthos, collected mainly in the middle stream of the Amur on a station in the Leninsk district, served as material for the paper.

We must give thanks to the instructor of the station in Leninsk, A.P. Makeev, and the graduate students of the Soil Biology Faculty of Moscow University, N. Meshkov, N. Mokeev, Zh. Chernyaev and S. Doroshev. During two summer seasons samples were taken by workers of the station in Leninsk of the seston of the Amur - all that which is carried in a suspended condition in the mass of the river stream, in the first instance with the object of studying the character of the drift of eggs and larvae of depth-loving fishes, and also of the drift of planktobenthos and tripton. Samples of planktobenthos were taken from the 2nd June to the 24th July in 1957 and from the 22nd May to 26th July in 1958.

In the ~~bed~~ channel of the Amur in the Leninsk district the Amur and Sungari waters are clearly demarcated. The latter are yellow coloured, always more turbid and warm, they are born by the River Sungari, discharging into the Amur 40 kilometers above Leninsk and carried under the right bank for 10 kilometers below, covering approximately 1/3 of the width of the stream, only gradually merging with the waters of the Amur. In accordance with this on the standard section of the bed of the Amur three stations were established; on the right bank in the Sungari stream, in the central ~~bed~~ channel of the Amur and on the left bank in the Amur stream. As sampling instruments of the planktobenthos, nets, stitched from silk milling gauze according to the type of quantitative plankton nets of Apshtein were used, on the end of which were fastened litre glass jars. In 1957 nets of gauze No.15 were used with the length of the net cone H = 2 metres, the depth of the extension h = 40 centimeters, diameter of the upper ring d = 50 centimeters, diameter of the lower ring D = 80 centimeters.[1] In 1958 analagous nets were used of gauze No.16, H = 1.3 meters, h = 25 centimeters, d = 25 centimeters, D = 30 centimeters. We took samples at the same time with both nets in the surface and middle (sometimes called deep) horizons of the water. The keeping of the net with a launch standing at anchor (because of the great speed of the current the launch was sometimes carried away) was prolonged for a period of 15 minutes. At the same time by means of a secchi disc the transparency of the water was recorded and the temperature and speed of the current be measured. Selections of the filtrate of the net organisms were fixed in 4% solution of formalin.

1 In 1957 with the object of increasing the catching power of the nets for ichthyoplankton a larger entry aperture was used.

A comparison of the density and biomass of the bottom populations of the Amur with those of European lowland rivers shows the significant poverty of the benthos of the Amur both by individual bottoms and by mean indicators for all rivers altogether (Borutskii, and others 1952; Nikol'skii and others 1958; Nikol'skii and others, 1959, 1960). The poverty of the benthos of the stream of the Amur is emphasized by I. Be-Lu and others (1959) and Chen Tsi-Yui (1959), who carried out simultaneously with us investigations on the upper and middle course of the Amur.

Nevertheless the concept of the comparative poverty of the Amur benthos evidently does not match up with reality. It is possible to come to a similiar conclusion only studying the bottom populations of the Amur by the usual generally accepted method - standard bottom grab method known to be leading at great depths (of the order of 10 to 20 metres) and higher speeds of current (greater than one metre per second) to a deficit of the infauna in the sandy ground most widely distributed in the Amur stream and to the not fully accounted for part of the bottom population, which in any given moment is travelling in the mass of the water. ~~The study of this seston carried in the mass of the water,~~ The study of this seston carried in the mass of the water, but the main part of it composed of bottom organisms and thus called the planktobenthos, carried out by the Amur ichthyological expedition 1945 - 1949 (Borutskii, 1952; Borutskii and Verigin, 1958) and the ichthyological sections of the combined Amur Expedition of 1957 - 1958 (Nikol'skii and others, 1959, 1960; Klyuchareva, 1962; Levanidova and Levanidov 1962), compels us to revise radically the previous concept of the quantity of larvae of a number of aquatic insects inhabiting the Amur, and it is not possible to talk about the comparative poverty of its benthos.

It is established that at the time of the summer floods with an increase in the speed of the current causing unstable conditions existing on the bottom, in each given moment part of the bottom population per unit area of bottom is found in the composition of the drift (Table 1.).

The biomass of the bottom invertebrates in the water mass of the lower course of the Amur, according to the data of I.M. & V.Ya. Levanidov (1962) comprises 1-2 mg/m^3. It is natural that the sections of the Amur with sharper variations of level must be characterized also by a more clear expression of the migration of the bottom organisms. The middle Amur and the upper section of its lower course are characterized by maximal amplitude of variations of level and floods. (Livovich, 1945). Below, the quantity of bottom animals in the mass of the water is decreased, which is well shown by I.M. & V.Ya Levanidov for the stretch of the Amur from Khabarovsk to the estuary. The food value of the bottom of the Amur, in general fairly low, is increased on account of the planktobenthos and the latter will play a significant role in the formation of the food basis of fish in the future Amur reservoirs especially in the middle course of the river.

Knowledge of specific composition of particular groups of the bottom organisms and on the ecology of the majority of representatives of the benthos of the Amur is found in the works of E.V. Borutskii and others (1952), O.H. Chernov (1952), A.S. Konstantinov (1950), O.H. Klynchareva 1952, N.L. Sokol'skaya (1958, 1961), E.I. Lukin 1962, I.I. Kurenkov (1950) and I.I. Sokolov 1950, therefore in this paper we produce only a general list of organisms, other than planktonic, caught in the mass of the Amur (Table 2) and a list of these forms from them which achieve diel vertical migration.

A determination of the kind of organisms drifting in the mass of water of the Amur was carried out by the following specialists; mayflies - N.P. Meshkova under the supervision of O.H. Chernov, Chironomids - A.S. Konstantinov, Oligochaetes - N.L. Sokol'skaya, Molluscs - Ya.I. Starobogatov, Leeches - E.I. Lukin, for which we take this opportunity to extend our thanks.

For us the greatest interest is the mass drifting forms, to which are attributed in the middle current of the Amur in the district of Leninsk primarily stoneflies and mayflies. Of the mayflies in the waters

of the Sungari stream are in mass : Anagenesia paradoxa, Oligoneuriella sp., Baetis sp., Polymitarcys nigridorsum, Ephemerella gracilis, and Brachicercus minutus, in the true Amur water under the left bank of the Amur - Heptagenia arsenjevi and Ordella maculata. If it is sure that part of the organisms quoted in Table 2 fell into the mass of the river current from the air (Formicidae, Cicadoidea, Thysanoptera), part were passively washed out of the bottom sediments with the raising of the level and the increase of speed of the current (Oligochaeta, Hirudinea, Mollusca), for a proportion of forms pertaining to the nekto-benthos (Palaemonidae, Neomysis intermedia), (for) inhabitants of the film of surface tension of the water (neuston) such as Gyrinus sp., and facultative ecto-parasites of fish (Livoneca amurensis, Argulus coregoni and A. foliaceus), living in the mass of the water, constant or periodical, it appears as a natural and well known fact, that the drift of larvae of a number of insects from the order Ephemeroptera (Anagenesia paradoxa, Oligoneuriella sp., Baetis sp., Polymitarcys nigridorsum), Plecoptera, Trichoptera (Polycentropidae gen.sp., Hydropsychidae gen.sp., Amphipsyche proluta and Triaenodes sp.) and possibly Diptera (apparently certain Pelopiinae) and Hemiptera (Aphelochirus sp.) in the basin of the Amur has an active nature.

As proof of the activity of drifting of the above mentioned forms there follows firstly this fact, that these organisms perform diel vertical migration, similar to that of the zooplankton in the sea and freshwaters and the peracarids of brackish and freshwater bodies, and secondly that their drifting proceeds significantly more intensively by night than by day, which is seen graphically on the diagram where is presented a summary of the weight of organisms of the planktobenthos from the catch of the surface and deep nets, together with the day and night time,on the background of the curves of variation of level of the Amur and Sungari in the summer of 1957.

These organisms, living in the larval form in the stream of the Amur, periodically rise from the bottom in association with the summer adult forms and are carried in the mass of the river flood downwards on the current, at night floating up to the surface, by day sinking to the deeper layers and partially, perhaps entirely, settling on the bottom, judging by the fact that in the day the quantity of carried organisms not only on the surface, but also in the middle horizons, is much less than in the night time. Thus in particular of the mayflies the great majority of the larvae of Anagenesia paradoxa (1774 to 2064 collected examples of this species) are found in the surface planktobenthos samples at night time. It is evident there predominated in the night samples collected in the mass of water of the Amur the larvae of Polymitarcys nigridorsum, Oligoneuriella sp. and the remaining above-mentioned species of mayfly.

An analagous phenomenon in regard to a number of benthic larvae of insects was noted by I.M. & V.E. Levanidov (1962), collecting simultaneously and with identical methods to ours a collection of seston in the Khabarovsk and Malmyzha district.

The nightly drift of bottom invertebrates is widely prevalent not only in the Amur itself but also in other rivers of its basin; thus we observed it in May to July 1956 in the mountain taiga River Ul, flowing into Lake Orel situated in the lower reaches of the Amur, and (so did) I.M. & V.E. Levanidov (1962) in a series of other foothill tributaries of the Amur and the Ussur, serving as spawning places of salmon.

The collection of invertebrates carried in the river floods was produced on the River Ul from cylindrical traps of small fish-counting barriers of the Ul fish breeding Amelioration station from the middle of May to the 10 July. Six traps were established across the whole width (33 metres) of the stream at identical distances from the bank and one another. The collection of fry and hydrobionts was produced from 2200 to 0300 hours (at the time of descent of the young keta and gorbuscha). Simultaneously with the session (10 mins) determined levels (surface, middle or near bottom) were established all six traps.

The interval of time between sessions was equal to 1.5 hours. On average the summary of the catch of all traps at night time comprised 60 organisms of a total weight of 6.25 grams.

A number of bottom invertebrates drifting in the mass of the water, principally the larvae of insects (Table 3), was invariably met in the night catches of the traps. The drift of the majority of these organisms was sufficiently extended and in each form is characterized by its own rise and peak; thus the maximum intensity of drift of Ephemera amurensis was registered on the 9 July, of Ephemera strigata on the 5 July, of Ephemerella taeniata at the end of June to the begining of July, Arctopsyche sp. in the middle of May, and amphipods in the first ten days of July.

The occurrence of all the organisms in the night time in the mass of the water, excluding a single caddis, was not connected with the emergence of the imaginal forms.

In the literature there is some information on the diel activity of the aquatic larvae of insects. There exist reports on the active migration of the larvae of Simuliidae by I.A. Rubtsov (1940) for rivers of eastern Siberia, by Z.A. Radzivilovskaya (1950) for the mountain rivers of the southern Ussuriiskoi Taiga and by V.N. Yakuba (1959) for part of the Angara above the Padunsk rapids.

J.E. Harker (1953) showed that some species of mayfly of the genera Baetis, Ecdyonurus and Heptagenia are more active in the night time. Experiments were carried out confirming the inherent diel rhythm of activity of the larvae of mayflies. J.H. Mundie (1959) studying the vertical distribution of bottom invertebrates in the Canadian lake La Ronge, Saskatchewan, also indicated diel vertical migration of a number of large crustaceans and also nymphs and larvae of certain insects from the orders Hemiptera, Ephemeroptera, Trichoptera, not dwelling on the cause of this phenomenon but confirming rather its statement.

The diel rhythm characteristics of the intensity of drift, and the diel vertical migration of these organisms serve as a demonstration of the active origin of the drift of these forms of the Amur benthos.

Materials of three daily series of experiments (30/6-1/7; 9-10/7; 19-20/7) carried out in 1957 (Table 4) in Leninsk district showed that in the night time the above - numerated benthic larvae of insects rise from the depths and the quantity of them in the surface layers significantly increases, correspondingly falling in the middle horizons. They are concentrated on the surface. In contrast to the light period of the day there appears to be as it were reverse stratification in the vertical distribution of these organisms; their biomass in the catch of the surface nets exceeds that of the deep ones. To the middle of the night this process increases. Towards morning appears the reverse picture; they plunge from the surface to the depths and the "reverse" stratification in their vertical distribution is replaced by "direct". During all the light period of the day the mass of these organisms in the middle horizons always exceeds that of the surface layers. An analogous picture was shown also in the daily series of experiments carried out in 1958.

The removal of the benthos by river current is known not only for the Amur. The drift of bottom invertebrates in some degree is known in all rivers and is caused by the features of the habitat of the bottom forms in the presence of dynamic river hydrological conditions. The first indications of this we obtain from A.P. Bening (1924) and E.S. Neizvestnova-Zhadina (1937) for the Volga.

V.I. Zhadin dwelt, in a series of his works (1940, 1941), on the question of the drift of bottom organisms. Later studies of the bottom drift on the Volga were made by G.V. Aristovskaya (1945) and on the Mologa by Ts.I. Ioffe (1949). In 1948-1949 in hydrobiological investigations of the lower Don F.D. Mordukhai-Boltovskoi (1957) established the participation in the biological discharge of the river of bottom invertebrates of the Peracarida, floating up in the night time from the bottom into the mass of the water. K. Muller (1953, 1953A) showed that the clearing of drift wood from streams in the north of Sweden, which was started in 1947, produces in relation to the bottom population effects similiar to those after floods. In the period of

hydrobiological investigation on the Volga preceding the filling of the Kuibyshev reservoir some attention to the drift of benthos was given by Kh.M. Kurbangalieva (1958). Of course, to the drift of bottom invertebrates in the Amur itself great attention was given in a series of works by E.V. Borutskii (1952, 1958).

All investigators, occupied with the study of the drift of bottom organisms, assess the rise of benthic forms from the bottom as a result of the mechanical washing out of organisms in the flood period, with an increase in the speed of the current, as a mechanical transfer simultaneously with a washing out of bottom alpuviol sediments (Aristovskaya, 1945 Borutskii, 1952 Lyakhov & Zhidkov, 1953 Ioffe 1957, Mordukhai-Boltovskoi 1957).

Emphasizing the passive washing out from the bottom sediments of the larvae of insects and worms, F.D. Mordukhai-Boltovskoi clearly delimits two kinds of bio-discharge of an active and passive nature; the migratory bio-discharge of peracarids and the flood drifting of secondary aquatic organisms.

The absence of diel vertical migration in the organisms such as are known as the"flood drift" in European lowland rivers (excluding Peracarids) and rivers of the west confirms the truth of the outlook of the afore mentioned authors on the passive origin of the drift of bottom invertebrates in these.

There is an indication on the diel vertical migration of organisms of the freshwater benthos, excluding the well known rise to the surface of the pupae of insects before emergence of the adult winged forms, in the native literature of F.D. Mordukhai-Boltovskoi (1957). With the hydrobiological investigations in 1948-1949 of the lower Don by this author the daily vertical migration of bottom invertebrates was found to be clearly expressed. All migrating forms were related exclusively to the Peracarids; these were Corophiids, "?Kumovye" and mysids. We did not find indications on similiar migrations of other groups of freshwater benthos, except for Harker (1953) Mundie (1959) and the three above quoted authors in relation to Simuliidae in the literature of research of the full Soviet Chinese Ichthyological series of the multiple Amur expedition of 1957 to 1958.

As regards the drift of a number of bottom organisms in rivers of the Monsoon climate of eastern Asia, well known for the Amur and a number of Chinese rivers it is evident, as it is already recorded by us and by I.M. & V. Ya. Levanidov (1962), that the concept of the passive nature of this phenomenon, as dependent on the basic simple mechanical washing out of the benthos from the bottom sediments with the increased speed of the current, is wrong.

The drift of these organisms in the basin of the Amur in our view appears a process of an active nature. It depends not only and not as much on the mechanical washing-out of organisms from the bottom sediments as on the periodic active rising of benthic forms from the bottom into the mass of the water and the floating of them in the river stream below by the current. As confirmation of the activity of the drift of part of the Amur benthos, the vertical diel migration of a number of bottom larvae of insects in the Amur serves firstly as a demonstration of the active origin of this process. The diel vertical migration in the state of drift of these organisms evidently is developed as an adaptation primarily to avoid being eaten up by predators in the light period of the day in the surface well-illuminated layers, in so far as the availability of bottom organisms in the drifting state for utilization in the food of fishes, guided on to the victim with the help of vision, in these conditions is significantly increased. Apart from this for a series of zooplankton-eating forms it is possible that vertical migration has importance as an adaptation to better conditions of fattening, in connection with the vertical migration of zooplankton, clearly expressed in the channel of the Amur. Not dwelling on a review of the literature about the diel vertical migration of aquatic organisms, to which is devoted the detailed report of B.P. Manteufel (1960), we, in accordance with him, calculate, that the zonation in distribution in the first instance of food and enemies is the basis of the vertical migration of the hydrobionts and explains

the presence of these migrations as similiar according to the significance of adaptation in aquatic animals of very different systematic and ecological goups.

For river predators guided on to the prey with the help of organs of vision, the sinking of the prey in the mass of the river stream even to a few metres is equivalent to the sinking of marine zooplankton to tens and hundreds of metres, considering that in the river, rich in seston, with depth, because of the sharp rise of quantity of carried alluvium the possibility of penetration of light is significantly weakened and soon reaches twilight. In the Amur in the Leninsk district the greater part of the transparent water of the Amur stream proper under the left bank has a mean transparency in the lower high-water of 1957 of about 75 centimetres and in the greater high-water of 1958 of about 60 centimetres, but the turbid waters of the Sungari stream under the right bank in all only 34 to 35 centimetres. With the prevallence in the current of the Amur of a depth of 10 to 20 metres, the vertical migrations of the above enumerated bottom organisms leads them as with zooplankton in the day time, out of the zone of eating by predators guided on to the prey by the help of organs of vision.

The biological significance of the periodic rise into the mass of the water of a series of bottom organisms and the carrying of them downwards by the current results in a guarantee of survival of these species in the presence of the high dynamic hydrological conditions of existence in rivers of the Amur type. If the benthic organisms inhabiting the mainly sandy river bottom easily washed away by the swift current of the river, especially during the long summer-autumn rise in level, did not possess the possibility of actively rising from the bottom and being washed down, drifting in the mass of the water by the current, then they might be condemned to death by grinding by the involved alluvium, the mobility of the washed-out sand grains and starvation in the old place after washing out of the former biotopes (Neizvestnova-Zhadina 1937; Neizvestnova-Zhadina and Ioffe 1941; Zhadin 1950). The active rise into the mass of the water saves them from this death and permits (them) evidently to settle in places with suitable conditions of existence. In the Amur as apparently also in a series of other rivers of Monsoon climate, the phenomenon of the rise of part of the benthic organisms from the bottom into the mass of the water and the diel vertical migration of them in a state of drift is conditioned in our opinion by the specific conditions of existence of the bottom forms with sharply dynamic river hydrological conditions with great variations of level, significant changes in speed of current with a high liability to wearing out by transported alluvium and travelling sediment with part of the washed away old and undeposited new bottom sediments. This active rise from the bottom and drift in the mass of the water appears an adaptation of part of the benthos of the Amur to specific abiotic factors. The vertical diel migrations of these organisms, whose susceptibility to eating up by planktophages guided on to prey with the help of vision, increases in the drifting state, reduce their destruction by predators. These vertical migrations appear adaptations to the biotic conditions of existence of the benthos of the Amur in the drifting state.

With the usually large quantity of carried alluvium, smoothing the difference in the illumination of the surface and near bottom layers of the water, the biological significance of the daily vertical migration of the drifting bottom organisms disappears, and in conformity with these appears a smearing of the clear picture of daily rhythm of vertical distribution of the planktobenthos in the mass of the current, explained by the variation of the illumination on the bottom and on the surface by trophic associations. Besides the rising of the turbiditity and the reduction of the transparency of the water, softening the abruptness of the change of illumination on the extent of the day in the depths of the river current, the abundance of tripton still determines as a mechanical (?) traumatic factor the change of the drifting organisms of the planktobenthos in the most surface layer, where the quantity of tripton is usually less.

A similiar disturbance of the vertical distribution of the planktobenthos in the mass of the water, appearing as an expression of the adaptation of benthos to the specific abiotic and biotic conditions of the medium, is observed when on the process dependent on this characteristic is superimposed another, process different by its nature, connected with the emergence of the imagines of insects. In the summer of 1958 when the emergence of the insects was extended this was in a significant degree expressed.

Thus the biological significance of the drift of the planktobenthos in the Amur has a double nature; firstly this emergence of the adult forms of secondary water organisms; secondly protection from unfavourable abiotic and biotic conditions of the medium. If in European rivers there remains and dominates only emergence, then in the Amur and evidently in a number of other rivers of Monsoon climate no less a role is played by the protective importance of the biodrift.

This unusual ecology of a number of organisms of the benthos of the Amur, a particular kind of adaptation to specific abiotic (hydrological) and biotic (conditions of eating up by predators) factors of existence, expressed in the active rise from the bottom to the mass of the water and the diel vertical migration of the bottom invertebrates in the drifting condition during the strong and extended summer-autumn floods, it seems to us, appears as one of the existing elements of the hydrological characteristics of rivers of the Amur type, standing together with such phenomena as the production by the fish of the Chinese faunistic complex - such as are called pelagophil - the possibility to pass the embryonal and larval development in a state of drifting with the river current. (Kryzhanovskii and others 1951).

Table 1

Weight* (in grams) of organisms of the planktobenthos carried in 1 min. through a cross-section of 1 m^2 in the Amur in Leninsk District, summer 1958.

Time of day. Время суток	Amur Stream Амурская струя	Middle Amur Середина Амура	Sungari Stream Сунгарийская струя	Mean В среднем
0630 — 0910	0,007 (0,006—0,008)	0,267 (0,031—0,503)	0,026 (0,014—0,039)	0,100 (0,006—0,503)
06 ч 30 мин — 09 ч 10 мин	0,024 (0,006—0,043)	0,072	0,107 (0,018—0,197)	0,067 (0,006—0,197)
	0,008 (0,004—0,013)	0,052 (0,028—0,077)	0,027 (0—0,056)	0,029 (0—0,077)
12 ч 50 мин — 14 ч 40 мин	0,026 (0,024—0,028)	0,048	0,044 (0,018—0,065)	0,039 (0,018—0,065)
	0,083 (0,012—0,155)	0,077	0,178 (0,116—0,340)	0,113 (0,012—0,340)
18 ч 50 мин — 20 ч 45 мин	0,015 (0,008—0,023)	0,037	0,107 (0,105—0,109)	0,053 (0,008—0,109)
	0,057 (0,049—0,064)	0,048 (0,009—0,117)	0,247 (0,028—0,637)	0,117 (0,009—0,637)
22 ч 04 мин — 00 ч 40 мин	0,020 (0,018—0,023)	—	0,116 (0,106—0,126)	0,068 (0,018—0,126)
	0,052 (0,048—0,057)	0,320 (0,139—0,620)	0,076 (0,023—0,138)	0,149 (0,023—0,620)
01 ч 05 мин — 03 ч 40 мин	0,023 (0,014—0,030)	—	0,098 (0,004—0,224)	0,060 (0,004—0,224)
	0,137 (0,020—0,225)	0,078 (0,046—0,140)	0,058 (0,018—0,090)	0,091 (0,018—0,225)
04 ч 10 мин — 05 ч 40 мин	0,016 (0—0,027)	—	0,019 (0,011—0,034)	0,017 (0—0,034)

* in the numerator is given the mean weight for the surface layers, in the denominator for the deep layers, in brackets, minimum and maximum weight.

Table 2

Organisms of the catch of planktobenthic families.

SPECIES. Виды	AMUR STREAM Амурская струя	MIDDLE AMUR Середина Амура	SUNGARI STREAM Сунгарийск. струя	SPECIES Виды	AMUR STREAM Амурская струя	MIDDLE AMUR Середина Амура	SUNGARI STREAM Сунгарийск. струя
Ephemera amurensis Nav.	—	+	—	Polypedilum laeviantennatum Tshern.	+	+	—
E. formosana Ulm.	—	+	+	P. «genuini № 3» Lip.	+	—	—
E. strigata Eat.	+	—	—				
Potamanthus luteus L.	+	—	—				
Polymitarcys virgo Oliv.	+	—	+	Stictochironomus sp.	—	—	+
P. nigridorsum Tshern.	+	+	⊕	Chironomus f. l. plumosus L.	+	—	+
Anagenesia paradoxa Buld.	+	+	⊕	Ch. annularius Meig.	—	—	+
Behningia ulmeri Lest. (?)	+	—	—	Ch. heterodentatus Konstantinov	+	+	—
Oligoneuriella sp.	+	+	⊕	Chironomini «genuini № 1» Lip.	+	—	+
Rhitrogena unicolor Tshern.	+	+	+	Cricotopus gr. algarum Kieff.	—	+	—
Heptagenia yoshidae Tak.	+	+	+	C. brevipalpis Kieff.	—	—	+
H. kibunensis Im.	—	+	—	C. gr. fuscimanus Kieff.	+	+	—
H. werestchagini Tshern.	+	—	—	C. macropodus Ljachov	—	+	+
H. soldatovi Tshern.	+	+	+	C. monstrosus Tshern.	+	—	+
H. arsenjevi Tshern.	⊕	+	+	C. gr. camptolabis Kieff.	—	+	+
Heptagenia sp.	+	—	—	C. gr. vulneratus Zett.	—	+	—
Ametropus eatoni Br.	+	+	+	C. zabolotzkii Goetgh.	—	—	+
Metretopus alter Bngtss.	—	+	—	C. sp. n.?	+	+	+
Siphlonurus sp.	—	+	—	Glyptotendipes sp.	—	—	+
Isonychia sp.	+	⊕	+	Leander modestus (Heller)	+	—	—
Baëtis obtusiceps Tshern.	—	+	—	Palaemonidae gen. sp. larvae	+	+	⊕
Baëtis sp. 1	+	⊕	+	Livoneca amurensis (Gerst.)	+	+	+
Baëtis sp. 2	+	+	⊕	Neomysis intermedia Czern.	+	—	+
Ephemerella sibirica Tshern.	+	+	+	Amphipoda gen. sp.	+	+	+
E. mucronata Bngtss.	+	—	—	Argulus coregoni Thorell	⊕	+	+
Brachycercus tubulatus Tshern.	+	+	+	A. foliaceus (L.)	—	—	+
Brachycercus sp.	—	+	—	Limnodrilus helveticus Piguet.	+	—	—
B. minutus Tshern.	+	+	⊕	Limnodrilus. sp.	—	+	—
Ordella cornuta Tshern.	+	+	+	Tubificidae gen. sp.	+	+	—
O. maculata Tshern.	⊕	+	+	Peloscolex nikolskyi Last.	—	—	+
O. horaria L.	+	+	+	Lumbriculidae gen. sp.	—	+	—
O. miliaria Tshern.	+	+	+	Herpobdella sp.	—	—	+
Plecoptera gen. sp.	+	+	+	Lymnaea auricularia plicatula Bens.	+	—	+
Polycentropidae gen. sp.	+	+	⊕	C. gr. silvestris F.	+	+	+
Hydropsychinae gen. sp. 1	+	+	⊕	Eukiefferiella longicalcar Kieff.	+	+	+
Hydropsychinae gen. sp. 2	+	+	⊕	Prodiamesa gr. bathyphila Kieff.	+	+	+
Hydropsyche sp.	—	⊕	+	Ablabesmyia gr. lentiginosa Fries.	+	+	+
Aethaloptera rossica Mart.	+	+	⊕	A. gr. monilis L.	+	+	+
Amphipsyche proluta Mc L.	+	+	+	Clinotanypus nervosus Mg.	+	+	—
Phryganeidae gen. sp.	—	+	+	Psilotanypus imicola Kieff.	+	+	⊕
Triaenodes sp.	+	+	⊕	Procladius gr. choreus Mg.	+	+	⊕
Mystacides sp.	—	—	+	Simuliidae gen. sp.	+	+	+
Lepidostomatinae gen. sp.	—	+	+	Culicoides sp.	+	—	—
Brachycentrinae gen. sp.	+	+	—	Culicinae gen. sp.	—	—	+
Cryptochironomus gr. defectus Kieff.	+	—	+	Chaoborus sp.	—	—	+
C. demeijerei Krus.	+	+	+	Diptera gen. sp.	+	—	+
Baëtis sp. 3	+	+	+	Corixa sp.	+	—	—
Centroptilum sp.	+	+	—	Aphelochirus sp.	+	+	⊕
Acentrella sp.	+	+	—	Odonata gen. sp.	+	+	+
Choroterpes trifurcata Uno	+	—	—	Gyrinus sp.	+	—	+
Paraleptophlebia sp.	—	+	—	Formicidae gen. sp.	+	+	+
Ephemerella gracilis Tshern.	+	+	⊕	Cicadoidea gen. sp.	+	+	+
E. lenoki Tshern.	+	+	+	Thysanoptera gen. sp.	+	+	+
Glyptotendipes gr. gripekoveni Kieff.	—	—	+	Insecta sp.	+	+	—
Limnochironomus gr. nervosus Staeg.	—	+	—	Gyraulus filiaris (= G. centrifugus West.)	—	+	—
L. gr. tritomus Kieff.	—	—	+	Hydracarina	+	+	+
L. bidentatus sp. n.	—	+	—	Araneina	+	—	+

* + имеются, — отсутствуют, ⊕ имеются в большом количестве.

1604 + present; — absent; ⊕ present in large quantities

Table 3

Nocturnal drift of benthic invertebrates (numbers) in the River Ul in 1956. (Summarised catch of traps of the fish-counting barrier of the Ul fishery amelioration station).

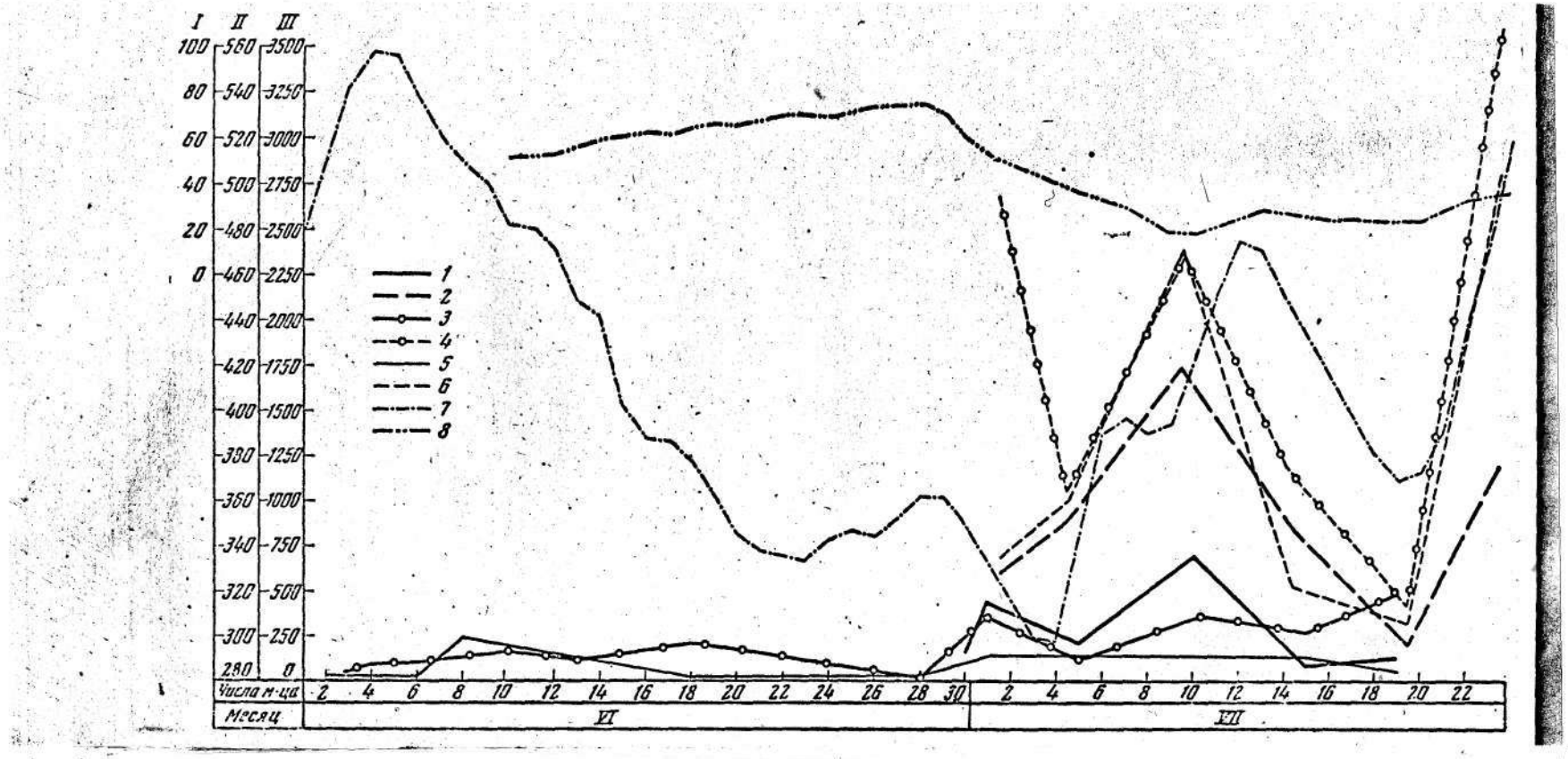
Organisms Организмы	DATES							
	16.V	11.VI	26.VI	27.VI	3.VII	5.VII	7.VII	9.VII
Ephemera amurensis Nav.	10	4	10	7	—	8	4	18
E. strigata Eat.	8	7	7	5	9	12	9	7
Ephemerella taeniata Tshern.	1	14	20	1	16	13	14	9
Dictyogenus sp.	15	8	1	15	—	2	1	1
Capnia sp.	—	1	1	3	4	—	2	9
Trichoptera gen. sp. subimago	—	—	6	—	3	—	1	3
Arctopsyche sp.	31	1	4	4	4	8	1	—
Diptera gen. sp.	13	4	1	11	—	—	4	—
Amphipoda gen. sp.	3	8	4	5	10	17	12	7

Table 4

Drift of benthic larvae of insects in day and night periods in the Amur in the Leninsk District.

AMUR STREAM Амурская струя		MIDDLE AMUR Середина Амура		SUNGARI STREAM Сунгарийская струя	
Time of day Время суток	Wet. weight Сырой вес в г*	Time of day Время суток	Wet wt. Сырой вес в г*	Time of day Время суток	Wet wt Сырой вес в г*
h min.		30.VI — 1.VII 1957			
14 ч 00 мин	0,025/—	14 ч 35 мин	0,006/0,156	15 ч 20 мин	0,027/0,171
18 ч 23 мин	0,016/0,089	19 ч 00 мин	0,116/0,137	19 ч 30 мин	0,162/0,160
00 ч 15 мин	0,441/0,245	01 ч 00 мин	0,521/0,177	01 ч 35 мин	2,370/0,320
06 ч 30 мин	0,030/0,127	07 ч 00 мин	0,142/0,288	07 ч 40 мин	0,161/0,192
12 ч 10 мин	—	12 ч 37 мин	0,083/0,227	12 ч 58 мин	0,039/0,070
		9—10.VII 1957			
—	—	—	—	08 ч 00 мин	0,125/0,029
—	—	14 ч 00 мин	0,031/0,252	15 ч 41 мин	0,025/0,041
—	—	19 ч 15 мин	0,400/0,103	20 ч 15 мин	0,106/0,163
23 ч 54 мин	1,698/0,698	00 ч 25 мин	1,342/0,389	00 ч 50 мин	1,483/0,905
—	—	06 ч 40 мин	0,288/0,412	07 ч 00 мин	0,256/0,113
		19—20.VII 1957			
—	—	07 ч 05 мин	0,238/0,248	—	—
—	—	13 ч 30 мин	0,016/0,124	14 ч 00 мин	0,126/0,376
—	—	19 ч 00 мин	0,005/0,007	19 ч 30 мин	0,174/0,220
23 ч 40 мин	0,202/0,142	00 ч 10 мин	0,119/0,094	—	—

* in the numerator - from catch of surface net; in the denominator, from catch of deep net.



Drift of organisms of the planktobenthos in the Amur at the Leninsk settlement in 1957 (in grams).

1 - Daytime drift of planktobenthos in the middle Amur.
2 - The same, night-time
3 - Daytime drift of planktobenthos in the Sungari stream.
4 - The same, night-time
5 - Daytime drift of planktobenthos in the Amur stream
6 - The same, night-time
7 - Level of the Amur at Leninsk set. in cm.
8.- Level of the R. Sungari at Harbin in cm.
I - Level of R. Sungari at Harbin in cm.
II Level of R. Amur at Leninsk set. in cm.
III Wet weight of planktobenthos in mg.

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Notice

Please note that these translations were produced to assist the scientific staff of the FBA (Freshwater Biological Association) in their research. These translations were done by scientific staff with relevant language skills and not by professional translators.