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Trophic Structure of Invertebrate Communities in Ecosystems of Salmon Rivers in the Southern Far East

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Abstract—The formation of trophic structure has been studied in communities of amphibiotic insects (mayflies, stoneflies, caddis flies, and dipterans) and gammarids accounting for 90% of the total benthos biomass. The results show that the trophic groups prevailing by biomass in the metarithral subzone of small rivers are as follows: filtering collectors in rivers of the moderately cold-water type, collectors and scrapers in rivers of the cold-water type, and scraping predators and scrapers in rivers of the moderately warm-water type. Predators, scraping predators, and scrapers show seasonal changes in abundance and biomass. In the rithron of Far Eastern rivers, the abundance of predators regularly decreases in a south–north direction. The change of dominant groups along the longitudinal profile of the river is related to its zones and subzones. In the trophic structure of rivers exposed to anthropogenic impact, the number of trophic groups decreases and the remaining groups undergo changes in their qualitative composition and the ratio of their individual members.

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Key words: ecosystem, community structure, invertebrates, trophic groups, salmon river.

Studies on the ecosystems of salmon rivers in the Far East, which began under the guidance of V.Ya. Levanidov in the 1950s, are underway at the Institute of Biology and Soil Sciences. To date, specialists have obtained abundant data on the species composition, abundance, and biomass of invertebrates in Far Eastern rivers and distinguished groups characterized by different modes of feeding. However, there is still not enough information on the trophic structure of invertebrate communities in rivers of different types and on seasonal and geographic changes in the ratio of trophic groups. Knowledge of the quantitative aspects of trophic interrelations of aquatic animals is necessary for many reasons: firstly, they must be taken into account while assessing utilization of organic matter formed in the water body and the efficiency of its further transformation; secondly, trophic interrelations are of primary importance for understanding quantitative aspects of biological productivity; and, thirdly, the trophic structure of invertebrate communities may serve as a reliable indicator of the state of river ecosystems exposed to anthropogenic factors (Yakovlev, 2000).

This study deals with the results of research on the formation of trophic structure in the communities of amphibiotic insects (mayflies, stoneflies, caddis flies, dipterans) and gammarids depending on the river zone and type, season, and the degree of anthropogenic impact. These groups are of special interest because they quantitatively prevail in Far Eastern rivers, accounting for up to 90% of the total benthos biomass. All rivers considered here are of the salmon river type; i.e., they are mountain or piedmont streams with a pebbly rock bed and rapidly flowing cold water (Levanidov, 1981).

The communities of hydrobionts comprise animal populations that can be divided, in the simplest way, into two trophic levels, nonpredatory and predatory. Among nonpredatory invertebrates, three categories differing in the mode of feeding are distinguished: (1) grinders, which destroy structured plant matter and transform it into organic detritus; (2) scrapers, which collect organic detritus from the surface of stones; and (3) collectors. The third category consists of two groups: animals collecting fine suspended matter in nets and those gathering sediment of fine organic matter from the substrate surface (Cummins, 1973). When the prevalence of a certain mode of feeding is less apparent (e.g., in mayfly larvae), two more trophic groups are distinguished: scraping predators and scraping collectors.

MATERIAL AND METHODS

A total of 486 quantitative samples of the benthos were taken in basins of the Kedrovaya (July 1979—August 1980), Bikin (July and August 1995), Frolovka (June–October 1984), Rudnaya (1982–1984), and

Table 1. Hydrologic characteristics of surveyed rivers

River	Length, km	Width (max), m	Mean slope, ‰	Depth (min–max), m	Flow velocity, m/s	Water temperature (max), °C	Ground	Tributary (basin)
Kedrovaya	25	15	10.3	0.3–0.7	0.3–1.5	20.0	Stones and pebbles	Sea of Japan
Frolovka	22	12	43.9	0.3–0.5	0.4–2.5	20.5	Boulders to pebbles	Partizanskaya River (Sea of Japan)
Zeva	139	53	–	0.4–1.2	0.3–1.4	20.0	Boulders to pebbles	Bikin River (Ussuri River)
Antonovskii	–	15	–	0.2–0.65	0.7–1.4	9.4	Pebbles	Zeva River (Bikin River)
Klyuchevaya	97	53	–	0.2–0.52	0.3–1.0	12.0	Stones and pebbles	Bikin River (Ussuri River)
Rudnaya	73		12.9	0.3–0.5	0.6–2.1	20.0	Large stones, pebbles, and gravel	Sea of Japan
Edinka	113	50	11.5	0.4–1.4	0.3–2.0	14.0	Stones and pebbles	Sea of Japan
Bikin	560	210	2.4	0.5–7	0.3–1.8	25.5	Large stones and pebbles	Ussuri River (Amur River)

Edinka rivers. The material was collected quantitatively using a Levanidov (1976) benthometer with a catching area of 0.12 m^2 and a benthometer of our modification (Tiunova, 2003) with a catching area of 0.0625 m^2.

Small larvae of the same species were weighted in batches of up to 100 specimens and large larvae were weighed by one or several specimens on a VT torsion balance to an accuracy of 0.05–0.1 mg. Before weighing, each larva (group of larvae) was dried on filter paper until moist spots disappeared. On the whole, over 70 000 specimens were treated.

The stations on the Frolovka River were distributed as follows: *station 1*, 2 km from the source; river segment approximately 1 m wide and 5–6 cm deep in the summer low-water period, flow velocity 0.1–0.2 m/s; *station 2*, 3 km from the source; a segment up to 2 m wide and 15–20 cm deep; *station 3*, 8.2 km from the source; a relatively gently sloping segment of the bed with an increased content of pebbles and sand in the ground; flow velocity 0.5–1.2 m/s, depending on water level; *station 4*, 15.7 km from the source; flow velocity in the low-water period 0.3–0.6 m/s; *station 5*, 20.6 km from the source, a segment 3 m wide in the low-water period, flow velocity 0.5 m/s; and *station 6*, 0.6 km from the mouth; stony–sandy ground with the content of fine fractions higher than in other segments. All stations were in the rithral zone: stations 1 and 2 corresponded to the epirithral subzone; stations 3–5, to the metarithral subzone; and station 6, to the hyporithral subzone.

The trophic structure of the community was assessed with reference to the classification of A.M. Chel'tsov-Bebutov modified by Levanidov (1977), according to which dominants make 15% and more of the total biomass; subdominants, 5.0–14.9%; secondary species, 0.1–4.9%; and third-grade species, less than 0.1%. Trophic groups of benthic invertebrates differing in the mode of feeding were distinguished on the basis of my original data on the food spectra of larvae and relevant published data (Slobodchikova, 1964; Morse et al., 1994; Kocharina, 1997; Teslenko, 1997).

RESULTS AND DISCUSSION

Seasonal changes in the trophic structure of the aquatic invertebrate community are considered using the example of the Kedrovaya River in southern Primorye. This model river flows in the Kedrovaya Pad' Nature Reserve and is not exposed to anthropogenic impact. Studies were performed in the middle reaches of the river in the metarithral zone (Table 1).

Among active predators, the larvae of large stoneflies such as *Kamimuria exilis* (VcL.), *Stavsolus manchuricus* Teslenko et Zhiltz., *Megarcys ochracea* Klap., *Skwala pusilla* Klap., and *Sweltsia colorata* Zhiltz., as well as smaller *Alloperla rostellata* (Klap.), *Isoperla* sp., *Haploperla maritime* Zhiltz., *Diura knoultoni* (Frison), etc., prevail in the river (Teslenko, 1997). In addition, this trophic group includes five caddis fly species of the genus *Rhyacophila* (Kochargina, 1996), dipterans of the genera *Hexatima* and *Dicranota* (Tipulidae), and some representatives of the family Empididae. The greatest species number (17) and biomass (16%) of active predators in the river were recorded in early May (Table 2). In this period, the larvae of many large stoneflies reach the maximum size and are ready for transformation into adult insects. Therefore, the number of species of predators in early June decreases to a minimum; in October, it increases again to 15 species. The group of animals that combine the functions of predators and scrapers is represented mainly by mayfly larvae of the genus *Drunella: D. aculea* Allen, *D. cryptomeria*

Table 2. Contribution to the total biomass (above the line, %) and species number (below the line, *n*) of trophic groups of invertebrates in the Kedrovaya River during the growing season of 1980

Date	Predators	Filtering collectors	Collectors	Scrapers	Grinders	Scraping predators	Scraping collectors
March 5	13.4/14	57.7/3	9.9/5	1.6/5	6.9/8	9.2/2	1.4/6
April 2	8.4/16	57.6/3	4.8/5	2.8/4	17.7/8	4.8/2	0.7/6
May 1–2	16.0/17	37.7/3	5.6/6	4.3/4	20.7/7	13.9/2	1.7/6
June 6–8	9.1/10	20.7/3	11.1/8	6.8/5	23.7/5	25.9/5	3.4/8
June 26–27	4.3/11	60.6/4	1.3/8	5.2/4	10.0/5	14.5/4	4.1/7
July 31	13.5/14	46.7/3	0.2/5	10.3/4	19.9/5	4.7/4	4.6/7
August 26	5.1/12	25.3/3	3.6/6	26.2/5	20.9/5	2.9/2	16.1/8
October 2	9.1/15	49.0/3	1.4/6	3.6/6	23.8/8	1.8/1	11.4/3

Note: Here and in Table 3, the proportion (%) of trophic groups of invertebrates by biomass was calculated from the total biomass of amphibiotic insects and gammarids.

(Iman.), *D. solida* (Baijk.), and *D. triacantha* (Tschern.). Previously, they were considered to be scrapers, as the relative amount of animal food in their diet was insignificant. According to my observations, however, the larvae of these species suck out their prey and, hence, animal food cannot be found in their stomachs (Tiunova, 1993). This group reaches the peak of species diversity and biomass in early June (25.9%) when the proportion of the biomass of active predators decreases from 16 to 9.1%.

The filtering collectors are represented in the Kedrovaya River mainly by three species, with *Stenopsyche marmorata* Navas and *Arctopsyche palpata* Mart. prevailing by biomass. The groups of filter feeders dominated by biomass throughout the study period, with a maximum of 60.6% in late June and a minimum of 20.7% in early June (Table 2). The group of collectors is represented by mayflies of the families Baetidae, Leptophlebiidae, and by some species of the family Heptageniidae, a total of five to eight species. Its species diversity is higher in June, and the contribution to the total biomass is greater in March (9.9%) and early June (11.1%), being minimum in late July (0.2%).

Similarly to collectors, scrapers account for a relatively small proportion of the benthos biomass and are represented by four to six species. These are mainly the larvae of caddis flies *Neophylax ussuriensis* (Mart.) and *Hydatophylax nigrovittatus* McL.; species of the genera *Glossosoma, Anagapetus*, etc.; and most species of chironomid larvae. The proportion of this group in the total biomass is maximum (26.2%) in late August and minimum (1.6%) in early March, immediately after ice melting.

The group of grinders comprises five to eight species. These are the amphipod *Gammarus koreanus* Ueno; stonefly larvae *Pteronarcys sachalina* (Klap.), *Taenionema japonicum* (Oam.), *Amphinemura verrucosa* Zwick, *Haploperla maritima* Zhiltz., and *Paracapnia khorensis* Zhiltz.; and caddis fly larvae *Dinarthrodes* sp. Except for two months, March and late June, grinders dominate by biomass in the river: its proportion is minimal in March (6.9%) and maximal in the beginning of June (23.7%) and in October (23.8%). The group of scraping collectors is represented mainly by mayfly larvae of the genera *Ephemerella, Cincticostella, Serratella, Epeorus*, and *Ecdyonurus.* The number of species during the study period varied from three to eight. The proportion of this group in the total biomass varies insignificantly from March to July (0.7–4.6%) and reaches a peak in late August (16.1%).

Thus, the ratio of leading trophic groups (dominant filtering collectors and grinders and subdominant predators) in the hierarchical structure of the community remains almost unchanged throughout the season of studies. Other groups manifest considerable seasonal fluctuations: for example, the proportions of scrapers and collectors change during the season by factors of 16 and 55, respectively.

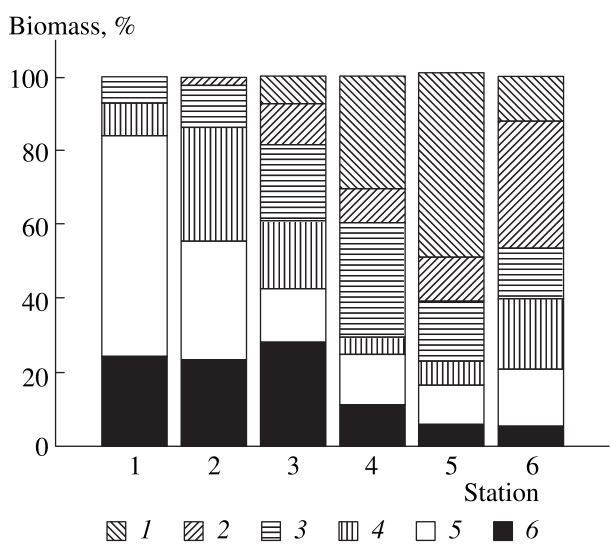
Changes in the trophic structure of hydrobiont communities along the longitudinal profile are considered on the model of the Frolovka River, which is characterized by a steeper slope angle (Table 1) and general elevation drop along the riverbed (Levanidova et al., 1989).

In the epirithral zone (station 1), the trophic structure of the community is represented by four trophic groups: predators, scrapers, collectors, and grinders (figure). Grinders dominate, accounting for up to 59.9% of the benthos biomass. This trophic group consists mainly of amphipods *Gammarus* sp. The proportion of predators is also large (24.2%). The dominant forms are the stonefly *Megarcys pseudochracea* Zhiltz. and dipterans of the genus *Pedicea.* The proportion of scrapers and collectors is small, and filter feeders are absent. The situation at station 2 is similar, but the proportion of grinders is almost half as small (32.2%) and that of collectors is noticeably greater (31%) due to the high biomass of mayflies *Epeorus (Iron) aesculus*

Table 3. Contributions of trophic groups of invertebrates to the total benthos biomass (%) in the Bikin River basin

Mode of feeding	Upper reaches of Zeva River	Sagdy-Biasy River	Antonovskii Spring	Lower reaches of Zeva River	Bikin River	Klyuchevaya River
Predators	8.8	10.4	18.6	21.3	4.7	13.1
Filtering collectors	57.4	0.03	4.6	10.2	0.70	3.7
Collectors	18.3	26.4	31.2	9.7	9.8	21.4
Scrapers	3.4	15.1	5.2	1.6	1.8	–
Grinders	9.6	8.5	16.9	37.1	13.8	10.9
Scraping predators	1.9	16.9	7.4	3.2	30.3	–
Scraping collectors	6.0	22.7	16.1	22.2	38.8	50.9

Iman. and *Cinygmula kurenzovi* Bajk. In the metarithral subzone (station 3), the situation is different. The proportion of predators remains the same as in the epirithral, but the proportion of grinders decreases. Grinders are represented by large *P. sachalina* stoneflies. The biomass of scrapers increases twice, and filtering collectors appear, although their proportion is small. The latter group is represented by the caddis fly *A. palpate* and blackflies (Simuliidae). At station 4, the ratio of trophic groups noticeably changes. The proportion of predators decreases, whereas that of scrapers and filtering collectors increases to 30% owing to the caddis fly *N. ussuriensis* (21.5% of the total benthos biomass) and *S. marmorata*, a representative of large filtering collectors that appears at this station and is also dominant by biomass. At the same time, the proportion of collectors continues to decrease. At station 5, the proportion of filter feeders in the biomass increases twice, mainly due to two large caddis fly species *S. marmorata* and *A. palpata.* The proportion of predators and scrapers decreases by half. The biomass of other groups changes insignificantly. At station 6 (the hyporithral zone), the contribution of scraping predators to the total biomass increases to 34.4%, whereas that of active predators and filtering collectors decreases. A similar fact was observed previously in the Bikin River (Kocharina and Tiunova, 1997).



Distribution of trophic groups along the longitudinal profile of the Frolovka River: (*1*) filtering collectors, (*2*) scraping predators, (*3*) scrapers, (*4*) collectors, (*5*) grinders, and (*6*) predators.

Thus, grinders as functional leaders are replaced by other forms in the course of transition from the epirithral to the metarithral zone. Their dominance in the epirithral is explained by rich supply of dead leaves, which are the main food resource for *Gammarus* sp. As this resource decreases in the transitional zone, the biomass of grinders sharply decreases as well. The biomass of predators reaches a peak in the same transitional zone, mainly on account of large larvae of stoneflies; that of filtering collectors and scrapers, in the middle metarithral zone; and that of scraping predators, in the hyporithral zone.

The ratio of trophic groups of invertebrates in the basin of a large river was studied on the model of the Bikin River (Kocharina and Tiunova, 1997; Tiunova, 2004). The Bikin is a right-bank tributary of the Ussuri River (Amur basin) that has retained most its initial characteristics. The Bikin basin is unique in comprising three types of rivers (Table 1): cold-water (Klyuchevaya River and Antonovskii Spring), moderately cold-water (Zeva and Sagdy-Biasy rivers), and moderately warm-water (Bikin).

The group of predators in water courses of the Bikin basin is dominated by representatives of the order Plecoptera, mainly *K. exilis, M. ochracea, Suwallia* sp., and *Arcynopteryx polaris* Klapalek. This group includes also several caddis fly species of the genus *Rhyacophila.* A considerable proportion of predators in the total biomass is observed in the lower reaches of the Zeva and Antonovskii Spring (Table 3). In other rivers, this proportion varies from 4.7% (Bikin) to 13.1% (Klyuchevaya). Scraping predators usually dominate in areas where the proportion of active predators is insignificant: in the Bikin, for example, these groups account for 30.3 and 4.7% of the total benthos biomass, respectively.

Table 4. Distribution of trophic groups of invertebrates in rivers of the southern Far East (July–August)

River*	Predators	Filtering collectors	Collectors	Scrapers	Grinders	Scraping predators	Scraping collectors
Kedrovaya	14/13.5	3/46.7	5/0.2	4/10.3	5/19.9	4/4.7	7/4.6
Frolovka	11/6.1	2/6.8	5/1.9	9/18.5	3/43.9	2/14.4	6/8.4
Zeva	10/8.1	4/57.2	10/6.0	5/10.7	5/13.3	2/0.4	7/4.3
Bikin	10/11.6	2/0.6	7/9.4	3/6.0	6/14.5	3/27.1	6/30.8
Edinka	8/8.0	1/0.4	8/13.3	7/26.3	5/19.1	5/10.5	5/18.3

* Rivers are listed in a south–north direction. Figures above and below the line show the number of species and proportion (%) of the total biomass of amphibiotic insects and gammarids.

The relative biomass of filtering collectors (two species of net-making caddis flies, *S. marmorata* and *A. palpata*, and representatives of the genus *Hydropsyche*) reached the highest value (57.4%) at the upstream station on the Zeva River owing mainly to the presence of *S. marmorata* larvae at the last instar. The results of studies on other rivers of southern Primorye (Levanidova et al., 1989; Kocharina, 1996) show that this species prevails by biomass in the metarithral of mountain and piedmont rivers and may serve as an indicator species of this subzone. At other stations, the larvae of *S. marmorata* either were absent (due to emergence of adults) or their biomass was small (represented by juveniles of a new generation). Hence, their contribution to the total benthos biomass did not exceed 11%, varying from 0.03% in the Sagdy-Biasy to 10.2% in the lower reaches of the Zeva.

The group of collectors in the Bikin and its tributaries consists mainly of mayflies of the families Baetidae, Ameletidae, and Leptophlebiidae; some species of the genera *Ephemerella, Serratella,* and *Torleya* (fam. Ephmerellidae); and the sole representative of caddis flies *Brachycentrus americanus* (Banks). They dominate in the benthos at all stations except for the lower reaches of the Zeva and Bikin (Table 3).

Macrogrinders decomposing whole dead leaves and wood remains are represented by larvae of the stonefly *P. sachalina.* The group of microgrinders transforming coarse organic particles into finer organic detritus are represented by larvae of caddis flies of the genera *Apatania, Dinarthrodes, Ceraclea*, and stoneflies of the genera *Nemoura, Paracapnia*, and *Paraleuctra.* The proportion of this trophic group in the total benthos biomass varies from 8.5% in the Sagdy-Biasy to 37.1% in the lower reaches of the Zeva.

Scrapers in all rivers make a relatively small contribution to the benthos biomass, except for the Sagdy-Biasy where it reached 15.1%. The main representatives of scrapers are the larvae of caddis flies *Anagapetus schmidti* (Levan.), *Agapetus sibiricus* Mart., *A. inaequispinosus* Schmid, *Glossosoma* sp., *Neophylax relictus* (Mart.), and *N. ussuriensis.* Some species combine the functions of scrapers and collectors. Among caddis flies, these are mainly representatives of the family Glossomatidae, but the bulk of such species consists of mayfly larvae. The proportion of scraping collectors in the benthos biomass is high at all stations but reaches a maximum of 50.9% in the Klyuchevaya (Table 3). Many representatives of the family Heptageniidae belong to this functional group.

Trophic groups, the numbers of species in them, and their contributions to the total benthos biomass in different rivers of the southern Far East are shown in Table 4. The number of species of active predators decreases in a south–north direction. In other groups, no regular changes in species diversity can be traced. It should be noted, however, that the proportion of collectors, scrapers, and scraping collectors in the total biomass noticeably increases in the Edinka, the northernmost of the rivers studied.

The Rudnaya River (see Table 1), exposed to the impact of wastewater discharge (Teslenko, 1986; Alimov and Teslenko, 1988), was used to study changes in the trophic structure of invertebrate community. For comparison, two stations were chosen: one beyond the pollution zone and the other downstream of the site of wastewater inflow.

At the clean station, all trophic groups were recorded, with collectors, predators, and scrapers accounting for 90.3% of the total benthos biomass. Among collectors, mayflies (*C. kurentzovi, E. aesculus, Baetis* sp., and chironomids *Pagastia orientalis* (Tschernov) and *Eukiefferiella* sp.) dominated by biomass. The group of predators (12 species) comprised the larvae of large stonefly species (*M. ochracea, Pictatiella asiatica* Zwick et Levan., and *Suwallia* sp.), a caddis fly *Rhyacophila narvae* Navas, and dipteran larvae of the genus *Dicranota.* The group of scrapers (nine species) included six species of caddis fly larvae, primarily *N. ussuriensis* which accounted for up to 20.1% of the benthos biomass. The group of grinders consisted of three stonefly species—*Taenionema japonicum* (Okam.), *Paraleuctra cerci* (Okam,), and *Amphinemura borealis* (Mart.)—and amphipods *Gammarus* sp., with *T. japonicum* (1.4%) and *Gammarus* sp. (1.3%) being dominant. Filtering collectors were represented by blackfly larvae, and their proportion was insignificant. The group of scraping predators comprised only mayfly larvae of the genus *Drunella: D. lepnevae* (Tshern.), *D. cryptomeria, D. aculea*, and *D. triacantha.* The group of collectors-scrapers consisted of only two species: the mayfly *Serratella zapekinae* (Bajk.) and the chironomid *Brillia flavifrons* (Joh.).

In the polluted river segment, only four trophic groups were revealed. Collectors dominated, accounting for 85% of the benthos biomass. The bulk of this trophic groups consisted of mayflies (six species), chironomids (six species), and oligochaetes. Compared to the clean station, the proportion of oligochaetes increased tenfold and reached 23.3% of the benthos biomass. The proportion of chironomid larvae also increased from 16.6% at the clean station to 61.1% at the polluted station. The proportion of mayfly larvae in the biomass decreased from 23.8% to 0.4%.

In the group of scrapers, the stonefly *Amphinemura coreana* Zwick, the mayfly *S. zapekinae*, and dipteran larvae of the genus *Tipula* were noted. The dipteran larvae accounted for up to 99.1% of the biomass of this group and for 10.8% of the total benthos biomass.

The group of predators consisted of two mayfly species, *S. pusilla* and *Diura majuscule* (Klap.); the caddis fly *Rhyacophila retracta*; chironomids *Thienemannimyia* gr. *lentiginosa* and *Psecrocladius* gr. *Dilatatus*; dipterans of the genus *Dicranota*; and representatives of the families Tabanidae and Ceratopogonidae. In the group of predators, dipterans of the genus *Dicranota* prevailed (56.7%) in the polluted area, whereas the larvae of stoneflies *P. asiatica* (32.9%) and *M. ochracea* (26.8%) were dominant in the clean area. Scraping collectors were the smallest group in the lower segment of the Rudnaya (two species and 0.2% of the benthos biomass), and their contribution to the total biomass in the upstream segment was only slightly greater (0.4%).

CONCLUSIONS

Methodologically, this study is based on the concept that rivers of different types are characterized by a certain trophic structure of their communities that changes depending on the river zone, season, and latitude. The results of comparative analysis show that the trophic structure of the invertebrate community in the metarithral of small rivers is characterized by dominance (with respect to biomass) of filtering collectors in rivers of the moderately cold-water type, of collectors and scrapers in rivers of the cold-water type, and of scraping predators and scraping collectors in rivers of the moderately warm-water type. Strickler and Lohman (2002) also noted some relevant differences in the ratio of trophic groups of invertebrates in the Columbia River basin.

Active predators, scraping predators, and scrapers manifest seasonal changes in their relative biomass. During the open-water season, their proportion in the community may change by a factor of 16–55, with the ratio of leading trophic groups remaining the same throughout the season.

Trends resulting from functional substitutions along the longitudinal profile of the river are related to its zones and subzones. In particular, the change of the functional leader in the Frolovka occurs when the epirithral passes into the metarithral.

Although seasonal fluctuations are an important parameter of the trophic structure of a water course, differences in the community structure along its longitudinal axis are more contrasting. Similar results were previously obtained for the rivers of Oregon (Hawkins and Sedell, 1981).

The parameters of the trophic structure of communities are useful for assessing the degree of ecological disturbances in rivers exposed to anthropogenic impact. In the Rudnaya River, for example, the number of trophic groups has decreased upon such exposure, and the remaining groups manifest noticeable changes in the qualitative composition and quantitative ratios of their members.

Unfortunately, neither a more or less mathematically strict definition of “the ecological state of a water body” nor a general set of control parameters for identifying this state has been proposed to date (Shitikov et al., 2003). Therefore, the above data on the ratios of trophic groups in the undisturbed ecosystem of a certain river type provide the basic factual material necessary for hydrobiological monitoring of the Far Eastern rivers.

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