

# THE LONGITUDINAL DISTRIBUTION OF TRICHOPTERA IN A SALMON RIVER OF SOUTH PRIMORYE

T.S. VSHIVKOVA

## SUMMARY

The longitudinal distribution of Trichoptera in Upper Komarovka River (south-western Sikhote-Alin) is investigated. 16 families, 37 genera and 65 species are recorded. Limnephilidae is dominant (17 spp.) followed by Rhyacophilidae (10 spp.) and Glossosomatidae (10 spp.). Crenal, rhithral and epi-, meta-, hyporhithral could be distinguished with hierarchical classification. Trophic structure of the invertebrate communities is investigated. Role of Trichoptera in trophic structure of river communities is examined.

## INTRODUCTION

The longitudinal distribution of biota in waters of various types and latitudes was reviewed by Botosaneanu (1979). There are two basic concepts in the character of the longitudinal distribution of organisms and communities: the theory of river zonation by Illies and Botosaneanu (1963) and the river continuum concept (Vannote *et al.* 1980). These two alternative concepts are representative of the discreteness and continuation of biota. Studies of the longitudinal distribution of biota of Far East rivers were started comparatively recently (Vshivkova 1987, 1988; Levanidova *et al.* 1988). This paper deals with the Trichoptera distribution in the small salmon river Komarovka, on the south-west slopes of the Sikhote-Alin.

## STUDY AREA AND SAMPLING METHODS

The Komarovka River rises on the south slopes of Przhhevskiy ridge and flows into Razdolnaya River about 94 km from its mouth near the city of Ussuriisk. The length of the river is 67 km, a square of drainage system is 1490 km<sup>2</sup>, source situated at an altitude of 360 m, average slope 5.8%. The upper part of the basin is situated in a zone of foothills (250–400 m) and the lower one on the undulating Razdolnaya plain. I have examined a section of the river, 36 km long, beginning from its source. Physiographically the river is rhithral the upper 25 km and below it a river of the plain. The upper 18 km is within the limits of the V.L. Komarov Ussuri Reserve. All river sites are situated in a zone of high water quality.

Samples of benthos were taken at 13 sites (Fig. 1). The quantitative samples were taken only on riffles by a sampler with a frame square covering 1200 cm<sup>2</sup> (Levanidov 1976). The qualitative samples were taken from riffles and pools, imagines from littoral plants were caught by net and light trap. The sampling period lasted from March 1983 to April 1984. Abiotic parameters were measured at every sampling sites (Table 1). Identification of imagines and larvae was made by the author. Allocation of species to functional feeding groups was determined according to the tables by Merritt and Cummins (1984) and from intestine dissections.

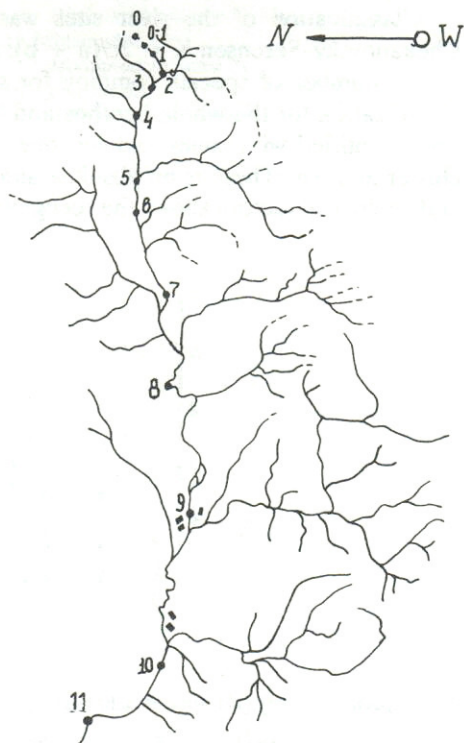


Fig. 1. Location of the sampling sites of River Komarovka.

Table 1. Abiotic characteristics of Komarovka River sampling sites.

Sites	Distance from source (km)	Gradient (‰)	Width (m)	Mean depth (cm)	Maximum depth (cm)	Current rate (m/s)	Mean summer water discharge (m <sup>3</sup> /s)	Maximum of water temperature (°C)	pH
0	0	-	0.15	1-1.5	2	very sluggish	0.00001	7	6.4
0-1	0.02	40				dry channel		9	6.5
1	0.5	35	0.5-1.5	10	10	0.2-0.3	0.0009	12	6.61
2	1	20	0.5-2	15	15	0.2-0.3	0.0065	14	6.81
3	2	10	4-4.5	15	24	0.3-1	0.13	16	6.81
4	3.5	12	3-4	15	25	0.5-1.2	0.3	16.5	6.91
5	6.5	6	6-8	20	50	0.5-1.2	0.4	17.5	7.01
6	8	4	7-9	10	52	0.4-1	0.32	18	7.01
7	11	10	7-10	17	55	0.5-1	0.9	20	7.11
8	16	7	7-9	20	60	0.5-1	1.2	21	7.11
9	23.5	3	20-25	30	100	0.5-1	2.2	24	7.11
10	31.5	3	25	30	100	0.5-1	2.2	24	7.11
11	36	1	25	60	100	0.2-0.3	2.4	24.5	7.11

## RESULTS AND DISCUSSION

The Trichoptera fauna of Komarovka River basin comprises 64 species from 37 genera and 16 families (Table 2). The greatest number of species belong to the families Limnephilidae, 17, Rhyacophilidae, 10, and Glossosomatidae, 10. Seven families are represented by a single species and the other six by no more than 4 or 5 species. The smallest number of species was recorded from the highest site, 1 km from the source. From here the number of species increases gradually and attains a maximum at site 7, then decreases again. The highest values of indices of species diversity (H) and species richness (D) calculated according to data for total zoobenthos are observed at sites 7 and 8 (Fig. 2). These represent an area of the river before passing to the plain where the mixing of faunas of rhithral and potamal is observed and the ecoton effect shows.

Classification of the river sites was made on similarity of species composition: the coefficient by Chekanovsky-Serensen  $K = 2c/(a + b)$ , a - number of species in sample A; b - number of species in sample B; c - number of species common for samples A and B) was used as a ratio of resemblance. Results of classification for the whole benthos and for Trichoptera are given on dendrograms (Fig. 3). Four groups of sites identified with zones and subzones of classification by Illies and Botosaneanu can be discerned using cluster analysis. There is no absolute similarity among dendrograms but comparison of the results obtained and ecological factors allows the recognition of the following sections.

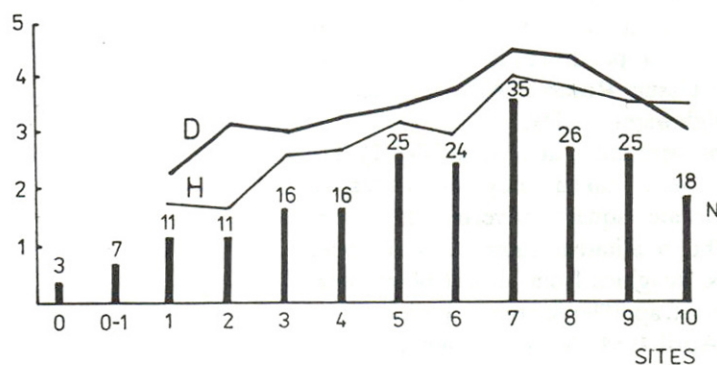


Fig. 2. Species diversity (H), species richness (D) of River Komarovka macrozoobenthos; number of Trichoptera species (N).

$$H = - \sum \left( \frac{n_i}{N} \right) \log \left( \frac{n_i}{N} \right); \quad D = \frac{S-1}{\log N}$$

Table 2. List of Trichoptera from Komarovka River Basin.

1. Psychomyiidae  
*Psychomyia flavida* Hag.  
*Psychomyia forcipata* Mart.  
*Psychomyia uncatissima* Bots.  
*Lype diversa* Banks  
*Paduniella uralensis* Mart.
2. Polycentropodidae  
*Neureclipsis bimaculata* L.  
*Plectrocnemia kusnezovi* Mart.
3. Arctopsychidae  
*Arctopsyche palpata* Mart.
4. Hydropsychidae  
*Hydropsyche nevae* Kol.  
*Hydropsyche orientalis* Mart.  
*Cheumatopsyche* sp.  
 ● *Macrostemum radiatum* McL.
5. Stenopsychidae  
*Stenopsyche marmorata* Nav.
6. Hydrobiosidae  
*Apsilochorema sutshanum* Mart.
7. Rhyacophilidae  
*Rhyacophila coreana* Tsuda  
*Rhyacophila depressa* Mart.  
*Rhyacophila egjirica* Schmid  
*Rhyacophila impar* Mart.  
*Rhyacophila lata* Mart.  
*Rhyacophila lenae* Mart.  
*Rhyacophila lepnevae* Levan.  
*Rhyacophila narvae* Nav.  
*Rhyacophila retracta* Mart.  
*Rhyacophila* sp.
8. Glossosomatidae  
*Glossosoma (Synafophora) altaicum* Mart.  
*Glossosoma (Synafophora) angaricum* Levan.  
*Glossosoma (Synafophora) intermedium* Klap.  
*Glossosoma (Synafophora) nylanderii* McL.  
*Glossosoma (Synafophora) ussuricum* Mart.  
*Glossosoma (Anagapetus) schmidi* Levan.  
*Agapetus inaequispinosus* Schmid  
*Agapetus jakutorum* Mart.  
*Electragapetus praeterius* Mart.
9. Hydroptilidae  
*Stactobia* sp.
10. Phryganeidae  
*Semblis atrata* Gmel.  
*Semblis phalaenoides* L.  
 ● *Oligotricha lapponica* Hag.  
 ● *Hagenella clathrata* Kol.
11. Limnephilidae  
*Imania* sp.  
*Dicosmoecus* sp.  
*Ecclisomyia kamtschatica* Mart.  
*Apatania complexa* Mart.  
*Apatania zonella* Zett.  
*Neophylax ussuriensis* Mart.  
*Pseudostenophylax adlimitans* Mart.  
*Pseudostenophylax amurensis* McL.  
 ● *Nemotaulius mutatus* McL.  
 ● *Asynarchus amurensis* Ulmer  
 ● *Limnephilus quadratus* Mart.  
 ● *Limnephilus sericeus* Say  
*Hydatophylax grammicus* McL.  
*Hydatophylax magnus* Mart.  
*Hydatophylax nigrovittatus* McL.  
*Hydatophylax variabilis* Mart.  
*Brachypsyche rara* Mart.
12. Brachycentridae  
*Micrasema primoricum* Bots.
13. Goeridae  
*Goera japonica* Banks  
*Goera parvula* Mart.  
*Goera tungusensis* Mart.
14. Lepidostomatidae  
*Goerodes sinuatus* Mart.  
*Dinarthodes elongatus* Mart.  
*Dinarthodes kurenzovi* Mart.
15. Molannidae  
*Molannodes tinctus* Zett.
16. Leptoceridae  
*Athripsodes gr. excisus*

● were collected only by light-traps

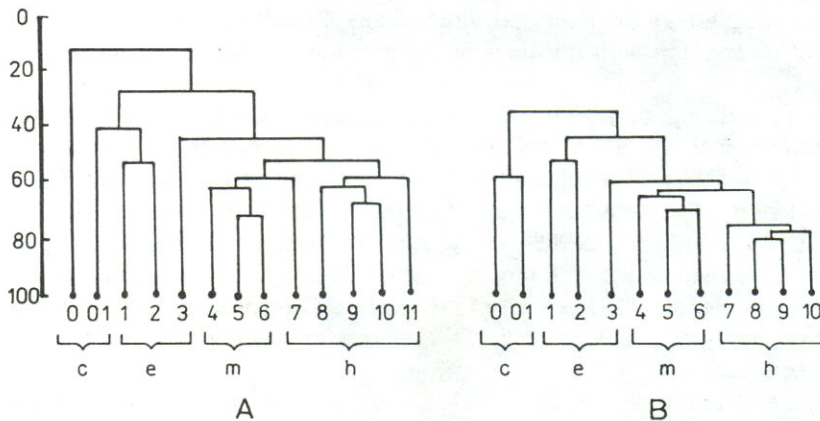


Fig. 3. Dendrograms of species composition similarity (A - for total macrozoobenthos, B - for Trichoptera: c - crenal, e - epihithral, m - metarhithral, h - hyporhithral).



Fig. 4. Site 0.

**Crenal** (sites 0 and "0-1"; Fig. 4) is the zone of the river source. The water discharge is less than  $0.00001 \text{ m}^3/\text{s}$ , the summer temperature does not exceed  $7^\circ\text{C}$ . Caddis flies are represented by typical crenobionts and cold-loving stenothermic species: *Imania* sp., *Pseudostenophylax adlimitans*, *Pseudostenophylax amurensis*, *Brachypsyche rara*, *Apatania zonella*, *Apatania complexa*, *Goerodes sinuatus*. Shredders and scrapers dominate here according to the character of feeding. Caddis flies are represented exclusively by the families Limnephilidae and Lepidostomatidae. Density of the former is 90–100% of the total density of Trichoptera. At the site "0-1", a dry river bed with a chain of small puddles, great numbers of *Pseudostenophylax* sp. larvae of diverse age with openings of the cases closed are found under a layer of dry ground throughout summer.

**Epirhithral** (sites 1–2; Fig. 5,6). Flow discharge is  $0.0008\text{--}0.006 \text{ m}^3/\text{s}$ , width of the river channel 0.5–1.5 m and maximum water temperature  $14^\circ\text{C}$ . In addition to the stenobiontic species there are species which are characterized by greater ecological plasticity and are found in metarhithral: *Synafophora angaricum*, *Electragapetus praeteritus*, *Anagapetus schmidi*, *Neophylax ussuriensis*, *Dinarthodes elongatus*. Biomass of scrapers is highest in epirhithral (82–90% of the total biomass of Trichoptera). Species of the families Limnephilidae and Lepidostomatidae are most numerous. Density of both families amounted to 82–98% of the total density of Trichoptera. Caddis flies of the families Glossosomatidae and Rhyacophilidae are not numerous. The community at site 3 which is close in species composition and trophic structure may be referred to a zone of epirhithral (Fig.7).

**Metarhithral** (sites 4–6; Fig. 8). The flow discharge is  $0.3\text{--}1.5 \text{ m}^3/\text{s}$ , width of the river channel 3–9 m, and maximum temperature  $17\text{--}18^\circ\text{C}$ . The number of rheophil eurybiontic species and net-spinning Trichoptera increases in the community. The scrapers form a considerable part of the trophic structure (20–56% of total biomass of Trichoptera) but filterers are also essential (33–73%). The main mass of net-spinning caddis flies

Fig. 5. Site 1.



Fig. 6. Site 2.



Fig. 7. Site 3.

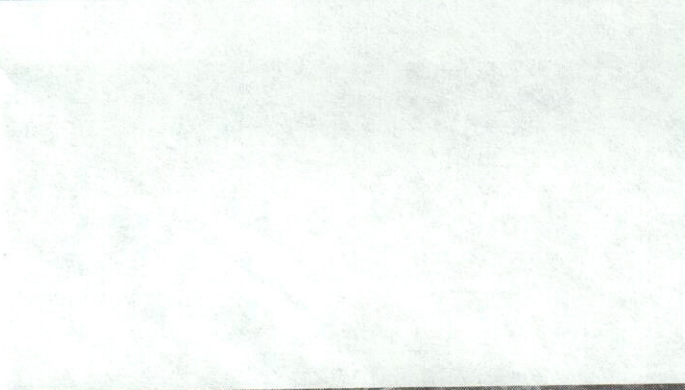


Fig. 8. Site 6.

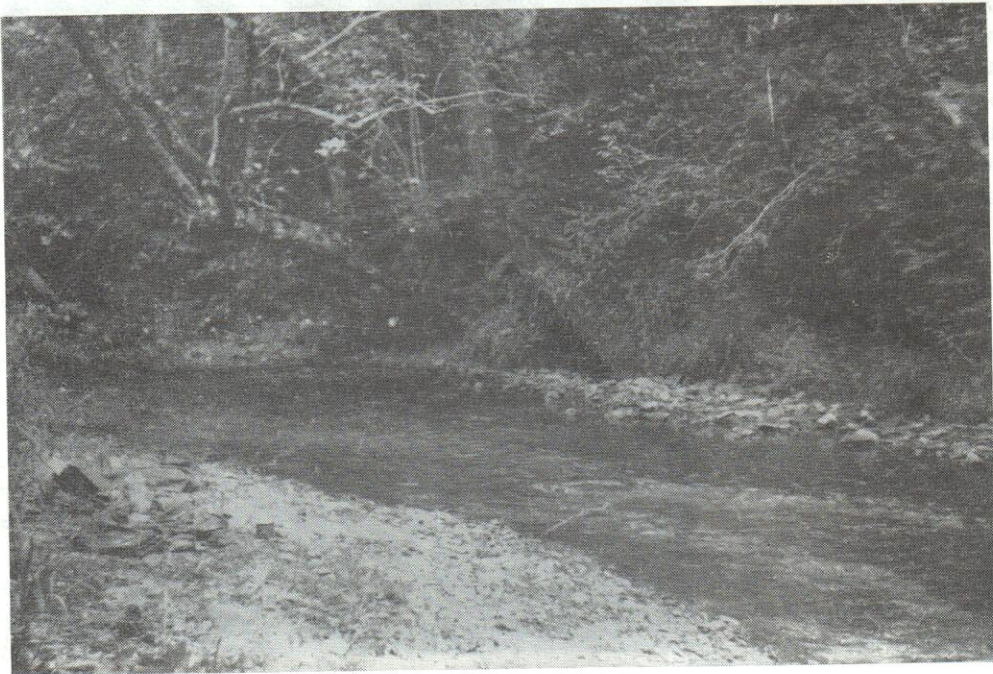


Fig. 9. Site 7.

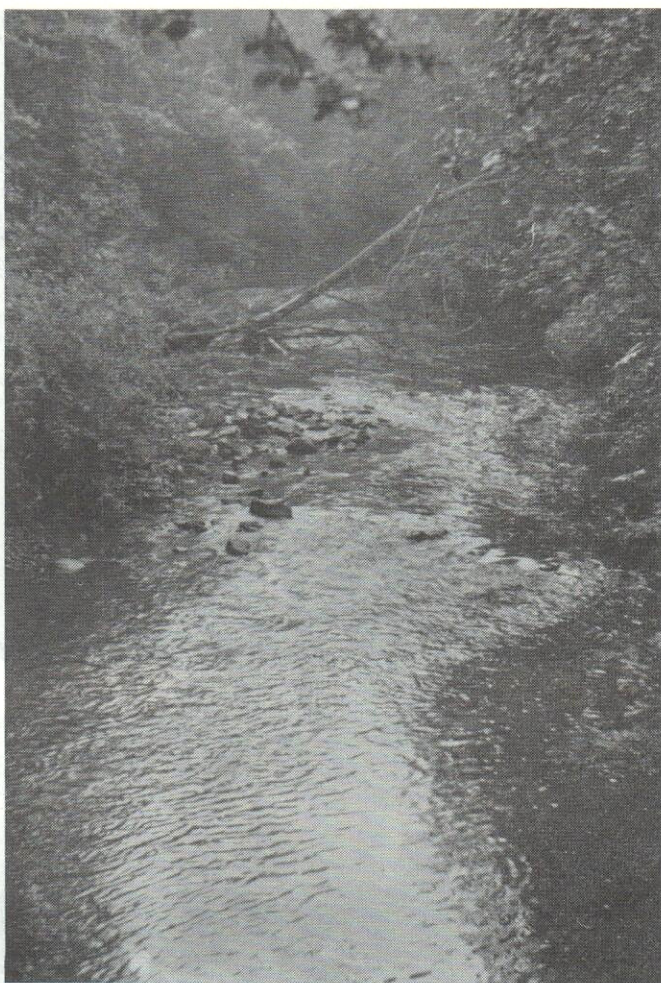


Fig. 10. Site 8.



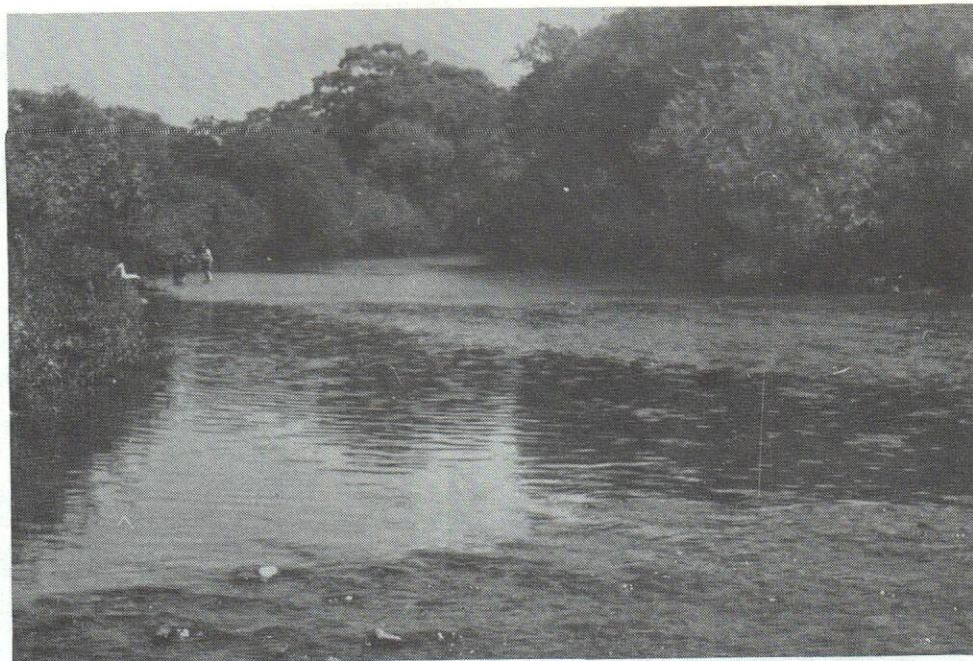


Fig. 11. Site 10.



Fig. 12. Site 11.

is represented by *Arctopsyche* and *Hydropsyche* spp. building large-mesh nets. The community at site 6 breaks the tendency of gradual increase of filterers and decrease of scrapers below the stream. This is accounted for by the character of substrate at this site which consists of small pebbles and gravel with large pebbles and boulders practically absent. A substrate of small size is convenient for small glossosomatid larvae of Agapetinae scraping off the algae encrustation but it is not suitable for net-spinners, which need larger and more stable substrate. Limnephilidae and Lepidostomatidae are hardly found in metarhithral (single specimens of *Dinarthrodes elongatus* and the large *Hydatophylax* may be found only on pools). On the contrary, species of the family Glossosomatidae are numerous and amount to 65–90% of the total Trichoptera.

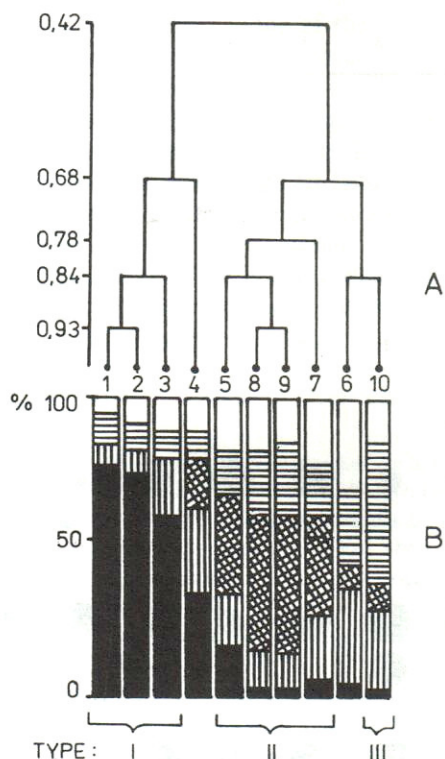


Fig. 13. Trophic structure of macrozoobenthos communities of Komarovka River (A - dendrogram of trophic structure - similarity of macrozoobenthos communities; B - quantitative ratio of functional feeding groups of macrozoobenthos).

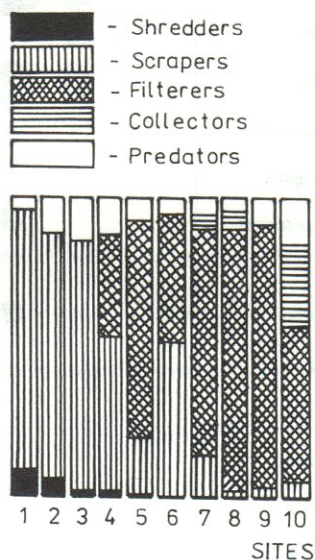


Fig. 14. Quantitative ratio of functional feeding groups of Trichoptera along Komarovka River.

**Hyporhithral** (sites 7–10; Fig. 9–11). The flow discharge amounts to  $2.5 \text{ m}^3/\text{s}$ , width of the river channel 15–20 m and water temperature up to  $20\text{--}24^\circ\text{C}$ . The eurybiontic rheophilus and thermophilic part of the fauna is the main core of the community. Filterers (77–89% of the total biomass of Trichoptera) dominate in the trophic structure, whereas collectors (25%) are increasingly essential at site 10. Caddis flies of hyporhithral are represented by 9 families; Psychomyiidae and Hydropterygidae dominate in density. Among Hydropterygidae one can observe prevalence of the genus *Cheumatopsyche* building the smallest-mesh nets and consuming finely dispersed organic material.

No Trichoptera larvae were found at site 11 (Fig. 12).

Based on the distribution of Trichoptera along the longitudinal profile of the Komarovka River the following four groups were classified:

I. Species limited to crenal and upper epirhithral:

a) crenobionts - *Imania* sp., *Pseudostenophylax adlimitans*, *Pseudostenophylax amurensis*, *Brachypsyche rara*, *Goerodes sinuatus*;

b) cold-loving rheophilic species - *Apatania zonella*, *Apatania complexa*, *Dicosmoecus* sp., *Micrasema primoricum*, *Electragapetus praeteritus*, *Ecclisomyia kamtschatica*.

II. Species of metarhithral: *Neophylax ussuriensis*, *Arctopsyche palpata*, *Synafophora intermedium*.

III. Species of the lower metarhithral and hyporhithral: *Cheumatopsyche* sp., *Athripsodes gr. excisus*, *Synafophora ussuriicum*, *Synafophora altaicum*, *Paduniella uralensis*, *Stactobia* sp.

IV. Species widespread over rhithral: *Anagapetus schmidi*, *Apsilochorema sutshanum*.

The quantitative data permit a more distinct indication of the ecological preferences of the species (Table 3).

Table 3. Longitudinal distribution of Trichoptera in Komarovka River.

Species	Sampling sites											
	0	"0-1"	1	2	3	4	5	6	7	8	9	10
<i>Imania</i> sp.	●	●										
<i>Pseudostenophylax</i> spp.	●	●										
<i>Apatania</i> spp.		●	●									
<i>Brachypsyche rara</i>		●										
<i>Goerodes sinuatus</i>		●	●									
<i>Synafophora angaricum</i>			+	+	+	+	+					
<i>Dinarthroides elongatus</i>												
<i>Electragapetus praeteritus</i>			●	●	●							
<i>Goera</i> spp.				●	●	●	●	●	●	●	●	●
<i>Dicosmoecus</i> sp.			●									
<i>Rhyacophila lepnevae</i>				●								
<i>Anagapetus schmidi</i>				●	●	●	●	●	●	●	●	●
<i>Neophylax ussuriensis</i>				●	●	●						
<i>Micrasema primoricum</i>				●								●
<i>Arctopsyche palpata</i>				●	●	●	●	●	●			
<i>Hydropsyche</i> spp.				●	●	●	●	●	●	●	●	●
<i>Synafophora intermedium</i>						+	+	+				
<i>Apsilochorema sutshanum</i>				●	●	●	●	●	●	●	●	●
<i>Agapetus</i> spp.					●	●	●	●	●	●	●	●
<i>Psychomyia</i> spp.								●	●	●	●	●
<i>Lype diversa</i>							●		●			
<i>Stenopsyche marmorata</i>							●	●	●	●	●	●
<i>Rhyacophila lata</i>							●	●	●	●	●	●
<i>Synafophora ussuricum</i>							+	+	+	+	+	
<i>Neureclipsis bimaculata</i>								●	●	●	●	●
<i>Cheumatopsyche</i> spp.								●	●	●	●	●
<i>Athripsodes gr. excisus</i>								●	●	●	●	●
<i>Rhyacophila impar</i>									●	●	●	
<i>Rhyacophila narvae</i>									●	●	●	
<i>Rhyacophila retracta</i>									●			
<i>Paduniella uralensis</i>									●			●
<i>Stactobia</i> sp.									●			●
<i>Rhyacophila coreana</i>										●	●	
<i>Synafophora altaicum</i>												+

● - > 1000 number of larvae/m<sup>2</sup>; ● - 100-1000; ● - 10-100; ● - 10; ● - very seldom; +- identified pupae only

### Classification of river sites on the basis of trophic structure of benthic communities

Data on the whole zoobenthos of the River Komarovka sites were analysed for classification. When classifying communities on the resemblance of trophic structure the quantitative ratios (biomass) of the following functional-feeding groupings were used as characters: filterers, scrapers, shredders, collectors and predators. Results of classification are given on the dendrogram (Fig. 13). Three groups of communities are established: Type I (communities of sites 1–3) the communities of shredders; Type II (communities of sites 5, 7–9) communities of filterers; Type III (site 10) community of collectors. Communities of sites 4 and 6 were not included, because they are communities of mixed type without domination by any one functional feeding group. Shredders and scrapers dominate equally at site 4, scrapers and collectors at site 6. These types of communities (shredders, filterers and collectors) are representative of relative abundance of food resources in the given parts of river and outline the limits of trophic zones. Quantitative ratios of functional feeding groups of Trichoptera are shown in Fig. 14.

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