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PARASITES OF LENOK, *BRACHYMYSTAX LENOK* (SALMONIDAE), AND THEIR COMMUNITIES

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Data on parasite fauna of lenok, structure and diversity of parasite communities are given including data available in the literature and original data obtained as a result of a complete parasitological study of fishes.

Lenok inhabits all rivers of Northern Asia from the Ob River up to the Kolyma River. In the south, it is common in Lakes Baikal and Khubsugul and in the Selenga River. It is absent in Chukotski Peninsula and Kamchatka Peninsula and in the majority of rivers the Sea of Okhotsk coast; inhabits the Amur River and is common in rivers of Primorsky Territory (Berg, 1948; Chereshnev, 1996). This is a typical inhabitant of mountain and piedmont rivers and lakes. It attains maturity at the age of 5-6 years. Spawning occurs from the middle of May till the end of June at water temperature 5-7°C in the areas with fast current and clean water at depths of 0.5-1.5 m and at bars. Diet range is very wide. Larvae and fingerlings in the first months of life feed on zooplankton, larvae of chironomids and small May flies. Up to two year age benthic invertebrates play the major role in lenok diet. The portion of fish in the diet of lenok increases and by the age of 8-9 years comprises 60-80% of its ration. In winter time lenok inhabits the major rivers and their large tributaries of the first order (Kirillov, 1972; Karasev, 1987). In early May 1988 in the upper Selenga River (Tola River and its tributaries) lenok did not occur at water temperature of 4-6°C as other fishes, such as grayling, river minnow and loach. Fish was successfully caught by electrofishing in large amounts down stream at water temperature above 7-8°C. Apparently in Selenga lenok spawns somewhat earlier than in water bodies situated further north. On the whole this is one of the most stenobiont species

among salmons. Some researchers believe that the stout-snouted form is a separate species - *B. savinovi*. In water bodies of Northern Asia a typical form of lenok commonly inhabits, whereas its stout-snouted form occurs in the basin of the Amur River and in rivers of the Primorsky Territory.

Material and Method

We have at our disposal primary data on results of a complete parasitological dissection of 24 specimens of lenok from Rivers Kolyma, Lena and Selenga. Data available in the literature being incomplete, only data of Pronin (1966, 1976) on lakes Leprindokan and Khubsugul and Ermolenko (1992) on the north-eastern Primorsky Territory were used for analysis of component communities of parasites of lenok. Choice of data available in the literature was determined primarily by the methods of selection of material (a complete parasitological dissection after Dogiel) and comparable qualification of researchers, which is particularly important when taxonomic groups of parasites difficult for discovery and identification are involved. At present there is every reason to believe that Salmonchus is a valid genus within monogeneans of the family Tetraonchidae.

In accordance with the existing approaches to the description of parasitic communities (Bush, Holmes, 1986; Holmes, Price, 1986; and others) the following notions are used in this work: infracommunity - all parasites of a separate individual of host; component community - sum of infracommunities in the given host population; compound community - all parasitic communities in the ecosystem. All species of parasites are subdivided into two groups (Lincoln, et al., 1982): allogenic - using fishes as intermediate hosts and reaching maturity in other vertebrates (normally in birds or mammals) and autogenic - reaching maturity in fishes. Statistical methods of processing and analysis of material were described in detail before (Pugachev, 2000)

Results and Discussion

A total of seventy one species of parasites including different stages of life cycle were recorded in lenok in waters of Northern Asia (Tabl. 1). Nematodes and monogeneans and also cestodes and protozoans are represented in the fauna in nearly equal proportions (Fig. 1). Presence of specific species is typical. These constitute 24% of the total number of species and are represented mostly by monogeneans. The degree of

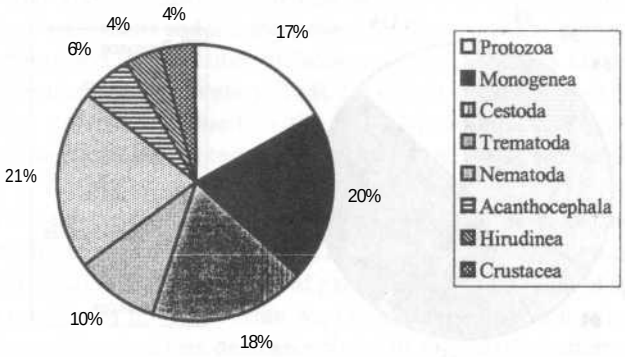

Fig. 1. Structure of *B. lenok* parasite fauna in the North Asia

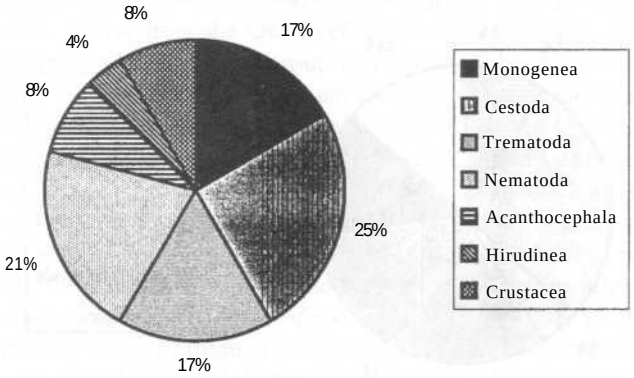

Fig. 2. Structure of *B. lenok* parasite fauna in the Yenisey river

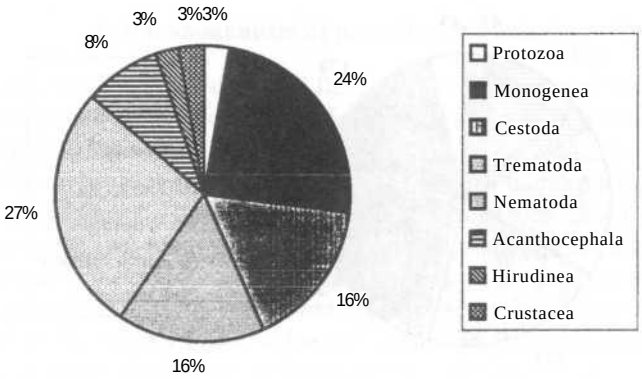

Fig. 3. Structure of *B. lenok* parasite fauna in the Lena river

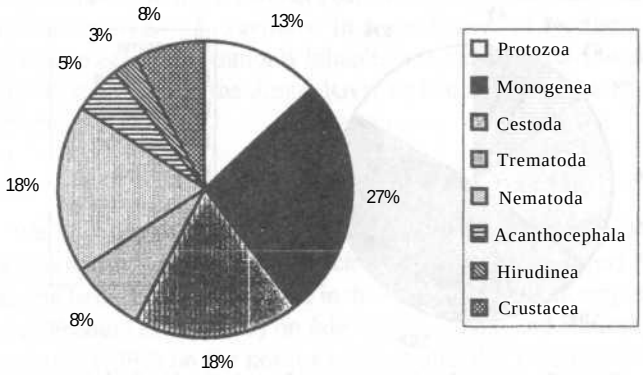

Fig. 4. Structure of B. *lenok* parasite fauna in the Selenga river

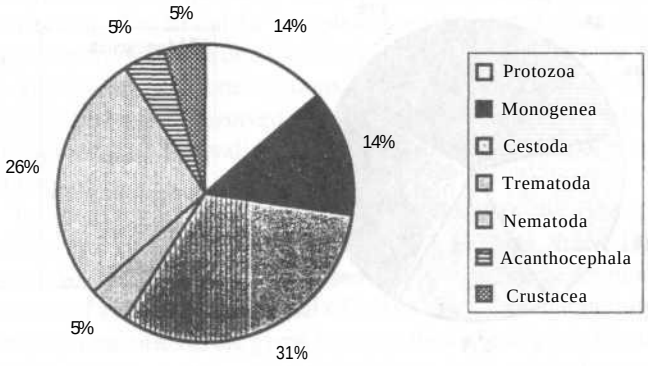

Fig. 5. Structure of *B. lenoκ* parasite fauna in the Baikal lake

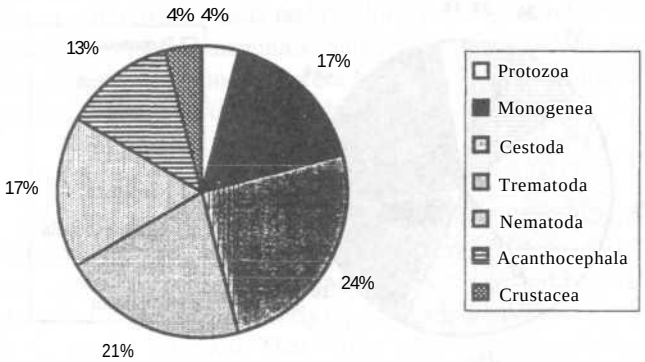

Fig. 6. Structure of *B. lenok* parasite fauna in the Kolyma river

knowledge about parasites in different basins varies considerably. In the Ob River protozoans and monogeneans have been insufficiently studied and information on parasites of lenok in basins of rivers Olenek and Indigirka are quite fragmentary (Tabl. 1). In the majority of water bodies cestodes are predominant in the parasite fauna, which reflects ichthyophagy of lenok. Predominant in the Lena River are nematodes, which in the majority of other water bodies form a large portion of parasitic fauna, which confirms feeding of lenok on both benthos and fish. Predominance of monogeneans in the Selenga River is typical (Fig. 1-6). The total number of species of parasites and the number of specific species increases gradually from west to east reaching its maximum in the Selenga River and then decreases gradually towards the eastern margin of the distribution range (Fig. 7). Similarity of lenok parasitic fauna by the Jaccard index reflects primarily similarity of its environmental conditions. Lenok from the Ob River differs fundamentally, whereas Selenga and Baikal form one group along with Kolyma, Yenisei and Lena (Fig. 8). Analysis of dendrogram of similarity by specific species of parasites also shows a specific position of lenok from the Ob River (Fig. 9). Similarity of lenok from the Kolyma River and Lake Baikal is ascribed first of all to impoverishment of specific parasite fauna in the Kolyma River on the margin of the distribution range. In Lake Baikal the same is apparently brought about by weak ability of specific parasites, primarily of monogeneans of the family Tetraonchidae, to infect host under conditions of plain areas of rivers and in lakes (Fig. 9). This is confirmed by data of Pronin (1966). Lenok in Lakes Leprindokan and Bolshoye Leprindo was not infected by tetraonchids, whereas these worms were discovered in the Chara River.

Infracommunities of parasites of lenok

The small number of dissected fish in the Rivers Lena and Selenga does not permit to carry out a significant comparison of structure and diversity of infracommunities, but permits to note some tendencies. All the infracommunities studied are similar in the small number allogenic species and generalists and their portion in the abundance. Lenok from the Upper Selenga River differs by the number of species of parasites and their abundance. Indexes of similarity between infracommunities of lenok in Kolyma are somewhat lower than those from two other rivers, as well as Brillouin's index, values of indices of predominance and evenness being similar. All infracommunities are similar in general

Distribution of parasites of *Brachymystax lenok*

Basins	Ob River	Yenisey river	Lena river	Selenga river	Baikal lake	Kolyma river	Olenek river	Indigirka river
	I	II	III	IV	V	VI	VII	VIII
Myxidium truttae	+							
Sphaerospora rota					+			
Myxobolus ellipsoides	+							
Myxobolus sp.			+					
Henneguya zschokkei	+							
Tetrahymena pyrifomis						+		
Trichodina californica				+				
Trichodina domerguei s.l.					+			
Trichodina sp.				+	+			
Tripartiella sp.				+				
Dermocystidium lenoki				+				
Dermocystidium sp.				+				
Salmonchus ergensi			+	+		+		
Salmonchus gvosdevi		+	+					
Salmonchus lenoki		+	+	+	+	+		
Salmonchus pseudolenoki			+					
Salmonchus pseudoroytmani			+	+				
Salmonchus rogersi			+	+	+			
Salmonchus roytmani		+	+	+	+	+		
Salmonchus skrjabini			+					
Salmonchus spasskyi		+	+	+				
Tetraonchus sp.	+					+		
Gyrodactylus asiaticus				+				
Gyrodactylus brachymystacis				+				
Gyrodactylus lenoki				+				
Gyrodactylus taimeni				+				
Cyathocephalus truncatus				+	+	+		
Triaenophorus crassus (pl)			+			+	+	
Triaenophorus nodulosus	+	+	+	+		+	+	
Eubothrium crassum	+	+	+	+	+			
Euhothrium s alvelini				+				
Ligula intestinalis	+							
Schistocephalus solidus					+			
Diphyllobothrium dendriticum (pl)		+		+	+			
Diphyllobothrium spp. (pl)		+	+		+			
Proteocephalus exiguus	+	+	+	+	+	+		

Table 1

in North Asia waterbodies

	I	II	III	IV	V	VI	VII	VIII
Proteocephalus sp.	+	+	+		+	+		
Diplostomum spp. (mc)		+				+		
Tylodelphys clavaia (mc)			+					
Ichthyocotylurus erraticus (mc)	+		+	+				
Azygia lucii		+	+			+		
Azygia robusta		+	+			+	+	
Crepidostomum farionis	+	+	+	+	+	+		
Crepidostomum metoecus			+	+		+		
Pseudocapillaria salvelini			+	+	+	+		
Pseudocapillaria tomentosa			+	+				
Pseudocapillaria sp.			+					
Eustrongylides sp.. (l)	+							
Raphidascaris acus	+	+	+	+		+		+
Contracaecum osculatum (l)					+			
Contracaecum sp. (l)		+						
Ichthyobronema hamulatum			+	+				
Ichthyobronema orthocephalum			+					
Cucullanus truttae			+			+		
Philonema sibirica					+			
Cystidicoloides ephemeridarum	+	+	+	+				
Ascarophis skrjabini		+	+	+	+			
Comephoronema werestschagini					+			
Cystidicola farionis		+	+	+	+	+	+	
Echinorhynchus borealis			+	+	+			
Echinorhynchuis salmonis		+		+		+		
Neoechinorhynchus crassus			+			+	+	
Neoechinorhynchus rutili	+	+	+			+		+
Acanthobdella peledina			+					
Piscicola geometra				+				
Piscicola respirans		+						
Ergasilus briani				+				
Basanistes briani		+	+	+	+	+	+	
Basanistes woskoboinikovi		+		+				

predominance of autogenic specialists: monogeneans, are parasites with direct life cycle, which are specific of lenok. Predominance of monogeneans and in particular of *Gyrodactylus taimeni* in the Selenga River may be related to an increase of infection by these specific parasites after spawning (Tabl. 2,3). In the Kolyma River *Salmonchus lenoki* was predominant in 40% of infracommunities and *Proteocephalus exiguus* was predominant in total abundance. In the Selenga River *Salmonchus pseudoroytmani, S. rogersi* and *Gyrodactylus taimeni* were predominant equally frequently, and *G. taimeni* was predominant in abundance. Along with the considerable variation of the major characteristics of infracommunities such **unsTabl.** character of predominance in lenok, which to a lesser extent may be referred to eurybiont species, indicates low predictability of the composition of infracommunities even in such hosts.

Component communities of parasites of lenok

Component communities of parasites of lenok differ insignificantly in the total number of species, in the number of allogenic species and their portion in the abundance and in the portion of generalized species in the abundance except lenok from Lake Leprindokan (Tabl. 4). Autogenic specialists being predominant in all water bodies, there is a predominant species in each component community. Predominant among the dominants are monogeneans and only in the Kolyma River; in Lakes Leprindokan and Khubsugul species with a complicated life cycle are predominant. In Lake Leprindokan two ecological forms of lenok are

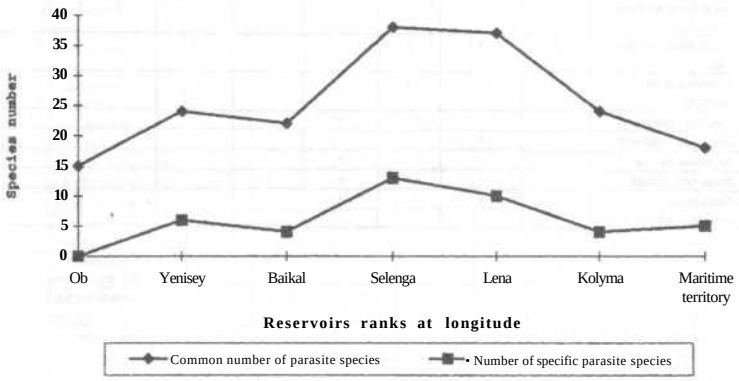

Fig. 7.

predominant in summer: a river form and a lake form (Karasev, 1987). In the Kolyma River lenok was studied mostly in the river bed in September, after it had already migrated from shallower tributaries. Probably in lakes and in the main river beds lenok feeds more on fish and infection by specific monogeneans declines abruptly. The low value of the Shannon index, the high value of predominance index in Lake Leprindokan, was apparently the result of heterogeneity of the sample. A very specific pattern is typical of component community of parasites of lenok from Lake Khubsugul. Here research was conducted in July through August after downstream migration of lenok from rivers falling into the lake. The majority of fishes prefer to concentrate in estuaries of rivers, whereas in the zone of open littoral their numbers are low. Lenok does not have long migrations feeding mostly on benthos (Baasanzhav

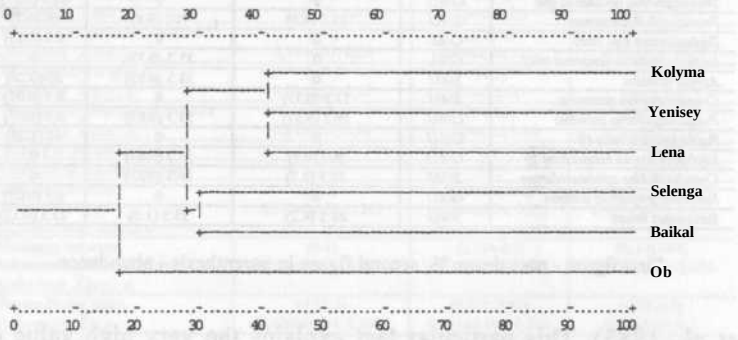

Fig. 8. Similarity (Jaccard index) of *B. lenok* parasite fauna (centroid linkage).

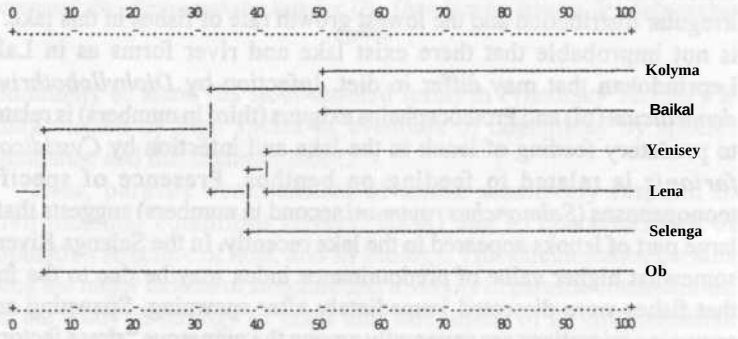

Fig. 9. Similarity (Jaccard index) of *B. lenok* specific parasite fauna (centroid linkage).

Table 2

Parasite fauna of *Brachymystax lenok* (original data)

Parasites	Character ofspecies	Selenga river basin (Tola river, Mongolia) 6 spec.	Lena river basin (Ljampushka river) 3 spec.	Kolyma river 15 spec.
Tetrahymena pyriformis	*G*	0	0	20
Trichodina californica	*S*	33.3	0	0
Dermocystidium sp.	*G*	66.7	0	0
Salmonchus ergensi	*S/AU*	33.3 (1.5)	66.7(1.3)	46.7(0.87)
Salmonchus lenoki	*S/AU*	100(17.5)	0	60(4.2)
Salmonchus pseudoroytmani	*S/AU*	33.3 (61)	33.3 (3.3)	46.7(3.9)
Salmonchus rogersi	*S/AU*	100(76.5)	100(11.2)	0
Salmonchus roytmani	*S/AU*	83.3 (25)	66.7(11.3)	0
Salmonchus spasskyi	*S/AU*	0	100(1.0)	0
Gyrodactylus ašiaticus	*S/AU*	50(3)	0	0
Gyrodactylus brachymystacis	*S/AU*	50(6.7)	0	0
Gyrodactylus lenoki	*S/AU*	66.7 (7.5)	0	0
Gyrodactylus taïmeni	*S/AU*	50(304.0)	0	0
Cyathocephahis truncatus	*S/AU*	0	0	6.7(0.07)
Triaenophorus nodulosus (pl)	*G/AU*	0	0	33.3 (0.87)
Proteocephalus exiguus	*S/AU*	83.3(4.5)	100(9.8)	80(6.7)
Diplostomum spp.. (mc)	*G/AL*	0	0	6.7(0.13)
Ichthyocotylurus erraticus (mc)	*G/AL*	0	33.3 (0.33)	0
Azygia robusta	*S/AU*	0	33.3 (0.33)	20 (0.26)
Crepidostomum metoecus	*S/AU*	33.3 (0.33)	0	6.7 (0.07)
Pseudocapillaria salvelini	*G/AU*	16.7(0.33)	33.3 (0.67)	6.7 (0.07)
Raphidascaris acus (l)	*G/AU*	0	0	40 (1.26)
Ichthyobronema hamulatum (l)	*G/AU*	50(10.3)	33.3 (0.67)	0
Cystidicoloides ephemeridarum	*S/AU*	33.3 (3.7)	33.3 (0.33)	0
Neoechinorhynchus crassus	*G/AU*	0	0	6.7 (0.07)
Basanistes briani	*S/AU*	83.3 (4.2)	33.3 (1.0)	13.3(0.13)

First figure - prevalence %, second figure in parenthesis - abundance.

et al., 1985). This particular fact explains the very high value of predominance index. The low values of the evenness index and the Shannon index are determined apparently by unfavourable of lenok's ennvironmnental conditions in the lake, which is confirmed by its very irregular distribution and the lowest growth rate of fishes in this lake. It is not improbable that there exist lake and river forms as in Lake Leprindokan that may differ in diet. Infection by *Diphyllobothrium dendriticum* (pl) and *Proteocephalus exiguus* (third in numbers) is related to predatory feeding of lenok in the lake and infection by *Cystidicola farionis* is related to feeding on benthos. Presence of specific monogeneans (*Salmonchus roytmani* second in numbers) suggests that a large part of lenoks appeared in the lake recently. In the Selenga River a somewhat higher value of predominance index may be due to the fact that fishes were dissected immediately after spawning. Spawning and spawning migrations are apparently among the numerous "stress factors" for parasite community, which result in its destabilization. Component

Table 3

Characteristics of the parasite infracommunities of *Brachymystax lenok*

Characteristics	River basin		
	Kolyma*	Selenga	Lena
Number of fish specimens examined/infected	15/15	6/6	3/3
Proportion of fish without parasites or with 1 parasite species	0,2	0	0
Total no. of parasite species (min-max) X±s.e.; σ	(1-8) 3,8±0,5; 2,1	(4-12) 9±1; 2,5	(6-7) 6,7±0,3; 0,5
Total no. of parasite individuals (min-max) X±s.e.; σ	(2-64) 18±4; 18	(81-1912) 527±260; 637	(15-146) 63±34; 59
No. of a utogenic species (min-max) X±s.e.; σ	(1-8) 3,7±0,6; 2,2	(4-12) 9±1; 2,5	(6-7) 6,3±0,3; 0,5
Propotion of autogenic individuals (min-max) X±s.e.; σ	(0-1) 0,93±0,06; 0,25	1	(0,97-1) 0,99±0,01; 0,01
No. of allogenic species (min-max) X±s.e.; σ	(0-1) 0,07±0,06; 0,25	0	(0-1) 0,3±0,3; 0,5
Propotion of allogenic individuals (min-max) X±.s.e.; σ	(0-1) 0,07±0,06; 0,25	0	(0-0,03) 0,01±0,01; 0,01
No. of specialist species (min-max) X±s.e.; σ	(0-6) 2,9±0,5; 1,8	(8-10) 8,3±0,8; 2,0	(5-7) 5,7±0,5; 0,9
Propotion of specialist individuals (min-max) X±s.e.; σ	(0-1) 0,79±0,07; 0,26	(0,88-1) 0,94±0,03; 0,08	(0,87-1) 0,92±0,03; 0,05
No. of generalist species (min-max) X±s.e.; σ	(0-3) 0,93±0,22; 0,85	(0-2) 0,7±0,3; 0,7	(0-2) 1±0,5; 0,8
Propotion of generalist individuals (min-max) X±s.e.; σ	(0-1) 0,21±0,07; 0,26	(0-0,12) 0,06±0,03; 0,08	(0-0,13) 0,08±0,03; 0,05
Identity of dominant species	*Pe*	*Gt*	*Sr*
Character of dominant species	*S/AU*	*S/AU*	*S/AU*
Similarity between infracommunities C_s (min-max) X±s.e.; σ	(0-1) 0,293±0,024; 0,245	(0,059-0,790) 0,301±0,054; 0,211	(0,338-0,605) 0,464±0,077; 0,134
Similarity between infracommunities on Jaccard index (min-max) X±s.e.; σ	(0-1) 0,274±0,022; 0,221	(0,154-0,8) 0,471±0,043; 0,168	(0,3-0,444) 0,382±0,043; 0,074
Berger-Parker index (min-max) X±s.e.; σ	(0,27-1) 0,626±0,064; 0,249	(0,402-0,87) 0,631±0,105; 0,258	(0,37-0,6) 0,46±0,06; 0,1
Evenness (min-max) X±s.e.; σ	(0-1) 0,647±0,09; 0,368	(0,259-0,661) 0,536±0,056; 0,138	(0,704-0,857) 0,761±0,039; 0,068
Brillouin index (min-max) X±s.e.; σ	(0-1,489) 0,698±0, 122; 0,474	(0,617-1,534) 1,103±0,146; 0,358	(0,96-1,401) 1,233±0, 112; 0,195

Comments: *Pe - Proteocephalus exiguus; Gt - Gyrodactylus taimeni; Sr - Salmonchus rogersi.*

community of lenok (its stout-snouted form) in Primorsky Territory is characterized by high values of evenness of community by species abundance and the Shannon index.

Thus, parasite communities of lenok sensitively respond to environmental conditions (rivers, lakes) and to characteristics of population structure of host, and its biology. This circumstance permits using the major indices of structure and diversity of parasite communities, for the study of biology of hosts and assessment of its environmental conditions.

Table 4

Characteristics of component parasite communitites of *Brachymystax lenok* in the waterbodies of North Asia and Primorsky Territory

Characteristics	Locality					
	Kolyma river*	Seienga river*	Khubsugul lake	Lena river*	Leprindokan lake	Peimorsky Territory
No. of fish examined	15	6	14	3	45	15
Total no. of parasite species	13	15	13	12	8	13
Total no. of parasite individuals	277	3158	11627	190	1441	306
No. of autogenic species	12	15	11	11	6	13
No. of allogenic species	1	0	2	1	2	0
Propotion of autogenic individuals	0,99	1	0,99	0,99	0,65	1
Propotion of allogenic individuals	0,01	0	0,01	0,01	0,35	0
No. of specialist species	8	13	9	9	4	10
Propotion of specialist individuals	0,88	0,98	0,99	0,97	0,61	0,88
No. of generalise species	5	2	4	3	4	3
Propotion of generalist individuals	0,12	0,02	0,01	0,03	0,39	0,12
Character of dominant species	*S/AU*	*S/AU*	*S/AU*	*S/AU*	*S/AU*	*S/AU*
Identity of dominant species	*Pe*	*Gt*	*Cf*	*Sr*	*Ar*	*Sl*
Berger-Parker index	0,371	0,578	0,914	0,353	0,550	0,464
Evenness	0,662	0,542	0,170	0,655	0,641	0,735
Shannon index	1,699	1,467	0,434	1,628	1,333	1,886

Comments: * - original data; Leprindokan lake - Pronin (1966); Khubsugul lake - Pronin (1976); Primorsky Territory - Ermolenko (1992). *Pe - Proteocephalus exiguus; Gt - Gyrodactylus taimeni; Cf - Cystidicola farionis; Sr - Salmonchus rogersi; Ar - Azygia robusta; Sl - Salmonchus lenoki.*

Literature

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ПАРАЗИТЫ ЛЕНКА, *BRACHYMYSTAX LENOK* (SALMONIDAE), И ИХ СООБЩЕСТВА

В статье приводятся данные о паразитофауне ленка, о структуре и разнообразии паразитарных сообществ с использованием литературных и оригинальных данных, полученных в результате полного паразитологического обследования рыб.