Volume 1
Number 2
1992

V. A. DOGIEL in memoriam

Ecological parasitology

ST. PETERSBURG
PETROZAVODSK

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1992, *1*(2): 135–149

POPULATION MORPHOLOGY OF *PROTEOCEPHALUS TORULOSUS* (CESTODA, PROTEOCEPHALIDAE) FROM CYPRINIDS OF THE KARELIAN LAKES

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(Accepted for publication 14 October, 1991)

ABSTRACT. Morphological features of *Proteocephalus torulosus* (Batsch, 1786) from three hosts (*Leuciscus idus, Leuciscus leuciscus, Alburnus alburnus)* were analyzed for Karelian lakes: Pjaozero, Korpijarvi (Northern Karelia) and Rindozero (Southern Karelia). Hostal polymorphism was found. Interpopulational differences in the morphology of *P. torulosus* were determined. It was concluded that the helminth population is independent in the lakes studied.

KEY WORDS: *Proteocephalus torulosus*: morphological peculiarities: interpopulational diversity; *Leuciscus idus, L. leuciscus, Alburnus alburnus.*

INTRODUCTION

Variability is an universal property of living organisms. It is expressed in all levels of their existence and is the base of evolution. It is possible to distinguish 3 chief approaches of its studies: morphological, biochemical and genetical one. Revision of species conception (change of typological thinking to a populational one) and biologization of systematic gave rise to a new branch of biological science – population morphology. All these three approaches and different methods can be used in the framework of its problems – study and comparison of populations and populational groups. Elucidation of morphological peculiarities of helminths is traditional study of their variability. It has been revealed that deep morphological changes are peculiar for helminths, which may be displayed in modificational, biocoenotical and trophical polymorphism (Freze, 1977). Most of the studies dealt with separated morphological features to understand their value as species criteria. Studies of helminth population morphology have been started not long ago.

This paper deals with analysis of morphological features of *Proteocephalus torulosus* (Batsch, 1786) widely distributed in North Europe and Asia, representing

boreal plain faunistic complex (Schulman, 1958). This parasite was found in 20 species of the cyprinids belonging to 8 genera of the subfamily Leuciscinae. Its most typical hosts are *Leuciscus idus* and *L. leuciscus* (Dubinina, 1952).

In Karelia *P. torulosus* was found in *Rutilus rutilus, Leuciscus leuciscus, L.idus, Alburnus alburnus, Abramis brama, A. ballerus* and *Blicca bjorkna* (Schulman et al., 1974). *P. torulosus* is very variable and its morphological borders are very wide (Freze, 1965; Kazakov, Perenleidzhamts, 1985). That is why we have chose this parasite for morphological analysis in separate populations.

MATERIALS AND METHODS

Analysis of morphological features has been made using samples of mature specimens of *P. torulosus* from *Leuciscus idus, L. leuciscus* and *Alburnus alburnus*, caught in different Karelian lakes. Two first fishes belong to one genus. *L. leuciscus* is a rather small fish. Average length is 16–18 cm, average mass is 53–83 g. Specimens become mature when they are 4–5 years old. Nutrition is rather diverse. There may be larvae of insects, leeches, molluscs, zooplankton, fragments of plants. *L. idus* is bigger. Its average mass is 400–500 g. Maturation takes place when the fish is 5–7 years old, 23–27 cm long and 300–400 g by weight. Food is extremely variable. Molluscs, leeches, insect larvae, zooplankton, plant fragments can be found in the gut. Fishes of older ages become predators. *Alburnus alburnus* is a small fish. Average length is 12–14 cm and average mass 25 g. Fishes of 2+ up 4+ were caught in most cases. It feeds on plankton (Meliyantsev, 1954; Pervozvansky, 1986).

Samples have been taken from three lakes: Pjaozero, Korpijarvi and Rindozero. Pjaozero is a big oligotrophic waterbody of North Karelia. Its area is 761.7 square kilometers; dominant fishes are salmonids and coregonids. Among cyprinids there are roach, bream and ide. *P.torulosus* has been found only in *Leuciscus idus*. Prevalence of infection is about 60%, intensity 1–24 and abundance is 5.5 (Rumyantsev, personal communication). Korpijarvi belongs to a rather complicated system of the Pista river (North Karelia). Dominant fishes are salmonids and coregonids. Cyprinids are represented by *Rutilus rutilus, Leuciscus idus, L.leuciscus* and *Alburnus alburnus*. Infection of three last species with *P. torulosus* is almost the same: prevalence 25–28%, intensity 1–28, abundance 1.4–2.6. Roach was not infected (Malakhova, 1976). Rindozero is a small mesotrophic waterbody of South Karelia. Chief fishes are *Perca fluviatilis* and *Rutilus rutilus*. *P. torulosus* infects Leuciscus leuciscus and *Alburnus alburnus*. Prevalence during year changes from 86 to 100%, abundance from 17 to 63 specimens (Anikieva, Ieshko, 1988). Methods of collection, staining and handling were standard (Bykhovskaya-Pavlovskaya, 1985). Such features had been analyzed: shape and size (length and width) of the scolex and suckers; shape and size of mature proglottids, index of their length and width; quantity of testes, their size; size (length and width) of the bursa cirri. Length of the scolex was taken from the anterior end up to the

neck narrowing, if the neck was absent — up to the lower side of the suckers. Only quite mature first proglottids were used in the study.

Statistical processing of all data was made. Chief exponents of morphological features variability were calculated such as M±m, average quadratic divergence, dispersion, coefficient of variability, asymmetry and excess. Comparison has been made using diverse coefficient

$$CD = \frac{M_a - M_b}{\sigma_a + \sigma_b}$$

(Mayr, 1971), of Fisher and Student.

Variability flow of different *P. torulosus* features have been constructed. To avoid influence of the features size on the value of the coefficient the zone of disperse was defined using two exponents: σ and CV. Features were arranged in each sample by the order of their values. Place of the feature was determined in different groups. Morphological profile of separate groups was represented by a graph. Principle of construction consists in comparison of relative values of the square deflection from the mean quantity, taken to the significance of the *P. torulosus* population in the Pjaozero, which was used as a standard for comparison. Size of the sample is given in Table 1.

Table 1. Available material (n)

Characteristics	L.Rindozero		L.Pyaozero	L.Corpijarvi	
	Bleak	Dace	Ide	Dace	Bleak
Scolex: length	35	12	13	14	1
width	35	13	16	14	1
Suckers: length	33	12	18	15	2
width	33	11	17	15	2
Segments: length	39	19	46	14	10
width	39	21	46	14	10
Testicles: number	26	17	26	14	10
size	30	30	30	30	30
Bursa: length	26	15	37	15	32
cirri: width	26	15	38	15	32
Total number of strobiles	46	30	18	18	12

RESULTS

1. Peculiarities of P. torulosus in different host species

Morphologically *P. torulosus* studied from different hosts has its peculiarities (Tables 2, 3). Especially variable are the features of parasites from Leuciscus idus. The size of the cestodes from *L. leuciscus* are within the limits of individual

variability of this or that feature of *P. torulosus* from *L. idus*. More variable are the indices of parasites from *Alburnus*. Mean indices of the features show that parasites from *Leuciscus idus* and *L. leuciscus* differ from one another in the length of scolex and suckers, of proglottids and in the number of testes. More pronounced differences have been found in the parasites from *Alburnus* caught in Rindozero. Only 2 features of the ten under analysis, that is the size of scolex and of proglottids, have a high coefficient of variability. Such a high variability impelled us to discuss this phenomenon in detail (Table 4). We have distinguished 3 variations of a scolex type using correlation of scolex length and width, and of existence or absence of neck narrowing: 1. pin-shaped, short and swelled; 2. pin-shaped, but elongated; 3. lancet-shaped. All cestodes from *Leuciscus idus* and *L. leuciscus* have a pin-shaped scolex with well expressed neck narrowing. As to correlation of scolex length and width – in cestodes of *L. idus* the first variation predominates, in *L. leuciscus* we have found mostly the second variation. In cestodes from Rindozero *Alburnus alburnus* all three variations can be seen, but lancet-shape predominates.

Table 2. Morphological indices of *Proteocephalus torulosus* from lake Rindozero, mm.

Characteristics	Host	Ranges	M ± m	σ	V
Scolex: length	Bleak	0.14–1.05	0.50±0.06	0.33	66
	Dace	0.70–1.05	0.85±0.03	0.117	14
width	Bleak	0.25–0.7	0.44±0.02	0.142	31
	Dace	0.30–0.40	0.36±0.01	0.048	11
Suckers: length	Bleak	0.10–0.23	0.15±0.005	0.03	21
	Dace	0.015–0.021	0.18±0.05	0.01	10
width	Bleak	0.10–0.20	0.14±0.004	0.025	18
	Dace	0.13–0.16	0.15±0.04	0.014	10
Segments: length	Bleak	0.35–0.88	0.58±0.02	0.129	22
	Dace	0.45–0.84	0.61±0.03	0.107	18
width	Bleak	0.67–1.55	1.04±0.03	0.194	19
	Dace	0.53–1.09	0.81±0.003	0.133	16
Testicles: number	Bleak	43–83	56±1.9	9.98	18
	Dace	53–104	71.2±3.14	13	18
size	Bleak	0.07–0.12	0.09±0.002	0.012	13
	Dace	0.042–0.077	0.062±0.03	0.010	17
Bursa length	Bleak	0.20–0.34	0.24±0.007	0.036	15
	Dace	0.18–0.28	0.22±0.07	0.027	12
cirri width	Bleak	0.07–0.13	0.09±0.002	0.013	14
	Dace	0.07–0.09	0.08±0.001	0.005	6

The shape of the proglottid and correlations of its length and width can be of 5 variations: 1. Proglottids are elongated; correlation of their length and width is less than 1:1; 2. Proglottids are square; correlation of length and width is 1:1; 3. Width of the proglottids is twice bigger than the length; 4. Width is three times

Table 3. Morphological indices of *Proteocephalus torulosus* from northern Karelian water basins, mm.

Characteristics	Limit	M ± m	σ	V
Lake Pyaozero, Ide				
Scolex: length	0.7–1.76	1.1±0.1	0.37	33
width	0.7–1.30	0.97±0.37	0.15	15
Suckers: length	0.24–0.44	0.33±0.013	0.06	18
width	0.21–0.35	0.27±0.011	0.04	16
Segments: length	0.07–0.88	0.47±0.032	0.22	47
width	0.70–2.10	1.30±0.06	0.37	29
Testicles: number	57–116	82±3.0	15.3	19
size	0.04–0.10	0.08±0.003	0.017	21
Bursa length	0.21–0.42	0.25±0.06	0.037	15
cirri width	0.07–0.12	0.099±0.02	0.013	13
Lake Corpijarvi, Dace				
Scolex: length	0.95–1.6	1.3±0.04	0.141	11
width	0.70–1.0	0.88±0.03	0.124	14
Suckers: length	0.20–0.3	0.25±0.08	0.03	12
width	0.21–0.43	0.34±0.01	0.05	17
Segments: length	0.28–0.99	0.58±0.05	0.19	33
width	0.78–1.41	1.10±0.04	0.16	15
Testicles: number	48–94	66.9±3.7	13.8	21
size	0.05–0.1	0.08±0.002	0.013	16
Bursa length	0.21–0.33	0.26±0.01	0.039	15
cirri width	0.08–0.13	0.10±0.003	0.012	13
Lake Corpijarvi, Bleak				
Scolex: length	0.6			
width	0.5			
Suckers: length	0.17–0.19			
width	0.2			
Segments: length	0.35–0.70	0.50±0.03	0.100	20
width	0.32–0.92	0.70±0.06	0.177	23
Testicles: number	67–105	85.5±4.2	13.4	16
size	0.05–0.08	0.07±0.003	0.008	12
Bursa length	0.14–0.26	0.21±0.005	0.03	14
cirri width	0.06–0.12	0.09±0.003	0.16	18

larger than the length; 5. Width is more than three times much as the length. Distribution of these variations in populations of *P. torulosus* from different hosts is shown in Table 4.

Table 4. Prevalence of variations of *Proteocephalus torulosus* in different hosts, %.

Variations	*Leuciscus idus* Pjaozero	*Leuciscus leuciscus* Corpijarvi	*Alburnus alburnus* Corpijarvi	*Alburnus alburnus* Rindozero	*Leuciscus leuciscus* Rindozero
			Scolex		
1. pin-shaped, short, swelled	72.5	21.5	–	5.7	0
2. pin-shaped, but elongated	27.5	78.5	–	25.6	100
3. lancet-shaped	0	0	+	68.7	0
			Proglottids		
1. elongated	0	0	8.7	46.0	0
2. square	1.7	0	72.6	46.0	70
3. broad	21.6	25.0	8.7	18.0	30
4. broader	51.1	60.0	0	0	0
5. very broad	21.6	15.0	0	0	0

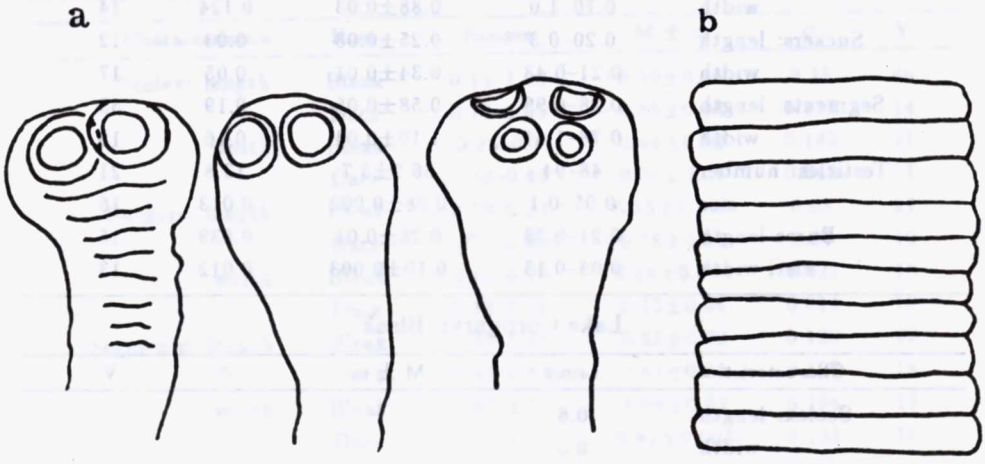

Figure 1. Scolex (a) and proglottids (b) of *P. torulosus* from Pjaozero *Leuciscus idus*.

Comparison of the features parameters and their variations have shown that *P.torulosus* from *Leuciscus idus* has mostly a big and swelled scolex, length of the suckers is mostly bigger than their width, proglottids are short and broad (Fig. 1). Scolex of the cestodes from *L. leuciscus* is longer and less broad, suckers are smaller than those from *L. idus*, number of testes is less and proglottids are longer and not so broad (Fig. 2). *Proteocephalus torulosus* from *Alburnus alburnus* has the smallest size of scolex, suckers and proglottids (Fig. 3).

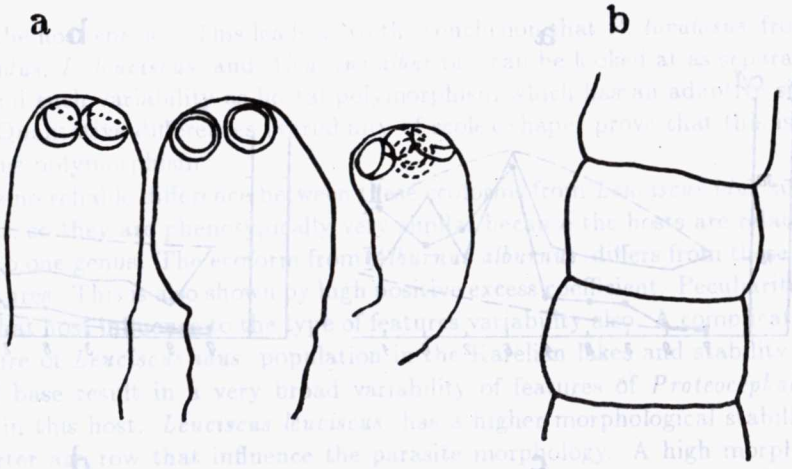

Figure 2. Scolex (a) and proglottids (b) of *P. torulosus* from Korpijarvi *Leuciscus leuciscus*.

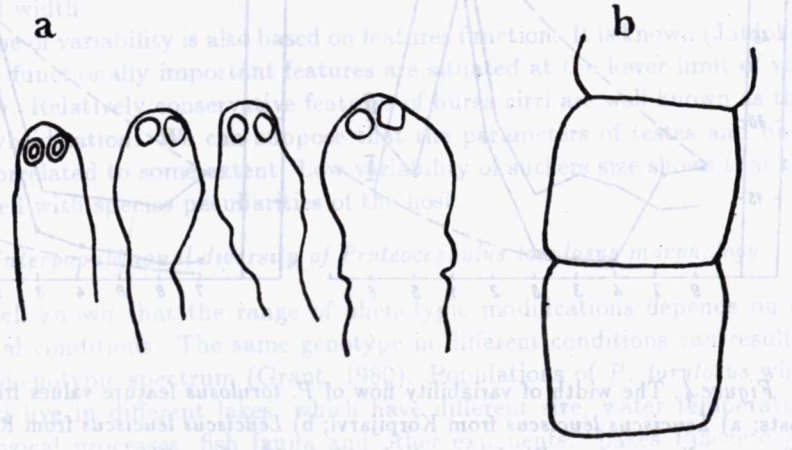

Figure 3. Scolex (a) and proglottids (b) of *P. torulosus* from Rindozero *Alburnus alburnus*.

Coefficient of excess is rather high and varies from 1.4 to 4.8, coefficient of asymmetry varies from 0.04 to 1.1. Analysis of the coefficients has shown that in samples of *P. torulosus* from *Leuciscus idus* specimens with smaller size of proglottids predominate with smaller length of scolex, suckers and bursa cirri than in the mean values. In *Proteocephalus torulosus* from *Leuciscus leuciscus* we find often specimens with a long scolex and broader suckers, with proglottids with less width and less number of testes. In *Proteocephalus torulosus* from *Alburnus alburnus* suckers and bursa cirri are smaller as the number of testes.

Flow width of *Proteocephalus torulosus* variability from different hosts is not the same. It is higher in groupings from *Leuciscus idus* and *Alburnus alburnus*

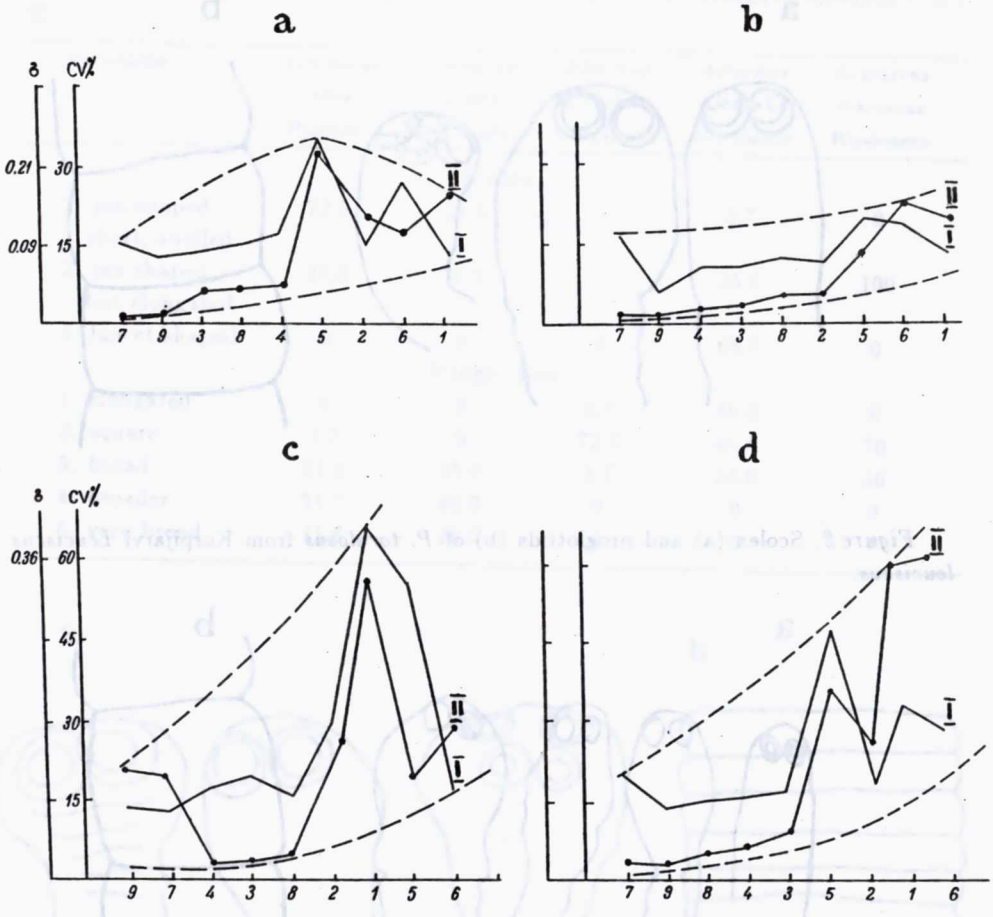

Figure 4. The width of variability flow of *P. torulosus* feature values from different hosts: a) *Leuciscus leuciscus* from Korpijarvi; b) *Leuciscus leuciscus* from Rindozero; c) *Alburnus alburnus* from Rindozero; d) *Leuciscus idus* from Pjaozero.

1 — length of scolex; 2 — width of scolex; 3 — length of suckers; 4 — width of suckkers; 5 — length of proglottids; 6 — width of proglottids; 7 — diameter of testes; 8 — length of bursa cirri; 9 — width of cirrus bursa. I - δ; II - CV

(Fig. 4). Five exponents: diameter of testes, length and width of bursa cirri and suckers are at the lower level. Indices of proglottids and of scolex length are at the upper limits of flow width.

It has been shown using different parasites that the host plays the main role in the formation of morphological groups. Such were the results in cestode *Diphyllobothrium latum* (Freze, 1977) and *Cyathocephalus truncatus* (Rinchino, 1989), in acanthocephalan *Pomphorhynchus laevis* (Edwards, 1987) and trematod *Azygia lucii* (Roytman, Kazakov, 1977) and in others. The results obtained have shown that morphological peculiarities of *Proteocephalus torulosus* depend

mostly on the host species. This leads us to the conclusion that *P. torulosus* from *Leuciscus idus, L. leuciscus* and *Alburnus alburnus* can be looked at as separate ecoforms and such variability as hostal polymorphism which has an adaptive significance. Qualitative differences (variability of scolex shape) prove that this is a heterozygous polymorphism.

There is no reliable difference between these ecoforms from *Leuciscus idus* and *L. leuciscus*; so they are phenotypically very similar because the hosts are related belonging to one genus. The ecoform from *Alburnus alburnus* differs from these in several features. This is also shown by high positive excess coefficient. Peculiarities of this or that host influence to the type of features variability also. A complicated age structure of *Leuciscus idus* population in the Karelian lakes and stability of nutritional base result in a very broad variability of features of *Proteocephalus torulosus* in this host. *Leuciscus leuciscus* has a higher morphological stability and a shorter age row that influence the parasite morphology. A high morphological variability in *Proteocephalus torulosus* from *Alburnus alburnus* caught in Rindozero is related not only to the age structure of its population but is also influenced by the competition within parasite population if the infection is high. This influence can be seen on the proglottids size and on the correlation of their length and width.

The type of variability is also based on features function. It is known (Jablokov, 1987) that functionally important features are situated at the lower limit of variability flow. Relatively conservative features of bursa cirri are well known as they prevent hybridization. We can suppose that the parameters of testes and bursa cirri are correlated to some extent. Low variability of suckers size shows that this is connected with species peculiarities of the host.

2. Interpopulational diversity of Proteocephalus torulosus morphology

It is well known that the range of phenotypic modifications depends on environmental conditions. The same genotype in different conditions can result in different phenotypic spectrum (Grant, 1980). Populations of *P. torulosus* which we studied live in different lakes, which have different size, water temperature, hydrobiological processes, fish fauna and other exponents. Lakes Pjaozero and Corpijarvi are of the White sea basin and belong to the European district of the Arctic province. Fauna genesis of both lakes has similar features. But these lakes are not connected. Rindozero belongs to the basin of Onega lake of the Neva district and Baltic province. About 700 km are between this and two other lakes. So in each of these waterbodies there is a separate population of *P. torulosus.* The density and structure of these populations in these different lakes are different. In Pjaozero *Leuciscus idus* is the only definite host of *Proteocephalus torulosus.* It is deep and cool. A short period of vegetation limits the growth tempo and the size of fish. This is why it is rare in this lake. As its number and infection rate are low it is possible that there is only one population of the parasite. In Corpijarvi *P. torulosus* infects three species of cyprinids: *Leuciscus idus, L. leuciscus* and *Alburnus alburnus. Leuciscus idus* is more numerous than the other. As the infection of all hosts is low and the lake is rather small it is possible that there is only one population of *Proteocephalus torulosus* but perhaps some population groups.

In Rindozero *P. torulosus* infects *Alburnus alburnus* and *Leuciscus leuciscus*, but the first is dominating. We have caught only 3 specimens of *L.leuciscus*. They were infected with 1.17 and 25 parasites. As the number of *L. leuciscus* is very low it seems to be doubtful that *P. torulosus* from this fish has formed a special group. Logically there is only one general population of it in the lake.

Our material was enough to make comparison of morphological features of *P. torulosus* ecoforms using pairs of hosts: samples from *Alburnus alburnus* of Corpijarvi and Rindozero and from *Leuciscus leuciscus* of the same lakes (Fig. 5a); from *Alburnus alburnus* and *Leuciscus leuciscus* of Corpijarvi and *Alburnus alburnus* and *Leuciscus leuciscus* of Rindozero. It has been revealed that the hostal ecoform from *Alburnus alburnus* of Rindozero is distinguished by bigger proglottids and testes but by lower number of both. This form has also high indices of features variability and a maximum quantity of modifications. Differentiation of *P. torulosus* ecoforms from *Leuciscus leuciscus* of Rindozero and Corpijarvi was high for all features except three of them: proglottids length, number of testes and length of bursa cirri (Fig. 5a).

Differences between two ecoforms of *P.torulosus* in one lake were not so high than of the same ecoform but from different waterbodies (Fig. 5b).

Difference coefficients of features indices are higher between ecoform from Pjaozero *Leuciscus idus* and Rindozero *Alburnus alburnus*, than between ecoforms from Pjaozero *Leuciscus idus* and that from Corpijarvi *Leuciscus leuciscus* (Fig. 5c).

Comparison of variation coefficient values and relative states of features have shown that these indices vary very broadly, but no regularity could be revealed. Probably the reason is that there are too many environmental factors which couldn't be isolated during general analysis. It is only to be noticed that in the *P.torulosus* specimens from *Leuciscus leuciscus* minimum indices of coefficient variations were registered rather often.

Analysis of comparative variability has shown that stability of features position in separate ecoforms of *P. torulosus* from different lakes was observed only in the ecoform of *Leuciscus leuciscus* (7 features of 9), (Table 5). Adaptive changes have been noticed for proglottids length and scolex width. It seems that there features are connected with the spectrum of hosts' nutrition. It has been shifted towards zooplankton for *Leuciscus leuciscus* from Rindozero.

Combination of a longer proglottids with scolex of less width shows, that defective food of the host is a limiting factor of morphogenesis. Our data confirm the thesis of V.I. Freze (1977) that "the quantity of food is not limited when infection is low. Its deficient quality can be a limiting factor for the parasite determined by species (generic, class) specificity of physiology of host digestion and the degree of its difference from that of an obligatory host" (p. 196).

Though ide and dace are systematically similar the position of features of *P. torulosus* hostal ecoforms in northern lakes Pjaozero and Corpijarvi coincided only in 4 of 9 cases and between *P. torulosus* ecoforms from *Leuciscus idus*, lake Pjaozero, and *L. leuciscus*, lake Rindozero, only in 2 cases. When *P. torulosus* ecoform from *Alburnus alburnus* was compared with other hostal ecoforms it was revealed that it is nearer to those from *Leuciscus leuciscus* of the same

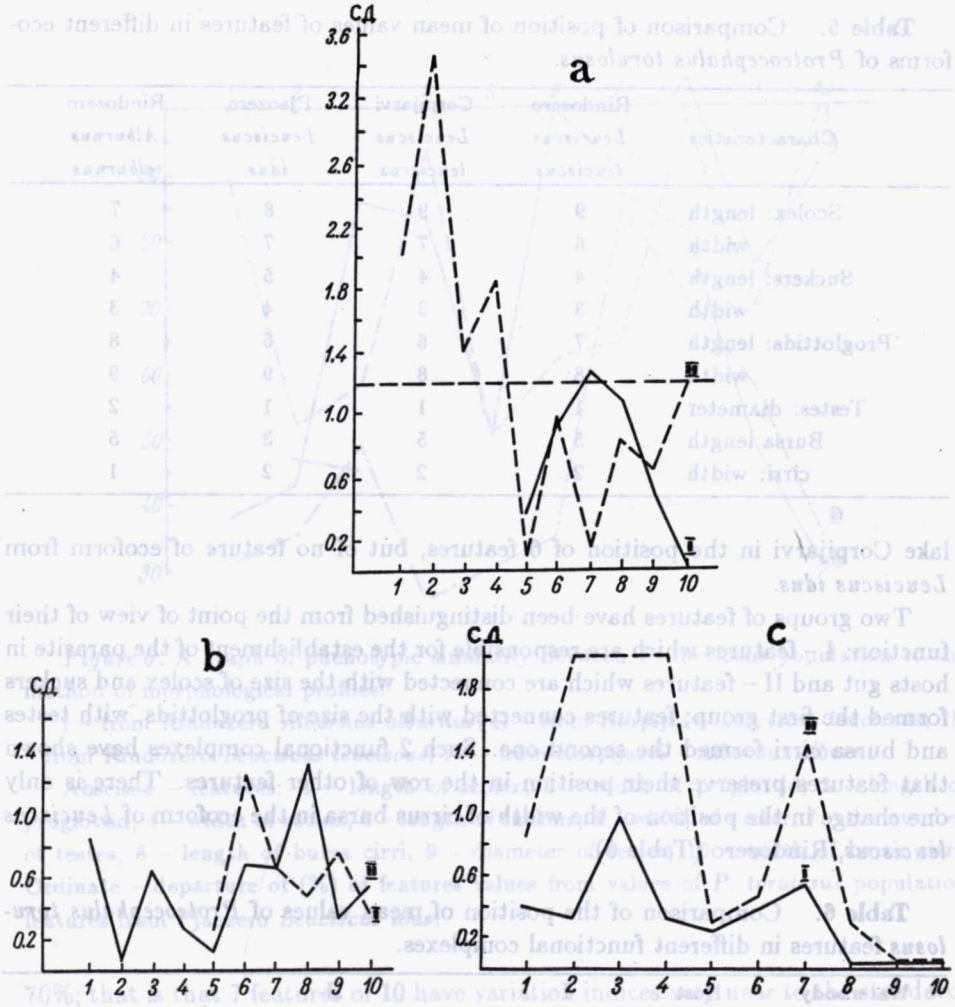

Figure 5. a Interpopulational differences of *P. torulosus*: *P. torulosus* from Korpijarvi and Rindozero *Alburnus alburnus* (I); *P. torulosus* from Korpijarvi and Rindozero *Leuciscus leuciscus* (II).

Abscissa – features. Feature symbols are the same as in Fig. 4. Ordinate – coefficient of diversity (CD) according to Mayr.

Figure 5b. Interpopulational differences of *P.torulosus*: *P. torulosus* from Korpijarvi *Alburnus alburnus* and *Leuciscus leuciscus* (I), *P. torulosus* from Rindozero *Alburnus alburnus* and *Leuciscus leuciscus* (II).

Abscissa and Ordinate – the same as in Fig. 5a.

Figure 5c. Interpopulational differences of *P.torulosus*: *P. torulosus* from Pjaozero *Leuciscus idus* and Korpijarvi *Leuciscus leuciscus* (I); *P. torulosus* from Pjaozero *Leuciscus idus* and Rindozero *Alburnus alburnus*.

Abscissa and Ordinate – the same as in Fig. 5a.

Rindozero. Situation coincided in the position of 4 features. *P.torulosus* ecoform from *Alburnus alburnus*, lake Rindozero, differ from *Leuciscus leuciscus* ecoform,

Table 5. Comparison of position of mean values of features in different ecoforms of *Proteocephalus torulosus.*

Characteristics	Rindozero *Leuciscus leuciscus*	Corpijarvi *Leuciscus leuciscus*	Pjaozero *Leuciscus idus*	Rindozero *Alburnus alburnus*
Scolex: length	9	9	8	7
width	6	7	7	6
Suckers: length	4	4	5	4
width	3	3	4	3
Proglottids: length	7	6	6	8
width	8	8	9	9
Testes: diameter	1	1	1	2
Bursa length	5	5	3	5
cirri: width	2	2	2	1

lake Corpijarvi in the position of 6 features, but of no feature of ecoform from *Leuciscus idus.*

Two groups of features have been distinguished from the point of view of their function: I – features which are responsible for the establishment of the parasite in hosts gut and II – features which are connected with the size of scolex and suckers formed the first group; features connected with the size of proglottids, with testes and bursa cirri formed the second one. Such 2 functional complexes have shown that features preserve their position in the row of other features. There is only one change in the position of the width of cirrus bursa in the ecoform of *Leuciscus leuciscus*, Rindozero (Table 6).

Table 6. Comparison of the position of mean values of *Proteocephalus torulosus* features in different functional complexes.

Waterbody	Host	I		II		
		Scolex	Suckers	Proglottids	Testes	Bursa cirri
Corpijarvi	*A. alburnus*	–	–	4 x 5	1	3 x 2
	L. leuciscus	4 x 3	2 x 1	4 x 5	1	3 x 2
Rindozero	*A. alburnus*	4 x 3	2 x 1	4 x 5	1	3 x 2
	L. leuciscus	4 x 3	2 x 1	4 x 5	2	3 x 1
Pjaozero	*L. idus*	4 x 3	2 x 1	4 x 5	1	3 x 2

The graph of phenotypic resemblance of different populations constructed by the method of morphological profiles shows variations of the feature indices correlated with the population from Pjaozero taken as a standard (Fig. 6).

Features of the standard population are arranged in diminishing order of their sigma relative values. Feature divergences of other populations from the standard are correlated by standard indices and are expressed in percentage taking into account the sign. It is revealed that *P. torulosus* ecoform from *Leuciscus leuciscus* lake Corpijarvi is nearer to the standard population. Resemblance is more than

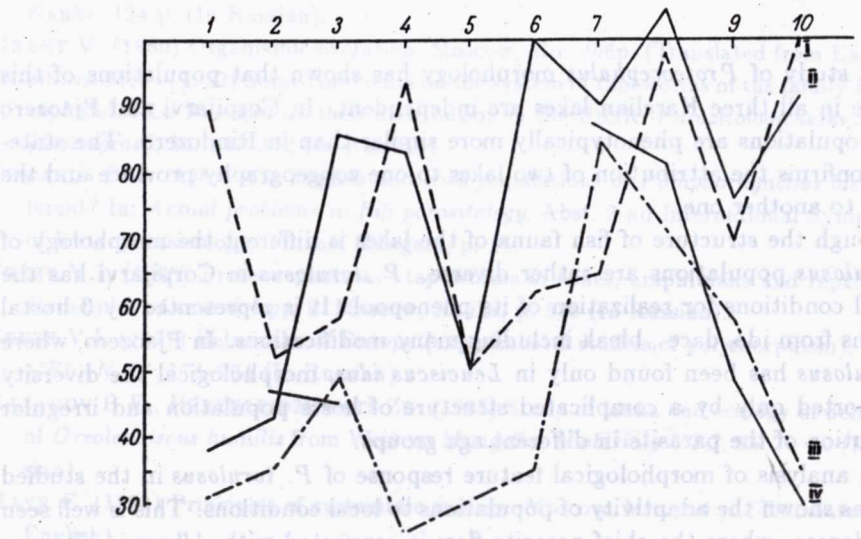

Figure 6. A graph of phenotypic similarity between *P. torulosus* population to the method of morphological profiles.

I – from Rindozero *Alburnus alburnus*; II – from Korpijarvi *Leuciscus leuciscus*; III – from Rindozero *Leuciscus leuciscus*; IV – from Korpijarvi – *Alburnus alburnus*.

Abscissa – features: 1 – length of scolex, 2 – width of proglottid, 3 – length of proglottid, 4 – width of scolex, 5 – length of suckers, 6 – width of sucker, 7 – the number of testes, 8 – length of bursa cirri, 9 – diameter of testes, 10 – width of bursa cirri. Ordinate – departure of (%) of features values from values of *P. torulosus* population features from Pjaozero *Leuciscus idus*.

70%; that is that 7 features of 10 have variation indices very near to the standard. Ecoform from *L. leuciscus* is significantly lower than that of *L. idus* if we take variability of 3 features (length of the scolex and suckers, width of the proglottids). Data on variability of *P. torulosus* from *Alburnus alburnus* of the same lake show a low variability of the size of proglottids, testes, width of the bursa cirri and rather similar type of variability of testes number and length of bursa cirri. In Rindozero the type of feature variability of the hostal ecoform from *Alburnus alburnus* is nearer to the standard than from *Leuciscus leuciscus* (4 features in bleak and only 1 in dace). This graph shows, on the whole, that each hostal ecoform and each population, as a totality of the ecoforms, is characterized by its own morphological profile.

DISCUSSION

The study of *Proteocephalus* morphology has shown that populations of this parasite in all three Karelian lakes are independent. In Corpijarvi and Pjaozero these populations are phenotypically more similar than in Rindozero. The statement confirms the attribution of two lakes to one zoogeography province and the third – to another one.

Though the structure of fish fauna of the lakes is different the morphology of *P. torulosus* populations are rather diverse. *P. torulosus* in Corpijarvi has the optimal conditions for realization of its phenopool. It is represented by 3 hostal ecoforms from ide, dace , bleak including many modifications. In Pjaozero, where *P. torulosus* has been found only in *Leuciscus idus*, morphological the diversity is supported only by a complicated structure of hosts population and irregular distribution of the parasite in different age groups.

The analysis of morphological feature response of *P. torulosus* in the studied lakes has shown the adaptivity of populations to local conditions. This is well seen in Rindozero, where the chief parasite flow is connected with *Alburnus alburnus* and the population of *P. torulosus* is adapted to this host. The response of the parasite to other hosts is changed in this situation and is realized incompletely. *Leuciscus leuciscus* as a secondary host of *Proteocephalus torulosus* has a stable impact on its population in this lake. Presence of the secondary host makes the genotypical structure of the population of bleak ecoform broader and increases its diversity. This results in a maximum quantity of parasite modifications in the studied lakes and the high indices of feature variability.

The revealed adaptation of *P. torulosus* to environmental conditions gives grounds to state, that genetical diversity of *P. torulosus* population within one waterbody is confirmed by intrapopulational hostal radiation, which makes the population more stable especially at the border of species area.

ACKNOWLEGEMENTS

I would like to thank Dr. E.A. Rumyantsev for his materials on *P. torulosus* from Lake Pjaozero.

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Необходимы дальнейшие исследования жизненных циклов других паразитических простейших с целью отыскания у них стадий, ответственных за потенциальную оппортунистическую природу соответствующих возбудителей протозойной природы.

ПОПУЛЯЦИОННАЯ МОРФОЛОГИЯ ЦЕСТОДЫ *PROTEOCEPHALUS TORULOSUS* (CESTODA, PROTEOCEPHALIDAE) — ПАРАЗИТА КАРПОВЫХ РЫБ В ОЗЕРАХ КАРЕЛИИ

Л. В. Аникиева

Выполнен анализ морфологических показателей *Proteocephalus torulosus* из трех видов хозяев (*Leuciscus idus, L. leuciscus, Alburnus alburnus*) водоемов Карелии: Пяозера, Корпиярви (система реки Писты), Северная Карелия и Риндозера (южная Карелия). Установлена ключевая роль хозяина в формировании морфологических группировок гельминта. По своеобразию проявления признаков гельминты из язя, ельца и уклеи охарактеризованы как отдельные экоформы, а изменчивость в зависимости от вида хозяина определена как гостальный полиморфизм, имеющий адаптивное значение. Обнаружены качественные различия, свидетельствующие о гетерозиготном полиморфизме *P. torulosus*. Показано, что степень изменчивости признаков связана с видом хозяина и функциональной значимостью самого признака.

Определены межпопуляционные отличия в морфологии *P. torulosus* из трех разнотипных водоемов. На основании морфологических данных сделан вывод о самостоятельности популяций гельминта в изученных водоемах. Установлено, что различия между экоформами гельминта в пределах одного водоема менее выражены, чем у одной и той же экоформы из разных озер. Предполагается, что между отдельными морфологическими группировками гельминта в водоеме происходит обмен генами — гостальная радиация. Она поддерживает разнокачественность популяции и ее устойчивость в условиях обитания вида на краю ареала.