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PARASITOFAUNA OF CARP *CYPRINUS CARPIO CARPIO* L. (CYPRINIDAE) IN AQUACULTURE OF LATVIA

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The aim of this study was to investigate parasitofauna of carp *Cyprinus carpio carpio* L., 1758 (Cyprinidae) from aquaculture of Latvia. The main task was to compare parasitofauna of carp by regions of Latvia. The study was carried out during the period from 2007 to 2012. The parasitofauna of carp was studied in all four regions of Latvia: Kurzeme, Zemgale, Vidzeme and Latgale. In general, 247 carps were investigated from all regions of Latvia. 41 carps were investigated from Kurzeme, 102 from Zemgale, 36 from Vidzeme and 68 from Latgale. Overall, in all regions, carps were the most infested with gill Monogenoidea parasites, where greatest diversity of species (n = 7) was also found.

Key words: *Cyprinus carpio carpio*, regions of Latvia, parasites, Protista, Trematoda, Monogenoidea, Cestoda, Nematoda, Mollusca, Hirudinida, Crustacea, prevalence, intensity.

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INTRODUCTION

Carp (*Cyprinus carpio carpio* L.) is one of the most cultivated fish species in aquaculture of Latvia and they are important for trade. Wild form of carp, called the sazan, also is found in natural water bodies. Fish reaches one meter in length and over 20 kg in weight. Carp feeds on parts of plants, zooplankton and zoobentos and live in small schools (Plikšs &Aleksejevs 1998).

Results of carp parasites survey from 1954 till 2007 had been compiled in the "Checklist of the parasites of fishes of Latvia" (Kirjusina & Vismanis 2007). In this period 58 parasite species belonging to the following taxonomic groups were found: Protozoa – 25 species, Trematoda – 7 species, Monogenea – 10, Cestoda – 9, Nematoda – 4, Acanthocephala - 2 and one species in each group of Hirudinida, Mollusca and Crustacea. However, carp parasites distributions were not analysed by regions of Latvia yet.

Carp is characterized by a diverse parasitofauna (Kirjusina & Vismanis 2007) infested with both protozoa and metazoa parasites. They are infested mainly by Monogenea and Trematoda parasite species that depend on fish biology such as: locomotion, fish density, feeding behaviour and so on. Also, fish parasitofauna depends on the level of organic pollution of water, but eutrophication and thermal effluent can raise reproduction and development rate of

parasites in water bodies, because these factors are also favourable for the development of the intermediate hosts of parasites with indirect life cycle (Kennedy & Watt 1994). Most carps infest with *Dactylogyrus* genus parasites, where prevalence can reach 100% and intensity is more than 200 parasites per fish (Bagge et al. 2004).

The aim of the study was to investigate parasite fauna of carps, *Cyprinus carpio carpio* L., from aquaculture of Latvia. The main tasks were to compare the parasite fauna of carp by Latvian regions and compare our own results with the data from the previous studies.

Parasite species reduce the quality of the fish (cause a variety of pathological lesions) and some of parasite species are pathogenic for human, thus making fishes unfit for human consumption. In general, parasitic diseases outbreaks have a negative impact on the aquaculture area.

MATERIALS AND METHODS

The study was carried out during the period from 2007 till 2012. The carp (*Cyprinis carpio carpio* L., 1758) samples were collected from all regions of Latvia – Kurzeme, Zemgale, Vidzeme and Latgale. A total of 247 carp were sampled. Captured fishes were placed in plastic bags with frozen elements and delivered to the laboratory.

The total length and weight of each fish was measured as well as their sex was detected. In laboratory fishes were dissected according to method for full parasitological investigation (Bihovskaja – Pavlovskaja 1985, Roberts 2012). The following organs of carp were investigated: skin, fins, gills, eyes, brain, gonads, kidneys, digestive tract, liver, spleen, gall bladder, urine bladder, swim bladder and musculature. Compression method was used for the investigation of visceral organs. Samples were examined with AZ100 Nikon stereoscopic and Nikon 90i light microscopes.

Metazoan parasite was counted and species were determined by Key of the parasites of freshwater fishes in fauna of the U.S.S.R. (Bauer et al. 1985, 1987). Prevalence, average intensity, minimal and maximal intensity were calculated. The terminology was developed by Bush et al. (1997), where prevalence of invasion is presented as a percentage of infected carp in the total sample. The intensity of invasion (for metazoan parasites, excluded metacercaria in musculature) is presented with the total number of parasites per fish, minimal intensity (minimal number of parasites per fish) and maximal intensity (maximal number of parasites per fish). Protozoa parasites were not counted.

RESULTS

The results of the present investigation are summarized in Tables 1 and 2. Overall, for four regions of Latvia 28 parasite species were detected from 8 systematic groups of parasites: Protozoa identified 4 species, Trematoda – 4 species, Monogenoidea – 7 species, Cestoda – 6, Nematoda – 3, Crustacea – 2 species and one species from each group of Hirudinida and Mollusca.

Although, parasitofauna of carp was investigated from 1954 and during previous studies 58 parasite species were recorded in total. In the present research there were found 6 new parasite species for carp in Latvia: *Paradiplozoon homoin homoin, Apharingostrigea cornu* (mtc.), *Paracoenigonimus ovatus* (mtc.), *Raphidascaris acus* (L_3), *Ergasilus sieboldi* and *Anodonta cygnea* (glochidia). Most of this parasite species are widespread in Latvia and have low hosts specificity.

Parasitic Protozoa were represented by four species. Parasites were observed in three regions of Latvia (except Kurzeme), as single or fairly numerous individuals. Among protozoa parasites *Ichthyophthirius multifiliis* and *Trichodina* spp. were recorded with highest prevalence, they occurred on the gills and body

Table 1. Parasite groups detected in carp

Nr.	Regions of Latvia / Parasite group	Kurzeme (n=41)	Zemgale (n=102)	Vidzeme (n=36)	Latgale (n=68)	Total regions
1.	**Protista**	-	3	3	2	**3**
2.	**Trematoda**	2	3	2	3	**4**
3.	**Monogenoidea**	5	6	2	3	**4**
4.	**Cestoda**	3	6	4	4	**4**
5.	**Nematoda**	2	2	1	1	**4**
6.	**Hirudinida**	1	-	1	1	**3**
7.	**Mollusca**	1	-	-	1	**2**
8.	**Crustacea**	2	2	1	-	**3**
		16	**22**	**14**	**15**	**27**

surface mucus, prevalence reached 14.7% and 34.3% respectively. *I. multifiliis* is highly pathogenic parasite for carp cultivated in ponds and cause heavy skin and gills lesions (Nigrelli et al. 1976, Ewing & Kocan 1992, Dickerson & Clark 1998, Scholz 1999). Myxosporidia cysts were rarely noted in gills of carp from Latgale region. The lower number of detected ectoparasitic protozoan species is explained by condition of investigated fish samples. All examined fishes were already dead before investigation; that affects the results despite mucus investigation.

All recorded Trematoda species have matacercaria stage in the present investigation. Two out of four detected trematoda species parasitize in carp musculature. *Diplostomum sphathaceum* is one of the widespread parasite species of fishes. The average intensity of infection was low and reached 5.4 parasites per fish. *Ichtyocotylurus platycephalus* located on the serosa was observed in five fishes from two regions. The number of parasites ranged from 1 to 35 per fish. *Paracoenogonimus ovatus* as well as *Apharingostrigea cornu* noted in the musculature were less prevalent. Those parasites recorded in four carps from two regions with higher prevalence of 5.1%.

The most diverse of carp parasitic group was Monogenoidea (n=7). Many monogenea species previously recorded in Latvia are detected in the present research. Single or rather numerous *Eudiplozoon nipponicum* were recorded in the gills of carps from pounds of all regions of Latvia. The prevalence and intensity of infection was higher in Vidzeme (P=52.8%; I=6.1) and lower in Zemgale region (P=1.2%; I=2.4). *Dactylogyrus extensus* and *D. achmerowi* are the most prevalent gill parasites of carp in the studied pounds with the highest intensity of infection, reaching 103 and 292 individuals respectively. However, those monogeneans were not found in Vidzeme region. *Dactylogyrus minutus* was the less frequently recorded parasite on the gills of carp noted only in Kurzeme region (P=7.7%; I=5). Also, *Gyrodactylus katharineri* and *Paradiplozoon homoin homoin* were observed only in pounds of two regions with low prevalence and intensity of carp infestation in contrast to *E. nipponicum* occurs in carp in all regions of Latvia. During the present investigation pathogenic *D. vastator* was not found. The high amount of monogenea species is explained by match of life cycle of monogeneans and carp behaviour. The most monogenean eggs, or first stage larva, settle to the bottom of the pond where carp spend the main time of its life (Kottelat & Freyhof 2007, Bihovskij 1957).

Cestoda were represented by six species (parasitizing digestive tract, gall bladder, seroza,

Table 2. The range of carp infection in aquaculture by regions of Latvia

Nr.	Regions of Latvia / Parasite species (n=28)	The location of parasites	Kurzeme (n=41)		Zemgale (n=102)		Vidzeme (n=36)		Latgale (n=68)		Total
			I	E, %	I	E, %	I	E, %	I	E, %	
	Protista (n=4)										
1	Myxosporidia cysts	gills	-	-	-	-	-	-	+	5.9	**1**
2	*Ichtyophthirius multifiliis*	gills, body surface	-	-	+	14.7	+	5	+	2.9	**2**
3	*Trichodina* sp.	gills, body surface	-	-	+	34.3	+	5.6	-	-	**2**
4	*Apisoma* sp.	body surface	-	-	+	9.8	+	13.9	-	-	**2**
	Trematoda (n=4)										
5	*Diplostomum sphathaceum*, mtc.	eyes	1-7 / 2.7	38.5	1-12 / 2.5	34.3	4-9 / 4.5	52.8	1-12 / 5.4	7.4	**4**
6	*Apharingostrigea cornu,* mtc.	musculature	+	5.1	-	-	-	-	+	2.9	**2**
7	*Paracoenogonimus ovatus*, mtc.	musculature	-	-	+	1.2	-	-	+	4.4	**2**
8	*Ichtyocotylurus platycephalus*, mtc.	serosa	-	-	1-35 / 12.7	2.9	3	5.6	-	-	**2**
	Monogenoidea (n=7)										
9	*Dactylogyrus extensus*	gills	1-63 / 22.6	51.2	1-103 / 14.7	62.7	-	-	10-40 / 27.5	11.8	**3**
10	*D. achmerowi*	gills	1	5.1	2-88 / 28	70.6	-	-	41-292 / 175	8.8	**3**
11	*D. anchoratus*	gills	22	2.6	6-34 / 17.3	3.5	-	-	-	-	**2**
12	*D. minutus*	gills	2-9 / 5	7.7	-	-	-	-	-	-	**1**
13	*Gyrodactylus katharineri*	body surface	-	-	1-4 / 2.7	2.9	-	-	1	1.5	**2**
14	*Eudiplozoon nipponicum*	gills	1-15 / 5.4	19.0	1-11 / 2.4	16.2	1-20 / 6.1	52.8	1-15 / 5.3	25.5	**4**
15	*Paradiplozoon homoin homoin*	gills	-	-	2.4	5.8	2-5 / 3.5	5.6	-	-	**2**

Nr.	Regions of Latvia / Parasite species (n=28)	The location of parasites	Kurzeme (n=41)		Zemgale (n=102)		Vidzeme (n=36)		Latgale (n=68)		Total
			I	E, %	I	E, %	I	E, %	I	E, %	
	Cestoda (n=6)										
16	*Caryophyllaeus fimbriceps*	intestine	1-15 4	28.2	1-10 3.9	14.7	1-5 1.5	72	1-20 0. 6	45.6	**4**
17	*Paradilepis scolecina*	liver bile ducts, gall bladder, intestine	1-19 8	17.9	1-16 5.1	12.7	1	5.6	2-5 3	4.4	**4**
18	*Valipora campylancristrota*	gall bladder	1-11 3.3	25.6	1-8 7.3	8.8	1-4 2.3	8.3	1-10 4.7	17.6	**4**
19	*Neogryporhynchus cheilancristrotus*	gall bladder	-	-	1	1.2	1-12 3.6	25	-	-	**2**
20	*Bothriocephalus acheilognathi*	intestine	-	-	13	1.2	-	-	1	2.9	**2**
21	*Khawia sinensis*	intestine	-	-	1-9 4	5.8	-	-	-	-	**1**
	Nematoda (n=3)										
22	*Philometroides cyprini*	under scales, swim-bladder	1-10 4.8	12.8	1-3 1.3	7	1-14 4.3	11.1	1-29 5.8	35.3	**4**
23	*Raphidascaris acus*	intestine	-	-	1	1.2	-	-	-	-	**1**
24	*Schulmanela petruschewskii*	intestine	10	2.6	-	-	-	-	-	-	**1**
	Hirudinida (n=1)										
25	*Piscicola geometra*	gills, body surface	1	2.6	-	-	1	2.8	3	1.5	**3**
	Mollusca (n=1)										
26	*Anodonta cygnea*	gills	1	2.6	-	-	-	-	1	2.2	**2**
	Crustacea (n=2)										
27	*Argulus foliaceus*	body surface	1-3 2	5.1	1	2	1	2.8	-	-	**3**
28	*Ergasilus sieboldi*	gills	1	2.6	1-2 1.3	3.5	-	-	-	-	**2**
	Total		**16**		**22**		**12**		**15**		

(min-max)/mean intensity

liver bile ducts and gall bladder). *Caryophyllaeus fimbriceps, Paradilepis scolecina* and *Valipora campylancristrota* occurred in carp pounds in four regions of Latvia and were the most prevalent species with high intensity of fish infection. *Neogryporhynchus cheilancristrotus* was observed as single specimen in gall bladder from Zemgale region and ranged from 1 to 12 in number in nine carps from Vidzeme region. The next Cestoda species, *Bothriocephalus acheilognathi* occurred in three carps from two regions of Latvia, but *Khawia sinensis* in five fishes form Zemgale region and their number ranged from 1 to 9 parasites per fish.

There are three parasite species representative of Nematoda. Females of *Philometroides cyprini* were observed under scales, as well as males in swimbladder from all four regions of Latvia with higher prevalence (P=35.3%) and intensity (I=5.8) of infection in Latgale. Ten *Schulmanela petruschewskii* specimens were found in one carp from Kurzeme region, but common for many fish species *Raphidascaris acus* only as single specimen from Zemgale region.

Hirudinida *Piscicola geometra* and Glochidia *Anodonta cygnea* were found individually in the carp from three regions of Latvia. *P. geometra* prevalence ranged from 1.5% to 2.8%, intensity of infection varies from 1 to 3 parasites per fish. *A. cygnea* occurred similarly. Also, two species of Crustacea were rarely found with low intensity of carp infection.

DISCUSSION

There are 28 parasite species from eight systematic groups from 58 registered for carp were detected (Kirjušina and Vismanis 2007). Despite the fact that monogeneans are affected by many different abiotic and biotic factors such as water temperature, stream, salinity, fish density etc., and the ability of monogenea`s larvae to find host decreases in turbid and chemically polluted water (Zaostrovceva 2007), the greatest diversity of parasite species belongs to Monogenea group and they were detected in all regions of Latvia, what makes you think that water quality in ponds is suitable for aquaculture. Carp is cultivated in ponds with high density, therefore the monogeneans larvae can easily find a host. Also, reproduction of monogeneans is depending on water temperature. Most of the species reproduce more intensively when temperature rises, except *D. extensus* which is a resistant species to low temperature. It is known that usually temperature in ponds is higher than in lakes; therefore diversity of monegenea in ponds is richer. Aydogdu et al. (2001) reported that for *D. extensus* the optimal reproduction temperature is +17 °C, when temperature increases – reproduction of the parasites decreases. Jajali & Molnár (1990) detected *D. extensus* from freshwater fishes in different seasons, but in different intensity of infection. Monogeneans can cause mechanical damage, such as fusion of gill lamellae (Gusev et. al. 1985, Bakke et al. 2007, Toksen 2007).

Carp infestation with monogenean were less in Vidzeme region, as the number of investigated fishes was small (n = 36) the chance to detect rare species was low. A great number of carps were infected with common monogeneans such as *D. extensus* that have low host-specificity and high tolerance to a wide range of temperature and salinity, and *D. achmerowi,* that are highly specialized to environmental conditions and parasitize only on carp (Shamsi et. al. 2009). *D. anchoratus* and *D. minutus* were rare species in present investigation. Kir&Tekin Özan (2007) recorded *D. minutus* as common parasite of carp (P=38.09%) for south regions, because optimal temperature for *D. minutus* ontogenesis is higher.

Trematodes (n = 4) have less biodiversity than monogeneans (n = 7). The most of investigated carps were infected with *Diplostomum* sp., which definitive hosts are *Larus* genus birds, less other waterfowl. It explains the most infected fish habitat in seacoast regions (Kurzeme and west part of Vidzeme). Life cycle of *Diplostomum* sp. trematoda is also depending on distribution of molluscs (*Lymnaea* genus), which are intermediate hosts and are common

in eutrophic water bodies (Zaostrovceva 2007). *Diplostomum* sp. is pathogenic species for carp which in high level of invasion may cause a cataract (Scholz 1999).

The larva stages of trematoda *Apharingostrigea cornu* is a highly host specific parasite species for first intermediate host *Anisus contortus* molluscs and specific for definitive hosts *Ardea* genus birds, but there are many second intermediate host species. There are only two potential definitive hosts of *A. cornu,* Grey heron (*Ardea cinerea*) and Great Egret (*Ardea alba*) that habitat in Latvia (Clements 2007). However, parasite was rarely occurred in fish. As opposed to that, *P. ovatus* infest wide definitive host range (predator birds) and at least two intermediate hosts (molluscs). This parasite species parasitize in 18 fish species (Kirjušina and Vismanis 2007).

First intermediate hosts of cestodes and nematodes mainly are zooplankton crustaceans which reproduction and development are depending on seasonal fluctuation such as water temperature, water quality, eutrophication level etc. (Jiménez-Melero et. al. 2005). For example, a first intermediate host of *P. scolecina* is *Eudiaptomus graciloides,* which development mainly depends on water temperature. These crustaceans intensively reproduce in warm season, but in low temperatures reproduction is terminated. Thereby, the distribution of *E. graciloides* could reduce a prolonged winter, poor water quality and high water pH. The most pathogenic cestoda is *B. acheilognathi,* which can cause lesions of intestinal wall and atrophy of fish tissue (Scholz 1999). That is reported in carp pond since 1972 (Kirjusina and Vismanis, 2004).

Parasites with direct life cycle (monogeneas, leeches, molluscs, crustaceans etc.) are negatively affected by anthropogenic pollution (Kurbanova et. al. 2002), due larvae development stages, which occurs in the aquatic environment. Some factors that may affect development of previously mentioned parasites are low in eutrophication level, deficiency of organic substances in ponds etc. However, crustacean *E. sieboldi* are resistant to water pollution (Zaostrovceva 2007). Infection by the same parasite species, such as *E. sieboldi*, glochidia, etc. is related to the biology of the host. Active carp movement in search for feed makes it difficult for fish to get infected with mentioned species, which are common for inactive lifestyle hosts. *E. sieboldi* are feeding by epithelium, mucus and blood of gills and cause anaemia, hyperplasia, increased secretion of mucus on the respiratory organs of fish and secondary bacterial infections. Also, there is documented seasonality of disease outbreaks that occur in July and August as parasite numbers increase (Einszporn 1964, 1965a, b, Dezfuli et al. 2003, Roberts, 2012).

In general, the greatest number of parasite species was detected in Zemgale region (n = 22), that can be explained by the large number of examined fish (n = 102) therefore rare species were found (see Table 2).

Parasites, especially pathogenic for fish, can negatively affect the fisheries due to low quality of the fish or high fish mortalities. High density of fish in aquaculture contributes parasitic diseases, thus parasitological investigations are actual for all types of farms.

REFERENCES

Aydoğdu A., Öztürk M. O., Oğuz C. M., Altunel N. F., 2001. Investigations on Metazoan Parasites of the Common Carp (*Cyprinus carpio* L. 1758) in Dalyan Lagoon, Karacabey, Turkey. *Acta Veteriharia,* 51 (5-6): 351 – 358.

Bagge A. M., Poulin R., Valtonen E. T., 2004. Fish population size, and not density, as the determining factor of parasite infection: a case study. *Parasitology,* 128: 305 – 313.

Bakke T. A., Cable J., Harris P. D., 2007. The biology of gyrodactylid monogeneans: the "Russian-doll killers". *Adv. Parasitol.* 64:

161 – 376.

Bauer O. N. et. al., 1987. Key of the parasites of freshwater fishes in fauna of the U.S.S.R. (3) (in Russian), Leningrad, Nauka, 583. (Бауер О. Н. и др. 1987. Определитель паразитов пресноводных рыб фауны СССР. Том 3. Ленинград. Наука. 583).

Bihovskaja – Pavlovskaja I. E., 1985. Fish parasites (in Russian), Nauka, 120. (Быховская – Павловская И. Е., 1985. Паразиты рыб. Руководство по изучению. Наука. 120.)

Bihovskij B. E., 1957. Monogenean system and phylogeny (in Russian). Moskov – Leningrad, 509. (Быховский Б. Е., 1957. Моногенетические сосальщики, их система и филогения. Москва – Ленинград, 509.)

Bush A. O., Lafferty K. D., Lotz J. M., Shostak A. W., 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited, *Journal of Parasitology,* 83: 575–583.

Clements J., 2007. The clements checklist of birds of the world, 6th edition. Cornell University Press, 843.

Dezfuli B. S., L. Giari R., Konecny P., Jaeger M. Manera, 2003. Immunohistochemistry, ultrastructure and pathology of gills of *Abramis brama* from Lake Mondsee, Austria, infected with *Ergasilus sieboldi* (Copepoda), *Diseases of Aquatic Organisms*, 53: 257 – 262.

Dickerson H., Clark T., 1998. *Ichthyophthirius multifiliis*: a model of cutaneous infection and immunity in fishes. *Immunol Rev.,* 166: 377 – 384.

Einszporn T., 1964. Observation on the kind of food taken up by *Ergasilus siebildi* Nordmann. *Wiadomosci Parazytologiczne,*10: 527 – 529.

Einszporn T., 1965a. Nutrions of *Ergasilus sieboldi* Nordmann. I. The uptake of food and the food material. *Acta Parasitologica Polonica,* 13: 373 – 380.

Einszporn T., 1965b. Nutrions of *Ergasilus sieboldi* Nordmann. I. Histological structure of the alimentary canal. *Acta Parasitologica Polonica,* 13: 71 – 80.

Ewing M. S., Kocan K. M., 1992. Invasion and development strategies of *Ichthyophthirius multifiliis*, a parasitic ciliate of fish. *Parasitol Today,* 8: 204 – 208.

Gusev A. V. (ed.), 1985. Key of the parasites of freshwater fishes in fauna of the U.S.S.R. (2) (in Russian), Leningrad, Nauka, 425. (Гусев А. В. и др., 1985. Определитель паразитов пресноводных рыб фауны СССР. Том 2. Ленинград. Наука. 425).

Jajali B., Molnár K., 1990. Occurence of monogeneans of freshwater fishes in Iran: *Dactylogyrus* spp. on cultured Iranian fishes. *Acta Veterinaria Hungarica,* 38 (4): 239 – 242.

Jiménez – Melero R., Santer B., Guerrero F., 2005. Embryonic and naupliar development of *Eudiaptomus gracilis* and *Eudiaptomus graciloides* at different temperatures: comments on individual variability. J*ournal of plankton research*, Vol. 27: 1175 – 1187.

Kennedy C. R., Watt R. J., 1994. The decline and natural recovery of an unmanaged coarse fishery in relation to changes in land use and attendant eutrophication. In Rehabilitation of Freshwater Fisheries. Pp. 366–375.

Kir İ., Tekin Özan S., 2007. Helminth Infections in Common Carp, *Cyprinus carpio* L., 1758 (Cyprinidae) from Kovada Lake (Turkey). *Türkiye Parazitoloji Dergisi*, 31 (3): 232 – 236.

Kirjusina M. and Vismanis K., 2004. Freshwater and marine fish parasites in Latvia. Clased catalogue. St.-Petersburg. 100 (In Russian). (Кирюшина М. и Висманис К., 2004. Паразиты пресноводных и морских рыб Латвии. Систематический каталог. Санкт-Петербург. 100.).

Kirjusina M., Vismanis K., 2007. Checklist of the parasites of fishes of Latvia, Food and Agriculture Organization of the United Nations, Rome, 106.

Kottelat M., Freyhof J., 2007. Handbook of European freshwater fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany, 646

Kurbanova A. I., Urazbajev A. N., Jusupov O. Ju., 2002. Changes of parasitofauna of some fish species in Southern Aral Sea under the influence of anthropogenic pressure (in Russian). *Vestnik zoologii*, 36 (1): 29 – 34. (Курбанова А. И. Влияние антропогенных факторов на паразитов рыб водоемов Южной Приаралья. *Вестник зоологии,* 36 (1): 29 – 34).

Molnár K., 2009. Data on the parasite fauna of the European common carp *Cyprinus carpio carpio* and Asian common carp *Cyprinus carpio haematopterus* support an Asian ancestry of the species. *International Journal of the Bioflux Society,* 2 (4): 391 – 400.

Nigrelli R. F., Pokorny A. S., Ruggieri G. D., 1976. Notes on *Ichthyophthirius multifiliis* a ciliate parasite on freshwater fishes, with some remarks on possible physiological races and species. *Trans. Am. microsc. Soc.,* 95: 607 – 613.

Plikšs M., Aleksejevs Ē., 1998. Zivis. Gandrs. 304.

Roberts R. J., 2012. (Editor) Fish Pathology. 4th edition. Wiley-Blackwell. Pp. 581.

Scholz T., 1999. Parasites in cultured and feral fish. *Veterinary Parasitology,* 84: 317–335.

Shamsi S., Jalali B., Aghazadeh Meshgi, M., 2009. Infection with *Dactylogyrus* spp. among introduced cyprinid fishes and their geographical distribution in Iran. *Iranian Journal of Veterinary Research, Shiraz University,* Vol. 10: 70 – 74.

Toksen E., 2007. *Lernanthropus kroyeri* van Benden, 1841 (Crustacea: Copepoda) infections of cultured sea bass (*Dicentrarchus labrax* L.). *Bulletin of the European Union of Fish Pathologists*, 27: 49 – 53.

Zaostrovceva S. K., 2007. Environmental analysis of parasite fauna of fish in Vistula Lagoon, rivers Preloga and Prohladhaja (in Russian), Kaliningrad, 1 – 24. (Заостровцева С. К. 2007. Эколого-фаунистический анализ паразитофауны рыб Вислинского залива, рек Преголи и Прохладной. Калининград: ГФГОУ ВПО Калининградский государственный технический университет. 1 – 24).

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