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Parasitological survey of some important fish species of Lake Balaton

Kálmán MOLNÁR and Csaba SZÉKELY

Veterinary Medical Research Institute of the Hungarian Academy of Sciences, H–1143 Budapest, Hungária krt. 21, Hungary

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Abstract: In the framework of a one-year survey, the parasitic infections of 299 specimens of the 15 economically and faunistically most important fish species of Lake Balaton were monitored. Seventy-one parasites species were identified to the species and 17 to the genus, and the data obtained on the parasites are reported. In Lake Balaton, the introduced eel parasite *Anguillicola crassus* can be considered the most prevalent parasite species. Besides the definitive host, it could be detected in several fish species acting as paratenic hosts. Occasionally a rather intensive *Ergasilus sieboldi* infection occurred on the pike-perch: both the gills and the operculum of the fish were covered by large masses of these crustaceans. *Ichthyocotylurus* metacercariae adhering to the pericardium of the pike-perch and the specimens of *Tracheliastes maculatus* colonising the body surface of the bream in the spring months seem to have pathological significance. Of the parasites found, *Hoferellus carassii, Spironucleus elegans, Paradilepis scolecina* and *Orientocreadium siluri* are now reported from Lake Balaton for the first time.

Key words: Protozoa (Mastigophora, Apicomplexa, Myxozoa, Ciliophora), Platyhelminthes (Monogenea, Cestoda, Aspidogastrea, Trematoda), Nemathelminthes (Nematoda), Annelida (Hirudinea), Mollusca (Bivalvia), Arthropoda (Crustacea), hosts: *Stizostedion lucioperca, S. volgensis, Anguilla anguilla, Abramis brama, Carassius auratus gibelio, Neogobius fluviatilis, Gymnocephalus cernuus, Silurus glanis, Pelecus cultratus, Blicca bjoerkna, Cyprinus carpio, Ctenopharyngodon idella, Hypophthalmichthys molitrix, Tinca tinca, Aspius aspius,* seasonal changes, parasite fauna, Lake Balaton

INTRODUCTION

Lake Balaton is the lake of the biggest water surface in Central Europe. It is important for Hungary as a site of both recreation and fishing.

Because of its shallow water, Lake Balaton is extremely sensitive to environmental effects. Therefore, factors influencing the biological balance of the lake very often give rise to fish mortality. Although the parasite fauna of Lake Balaton fishes is relatively well studied, the fish mortalities observed in recent years call for more thorough investigations.

The earliest studies were carried out by Rátz (1897) who reported the occurrence of some protozoan, metazoan and crustacean parasites in the lake. Subsequently, data on the occurrence of parasites were contained in the works of Jaczó (1940, 1941, 1949), who also described some new myxosporean species from fishes. Systematic studies on the parasite fauna of Lake Balaton were performed by Molnár (1962, 1964, 1966a, b, 1968, 1969, 1970a, b) who provided data primarily on the occurrence of helminth parasites. Of the other authors, Geyer (1939a, b) and Ponyi and Molnár (1969) reported on the crustacean parasites occurring on Lake Balaton fishes. Faunistic studies have been conducted by Matskási (1967, 1968), Matskási et al. (1971), and Mészáros (1967, 1968). Mödlinger (1934) reported the frequent incidence of *Apophallus donicus* while Molnár et al. (1968) that of *Ligula intestinalis*. Relatively little is known about the protozoan infections of Lake Balaton fishes. Although the occurrence of some species has been described by Molnár (1970a, b), instead of conducting a systematic faunistic survey only the development of some species has been studied and some new species have been demonstrated (Molnár 1988, 1989).

A new survey of the parasite fauna was called for by the massive eel mortality that occurred in Lake Balaton in 1991-1992, which Molnár et al. (1991, 1993) attributed to the swimbladder injury caused by the introduced eel nematode *Anguillicola crassus*.

Of the fish species living in Lake Balaton, the pike-perch, which is the "heraldic fish" of the lake, and the introduced eel have outstanding economic importance. Other fish species whose health status can affect the biological balance of the lake include the bream (which accounts for 80% of the fishermen's catch), the ruffe and bleak serving as pike-perch food, and the river goby and gibel carp which are new arrivals (Bíró 1995).

The aim of this work was to detect the parasites of these fish species and to collect data on their seasonal occurrence.

MATERIALS AND METHODS

The studies were conducted in 1994, in the fishing season which lasted from 16 April to 9 November. On a total of 12 occasions, 299 fish belonging to 15 different species were collected at several sampling sites of the lake (Alsóörs, Sóstó, Csopak, Tihany, Szemes, Keszthely) and subjected to complete parasitological examination. Of the species included in our test protocol higher numbers of fish were dissected: thus, the results contain parasitological data of 55 pike-perch (*Stizostedion lucioperca*), 29 Volga pike-perch (*Stizostedion volgense*), 82 eels (*Anguilla anguilla*), 60 breams (*Abramis brama*), 18 gibel carp (*Carassius auratus gibelio*) and 27 river gobies (*Neogobius fluviatilis*). The distribution and numbers of the fish species of which only a few specimens were examined were as follow: sheatfish (*Silurus glanis*) 4, ruffe (*Gymnocephalus cernuus*) 4, knife (*Pelecus cultratus*) 3, white bream (*Blicca bjoerkna*) 7, common carp (*Cyprinus carpio*) 4, grasscarp (*Ctenopharyngodon idella*) 1, silver carp (*Hypophthalmichthys molitrix*) 2, tench (*Tinca tinca*) 2, and asp (*Aspius aspius*) 1. The body length of the fish species studied was not uniform (it ranged between 10 and 75 cm). The fish derived from the fishermen's catch included bigger specimens while those caught with a small net were of smaller size, due to the use of nets of different mesh sizes. The species distribution of the fish studied at the individual sampling times was unfortunately not uniform, as it depended on the catch.

Most of the fish were caught from the basin of the lake with the help of the research boat of the Limnological Research Institute of the Hungarian Academy of Sciences and of

fishermen from the Balaton Fisheries Co. Ltd. In some instances, we caught fish in the littoral zone with our own 20-metre trawl-net. In each case, the fish were transported to the laboratory alive, in aerated cans or nylon bags inflated with oxygen. When samples were taken in the summer, the water used for transportation was cooled with ice. After arrival at our institute, the fish were placed into concrete basins with flow-through water or in large plastics tanks with air insufflation, and were then dissected within the shortest time possible (within a few days). As far as possible, all inner organs (liver, kidney, heart, intestines, swimbladder, gallbladder), the gill filaments, the eyes, the fins and the skin were examined during dissection. The examinations included dissections under stereomicroscope, a light-microscopic protozoological examination, and a histological processing of the most interesting cases. The taxonomical classification of the demonstrated parasites was done on the basis of Lom and Dykova's manual (1992) and, for the metazoans, the parasite identification handbook edited by Bauer (1985, 1987).

RESULTS

The taxonomical position and species composition of the parasites recorded during the dissections are shown in parasite-host list. Data on the occurrence of parasites by fish species and depending on the season are contained in Tables 1-7.

Parasite-host relationships

PROTOZOA

Mastigophora

Kinetoplastidea

TRYPANOSOMATIDAE

Trypanosoma danilewskyi Laveran et Mesnil, 1904 — *Abramis brama*

Diplomonadea

HEXAMITIDAE

Spironucleus elegans Lavier, 1936 — *Carassius auratus gibelio*

Apicomplexa

Coccidia

EIMERIIDAE

Eimeria anguillae Léger et Hollande, 1922 — *Anguilla anguilla*
Eimeria rutili Dogiel et Bychovsky, 1938 — *Abramis brama*
Goussia acerinae (Pellérdy et Molnár, 1971) — *Gymnocephalus cernuus*
Goussia carpelli (Léger et Stankovitch, 1921) — *Cyprinus carpio, Carassius auratus gibelio*
Goussia pannonica Molnár, 1989 — *Abramis brama*
Goussia leucisci (Schulman et Zaika, 1964) — *Abramis brama, Carassius auratus gibelio*
Goussia stankovitchi (Stankovitch, 1920) — *Abramis brama*
Goussia sinensis (Chen, 1956) — *Hypophthalmychthis molitrix*
Goussia sp. *I.* — *Stizostedion volgense*
Goussia sp. *II.* — *Stizostedion volgense*
Goussia sp. *III.* — *Neogobius fluviatilis*

Myxozoa

Myxosporea

SPHAEROSPORIDAE

Sphaerospora danubialis Molnár, 1991 — *Stizostedion lucioperca, Stizostedion volgense*
Sphaerospora spp. — *Pelecus cultratus, Abramis brama*
Myxobilatus legeri (Cépéde, 1905) — *Abramis brama, Aspius aspius, Pelecus cultratus*
Hoferellus carassii Achmerov, 1960 — *Carassius auratus gibelio*
Chloromyxum sp. — *Abramis brama*
Myxidium rhodei Léger, 1905 — *Abramis brama*
Myxidium giardi Cépede, 1906 — *Anguilla anguilla*
Myxidium spp. — *Aspius aspius, Abramis brama, Pelecus cultratus, Hypophthalmychthis molitrix*

MYXOBOLIDAE

Myxobolus bramae Reuss, 1906 — *Abramis brama*
Myxobolus cyprini Doflein, 1898 — *Cyprinus carpio*
Myxobolus pseudodispar Gorbunova, 1936 — *Abramis brama*
Myxobolus portucalensis Saraiva et Molnár, 1990 — *Anguilla anguilla*
Myxobolus spp. — *Stizostedion lucioperca, Stizostedion volgense, Abramis brama, Blicca bjoerkna*
Henneguya creplini (Gurley, 1894) — *Stizostedion lucioperca*

Ciliophora

Kinetophragminophorea

TRICHOPHRYIDAE

Capriniana piscium (Bütschli, 1889) — *Stizostedion lucioperca*

Oligohymenophorea

ICHTHYOPHTHIRIIDAE

Ichthyophthirius multifiliis Fouquet, 1876 — *Stizostedion lucioperca, Abramis brama*

TRICHODINIDAE

Trichodina sp. — *Stizostedion lucioperca*
Trichodinella sp. — *Stizostedion lucioperca*

EPISTYLIDIDAE

Apiosoma spp. — *Stizostedion lucioperca, Gymnocephalus cernuus*

Miscellaneous organisms:

Dermocystidium percae Reichenbach-Klinke, 1950 — *Stizostedion lucioperca*

Metazoa

Platyhelminthes

Monogenea

DACTYLOGYRIDAE

Dactylogyrus auriculatus (Nordmann, 1832) — *Abramis brama*
Dactylogyrus falcatus (Wedl, 1857) — *Abramis brama*
Dactylogyrus wunderi Bychowsky, 1931 — *Abramis brama*
Dactylogyrus zandti Bychowsky, 1933 — *Abramis brama*
Dactylogyrus amphibothrium Wagener, 1857 — *Gymnocephalus cernuus*
Dactylogyrus hemiamphibothrium Ergens, 1956 — *Gymnocephalus cernuus*

Dactylogyrus extensus Mueller et van Cleave, 1932 — *Cyprinus carpio*
Pseudodactylogyrus bini (Kikuchi, 1929) — *Anguilla anguilla*
Pseudodactylogyrus anguillae (Yin et Sproston, 1948) — *A. anguilla*
Ancyrocephalus paradoxus Creplin, 1839 — *Stizostedion lucioperca, Stizostedion volgense*

GYRODACTYLIDAE

Gyrodactylus luciopercae Gussev, 1962 — *Stitostedion lucioperca, Stizostedion volgense*
Gyrodactylus spp. — *Neogobius fluviatilis, Gymnocephalus cernuus*

DIPLOZOIDAE

Diplozoon paradoxum Nordmann, 1932 — *Abramis brama*
Paradiplozoon pavlovskii (Bychowsky et Nagibina, 1959) — *Aspius aspius*

Cestoda

CARYOPHYLLIDAE

Caryophyllaeus laticeps (Pallas, 1781) — *Abramis brama*
Caryophyllaeus fimbriceps Annenkova-Chlopina, 1919 — *Cyprinus carpio*

TRIAENOPHORIDAE

Triaenophorus nodulosus (Pallas, 1781) (l.) — *Stizostedion lucioperca*

LIGULIDAE

Ligula intestinalis (Linnaeus, 1758) (l.) — *Abramis brama*
Ligula sp. (l.) — *Neogobius fluviatilis*

BOTHRIOCEPHALIDAE

Bothriocephalus claviceps (Goeze, 1782) — *Anguilla anguilla*

PROTEOCEPHALIDAE

Proteocephalus cernuae (Gmelin, 1790) — *Gymnocephalus cernuus*
Proteocephalus percae (Müller, 1780) — *Stizostedion lucioperca, Stizostedion volgense*
Proteocephalus macrocephalus (Creplin, 1825) — *Anguilla anguilla*
Proteocephalus osculatus (Goeze, 1782) — *Silurus glanis*
Proteocephalus torulosus (Batsch, 1786) — *Aspius aspius*
Proteocephalus sp. — *Neogobius fluviatilis*

DILEPIDIDAE

Paradilepis scolecina (Rudolphi 1919) (l.) — *Abramis brama, Carassius auratus gibelio*

Aspidogastrea

ASPIDOGASTRIDAE

Aspidogaster limacoides Diesing, 1895 — *Cyprinus carpio*

Trematoda

BUCEPHALIDAE

Bucephalus polymorphus Baer, 1827 — *Stizostedion lucioperca, Stizostedion volgense*
Bucephalus polymorphus (l.) — *Stizostedion lucioperca, Stizostedion volgense*
Rhipidocotyle illense (Ziegler, 1883) — *Stizostedion lucioperca, Stizostedion volgense*
Rhipidocotyle illense (l.) — *Abramis brama, Stizostedion lucioperca, Stizostedion volgense*

SANGUINICOLIDAE

Sanguinicola inermis Plehn, 1905 (l.) — *Cyprinus carpio, Carassius auratus gibelio*
Sanguinicola sp. (l.) — *Abramis brama*

MONORCHIDAE

Asymphylodora immitans (Mühling, 1898) — *Abramis brama, Blicca bjoerkna*

Asymphylodora tincae (Modeer, 1790) — *Tinca tinca*

OPECOELIDAE

Nicolla skrjabini (Iwanitzky 1928) — *Stizostedion lucioperca, Stizostedion volgense, Gymnocephalus cernuus , Pelecus cultratus*

ORIENTOCREADIIDAE

Orientocreadium siluri (Bychowsky et Dubinina, 1954) — *Silurus glanis*

HETEROPHYIDAE

Apophallus muehlingi (Jägerskiöld 1898) (l.) — *Stizostedion lucioperca, Abramis brama, Carassius auratus gibelio*

DIPLOSTOMIDAE

Diplostomum spathaceum (Rudolphi, 1819) (l.) — *Stizostedion lucioperca, Abramis brama, Carassius auratus gibelio, Ctenopharyngodon idella, Silurus glanis, Hypophthalmichthys molitrix*

Tylodelphis clavata (Nordmann, 1832) — *Stizostedion volgense*

STRIGEIDAE

Ichthyocotylurus spp. — *Stizostedion lucioperca, Stizostedion volgense, Abramis brama, Gymnocephalus cernuus, Blicca bjoerkna*

Nemathelminthes

Nematoda

CAMALLANIDAE

Camallanus truncatus (Rudolphi, 1814) — *Stizostedion lucioperca, Stizostedion volgense, Gymnocephalus cernuus*

PHILOMETRIDAE

Philometra ovata (Zeder, 1803) — *Abramis brama*

Philometra kotlani (Molnár, 1969) — *Aspius aspius*

Philometroides sanguinea (Rudolphi, 1819) — *Carassius auratus gibelio*

DRACUNCULIDAE

Anguillicola crassus Kuwahara, Niimi et Itagaki, 1974 — *Anguilla anguilla*

Anguillicola crassus (l.) — *Neogobius fluviatilis, Pelecus cultratus, Gymnocephalus cernuus, Silurus glanis*

DANICONEMATIDAE

Daniconema anguillae Moravec et Koie, 1897 — *Anguilla anguilla*

Daniconema anguillae (l.) — *Anguilla anguilla*

ANISAKIDAE

Contracoecum sp. (l.) — *Abramis brama*

Raphidascaris acus (Bloch, 1779) (l.) — *Stizostedion volgense*

Annelida

Hirudinea

PISCICOLIDAE

Piscicola geometra (Linnaeus, 1761) — *Abramis brama*

Mollusca

Bivalvia

UNIONIDAE

Anodonta sp. (l.) — *Stizostedion lucioperca, Stizostedion volgense, Pelecus cultratus*

Arthropoda

Crustacea

ERGASILIDAE

Ergasilus sieboldi Nordmann, 1832 — *Stizostedion lucioperca, Stizostedion volgense, Abramis brama, Carassius auratus gibelio, Silurus glanis, Pelecus cultratus, Cyprinus carpio, Ctenopharyngodon idella, Tinca tinca*

Ergasilus gibbus Nordmann, 1832 — *Anguilla anguilla*

LERNAEOPODIDAE

Achtheres percarum Nordmann, 1832 — *Stizostedion lucioperca, Stizostedion volgense*

Tracheliastes maculatus Kollar, 1836 — *Abramis brama*

ARGULIDAE

Argulus foliaceus (Linnaeus, 1758) — *Stizostedion lucioperca, Tinca tinca*

In the pike-perch (Table 1), a gut-parasitic trematode, *Rhipidocotyle illense* proved to be the commonest parasite: its metacercariae were also found on pike-perch. (Members of the genera *Rhipidocotyle* and *Bucephalus* differ only in the fimbria located at the cephalic end. At the same time, the cephalic fimbria of *B. polymorphus* are often drawn in; therefore, the data presented in the table not necessarily reflect the real incidence ratio of the two species). The nematode *Camallanus truncatus*, found in the gut and in the pyloric appendices, also proved to be a common pike-perch parasite.

Of the protozoan parasites, *Trichodina* spp. identified only to genera found on the gills occur much more frequently than suggested by the data shown in the table; namely, these ectoparasites disappear soon after placing the fish into an aquarium.

The cysts of *Henneguya creplini* could be detected on the gills in practically all seasons; however, spores developed in them only in the early spring period.

The renal tubules of pike-perch dissected in the spawning period often contained spores of *Sphaerospora danubialis*.

Of the pathogenic parasite species, mention should be made of the "teracotyle" metacercariae of the *Ichthyocotylurus* species parasitic in birds. These metacercariae were located in the abdominal organs and the peripharyngeal tissues, but in the majority of cases they also occurred as a mass attached to the pericardium, moving together and identical in size with the heart.

The gill-parasitic helminth *Ancyrocephalus paradoxus* was consistently found to possess demonstrable pathogenicity. Groups of this monogenean colonised the filaments at the convolutions of the gill arch; at these places the filaments broke and came off in fragments.

Ergasilus sieboldi infection also gave rise to gill lesions well visible with the unaided eye. That parasite established itself in large masses on the gill filaments and also on the external surface of the operculum.

The parasite fauna of the Volga pike-perch (Table 2) is practically identical with that of the pike-perch. It was interesting to note that in this fish species the individuals of *E. sieboldi* could only be found, in lower numbers, on the operculum. *Achtheres percarum*, which commonly occurred on the pike-perch, could not be demonstrated on the Volga pike-perch.

As regards the protozoan fauna, the *Goussia* species causing nodular coccidiosis and revealed by an early spring examination should be mentioned.

Only aimed studies concentrating on a few species were carried out on the parasite fauna of the eel (Table 3). First of all the infection and swimbladder lesions caused by *Anguillicola crassus* were monitored; however, we consistently looked for the occurrence of two fin parasites, *Myxobolus portucalensis* and *Daniconema anguillae* as well.

The commonest parasites of the bream (Table 4) included *Myxobolus* species and *E. sieboldi* specimens on the gills, the imago stages of *Asymphylodora immitans* in the gut and the metacercaria stages of *Apophallus muehlingi* in the fins. In the May to mid-June period female specimens of *Tracheliastes maculatus* were found on the skin of all breams examined. The species indicated in the table as *Myxobolus* sp. I, II and III seem to represent separate species differing in location and morphology. In all probability, one of them found on the scales is a hitherto undescribed new parasite. In all but two cases, the developing female specimens of *Ph. ovata* were detected from breams infected with *Ligula intestinalis* plerocercoids. At the same time, the so-called "retarded", non-developing specimens of *Ph. ovata* were found in the swimbladder of all breams examined. The data shown in the tables indicate lower-than-actual prevalence values, as not all fish were dissected in physiological saline, which procedure is a precondition of reliable detection.

Only large sized, several years old specimens of gibel carp could be obtained from the fishermen. These fish were found to have a surprisingly low degree of parasitic infection (Table 5). At the same time, two protozoans (*Hoferellus carassii* and *Goussia carpelli*) proved to be very common parasites.

As a fish species that has recently migrated into Lake Balaton, the river goby is infected by few parasite species (Table 6). No specific parasite was detected among the species found. At the same time, the river goby showed a conspicuously intensive infection with 3rd stage larvae of the eel parasite *A. crassus*.

As regards the parasitic infections of other fish species (Table 7), the low-intensity infection of the common carp and the extremely rare occurrence of parasite-free individuals should be mentioned.

The intensity of infection of other cyprinid species corresponds to that observed in the bream.

In the sheatfish fry and the ruffe (Table 6), infection with 3rd stage larvae of *A. crassus* was a conspicuous finding. In the sheatfish this infection even caused mortality due to ascites.

DISCUSSION

Studies on the parasite fauna and seasonal occurrence of fish species living in a given habitat require extremely lengthy and consistent work. Studies of such type have first of all been carried out by specialists from the former Soviet Union. Of them, Shulman and Chernisheva (1969) studied the parasite fauna of fish in Lake Selinger, Allamuratov (1974) in the watershed area of the Surchandarya, while Pugachev (1984) studied it in fish derived from some rivers of North-east Asia. Data on the parasite fauna of fish in different reaches

Table 1

Parasitic infections of *Stizostedion lucioperca* in Lake Balaton in 1994

		Spring	Summer				Autumn	
Number of fish examined		1	7	10	5	4	4	13	11
Body length (cm)		16	15–50	5–40	5–20	20–42	33–51	12–33	30–51
Sampling time		Apr	Jun	Jun	Jul	Aug	Sep	Oct	Nov
Sampling site		Szemes	Tihany	Keszthely	Csopak	Keszthely	Keszthely	Keszthely	Alsóörs
Parasite recorded	Location								
Ichthyophthirius multifiliis	fins, gills	–	–	2/*	–	–	–	–	–
Trichodinella sp.	gills	–	–	6/(*–***)	–	–	–	–	1/*
Trichodina spp.	fins, gills	1/**	2/(*–**)	4/(*–**)	1/***	–	–	1/*	–
Capriniana piscium	gills	–	–	–	–	–	–	1/***	–
Apiosoma sp.	gills	1/**	–	–	–	–	–	–	–
Sphaerospora danubialis	kidney	1/***	–	–	–	–	–	–	–
Henneguya creplini	gills	–	3/(*–**)	7/(*–***)	–	2/**	1/*	1/**	5/(*–***)
Myxobolus sp.	kidneys	–	1/*	–	–	1/*	–	–	–
Dermocystidium percae	fins	–	1/**	1/*	–	–	–	2/*	–
Ancyrocephalus paradoxus	gills, operc.	–	1/40	8/9.8(1–18)	–	1/4	–	6/2.2(1–7)	7/4.4(2–8)
Gyrodactylus luciopercae	fins	1/30	1/30	–	–	–	–	–	–
Triaenophorus nodulosus (l.)	liver	–	1/1	–	–	–	–	–	–
Proteocephalus percae	gut	–	3/32(10–70)	2/25(20–30)	1/15	–	–	–	–
Bucephalus polymorphus (l.)	fins, gills	–	1/20	3/2.7(2–3)	–	–	–	–	–
Bucephalus polymorphus	gut	1/3	2/24	5/4.4(2–8)	–	–	1/25	5/8.8(3–21)	3/5.3(4–6)
Rhipidocotyle illense (l.)	fins	–	–	1/1	–	–	–	1/1	1/1
Rhipidocotyle illense	gut	1/10	5/58	7/69(1–300)	–	5/43(30–50)	2/51(42–60)	13/19.5(4–48)	9/14.1(4–20)
Nicolla skrjabini	gut	–	1/6	–	1/15	4/17(5–22)	–	–	3/7.3(2–14)
Diplostomum spathaceum (l.)	eye lenses	–	–	–	–	–	1/12	–	–
Ichthyocotylurus spp. (l.)	abd. cavity, heart	1/6	3/9.3(6–30)	5/16.4(6–25)	2/5(2–8)	1/8	2/2.5(2–3)	10/13.1(1–30)	8/62.9(20–118)
Apophallus muehlingi (l.)	fins	1/*	–	3/(*–***)	–	1/*	–	–	1/*
Camallanus truncatus	gut	1/20	4/15.8(3–20)	2/2(2)	1/15	3/2.7(2–4)	2/5(2–8)	10/9.1(4–22)	10/24.9(14–42)
Ergasilus sieboldi	gills, operc.	–	6/48(10–100)	5/63.6(22–99)	–	3/24(1–70)	1/6	11/28.2(1–50)	10/54.4(28–100)
Argulus foliaceus	fins	–	1/1	3/1.7(1–3)	–	2/1(1)	–	–	1/1
Achtheres percarum	gills	–	6/13.7(8–30)	6/7.8(5–10)	–	3/3(1–6)	–	3/2.3(1–4)	10/5.7(1–16)
Anodonta sp. (l.)	gills, fins	–	–	4/5.5(2–8)	–	1/1	–	–	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 2

Parasitic infections of *Stizostedion volgense* in Lake Balaton in 1994

		Spring		Summer		Autumn	
Number of fish examined		6	3	3	11	5	2
Body length (cm)		14–21	23–28	13–16	14–29	14–27	29–30
Sampling time		Apr	May	Aug	Sep	Oct	Nov
Sampling site		Szemes	Szemes	Keszthely	Keszthely	Keszthely	Alsóörs
Parasite recorded	Location						
Goussia sp. I	gut	–	–	–	1/**	–	–
Goussia sp. II	gut	2/(*–***)	–	–	–	–	–
Sphaerospora danubialis	kidney	2/(*–***)	–	–	2/*	–	–
Myxobolus spp.	gut, kidney	2/*	–	–	–	–	–
Ancyrocephalus paradoxus	gills, operc.	6/6.2(2–15)	1/40	8/9.8(1–18)	–	1/4	–
Gyrodactylus luciopercae	fins	2/5(1–10)	1/4	–	–	–	–
Proteocephalus percae	rectum	–	–	1/12	–	–	–
Bucephalus polymorphus	gut	2/10(10)	1/10	–	3/6.3(3–10)	–	–
Rhipidocotyle illense	gut	4/23.8(5–40)	2/22(14–30)	3/31.7(15–40)	5/29.4(11–70)	4/17.5(7–39)	1/16
Nicolla skrjabini	gut	1/20	–	2/11.5(3–20)	4/1.8(1–2)	1/3	–
Ichthyocotylurus spp. (l.)	body cavity	4/9(4–20)	1/30	2/11.5(8–15)	11/40.1(8–100)	2/24.5(18–31)	2/39(35–43)
Tylodelphis clavata	eye lens	–	1/2	–	–	–	–
Raphidascaris acus (l.)	gut wall	–	–	1/1	–	–	–
Camallanus truncatus	gut wall	5/23.2(4–50)	3/12.7(3–20)	2/8(8)	11/8.8(2–20)	4/5.5(3–8)	2/46(45–47)
Anguillicola crassus (l.)	gut wall	–	–	2/19(16–22)	1/35	–	–
Ergasilus sieboldi	gills	–	–	1/10	–	–	2/31(18–44)
Anodonta sp. (l.)	gills, fins	3/2.3(2–3)	–	2/2.5(2–3)	–	–	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 3

Parasitic infections of *Anguilla anguilla* in Lake Balaton in 1994

		Spring			Summer			Autumn		
Number of fish examined		2	4	13	3	6	5	15	12	21
Body length (cm)		71–75	61–70	54–80	45–74	22–74	30–50	42–75	46–84	46–72
Sampling time		Apr	Apr	Jun	Jun	Jul	Jul	Aug	Sep	Oct
Sampling site		Szemes	Keszthely	Tihany	Keszthely	Tihany	Csopak	Keszthely	Keszthely	Keszthely
Parasite recorded	Location									
Anguillicola crassus	swimbladder	2/13.5(1–26)	3/2.3(1–4)	8/17.6(3–26)	3/11(4–20)	5/7.4(3–17)	2/3.5(1–6)	8/4.9(1–17)	10/10.5(1–40)	13/12.1(1–108)
Anguillicola crassus (l.)	swimbladder wall	1/20	–	8/9.4(1–50)	2/37.5(21–54)	4/4.5(2–8)	–	3/3	8/12.4(1–30)	9/17.9(1–140)
Myxobolus portucalensis	fins	–	–	2/*	1/***	3/*	–	8/*–***	–	6/*–**
Myxidium giardi	kidney, gill	1/*	–	2/*	–	–	–	–	–	–
Proteocephalus macrocephalus	gut	–	–	1/5	–	–	–	–	–	–
Bothriocephalus claviceps	gut	–	–	1/7	–	–	–	–	–	–
Pseudodactylogyrus bini	gill	–	–	2/8.5(8–9)	–	–	2/5.5(5–6)	–	–	–
Pseudodactylogyrus anguillae	gill	–	–	2/11.5(11–12)	–	–	3/10.3(8–12)	–	–	1/1
Daniconema anguillae	fins	–	–	–	1/2	–	–	–	–	–
Daniconema anguillae (l.)	fins	–	–	2/***	2/***	–	–	1/**	–	1/*
Ergasilus gibbus	gill	–	–	2/3.5(3–4)	–	–	–	–	–	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 4

Parasitic infections of *Abramis brama* in Lake Balaton in 1994

		Spring			Summer				Autumn	
Number of fish examined		18	7	4	4	4	3	5	3	12
Body length (cm)		14–40	19–30	22–28	10–30	12–32	27–30	26–33	26–28	20–30
Sampling time		Apr	May	Jun	Jun	Jul	Aug	Sep	Oct	Nov
Sampling site		Szemes	Szemes	Tihany	Keszthely	Csopak	Keszthely	Keszthely	Keszthely	Alsóörs
Parasite recorded	Location									
Trypanosoma danilewskyi	blood	2/*	–	–	–	–	–	–	–	–
Eimeria rutilii	gut	–	–	–	1/*	–	–	–	–	–
Goussia stankovitchi	gut	–	–	–	1/*	1/*	–	–	–	–
Goussia pannonica	gut	1/*	–	–	–	–	–	–	–	–
Goussia leucisci	kidney	1/***	–	–	–	–	–	–	–	–
Chloromyxum sp.	gall bl.	3/*–***	–	–	–	–	–	–	–	2/*
Sphaerospora sp.	kidney	1/*	–	–	–	–	–	–	–	–
Myxidium rhodei	kidney	–	–	1/**	–	2/*–***	–	–	–	–
Myxidium sp.	gall bl.	1/**	1/***	–	–	–	–	–	–	1/**
Myxobilatus legeri	ureter	3/*–**	–	–	–	–	–	–	–	–
Myxobolus bramae	gills	11/*–***	4/*–**	–	2/*–**	3/*–***	1/***	–	–	2/*
Myxobolus sp. (I)	gills	4/*	–	–	–	–	–	–	–	–
Myxobolus sp. (II)	scales	6/*–***	3/*	–	–	2/*	1/***	–	–	–
Myxobolus sp. (III)	gut	1/**	–	–	1/*	–	–	–	–	1/*
Myxobolus pseudodispar	kidney	1/*	1/*	–	–	1/*	–	–	–	–
Ichthyophthirius multifiliis	gills	–	2/*	–	–	–	–	–	–	–
Dactylogyrus auriculatus	gills	–	–	–	–	1/20	–	–	1/57	–
Dactylogyrus falcatus	gills	–	5/13.6(8–20)	1/10	1/8	2/22.5(15–30)	2/5.5(4–7)	–	–	1/6
Dactylogyrus wunderi	gills	–	–	–	–	1/10	–	–	1/22	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 4

Parasitic infections of *Abramis brama* in Lake Balaton in 1994 (continued)

		Spring			Summer				Autumn	
Number of fish examined		18	7	4	4	4	3	5	3	12
Body length (cm)		14–40	19–30	22–28	10–30	12–32	27–30	26–33	26–28	20–30
Sampling time		Apr	May	Jun	Jun	Jul	Aug	Sep	Oct	Nov
Sampling site		Szemes	Szemes	Tihany	Keszthely	Csopak	Keszthely	Keszthely	Keszthely	Alsóörs
Parasite recorded	Location									
Dactylogyrus zandti	gills	–	–	–	2/13(6–20)	–	–	–	1/20	–
Diplozoon paradoxum	gills	–	2/6(2–10)	–	–	2/2.5(1–4)	1/4	–	–	1/1
Caryophyllaeus laticeps	gut	–	1/6	–	–	–	–	–	–	–
Ligula intestinalis (l.)	abd. cav.	3/1.3(1–2)	–	–	–	–	–	–	–	–
Paradilepis scolecina (l.)	abd. cav.	2/5(2–8)	–	–	1/2	1/8	3/26.7(20–30)	1/15	1/30	2/10.5(1–20)
Bucephalus polymorphus (l.)	gills	–	–	–	–	–	–	1/5	–	–
Rhipidocotyle illense (l.)	fins	–	–	1/4	3/13.7(1–20)	1/15	2/8.5(8–9)	–	–	–
Sanguinicola sp. (l.)	kidney	2/*	–	1/*	–	–	1/**	–	3/*	2/*
Asymphylodora immitans	gut	8/22.5(10–40)	5/34.4(5–100)	2/19(8–30)	3/23.3(5–45)	2/11.5(2–21)	–	–	–	1/8
Apophallus muehlingi (l.)	fins	7/*–***	3/*–**	–	4/*–***	3/**–***	2/*	5/*	–	5/*–***
Diplostomum spathaceum (l.)	eye lenses	2/5.5(4–7)	–	–	–	2/14(8–20)	–	–	1/2	–
Ichthyocotylurus spp. (l.)	abd. cav.	3/12.3(10–15)	1/1	–	–	–	1/20	–	1/1	–
Philometra ovata retard	swimbl.	5/2.2(1–4)	4/2(1–3)	2/1.5(1–2)	1/2	2/8.5(2–15)	3/14.7(4–30)	1/4	3/14(8–24)	11/5(2–10)
Philometra ovata	abd cav.	4/14(1–40)	–	–	1/1	1/1	–	–	–	–
Contracoecum sp. (l.)	int. wall	–	–	–	–	–	1/1	1/15	1/1	1/1
Piscicola geometra	scale, mouth	–	1/6	–	–	–	–	–	–	–
Ergasilus sieboldi	gills	10/7.7(2–10)	–	1/5	–	–	–	–	–	8/7.8(3–20)
Tracheliastes maculatus	scales	–	7/21.9(14–36)	4/21(10–38)	3/15(2–40)	–	–	–	–	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 5

Parasitic infections of *Carassius auratus gibelio* in Lake Balaton in 1994

		Spring		Summer			Autumn	
Number of fish examined		2	1	4	2	1	4	4
Body length (cm)		15–30	25	29–40	28–30	30	27–32	27–34
Sampling time		Apr	Jun	Jun	Jul	Aug	Sep	Oct
Sampling site		Szemes	Tihany	Keszthely	Tihany	Keszthely	Keszthely	
Parasite recorded	Location							
Spironucleus elegans	gut	–	–	–	–	–	–	1/**
Goussia carpelli	gut	–	1/**	2/*–**	-	1/***	4/*–***	4/**
Goussia leucisci	kidney	–	–	–	–	–	1/*	–
Hoferellus carassii	kidney, ureter	2/***	1/***	2/***	2/***	1/***	4/***	4/*–***
Paradilepis scolecina (l.)	abdominal cavity	–	–	–	–	1/1	–	–
Sanguinicola inermis	kidney	–	–	1/1	–	–	–	–
Apophallus muehlingi (l.)	fins	–	1/20	–	–	–	–	–
Diplostomum spathaceum (l.)	eye lenses	–	–	–	–	–	1/4	–
Philometroides sanguinea	fins	1/2	–	–	–	1/1	–	–
Ergasilus sieboldi	gills	1/4	1/6	1/2	1/1	–	–	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 6

Parasitic infections of *Silurus glanis, Gymnocephalus cernuus* and *Neogobius fluviatilis* in Lake Balaton in 1994

		Silurus glanis		Gymnocephalus cernuus		Neogobius fluviatilis	
Number of fish examined		Summer 2	Autumn 2	Spring 4	Spring 9	Summer 11	7
body length (cm)		34–36	24–34	8–10	7–12	5–11	4–7
sampling time		Aug	Sep	Apr	Apr	Jul	Aug
sampling site		Keszthely		Szemes	Szemes	Csopak	Sóstó
Parasite recorded	Location						
Goussia acerinae	gut	–	–	1/*	–	–	–
Goussia sp.	gut	–	–	–	1/*	–	–
Apiosoma sp.	fins	–	–	1/**	–	–	–
Dactylogyrus amphibothrium	gills	–	–	2/12.5(5–20)	–	–	–
Dactylogyrus hemiamphibothrium	gills	–	–	1/10.	–	–	–
Gyrodactylus sp. I.	fins	–	–	2/45(40–50)	–	–	–
Gyrodactylus sp. II.	fins	–	–	–	1/4	–	–
Proteocephalus osculatus	gut	2/15(8–22)	2/19(8–30)	–		–	–
Proteocephalus cernuae	gut	–	–	1/3		–	–
Proteocephalus sp.	gut	–	–	–	–	1/2	–
Ligula sp.	abd. cav.	–	–	–	–	3/1	–
Nicolla skrjabini	gut	–	–	4/10.5(8–15)	–	–	–
Orientocreadium siluri	gut	1/9	–	–	–	–	–
Diplostomum spathaceum (l.)	eye lenses	–	1/19	–	–	–	–
Ichthyocotylurus sp. (l.)	abd. cav.	–	–	4/8.5(2–17)	–	–	–
Camallanus truncatus	gut	–	–	3/4.3(1–8)	1/1	8/3.1(2–6)	–
Anguillicola crassus (l.)	intestinal wall	1/27	2/170(40–300)	4/56.8(40–72)	6/14.8(1–40)	11/4.1(1–10)	6/18.8(4–58)
Ergasilus sieboldi	gills	2/4(2–6)	1/2	–	–	–	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

Table 7

Parasitic infections of some cyprinids in Lake Balaton in 1994

		Spring			Spring	Summer	Autumn		Summer	Spring
		Pelecus cultratus		B. bjoerkna	Cyprinus carpio		C. idella	H. molitrix	Tinca tinca	Aspius aspius
Number of fish examined		2	1	7	2	2	1	2	2	1
Body length (cm)		30	30	17–25	36–39	23–50	68	70	15–30	48
Sampling time		Apr	May	Apr	May	Jun	Nov	Aug	Jul	May
Sampling site		Szemes	Szemes	Szemes	Szemes	Keszthely	Alsóörs	Sóstó	Tihany	Szemes
Parasite recorded	Location									
Goussia carpelli	gut	–	–	–	1/**	–	–	–	–	–
Goussia sinensis	kidney	–	–	–	–	–	–	1/*	–	–
Sphaerospora sp.	kidney	1/*	–	–	–	–	–	–	–	–
Myxobilatus legeri	ureter	2/*	1/*	–	–	–	–	–	–	1/**
Myxidium spp.	gall bladder	–	1/*	–	–	–	–	–	–	1/*
Myxidium sp.	kidney	–	–	–	–	–	–	1/*	–	–
Myxobolus cyprini	gut	–	–	–	2/*	–	–	–	–	–
Myxobolus sp.	gills	–	–	2/*	–	–	–	–	–	–
Dactylogyrus extensus	gills	–	–	–	–	1/30	–	–	–	–
Paradiplozoon pavlowskii	gills	–	–	–	–	–	–	–	–	1/24
Caryophyllaeus fimbriceps	gut	–	–	–	1/3	–	–	–	–	–
Proteocephalus torulosus	gut	–	–	–	–	–	–	–	–	1/90
Aspidogaster limacoides	gut	–	–	–	1/5	–	–	–	–	–
Sanguinicola inermis	gills, kidney	–	–	–	–	1/5	–	–	–	–
Asymphylodora tincae	gut	–	–	–	–	–	–	–	2/37.5(35–40)	–
Asymphylodora immitans	gut	–	–	1/50	–	–	–	–	–	–
Nicolla skrjabini	gut	–	1/18	–	–	–	–	–	–	–
Apophallus muehlingi	fins	2/2(1–3)	–	–	–	–	–	–	–	–
Diplostomum spathaceum (l.)	eye lenses	–	–	–	–	–	–	2/40	–	–
Ichthyocotylurus sp. (l.)	body cavity	–	–	1/10	–	–	–	–	–	–
Philometra kotlani retard	swimbladder	–	–	–	–	–	–	–	–	1/35
Anguillicola crassus (l.)	intestinal wall	1/100	1/70	–	–	–	–	–	–	–
Anodonta sp. (l.)	gills	–	1/8	–	–	–	–	–	–	–
Ergasilus sieboldi	gills	1/2	–	–	–	1/2	1/15	–	2/16.5(3–30)	–

numerator = number of infected fish, denominator = mean intensity (range in brackets), stars = intensity of protozoan or larval infections

of the River Danube can be found in works of Roman (1955) and Vojtek (1959), while those for the River Tisza have been reported by Edelényi (1967) and Ergens et al. (1975).

The results of this study indicate that the parasite fauna of fishes of the Palaearctic region is rather uniform. The fact that in Lake Balaton we could not detect numerous parasites recorded from other places, reflects differences between the intermediate host organisms living in the different habitats, rather than actual differences between regions.

This work involved a larger sample of fish of the greatest economic and biological importance. Therefore, the data obtained on such species enable a more reliable evaluation of the parasite fauna than do the dissection data of fish of which a smaller sample was examined. However, the interpretation of even the former data requires some caution. The presence of endoparasitic helminths is always a reliable indicator of the degree of infection. At the other side, data concerning protozoans, crustaceans and monogeneans freely moving on the skin and gills must be evaluated critically. Namely, in laboratory the number of these organisms usually decreased if the fish were kept in flow-through water, while in aerated aquaria it increased.

The parasites found generally correspond to those demonstrated by Molnár (1962, 1964, 1966a, 1966b, 1968, 1969, 1970a, 1970b), Matskási (1967, 1968), Matskási et al. (1971) and Mészáros (1967, 1968). However, the data obtained on the protozoan fauna so far indicate that the occurrence of several species hitherto not described or not detected in Lake Balaton should be reckoned with.

The results of this study suggest that in some respects the parasite fauna of Lake Balaton fishes is characterized by stability, which is reflected in the continuing presence of species that were demonstrated decades ago. On the other hand, the changes occurring in the life of the lake, such as the immigration or introduction of new fish species, have led to the appearance and, in some cases, mass multiplication of new parasites.

Of parasites which are outstanding because of their permanent presence, the commonest species is *E. sieboldi* which establishes itself on the gills and even on the operculum of the pike-perch. That parasite had already been described by Geyer (1939a). It was also Geyer (1939b) who reported the periodic occurrence of, and the skin lesions caused by *Tracheliastes maculatus* on bream. Already Jaczó (1940) pointed out the high prevalence of *Myxobolus* spp. living on the gills of the bream, although the spores found by us could not yet be identified with the species *M. hungaricus* and *M. variabilis* described by him. From *Perca fluviatilis,* Jaczó (1940) also detected *Henneguya* cysts which probably belonged to the species recorded by us from pike-perch as *H. creplini.* Molnár (1966a) mentions it as a characteristic feature of the Lake Balaton bream that the female specimens of *Ph. ovata* can reach their full maturity only in fish infected by the plerocercoid of *Ligula intestinalis*, while in other fish they remain in a stunted, "retarded" state. In the majority of cases, this rule applied also in the present studies; however, the two cases when larva-containing females were found also in breams not infected by *Ligula* suggest that completion of the cycle is possible also in *Ligula*-free fish.

In the pike-perch and Volga pike-perch the most typical finding was the mass of *Ichthyocotylurus* metacercariae which established themselves in the abdominal cavity, primarily on the surface of the heart. This is obviously related to the increase of the bird population in the Lake Balaton region.

As regards the new parasites demonstrated from Lake Balaton, the most important findings were the mass occurrence and pathogenicity of *A. crassus* in eel (Molnár et al. 1991, 1993, 1994, Székely et. al. 1991) and the high prevalence of its paratenic larvae in other fish species (Székely 1994, 1995). At the same time, it was surprising to see that the

Pseudodactylogyrus species common in intensive eel farms cause only moderate infection in Lake Balaton eels.

The species *Hoferellus carassii, Spironucleus elegans* and *Paradilepis scolecina, Orientocreadium siluri* are now reported from Lake Balaton for the first time, even though their appearance there could be expected. In addition, it is probable that among the parasites now designated as *Goussia* sp. and *Myxobolus* sp. new, hitherto not described species could be distinguished by more thorough studies.

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Molnár, K. és Székely, Cs.: A Balaton néhány fontosabb halfajának parazitológiai vizsgálata

A szerzők a Balaton gazdaságilag és faunisztikailag legfontosabb 15 halfaja 299 egyedének parazitás fertőzöttségét követték nyomon. Egy éves vizsgálat keretében 71 parazita teljes faji, 17 parazita genusig történő meghatározását végezték el, s adtak azokra nézve adatokat. A fajilag azonositott 23 egysejtű élősködőből legnagyobb fajszámmal a Myxosporea osztály tagjai (10) kerültek kimutatásra. A Coccidia osztályt 8 faj, az Oligohymenophorea, Kinetophragminophorea, Kinetoplastidea, Diplomonadea osztályokat 1-1 faj képviselte. Ugyancsak kimutatásra került a bizonytalan rendszertani helyű *Dermocystidium percae* faj is. A metazoonok közül a Monogena 13, a Cestoda 11, az Aspidogastrea 1, a Trematoda 10, a Nematoda 7, a Hirudinea 1, a Crustacea osztályok 5 faja került kimutatásra. A Balatonban a leggyakoribb parazitának a behurcolt angolnaélősködő, az *Anguillicola crassus* tekinthető, mely a végleges gazdán kivül több halfajból, mint paratenikus gazdából kimutatható volt. Esetenként jelentős *Ergasilus sieboldi*-fertőzöttség alakult ki süllőn, amelynek a kopoltyúján kivül a kopoltyúfedőit is nagy tömegben lepték el ezek a rákok. Kórtani szempontból jelentősnek látszanak a süllő szivburkához tapadó *Ichthyocotylurus*-metacerkáriák, illetve a dévér testfelületén a tavaszi hónapokban megtelepedő *Tracheliastes maculatus* egyedei. A talált élősködők közül a *Hoferellus carassii, Spironucleus elegans, Paradilepis scolecina* és *Orientocreadium siluri* első izben kerülnek kimutatásra a Balatonból.

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