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THE NATURE PROTECTION ASPECT OF THE BLACK SEA FISH MYXOSPOREAN STUDIES

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The Nature Protection Aspect of the Black Sea Fish Myxosporean (Myxozoa, Myxosporea) Studies. Yurakhno V. M. — The species composition and indices of the myxosporeans infecting fish from the different nature conservation Black Sea regions were considered on the base of the original investigations and literature data. Myxosporean inhabiting the Red Book fish hosts were investigated. The myxosporean species potentially pathogenic for the fish health were identified and epizootological situation was estimated.

Key words: myxosporeans, fish, the Black Sea , nature preservation.

Миксоспоридии (Myxozoa, Myxosporea) рыб Чёрного моря в природоохранном аспекте. Юрахно В. М. — На основе оригинальных исследований и литературных данных рассмотрены видовой состав и показатели заражённости миксоспоридиями рыб из различных природоохранных регионов Чёрного моря. Исследованы миксоспоридии, встречающиеся в краснокнижных видах рыб-хозяев. Обозначены потенциально патогенные для здоровья рыб виды слизистых споровиков, оценена эпизоотологическая ситуация.

Ключевые слова: миксоспоридии, рыбы, Чёрное море, охрана природы.

Introduction

"Variety of the wild nature is the pledge of our prosperity. It is a base of our life and its necessary condition" (UNO Program concerning the environment). A number of reserves, wildlife preserves, national parks as well as the "Red Book" of Ukraine — the annotated list of rare and endangered species of animals, plants and mushrooms have been created to preserve the unique nature formations, support the biological and landscape diversity, preserve the wild vegetation and animals gene pool.

Inventory and stocktaking of the rare and endangered species is the main organizational purpose of the preservation. Neither theoretical problem consideration, nor practical recommendation on the definite species saving can be done without that. Learning new data concerning parasites of the free-living species, subject to preservation, their species composition, size and dynamics of infection indices, some species pathogenic impact on the host's life and health is quite important at these species studying.

The myxosporean infection of various fish species from the separate Black Sea parts, most of which did not undergo studies of this group of parasites was studied, and myxosporeans inhabiting the Red Book host fish species are identified (potentially pathogenic for the life and health are named) in the present work.

Material and methods

We used our own data on fish myxosporeans fauna inhabiting the protected Black Sea aquatoria in the region of Karadag nature reserve and its vicinities, ornithological branch "Swan islands" of the Crimean nature reserve, state landscape reserve "Cape Aya" (AR Crimea) and all-zoological reserve of the state importance "Zmeiniy island" (Odessa district) (table 1). We have also studied myxosporeans of the rare fish species mentioned in the Red Book of Ukraine (2009) along the whole sea aquatorium in 1987–1989 and in 1999–2004. The material was gathered along the whole Black Sea aquatorium adjacent to the former USSR territory — in the north western sea part in the Kerch strait, near the Crimean and Caucasian coasts.

The fish identification was carried out according to A. N. Svetovidov (1964), the species names were adjusted in accordance with changes proposed by T. S. Rass (1993) for all Black Sea species.

All studied myxosporean species were found as a result of incomplete parasitological dissection of fish aimed at discovering representatives of this parasitic group in coherence with the generally accepted methodology (Bykhovskaya-Pavlovskaya, 1985). The found spore and plasmodia of the myxosporeans were placed into gelatin-glycerine according to the methodology applied by Z. S. Donets and S. S. Shulman (Donets, Shulman, 1973). Laboratory processing of the material was carried out with the use of MBI–1 microscope equipped with phase contrast device.

Table 1. Regions, time and methods of fish catching for studies on myxosporeans in protected water areas of the Black Sea

Таблица 1. Районы, время и методы отлова рыб для исследования заражённости миксоспоридиями из природоохранных регионов Чёрного моря

Sampling regions	Sampling time	Depth, m	Catching instruments	Number of fish studied	Number of studied fish species
Karadag (open sea)	June—July 1988	32–80	Bottom trawls	61	7
Karadag (coastal part)	September—October 1988	15	Standing nets	83	11
	June 2009, July 2012	0.5–3	Sacs,	126	11
	June 2009		fish-rods	21	2
Koktebel	June 2009	4–5	Standing nets	111	11
Ordzhonikidze	June 2012	15	Standing nets	38	12
				40	1
Swan Islands	August–October 2007–2008	5–8	Standing nets	61	3
Cape Aya-Batiliman	August 1988	1–5	Fish rod,	37	12
	June 1989	1–5	trap, net	47	7
Zmeiniy Island	August 2006	–	Standing nets	40	1

Results and discussion

Studies on myxosporeans in the nature conservation Black Sea zones. Five species of myxosporeans were found in summer of 1988, in the course of the marine expedition along the Crimean and Caucasian coasts and in the north western sea part in the open sea near Karadag: *Myxidium gadi* (Prevalence — P = 54 %) and *Ceratomyxa merlangi* (P = 38 %) in the gallbladder of the Black Sea whiting *Merlangius merlangus euxinus*, *M. gadi* (P = 5 %) in the gallbladder and *Myxobilatus platessae* (P = 5 %) in the urinary bladder of the gloss *Platichthys flesus luscus, Chloromyxum ovatum* in the gallbladder of 2 of 5 investigated spurdog *Squalus acantias* and *Myxidium cochleatum* in the gall bladder of 1 of 4 investigated turbots *Psetta maxima maeotica* (table 2). All species of the found myxosporeans, excluding *C. merlangi*, were found in the north eastern Black Sea part near the Crimean shores for the first time. We should mention that 4 samples of two goby species — *Mesogobius batrachocephalus* and *Neogobius melanostomus* turned to be myxosporean-free.

The fish myxosporeans studies near Karadag were continued in the autumn of 1988. Only three species of myxosporeans were found in the gallbladders of their hosts: *Alataspora solomoni* in the Black Sea horse mackerel *Trachurus mediterraneus ponticus*, *Fabespora nana* in cuskeel *Ophidion rochei*, *Chloromyxum psetti* in thornback ray *Raja clavata*. All these myxosporean species were found near Karadag for the first time.

Finally, after nearly 20 years, we continued the by-land expedition investigations of the myxosporeans in summer of 2009 and 2012 in Karadag (Yurakhno, 2009 a, b; 2012 b). Eight myxosporean species were discovered as a result. The following species were found in the gallbladders of their hosts: *Myxidium sphaericum* in garfish *Belone euxini*, *Alataspora solomoni* in the Black Sea horse mackerel *Trachurus mediterraneus ponticus*, *Myxidium parvum* in sphinx blenny *Aidablennius sphynx*, *Sphaeromyxa sabrazesi* in the broadnosed pipefish *Syngnathus thyphle*, *Sphaeromyxa sevastopoli* in the rusty blenny *Parablennius sanguinolentus*. One species, *Ortholinea divergens*, discovered in 3 hosts (*Aidablennius sphynx*, P*arablennius sanguinolentus* and *Parablennius tentacularis*) was found in the urinary bladders of fishes. *Kudoa stellula* was found in the kidneys of mediterranean sand smelt *Atherina hepsetus* and *Kudoa nova* was discovered in the muscles of round goby, *Neogobius melanostomus*, and black goby, *Gobius niger*.

Myxidium parvum, *Sphaeromyxa sabrazesi*, *Ortholinea divergens*, *Kudoa stellul*a were found in the Karadag region for the first time. Moreover, *Kudoa nova* was also found for the first time near Ordzhonikidze. Forty samples of goatfish *Mullus barbatus ponticus* tested for Myxosporea and Microsporidia in 2012 in the Provato bay near the Ordzhonikidze settlement turned to be free from these parasites.

Table 2. Indices of infection of fish by myxosporeans in the Karadag nature reserve and its region (original studies)

Таблица 2. Индексы инфицированности рыб миксоспоридиями в заповеднике Карадаг и его окрестностях (собственные данные)

Host species	Region	Month and year	Number / Length of fish, cm	Parasite species	Indices of infection	
					Prevalence, %	Intensity of infection,spore speciments / smear
Atherina hepsetus	Koktebel	06.2009	17/11.0–15.0	*Kudoa stellula*	5	Units
Trachurus mediterraneus ponticus	Biological station	09–10.1988	24/11.4–16.5	*Alataspora solomoni*	13	Units, tens
	Koktebel	06.2009	27/14.0–17.1		22	Units, tens
Aidablennius sphynx	Biological station	06.2009	18/2.9–5.0	*Ortholinea divergens*	8	Units; plasmodia (units)
	Kuzmichevystones	06.2009	15/3.0–6.5		13	Units
	Biological station	06.2009	18/2.9–5.0	*Myxidium parvum*	44	Units, tens; plasmodia (units)
	Putsolanovaya Bay	06.2009	11/3.0–6.0		50	Units, tens; plasmodia (units, tens)
	Kuzmichevy stones	06.2009	15/3.0–6.5		33	Units, tens
Parablennius sanguinolentus	Putsolanovaya Bay	06.2009	4/10.01–5.6	*Ortholinea divergens*	1/4	Units
				Sphaeromyxa sevastopoli	1/4	Units
Parablennius tentacularis	Putsolanovaya Bay	06.2009	16/4.8–8.0	*Ortholinea divergens*	25	Units, tens; plasmodia (units, tens)
Gobius niger jozo	Ordjonikidze	06.2009	4/10.3–12.4	*Kudoa nova*	1/4	Units, tens
Neogobius melanostomus	Ordjonikidze	06.2009	11/13.8–19.5	*Kudoa nova*	60	Units, tens
Raja clavata	Biological station	09–10.1988	1/62	*Chloromyxum psetti*	1/1	Tens
Ophidion rochei	Biological station	09–10.1988	2/18.2–20.2	*Fabespora nana*	2/2	Hundreds
Merlangius merlangus euxinus	Open sea (lat. 44°49', long. 36°48'; lat. 44 °47'7, long. 36°41'1)	06–07.1988	26/7.6–22.4	*Ceratomyxa merlangi*	35	No data
				Myxidium gadi	54	No data
Platichthys flesus luscuc	Open sea (lat. 44°49', long. 36°48'; lat. 44°47'7,long. 36°41'1)	06–07.1988	19/16.1–24.0	*Myxidium gadi*	5	No data
	open sea (lat. 44°49', long. 36°48')			*Myxobilatus platessae*	5	No data
Psetta maxima maeotica	Open sea (lat. 44°45'0, long. 36 °33'2)	06–07.1988	4/46.0–52.0	*Myxidium cochleatum*	1/4	No data
Squalus acanthias	Open sea (lat. 44°45'0, long. 36°33'2)	06–07.1988	6/6.0–123.0	*Chloromyxum ovatum*	2/6	No data
Belone belone euxini	Koktebel	06.2009	14/25.5–40.0	*Sigmomyxa sphaerica (Syn. Myxidium sphaericum)*	7	Units
Syngnathus thyphle	Koktebel	06.2009	1/31.1	*Sphaeromyxa sabrazesi*	1/1	Hundreds

O. divergens and *M. parvum* were reported in *Aidablennius sphinx* as well as *K. stellula* was found in *Atherina hepsetus* on the territory of the reserve in the Karadag bay waters near the biological station. The peacock blenny *Lipophris pavo* turned to be myxosporean-free.

There were no myxosporeans observed in the haarder *Liza haematocheilus* caught near the shields at the beach at the entrance into the reserve.

Myxosporeans *O. divergens* and *M. parvum* were found in *A. sphinx* caught near Kuzmichovy kamni only. The peacock blenny *Lipophris pavo* and tentacle blenny *Parablennius zvonimiri*, ratan goby *Neogobius ratan ratan* and toad goby *Mesogobius bathrachocephalus* as well as the common stingray *Dasyatis pastinaca* were found to be myxosporean-free.

O. divergens was found in *P. tentacularis* and *P. sanguinolentus* in the Putsolanovaya bay. *Sphaeromyxa sevastopoli* was found in *P. sanguinolentus* and *Myxidium parvum* was found in *Aidablennius sphinx*. There was no myxosporeans in *P. zvonimiri*, *L. pavo*, *Liza aurata*, *Atherina boyeri*, *Neogobius ratan*, *Symphodus ocellatus*, *Neogobius eurycephalus* caught in the given region. *N. eurycephalus* from the Serdolikovaya bay was myxosporean-free as well.

We studied in details the whole existing literature which concerns the given problem (table 3) apart from our own investigations of the myxosporean fauna in the Karadag region. The number of false facts concerning the species identification, regions where myxosporeans were found, spelling of the Latin names mentioned in this work were also found.

Studies of myxosporeans started near the Karadag shores in 1950s. Results of investigations conducted by A. V. Reshetnikova (1954, 1955 a, b), A. A. Kovaleva (1963, 1966) and T. P. Pogoreltseva (1964) were the first materials. Then the Karadag species list was completed by N. N. Naidenova (Naidenova, 1974; Naidenova, Solonchenko, 1989), Guinean researcher S. Mange (1993), and A. I. Miroshnichenko (2004 a, b). Thus, we composed a table in which all myxosporean species inhabiting the Karadag region are listed on the base of these works as well as on the base of our own expeditions in the studied region (table 3).

Unfortunately, two myxosporean species were identified by A. I. Miroshnichenko (2004 a) incorrectly. *Ceratomyxa peculiaria* could not be found in the Black Sea mackerel because this species is very specific for pickerel *Spicara flexuosa* and can be met very seldom. *Alataspora solomoni* is the common parasite in the Black Sea mackerel, including the Karadag region. From the genus *Zschokkella*, only *Zschokkella admiranda* can be found in the Black, Azov and Mideterranean Seas as a myxosporean inhabiting mullets. *Z. nova* is probably the representative of the fresh water myxosporeans typical fauna. This species has not been found by us for more than 20-year investigation period. It is surprising that A. I. Miroshnichenko did not include data from an abstract by S. Mange (1993), who has found 3 myxosporean species in this region, into his review articles concerning Karadag fauna (Miroshnichenko, 2004 a, b). However, the fact that S. Mange did include data on Karadag into his thesis "Parasite fauna of fishes in the Alushta aquatorium of the Black Sea" is not less surprising. It looks like Karadag is the region of Alushta and it is not so at all.

Information from the review article of N. N. Naidenova and A. I. Solonchenko (1989) needs to be corrected. Four species (of five mentioned in our table for the region of Sudak) were included into Karadag species list by N. N. Naidenova, according to her oral report, but at Karadag they have not been found yet. A. I. Miroshnichenko has mentioned *Ceratomyxa reticularis, Myxidium incurvatum, Sphaeromyxa incurvata, Myxobolus asymmetricus* automatically as well for the reserve fauna. However, he did not mention *Leptotheca hepseti*, which was not included into the list by the authors of the previous work as well.

Table 3. Myxosporeans (29 species) of fish (30 species), found in the Karadag region (literature and original data)

Таблица 3. Миксоспоридии (29 видов) рыб (30 видов), найденные в окрестностиях Карадага (литературные и собственные данные)

Name of parasite	Name of fish-host	Region of parasite finding	Authors
Leptotheca hepseti	*Atherina hepsetus*	Karadag	Kovaleva, 1963, 1966
L. agilis	*Dasyatis pastinaca*	Karadag	Mange, 1993; Miroshnichenko, 2004 a, b
Ceratomyxa parva	*Scomber scomber*	Karadag	Reshetnikova, 1954, 1955 b; Pogoreltseva, 1964
C. reticularis	*Trachinus draco*	Sudak	Pogoreltseva, 1964
*C. merlangi**	*Merlangius merlangus euxinus*	Karadag, open sea (lat. 44°49', long. 36°48′; lat. 44°47'7, long. 36°41'1)	Naidenova, Solonchenko, 1989, Yurakhno, 2010 b
Myxidium incurvatum	*Scorpaena porcus, Parablennius zvonimiri*	Sudak	Pogoreltseva, 1964
*M. gadi**	*Merlangius merlangus euxinus, Platichthys flesus luscuc*	Open sea (lat. 44°49', long. 36°48′; lat. 44°47'7, long. 36°41'1)	Yurakhno, 2010 b
*M. sphaericum**	*Belone belone euxini*	Sudak, Karadag Koktebel*	Pogoreltseva, 1964; Miroshnichenko, 2004 a, b; Yurakhno, 2009 a
*M. parvum**	*Aidablennius sphynx*	Karadag	Yurakhno, 2009 a
*M. cochleatum**	*Psetta maxima maeotica*	Open sea (lat. 44° 45'0, long. 36°33'2)	Yurakhno, 2010 b
*Myxobilatus platessae**	*Platichthys flesus luscus*	Open sea (lat. 44°49', long. 36°48′)	Yurakhno, 2010 b
Sphaeromyxa incurvata	*Solea nasuta*	Sudak	Pogoreltseva, 1964
*Sph. sevastopoli**	*Neogobius platyrostris, Parablennius sanguinolentus**	Karadag	Naidenova, 1974; Yurakhno, 2009 a
*Sph. sabrazesi**	*Syngnathus thyphle*	Koktebel	Yurakhno, 2009 a
Sphaerospora caudata	*Alosa finta, Engraulis encrasicholus*	Karadag	Reshetnikova, 1954, 1955 b
Kudoa quadratum	*Trachurus mediterraneus ponticus*	Karadag	Reshetnikova, 1954, 1955 b
Myxobolus muelleri	*Liza aurata, L. saliens, Mugil cephalus*	Karadag	Reshetnikova, 1954, 1955 a, b
M. exiguus	*Liza aurata, Mugil cephalus*	Karadag	Reshetnikova, 1955 a; Pogoreltseva, 1964; Mange, 1993; Miroshnichenko, 2004 a, b
M. parvus	*Mugil cephalus, Liza haematocheilus*	Karadag	Miroshnichenko, 2004 a, b
M. asymmetricus	Family Labridae	Sudak	Pogoreltseva, 1964
Zschokkella nova	Family Mugilidae	Karadag	Pogoreltseva, 1964
Z. admiranda (Syn. *Zschokkella nova* Miroshnichenko, 2004 a, b)	*Liza aurata*	Karadag	Miroshnichenko, 2004 a, b
*Kudoa nova**	*Neogobius platyrostris, N. melanostomus*, Gobius niger jozo**	Karadag Ordjonikidze*	Naidenova, 1974; Naidenova, Solonchenko, 1989; Yurakhno, 2009 a*
*K. stellula**	*Atherina hepsetus*	Koktebel*	Yurakhno, 2009 a
*Alataspora solomoni** (Syn. *Ceratomyxa peculiaria* Miroshnichenko, 2004 a, b)	*Trachurus mediterraneus ponticus*	Karadag Koktebel*	Mange, 1993; Miroshnichenko, 2004 a, b; Yurakhno, 2009 a
*Fabespora nana**	*Ophidion rochei*	Karadag	Yurakhno, 2009 a
*Chloromyxum psetti**	*Raja clavata*	Karadag	Yurakhno, 2009 a
*Ch. ovatum**	*Squalus acanthias*	Open sea (lat. 44°5'0, long. 36°33'2)	Yurakhno, 2010 b
*Ortholinea divergens**	*Aidablennius sphynx, Parablennius sanguinolentus, P. tentacularis*	Karadag	Yurakhno, 2009 a

* Data of own studies.

I should specify one more circumstance concerning the myxosporeans studied near Karadag in 2006. Yu. M. Kornyychuck with co-authors (Kornyychuck et al., 2008) mentions *Mixosporidia* gen. sp. of *Parablennis sanguinolentus* in the list of hydrobiont parasites in the given region. The correct spelling of the myxosporean class is Myxosporea. Most probably, the authors dealt with *Sphaeromyxa sevastopoli* from the gallbladder of the blenny.

In the list of myxosporeans species found near Karadag I use the new generic name for *Myxidium sphaericum — Sigmomyxa sphaerica* (Thelohan, 1895), which was changed as a result of the revision carried out by Danish scientists (Karlsbakk, Køie, 2011).

Now I can summarize the written above. I have found 10 myxosporean species in 11 of 30 investigated fish species (1/3 species were inhabited by myxosporeans according to our data) near Karadag. The complete myxosporean species list makes 25 species in 30 species of fish by taking into consideration other researchers' findings in this region. Thus, 40 % of the myxosporean species, inhabiting KaNaRe fishes were discovered by us. This testifies that the given parasitic group has not been fully studied in the given nature reserve.

Nineteen species (76 %) of the Karadag reserve myxosporeans can be met in the Sevastopol region as well, where salinity and underwater biocenosis is similar to Karadag. Only 1 species was found near Karadag recently (*L. agilis*) when compared with the others (*Leptotheca hepseti, Ceratomyxa parva, C. reticularis, Sphaeromyxa incurvata, Myxobolus exiguus* and *Zschokkella nova*) that were found there 45–55 years ago. Four representatives of *Lephohteca*, *Ceratomyxa* and *Sphaeromyxa* genera which can be considered as rare enough are to be re-studied.

Unfortunately, investigations in the Karadag region were conducted during the short-term expeditions in the warm time of the year for the past decades. And the long-term parasitological monitoring in the Karadag region in different seasons need to be conducted to have the complete information concerning the contemporary state and long-term changes of the Karadag natural reserve fish myxosporeans fauna.

Material on the Black Sea nature conservation zones was obtained from other Black Sea regions, which are also subject to preservation. Thus, 7 myxosporean species were found in August of 1988 and in June of 1989 near the cape Aya and Batiliman: *Myxidium pulchrum* in the gallbladder of one *Lepadogaster candollei* studied in 1988 and in 21 % of *Diplecogaster bimaculata euxinica*, caught in 1989; *M. parvum* from the gallbladder, *Myxobilatus convexum* and *Myxobolus improvisus* from the urinary bladder of 1 of 6 studied in 1988 *Blennius tentacularis*, *Sphaeromyxa sevastopoli* from the gallbladder of 1 of 3 Mediterranean rock lings *Gaidropsarus mediterraneus* caught in 1988 and in 10 % of investigated *Pomatoschistus minutus elongates* in 1989; *Myxidium cochleatum* from the gallbladder of one studied *Psetta maxima maeotica*, and *Chloromyxum psetti* from the gallbladder of 4 of 5 sampled *Raja clavata,* caught in 1989.

The frozen sample of round goby *Neogobius melanostomus* taken in August of 2006 near the Zmeiniy Island and given by scientists of IBSS Odessa branch was studied. The muscle species *Kudoa nova* was found in the given region for the first time. It appeared that prevalence of round goby infection by this parasite species was 73 %.

One more set of the frozen gobies, brought by scientists of the Department of ecological parasitology of IBSS from the Crimean natural reserve ornithological branch "Swan Islands" was studied in August of 2008. Gobies of 3 species (grass goby *Zosterisessor ophiocephalus*, round goby *Neogobius melanostomus* and monkey goby *N. fluviatilis fluviatilis*) were present in the sample. Myxosporean *Kudoa nova* was registered in this region for the first time and was found in 47 % of round goby and 56 % of monkey goby. The grass goby turned to be infection-free.

Share of infected gobies from the periodically desalinated regions of Zmeiny Island and Swan Islands can be compared with the prevalence of *K. nova* in the Azov Sea, whereas these indices for gobies caught in the Sevastopol salty waters are significantly lower (do not exceed 29 %). Apparently, salinity is one of the main factors affecting the infection of the gobies by *K. nova*.

Investigations on the myxosporeans of the Ukrainian Red Book fish

151 specimens of 20 fish species listed in the Ukrainian Red Book (more than 50 % of all Red Book fishes (38 species) inhabiting the Black Sea) were investigated (table 4). Two myxosporean species were found in 4 fish species. *Syngnathus tenuirostris* and common seahorse *Hippocampus guttulatus* were the hosts for the *Sphaeromyxa sabrazesi*. *S. sabrazesi* was discovered in the gallbladder of *S. tenuirostris* caught in the Gelendgik — Idocopas region, near Taman and New Matzesta (Caucasian shore), near setl. Zavetnoe (Crimea) and *H. guttulatus* caught near setl. Zavetnoe. Another myxosporean species *Myxidium pulchrum* was found in the gallbladders of clingfish. *M. pulchrum* was found in *Lepadogaster candollei* from Batiliman and in *Diplecogaster bimaculata euxinica* caught in the Sevastopol as well as in Batiliman.

It was known beforehand, according to the literature data, that *Sphaeromyxa sabrazesi* can be found in the gallbladder of the seahorse, and *Myxidium salmonis* in gallbladder of salmon *Salmo labrax* (Iskov, 1989), *Sphaeromyxa sabrazesi* and *Chloromyxum osmanovi* in *S. tenuirostris* (Karataev, 1984; Karataev, Iskov, 1984). *Myxobolus cerebralis* from the skeleton cartilaginous tissues of the Black sea salmon *Salmo labrax* (Yurakhno, 2010 a) caught in the river Chernaya, which falls into the Inkerman bay (Sevastopol) mentioned by us before according to the data taken from Identification Guide (Gaevskaya et al., 1975: 39), turned to be in truth the *Myxobolus cerebralis* caught in another river Chernaya (Caucasian shore in Abkhazia (Nechaeva, 1970).

Thus, we know that only 5 myxosporean species from 5 hosts inhabit marine fishes of the Black Sea listed in the Red Book of Ukraine. 75 % of the investigated fish spe-

Table 4. Myxosporea of the Red Book fish species in the Black Sea (original data)

Таблица 4. Миксоспоридии черноморских видов рыб, занесённых в Красную книгу (собственные данные)

Name of the fish-host	Number of ex. Fish / Number of infected fish	Myxosporean species	Region of investigations
Huso huso	1/0	–	Kerch strait
Acipenser gueldenstaedtii	1/0 2/0	– –	N-w*part of the sea, S-e**coast of Crimea
A. stellatus	1/0	–	Caucasus
Salmo labrax	1/0	–	Sevastopol
Syngnathus tenuirostris	4/4	*Sphaeromyxa sabrazesi*	Caucasus, Kerch strait
S. variegatus	1/0	–	Sevastopol
Hippocampus guttulatus	3/1	*Sphaeromyxa sabrazesi*	N-w part of the sea, Kerch strait
Sciaena umbra	66/0	–	Sevastopol
Umbrina cirrosa	2/0	–	Caucasus
Diplodus puntazzo	11/0	–	Sevastopol
Chromis chromis	9/0	–	Sevastopol
Symphodus rostratus	1/0	–	Sevastopol
Labrus viridis	7/0	–	Sevastopol
Tripterygion tripteronotus	7/0 2/0	– –	Batiliman, Sevastopol
Lepadogaster candollei	2/2	*Myxidium pulchrum*	Batiliman
Diplecogaster bimaculata euxinica	1/1 15/3	*Myxidium pulchrum*	Sevastopol Batiliman
Gobius bucchichi	1/0	–	Sevastopol
Serranus scriba	2/0	–	Sevastopol
Callionymus pusilus	1/0	–	Sevastopol
Trigla lucerna	1/0 1/0 4/0 6/0	– – – –	N-w part of the sea, Sevastopol, S coast of Crimea***, Caucasus

* Northwest part of the Black Sea. ** Southeast coast of Crimea. *** Southern coast of Crimea.

cies are not the hosts for myxosporeans; cavitary forms which can not be referred to the conventional pathogenic species and cause no hyperinfections, host diseases and death are parasitic only in 20 % of fishes.

M. cerebralis is the only causative agent of the fish diseases called in Russian "vertezh". But this disease can be found mainly in hutchling at the age up to 6 months, being especially severe under the artificial salmon cultivation. We should take into consideration that *M. cerebralis* parasitizing bulltrout was mentioned just once, in 1970 in Abkhazia. Many-year studies of the myxosporeans of different Salmonidae species from the different fresh-water reservoirs of Crimea by A. I. Miroshnichenko gave negative results.

Conclusion

Thus, we have obtained first information concerning the species composition and indices of fish infestation by myxosporeans from different Black Sea protected regions. The species composition of myxosporeans inhabiting the fishes listed in the Red Book of Ukraine is studied by me for the first time.

Conventionally pathogenic species were identified and epizootiological situation was estimated. On the base of our own many-year investigations as well as on the base of the data of other authors we can conclude that: all 4 myxosporean species are conventionally pathogenic for the 25 Black Sea fishes known for the region of Karadag natural reserve — *Myxidium gadi* for whiting, *Kudoa nova* for 3 species of gobies, *Myxobolus exiguus* and *M. parvus* for 3 mullet species. Nevertheless, epizootiological situation in the reserve is invariably favorable. Prevalence and intensity of infection by these myxosporean species are, as a rule, not high. No cases of hyperinfection or mass fish kills were observed. Infection indices are stated at the low or average level of the natural limits, which allowed A. I. Miroshnichenko to refer the number of species (*K. nova, M. exiguus*) to the relatively rare in this region.

The pathogenic species were not found in the state landscape reserve "Cape Aya". One pathogenic muscle species *Kudoa nova* with the high values of the prevalence was found in the ornithological branch of the Crimean natural reserve "Swan Islands" and in the all-zoological reserve of the state importance "Zmeiniy Island".

As soon as 4 of 5 myxosporeans found in the Red Book fish species were cavitary forms, which could not be referred to conventionally pathogenic species, causing hyper infections and diseases and death of hosts, epidemiological situation concerning these myxosporeans in the Red Book fish species in the Black Sea can be considered as very favorable. The only pathogenic species *Myxobolus cerebralis* was stated just once in the Abkhazia territory more than 40 years ago. This parasite has not been found in the Crimean waters.

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