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PREFACE

This volume contains the papers presented at the V. International Congress on Domestic Animal Breeding Genetics and Husbandry - 2021 (ICABGEH-21) was held on September 28, 2021.

The ICABGEH-21 has been organized by the Agricultural Faculty of Ondokuz Mayıs University. ICABGEH-21 is the fifth international event of the congress series with the participation of top-rated invited speakers; Dr. Ann Van Soom (Ghent University, Belgium), Dr. Dariusz Piwczyński (Bydgoszcz University of Science and Technology, Poland), and Dr. Theodore A. Tsiligiridis (Athens University of Agriculture, Greece). This event has been planned to bring together leading researchers, engineers, and scientists in animal science worldwide. It also provided opportunities for the delegates to exchange new ideas and application experiences, establish business or research relations, and find global partners for future collaboration. The organizing committee has done serious planning and preparation to ensure that the Turkish and international animal science scientific community to meet the challenges and move safely and successfully into the advanced information era. To this end, ICABGEH-2021 has been focused on recent developments and research on animal science aimed at protecting the environment and food safety. Thus, ICABGEH-2021 has achieved its main twofold objective: Firstly, the presentation of current research works in the field of animal science, and secondly, connecting the animal science community.

Prof. Dr. Hasan ONDER,

Congress President

DISTRIBUTION OF MONOGENEAN PARASITES IN CYPRINID FISH FROM THE MACEDONIAN AQUACULTURE

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Abstract

*The representatives of the class Monogenea are ectoparasites with a direct life cycle and most of them live mainly on the gills or the surface of freshwater or marine fish. Monogenea parasites in aquatic ecosystems are present in large numbers and manifest a clear specificity to their host - fish. They can cause enormous damage not only to the host but also to the aquatic environment. They are also considered to be a sensitive indicator of the health status of an ecosystem. This study aimed to determine the distribution of parasites of the class Monogenea in cyprinid fish from the Macedonian aquaculture. 656 fish out of 1134 examined were infected with monogenean parasites, with a mean intensity of 6.84, and a prevalence of 57.85%. In this study, the following monogenean parasite species in cyprinid fish were established: *Dactylogyrus extensus*, *Dactylogyrus minutus*, *Dactylogyrus vastator*, *Dactylogyrus anchoratus*, *Dactylogyrus lamellatus*, *Dactylogyrus aristichthys* and *Eudiplozoon nipponicum*. Representatives of class Monogenea are commonly occurring during the winter (in 88.89 % of examined fish), followed in spring (56.47%), autumn (45.67%), and less in summer (39.78%). Based on the total number of fish examined from cyprinid aquaculture facilities in Macedonia, the highest prevalence (16.58 %) is determined with *Dactylogyrus extensus* in winter while the lowest (0.44 %) with *Dactylogyrus aristichthys* in spring and autumn. The highest mean intensity (90.40) is determined with *Dactylogyrus aristichthys* in autumn, while the lowest (1.89) with *Dactylogyrus minutus* and *Eudiplozoon nipponicum* in spring.*

Key words: *parasites, monogenean, aquaculture, cyprinid fish*

INTRODUCTION

Representatives of the class Monogenea are of great importance in fish pathology. Most of the Monogenea are ectoparasites with a direct life cycle. According to Buchmann & Bresciani (2006), monogenean trematodes are hermaphroditic plate worms that complete their life cycle in a single host. Most of them live mainly as ectoparasites on the gills or the outer surface of the body of freshwater or marine fish. The most recognizable morphological features of this group of parasites, according to which they can be identified, are the posterior adhesive apparatus, called the descriptor, and the attachment organ called the haptor.

Abowei et al. (2011) state that only a few of these parasites are viviparous. Everyone else is oviparous. Specially adapted so-called haptor

and opishaptor enable their attachment to the host. Hooks and sucks are responsible for damage to the host, which allows entry for opportunistic pathogens. It occurs only in severe infestations with these parasites species.

Monogenea parasites in aquatic ecosystems are present in large numbers and manifest a clear specificity to their host - fish. They can cause enormous damage not only to the host but also to the aquatic environment. They are also considered to be a sensitive indicator of the health status of an ecosystem. Obiakezie & Taege (1991) state that monogenean can cause enormous damage to fisheries and aquaculture and thus contribute to high mortality and large losses of fish populations. Because monogenean trematodes are ectoparasites in fish, they are more exposed to changes caused by the

physicochemical properties of the environment, i.e. the water to which they must adapt. According to Koskivaara et al. (1991), Overstreet (1997), and Dušek et al. (1998), the number of monogenean decreases in polluted waters, compared to unpolluted waters. However, in waters with different trophic levels and degrees of pollution, the extent of the infestation is approximately the same, but there are differences in the intensity of infestation, which is significantly higher in polluted waters.

MATERIALS AND METHODS

Samples of four fish species including common carp (*Cyprinus carpio*), grass carp (*Ctenopharingodon idella*), silver carp (*Hypophthalmichthys molitrix*), and bighead carp (*Hypophthalmichthys nobilis*) from the most significant and larger cyprinid aquaculture facilities in Macedonia, including fishponds and cage farms on reservoirs, were examined for parasitological investigations. This study was carried out by seasons, in three years. The specimens were placed in plastic tanks with fishpond water and immediately transferred to

the research laboratory or were inspected on the spot.

During the dissection, gills, fins, and skin were examined using stereomicroscopes „Zeiss“-Stemi DV4 and „MBS 10“, as well as microscopes „Zeiss“-PrimoVert and „Reichert“, at the Laboratory for fish diseases in Hydrobiological Institute - Ohrid (Macedonia).

All parasites found in each fish were identified and enumerated. During the study period, data on parasite species were categorized according to the season, including prevalence and mean intensity. Classical epidemiological variables (prevalence and mean intensity) were calculated according to Bush et al. (1997). The parasite specimens were identified using reference keys of Bauer (1985, 1987) and Gussev (1983).

RESULTS AND DISCUSSION

During the parasitological examinations of the fish from the most significant and larger cyprinid aquaculture facilities in Macedonia, a total of 1134 fish samples were examined, from which parasite infestation with class Monogenea was determined in 656 fish, with a total prevalence of 57.85 % and a mean intensity of 6.84 (Table 1).

Table 1. Total prevalence and mean intensity with representatives of class Monogenea in cyprinid aquaculture facilities in Macedonia

Parasites	Number of examined fish	Number of infected fish	Mean intensity	Prevalence
Monogenean species	1134	656	6.84	57.85 %

During our research, seven (7) parasite species were identified from the representatives of class Monogenea, as following: *Dactylogyrus extensus*, *Dactylogyrus minutus*, *Dactylogyrus vastator*, *Dactylogyrus anchoratus*, *Dactylogyrus aristichthys*, *Dactylogyrus lamellatus* and *Eudiplozoon nipponicum*. Based on the total number of fish examined (1134), the highest prevalence (32.804 %) with monogenean parasites is confirmed with *Dactylogyrus extensus*, followed by *Eudiplozoon nipponicum* (10.670 %), *Dactylogyrus minutus* (6.702 %),

Dactylogyrus vastator and *Dactylogyrus anchoratus* (2.381 %, each), *Dactylogyrus lamellatus* (2.028 %) and *Dactylogyrus aristichthys* (0.882 %). The highest mean intensity with monogenean parasites is determined with *Dactylogyrus aristichthys* (70.000), followed by *Dactylogyrus lamellatus* (19.000), *Dactylogyrus vastator* (6.850), *Dactylogyrus extensus* (6.212), *Dactylogyrus minutus* (4.750), and *Dactylogyrus anchoratus* (3.852) and *Eudiplozoon nipponicum* (2.554). (Table 2).

Table 2. Mean intensity and prevalence with determined monogenean parasites in cyprinid aquaculture facilities in Macedonia

	Parasites species	Mean intensity	Prevalence (%)
1	<i>Dactylogyrus extensus</i>	6.212	32.804
2	<i>Dactylogyrus minutus</i>	4.750	6.702
3	<i>Dactylogyrus vastator</i>	6.850	2.381
4	<i>Dactylogyrus anchoratus</i>	3.852	2.381
5	<i>Dactylogyrus aristichthys</i>	70.000	0.882
6	<i>Dactylogyrus lamellatus</i>	19.000	2.028
7	<i>Eudiplozoon nipponicum</i>	2.554	10.670

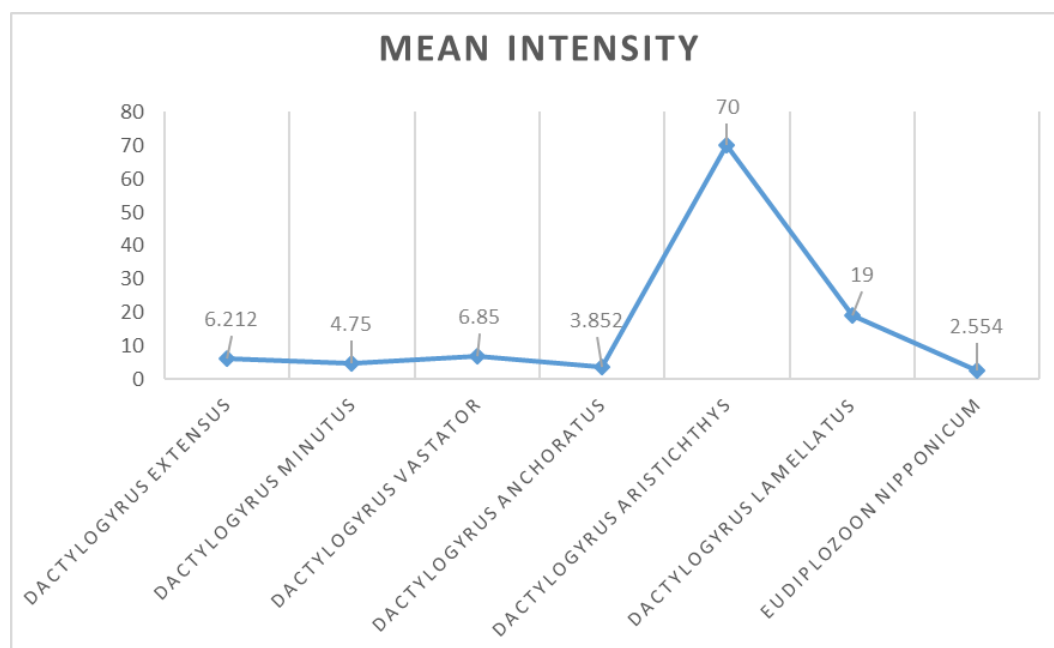


Figure 1. Mean intensity with determined monogenean parasites in cyprinid aquaculture facilities in Macedonia

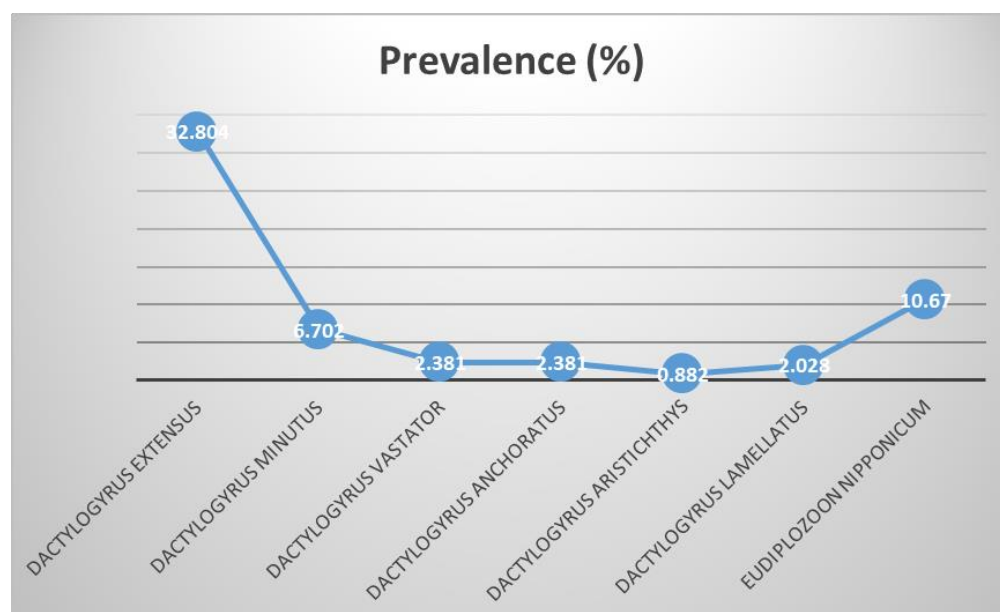


Fig. 2. Prevalence with determined monogenean parasites in cyprinid aquaculture facilities in Macedonia

Table 3. An infestation of monogenean parasites during the seasons

Season	Number of examined fish	Number of infected fish	% of infected fish
Spring	278	157	56.475
Summer	279	111	39.785
Autumn	289	132	45.675
Winter	288	256	88.889

Representatives of the class Monogenea are commonly occurring during the winter (in 88.889 % of examined fish), followed in spring (56.475%), autumn (45.675%), and less in summer (39.785%). From the total number of

examined fish, 656 fish are infested with parasites from the class Monogenea. By season, the number of infected fish is as follows: spring - 157; summer - 111; autumn - 132, and winter - 256. (Table 3).

Table 4. Prevalence (P) and mean intensity (I) with monogenean parasites in cyprinid aquaculture facilities in Macedonia, by seasons

Parasite species	Spring		Summer		Autumn		Winter	
	I	P (%)	I	P (%)	I	P (%)	I	P (%)
<i>Dactylogyrus extensus</i>	4.063	7.055	2.562	2.822	5.500	6.349	8.021	16.578
<i>Dactylogyrus minutus</i>	1.889	0.794	4.792	4.233	3.400	0.596	6.929	1.235
<i>Dactylogyrus vastator</i>	/	/	/	/	/	/	6.850	2.381
<i>Dactylogyrus anchoratus</i>	/	/	/	/	/	/	3.852	2.381
<i>Dactylogyrus aristichthys</i>	49.600	0.441	/	/	90.400	0.441	/	/
<i>Dactylogyrus lamellatus</i>	7.333	0.794	/	/	26.500	1.235	/	/
<i>Eudiplozoon nipponicum</i>	1.889	4.762	2.387	6.526	3.694	11.728	/	/

Based on the total number of fish examined (1134), the highest prevalence (16.578 %) with parasites from the class Monogenea is determined with *Dactylogyrus extensus* in winter, while the lowest (0.441 %) with *Dactylogyrus aristichthys* in spring and autumn. The highest mean intensity (90.400) is determined with *Dactylogyrus aristichthys* in autumn, while the lowest (1.889) with *Dactylogyrus minutus* and *Eudiplozoon nipponicum* in spring. During our research, 5 monogenean parasites were identified in the spring, as follows: *Dactylogyrus extensus*, *Dactylogyrus minutus*, *Dactylogyrus aristichthys*, *Dactylogyrus lamellatus* and *Eudiplozoon nipponicum*. During the summer seasons, 3 monogenean parasites were determined: *Dactylogyrus extensus*, *Dactylogyrus minutus* and *Eudiplozoon nipponicum*. During the autumn seasons, 5 monogenean parasites were determined: *Dactylogyrus extensus*, *Dactylogyrus minutus*, *Dactylogyrus aristichthys*, *Dactylogyrus lamellatus* and *Eudiplozoon nipponicum*. During the winter seasons, 4

monogenean parasites were determined: *Dactylogyrus extensus*, *Dactylogyrus minutus*, *Dactylogyrus vastator* and *Dactylogyrus anchoratus*. By seasons, in spring, the highest prevalence (7.055 %) is determined with *Dactylogyrus extensus*, and the lowest (0.441 %) with *Dactylogyrus aristichthys*. On the other hand, the highest mean intensity (49.600) is determined with *Dactylogyrus aristichthys*, and the lowest (1.889) with *Dactylogyrus minutus* and *Eudiplozoon nipponicum*. In summer, the highest prevalence (6.526 %) is determined with *Eudiplozoon nipponicum*, and the lowest (2.822 %) with *Dactylogyrus extensus*. The highest mean intensity (4.792) is determined with *Dactylogyrus minutus*, and the lowest (2.387) with *Eudiplozoon nipponicum*. In autumn, the highest prevalence (11.728%) is determined with *Eudiplozoon nipponicum* and the lowest (0.441%) with *Dactylogyrus aristichthys*. The highest mean intensity (90.400) is determined with *Dactylogyrus aristichthys*, and the lowest (3.400) with *Dactylogyrus minutus*. In winter, the highest

prevalence (16.578 %) is determined with *Dactylogyrus extensus*, and the lowest (1.235 %) with *Dactylogyrus minutus*. The highest mean intensity (8.021) is determined with *Dactylogyrus extensus*, and the lowest (3.852) with *Dactylogyrus anchoratus* (Table 4).

Table 5. Prevalence and mean intensity with monogenean parasites in common carp (*Cyprinus carpio*) from cyprinid aquaculture facilities in Macedonia

Parasite species	Number of infected fish	Mean intensity	Prevalence (%)
1 <i>Dactylogyrus extensus</i>	372	6.212	38.830
2 <i>Dactylogyrus minutus</i>	76	4.750	7.933
3 <i>Dactylogyrus vastator</i>	27	6.850	2.818
4 <i>Dactylogyrus anchoratus</i>	27	3.852	2.818
5 <i>Eudiplozoon nipponicum</i>	121	2.554	10.670

* Prevalence is estimated according to the total number of examined fish of *Cyprinus carpio* (958)

Table 6. Prevalence and mean intensity with monogenean parasites in grass carp (*Ctenopharyngodon idella*) from cyprinid aquaculture facilities in Macedonia

Parasite species	Number of infected fish	Mean intensity	Prevalence (%)
1 <i>Dactylogyrus lamellatus</i>	23	19.000	30.263

* Prevalence is estimated according to the total number of examined fish of *Ctenopharyngodon idella* (76)

Table 7. Prevalence and mean intensity with monogenean parasites in bighead carp (*Hypophthalmichthys nobilis*) from cyprinid aquaculture facilities in Macedonia

Parasite species	Number of infected fish	Mean intensity	Prevalence (%)
1 <i>Dactylogyrus aristichthys</i>	10	70.000	18.868

* Prevalence is estimated according to the total number of examined fish of *Aristichthys nobilis* (53)

By fish species, in common carp, the highest prevalence (38.830 %) is determined with *Dactylogyrus extensus*, while the lowest (2.818 %, each) with *Dactylogyrus vastator* and *Dactylogyrus anchoratus*. The highest mean intensity (6.850) is determined with *Dactylogyrus vastator*, while the lowest (2.554) with *Eudiplozoon nipponicum* (Table 5). *Dactylogyrus lamellatus* is the only monogenean parasite found in grass carp with a prevalence of 30.263% and a mean intensity of 19.000 (Table 6). *Dactylogyrus aristichthys* is the only monogenean parasite found in bighead carp with a prevalence of 18.868% and a mean intensity of 70.000 (Table 7). The family Dactylogyridae includes a large number of parasitic species that mainly parasitize the gills of freshwater fish. Dove & Ernst (1998) state that *Dactylogyrus* is one of the largest genera of parasitic helminths, 95% of which are gill parasites in fish of the family Cyprinidae. According to Woo (2006), the representatives of

the genus *Dactylogyrus* represent the largest group of fish ectoparasites and are of great importance for the pathology of fish. Young fish are more at risk of infection with these parasites, which can lead to disease and high mortality in lakes, but older fish are not excluded. Kearns (1994) states that in general, most species of the genus *Dactylogyrus* are strictly host-specific, or limited to one or more closely related hosts. Pietrock et al. (2001) found that the diversity of monogenean trematodes in fish decreases in polluted areas, probably because pollutants causing damage to the life of the leisure-swimming stage of the parasite. On the other hand, according to Galli et al. (2001) and Lafferty & Kuris (2005) prevalence and intensity of infestation of monogenean in the fish gills increases in polluted areas due to increasing host acceptability.



Figure 3. *Eudiplozoon nipponicum* in common carp (glandular formations on the anterior part) (Blazhekovikj - Dimovska Dijana & Stojanovski Stojmir)

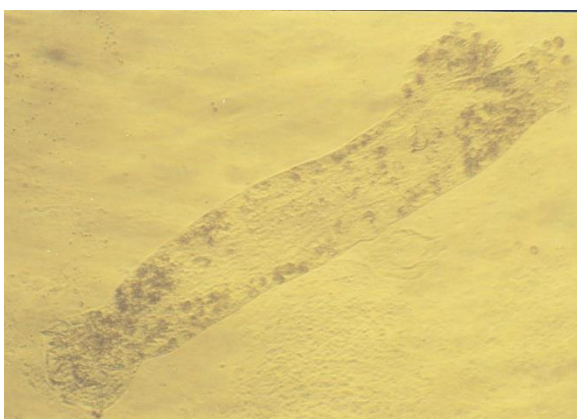


Figure 4. *Dactylogyrus lamellatus* in grass carp - whole parasite (Blazhekovikj - Dimovska Dijana & Stojanovski Stojmir)

CONCLUSIONS

Seven representatives of monogenean parasites in cyprinid fish from the Macedonian aquaculture were identified in this study: *Dactylogyrus extensus*, *Dactylogyrus minutus*, *Dactylogyrus vastator*, *Dactylogyrus anchoratus*, *Dactylogyrus aristichthys*, *Dactylogyrus lamellatus* and *Eudiplozoon nipponicum*. A total of 1134 fish samples were examined, from which parasite infestation with representatives of the class Monogenea was determined in 656 fish, with a total prevalence of 57.85 % and a mean intensity of 6.84. Based on the total number of fish examined, the highest prevalence (32.804 %) with monogenean parasites is confirmed with *Dactylogyrus extensus*, while the lowest with *Dactylogyrus aristichthys* (0.882 %). The highest mean intensity with monogenean parasites is determined with *Dactylogyrus aristichthys*

(70.000), while the lowest with *Eudiplozoon nipponicum* (2.554).

There is a close correlation between parasitic communities and the level of pollution of the water. In polluted environments, the degree of parasites prevalence and mean intensity can be an indicator of environmental quality. Because the level of water contamination can directly or indirectly affect the aquatic ectoparasites through the action of their intermediate host, ectoparasites that are directly exposed to water may be more sensitive to contaminants, thereby reducing their rates of survival and reproduction. The degree of activity of ectoparasites and endoparasites of the body surface and/or inside the fish body depend on the degree of water purity in combination with other environmental factors. In conditions of inadequate water quality that filled ponds, poor hygienic ponds conditions have a major contribution to the development of the parasitic disease.

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