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FIRST RECORD OF *DACTYLOGYRUS VASTATOR* (NYBELIN 1924) (MONOGENEA: DACTYLOGYRIDAE) IN COMMON CARP (*CYPRINUS CARPIO* LINNAEUS, 1758) FROM AQUACULTURE FACILITIES IN MACEDONIA

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ABSTRACT
The representatives of the class Monogenea are of great importance in fish pathology. *Dactylogyrus vastator* (Nybelin 1924) (Monogenea: Dactylogyridae) is a common pathogenic monogenean parasite in common carp (*Cyprinus carpio* Linnaeus, 1758) from freshwater lakes and cyprinid ponds, worldwide. In our study, a total of 133 specimens of common carp from the cage culture system on Mladost Reservoir (N. Macedonia) were subjected to a parasitological investigation, by seasons. Only fresh fish were subjected to routine identification, dissection, and observation methods. Parasite identification was performed morphologically, based on the character of significant organs, using referent keys for determination. *Dactylogyrus vastator* was found in winter, on gills of 27 specimens of common carp, with a prevalence of 2.818%, and mean intensity of 6.850. During our research, the presence of *Dactylogyrus vastator* was found in an aquaculture facility with a very high fish stock density. This parasite species would lead to fish mortality and it depends primarily on the mean intensity, the fish condition, and size, as well as the water temperature and oxygen content.
The records of *Dactylogyrus vastator* in common carp in the present study are considered as the first records in N. Macedonia. The common carp is regarded as a new host for these parasite species in Macedonian aquaculture.

Keywords: monogenean, parasites, common carp, cage culture system

INTRODUCTION

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. The family Dactylogyridae which belong to the class Monogenea includes a large number of parasitic species that are the most common gill parasites of freshwater fishes (WOO 2006). 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 GIBSON ET AL. (1996), the genus *Dactylogyrus* Diesing, 1850 (Dactylogyridae) includes more than 900 nominal species. *Dactylogyrus* parasites cause serious infections in the gill filaments causing impaired respiration and resulting in high mortalities (JIANG ET AL. 2013; TU ET AL. 2015) as well as significant economic losses in aquaculture (WOO ET AL. 2002).

In the present study, *Dactylogyrus vastator* (NYBELIN 1924) (Monogenea: Dactylogyridae) was identified from gill filaments of common carp (*Cyprinus carpio* Linnaeus, 1758) from the cage culture system on Mladost Reservoir (Macedonia) using a morphological approach.

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MATERIALS AND METHODS

Fish material from a total of 133 specimens of common carp (*Cyprinus carpio*, L. 1758) from the cage culture system on Mladost Reservoir (N. Macedonia) was subjected to a parasitological investigation, by seasons. Only fresh fish were subjected to routine identification, dissection, and observation methods. Cleaned parasites were separated and put in certain fixatives, prepared for determination with determined techniques of staining and clearing (Vasiljkov, 1983; Gussev, 1983). Parasites on native smears are observed under a light microscope at magnification × 200 and × 400.

For the collection of *Dactylogyrus* species, gill filaments were examined using the stereomicroscopes „Zeiss"- Stemi DV4 and „MBS 10" and parasites were removed. For morphological examination, permanent slides of whole individual parasites were prepared by staining with acetocarmine, dehydrating with ascending grades of alcohol and mounting in Canada balsam. For the study of sclerotized structures, whole parasites were cleared gradually in water and mounted in glycerin. Specimens were examined using a light microscope „Reichart". Identification was made throught the morphology of haptoral hard parts and the copulatory complex.

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

Dactylogyrus vastator was found on the gills of 27 specimens of common carp from the cage culture system on Mladost Reservoir (N. Macedonia) in winter, with the prevalence of 2.818%, while the mean intensity was 6.850 (*Table 1*.).

Table 1. Prevalence (P) and mean intensity (I) with Dactylogyrus vastator in common carp from the aquaculture facility in N. Macedonia, by seasons

Parasite species	**Spring**		**Summer**		**Autumn**		**Winter**	
	I	**E (%)**	**I**	**E (%)**	**I**	**E (%)**	**I**	**E (%)**
Dactylogyrus vastator	/	/	/	/	/	/	6.850	2.381

Dactylogyrus vastator is a large parasite, with a body length of up to 1.25 mm and a width of up to 0.48 mm. The middle hooks are characterized by the following dimensions: length of the general part 0.038 - 0.048 mm; base part 0.036 - 0.038 mm; internal growth 0.019 - 0.021 mm; external growth 0.009 - 0.011 mm. The sharp part is small and ranges from 0.004 - 0.005 mm. There is only one connecting plate with dimensions 0.007 - 0.008 × 0.024 - 0.032 mm. The length of the peripheral hooks is from 0.030 - 0.035 mm. The length of the copulatory organ ranges from 0.045 - 0.055 mm.

The parasites were identified using morphometric measurements of hard parts, the morphology of the haptoral parts, and the shape of the male copulatory organ.

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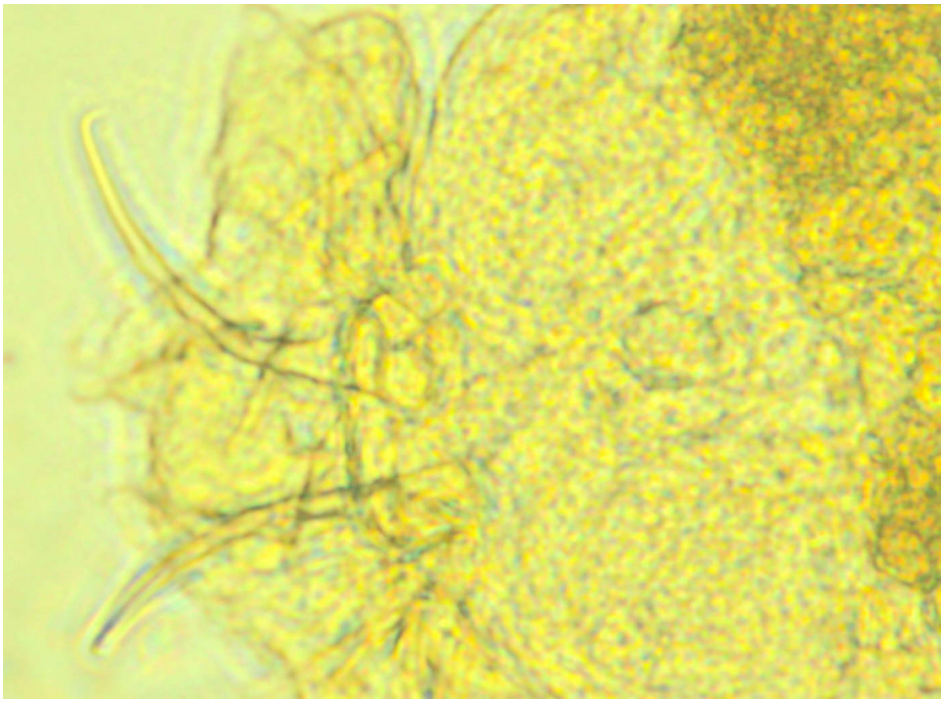

Figure 1. Dactylogyrus vastator on gills in common carp – hooks (original)

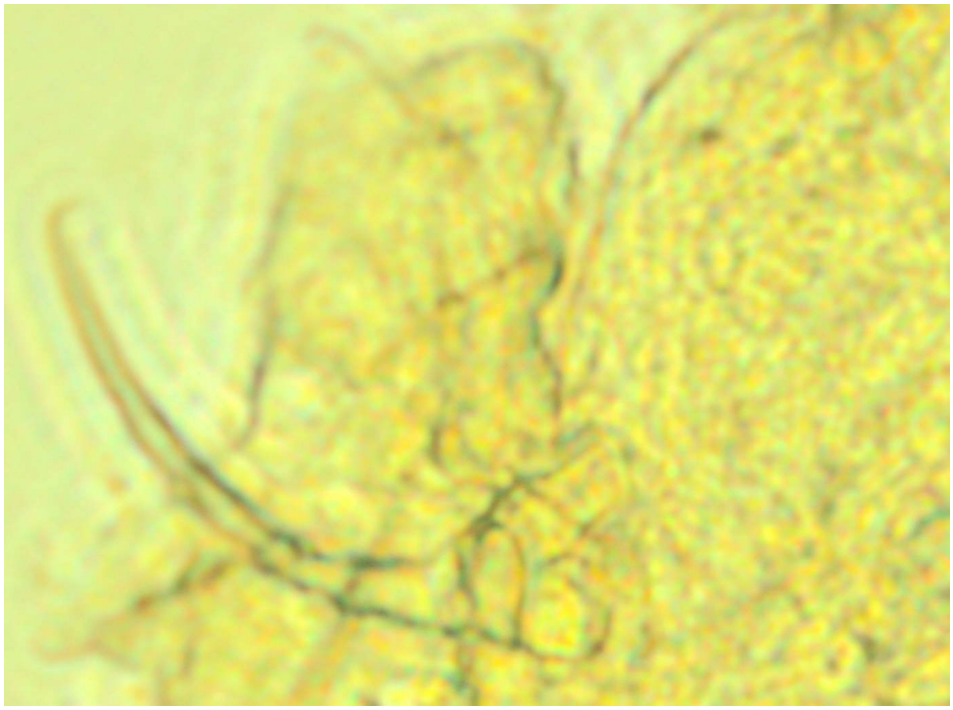

Figure 2. *Dactylogyrus vastator on gills in common carp – hooks (original)*

DISCUSSION

Dactylogyrus vastator is a typical parasite that attacks the tips of the gill filaments of common carp. It is a highly pathogenic species, especially for young carp with a length of 2 - 5 cm. Diseased fish consume little food. The color of the gills fades, they are covered

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with mucus, and in some places, blood clots form. This parasite causes impaired respiratory function in fish, so due to the impossibility of normal breathing, they die.

According to KAKACEVA-AVRAMOVA (1983), *Dactylogyrus vastator* causes mortality in fish with a length of 2.5 cm, whose gills parasitize 60-80 specimens, as well as in fish with a length of 3.5 - 4.0 cm, on whose gills parasitize 140 - 160 specimens of this parasite. ČANKOVIĆ ET AL. (1976) state that *Dactylogyrus vastator* is a highly pathogenic species for young carp with a length of 2-5 cm. Parasites, during strong invasions, are distributed over the entire surface of the gill filaments, which causes severe pathological changes and significant losses in the offspring.

According to the data from previous parasitological researches in Macedonia, *Dactylogyrus vastator* was found only in *Carassius gibelio* (prussian carp) from Lake Ohrid, Prespa, and Dojran, by STOJANOVSKI (2003), which is the first data on the presence of this parasite in our country. HRISTOVSKI ET AL. (2006, 2012) found the *Dactylogyrus vastator* in *Carassius gibelio* from Lake Prespa.

According to the literature reviews of the Balkan countries, the presence of *Dactylogyrus vastator* at common carp in Bosnia and Herzegovina was established by TESERČIK & IVASIK (1973) in the carp fish pond "Majdan"; KIŠKAROLY ET AL. (1980) and KIŠKAROLY (1987) in carp fish pond "Bardac", "Prnjavor" and "Sanicani" in Prijedor; ČANKOVIĆ ET AL. (1976) in carp fish pond "Vucijak" in Prnjavor. In waters in Bulgaria, this finding was established by MARGARITOV (1962); in the Seyhan River in Turkey by CENGIZLER ET AL. (2001), while in fish ponds in Romania by RADU ET AL. (2008).

According to world literature, data on the presence of *Dactylogyrus vastator* in common carp were published by SHAMSI ET AL. (2009) from fishponds in Iran and HOFFMANN (1999) from fishponds in California and southern Ontario, with enormous damage and high mortality in the fish population.

Dactylogyrus vastator is a fairly common parasite in freshwater lakes and cyprinid ponds. Due to the special sensitivity of this parasite to water hardness, pH, and NH_3, it does not occur in common carp which live in lakes or fish ponds with high alkalinity (JALALI & MOLNÁR, 1990a). ŠIMKOVÁ ET AL. (2007) concluded that these parasites mainly infecting cyprinid fishes.

During our research, the presence of *Dactylogyrus vastator* was determined in a cage fish farm with a very high fish stock density. *Dactylogyrus vastator* was found in winter, on gills of 27 specimens of common carp, with a prevalence of 2.818%, and mean intensity of 6.850. Whether this parasite would lead to fish mortality, depends primarily on the mean intensity, the fish condition, and size, as well as the water temperature and oxygen content.

The records of *Dactylogyrus vastator* in common carp in the present study are considered as the first records in N. Macedonia. The common carp is regarded as a new host for these parasite species in Macedonian aquaculture.

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