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CONTRIBUTION TO PARASITE FAUNA OF PRESPA BLEAK *(ALBURNUS BELVICA* KARAMAN, 1924) (PISCES: CYPRINIDAE) IN LAKE PRESPA, REPUBLIC OF MACEDONIA

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ABSTRACT
Eight out of the eleven indigenous fish species of Prespa are endemic, i.e. they exist only in the Lake Prespa. One of these endemic fish species is Prespa bleak *(Alburnus belvica).* The parasitological examination from the Macedonian part of the Lake Prespa in 2023 showed that all of 14 examined specimens of Prespa bleak fishes were infested (100.0%). In our case study the presence of 8 parasite species was established: *Gyrodactylus sp., Dactylogyrus alatus f. typica, Dactylogyrus fraternus, Dactylogyrus sphyrna, Posthodiplostomum cuticola* (larva), *Cestoda gen. sp.* (larva), *Raphidascaris acus* (larva) and *Ergasilus sieboldi.* Individually, by the parasite species, the highest prevalence was with *Dactylogyrus fraternus, Dactylogyrus sphyrna* and *Posthodiplostomum cuticola* (larva) (71.43%). The lowest one was with *Cestoda gen. sp.* (larva) (7.14%). In our case study the parasites *Gyrodactylus sp., Dactylogyrus fraternus* and *Cestoda gen. sp.* (larva), are recorded for the first time in the ichthyoparasitofauna of Lake Prespa and Macedonia.

KEY WORDS: Parasite fauna, *Alburnus belvica,* Lake Prespa

INTRODUCTION

Lake Prespa is a high-altitude basin (approximately 850 m asl.) situated in the southwestern region of R.N. Macedonia (Figure 1). It consists of two interlinked lakes, Macro Prespa (47.4 km^2) and Micro Prespa (259,4 km^2), which together constitute an inner-mountainous basin that has no natural surface outflow. The Macro Prespa Lake is shared between three countries: North Macedonia, Albania, and Greece. In the past, its maximum depth was 54.2 m and the average depth was 18,74 m, a situation that has drastically changed in recent years

[1]. The lake has several small rivers as tributaries. In the past, its trophic state was on the border between oligotrophic and mesotrophic. Nowadays, the surface level of the lake has significantly decreased, especially in the last decade, due to a long-term dry period, which has resulted in eutrophication. Consequentially, at present, its trophic state has decreased to eutrophic and, in the near future, has the potential to become a hyper-eutrophic ecosystem [1]. The lake was formed in Pliocene and is the same age as Lake Ohrid. Considering the fish fauna, this lake is a typical cyprinid lake, although the trout (*Salmo peristericus*) live in the rivers on the side of the Pelister Mountain and penetrate the lake waters, particularly in the summer.

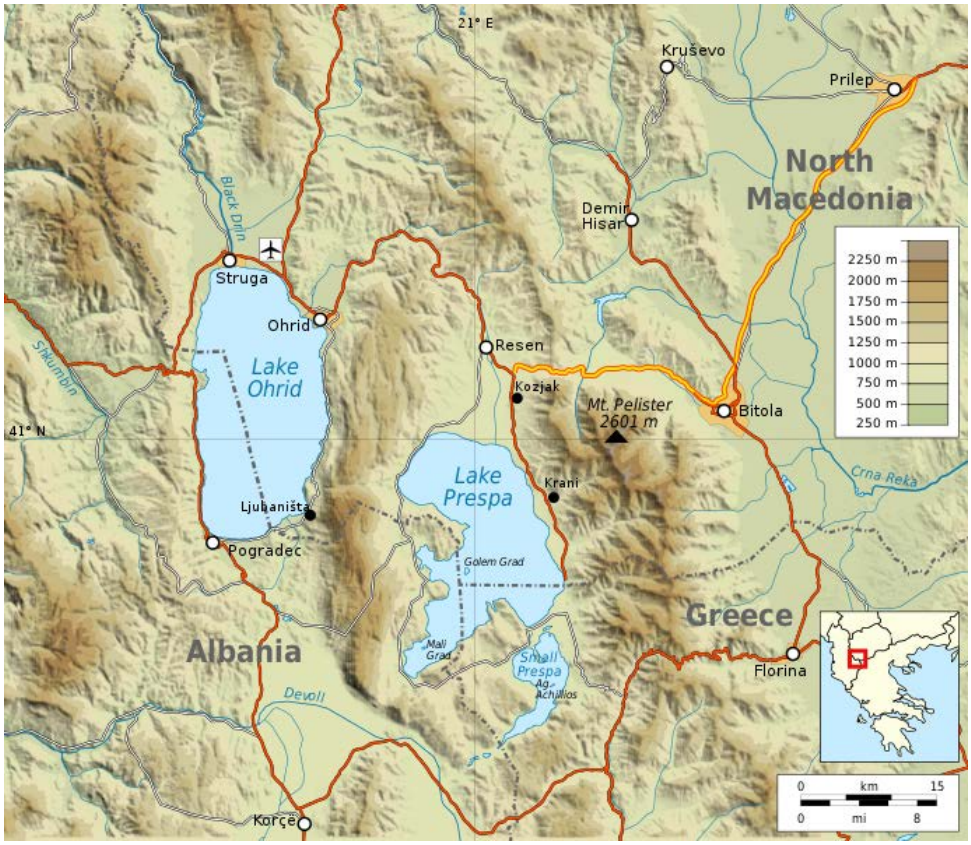

Figure 1. Topographic map of the Ohrid and Prespa lakes (from Wikimedia Commons).

Unfortunately, over recent years, the entire ecosystem has faced serious environmental challenges such as pollution, ineffective planning for land and water use, and poor preservation of rare and threatened species. The unsustainable agricultural, fishery, forest, water, wastewater, and solid waste management practices have had a harsh impact on the ecosystem's health [2].

In addition, due to the unfavorable hydrological conditions, the system lost excessive quantities of freshwater which resulted in a 9-meter water level decline over a period of 25 years. This has not only severely affected valuable shoreline habitats but has also intensified major degradation processes [2].
The pollution and eutrophication processes have not only affected the region's valuable biodiversity but also key sectors such as tourism, water, and fisheries, all of which have been imperative in ensuring the local population's socio-economic well-being [2].

The measures for protection of the lake are based on the Watershed Management Plan's recommendations from the UNDP project RESTORATION OF THE PRESPA LAKE ECOSYSTEM — Implementation of the Prespa Lake Watershed Management Plan, aiming at reducing the pressures from:

- Agriculture (through the introduction of agro-ecological practices);
- Forestry (erosion control by reforestation and control of torrents);
- River pollution (wetland restoration techniques would be used for flood control and water filtering of the Golema Reka River);
- Wastewaters (use of wetlands to upgrade the technology of the existing municipal wastewater treatment plant for nutrient removal);
- Solid waste (upgrade of the agricultural waste management systems).

Neighboring Lake Ohrid is inhabited by the related species *Alburnus scoranza* Heckel & Kner, 1857.
Primarily investigations of the parasite fauna of the fish from Lake Prespa and neighboring Lake Ohrid were carried out by [3,4,5,6], who found *Allocreadium markewitchi, Phyllodistomum elongatum, Caryophyllaeus laticeps, Ligula intestinalis* (plerocercoid), *Contracaecum microcephalum* (larva), *Cystidicoloides tenuissima, Philometra ovata, Metechinorhynchus truttae* and *Pomphorhynchus bosniacus* at *Alburnus belvica* from Lake Prespa; *Allocreadium markewitschi, Phillodistomum elongatum, Ligula intestinalis* (plerocercoid), *Caryophyllaeus laticeps, Caryophyllaeides fennica, Proteocephalus torulosus, Rhabdochona denudata, Contracaecum microcephalum* (larva) and *Pomphorhynchus bosniacus* at *Alburnus scoranza* from Lake Ohrid; *Allocreadium isoporum, Phillodistomum elongatum, Ligula intestinalis* (plerocercoid), *Caryophyllaeides fennica, Rhabdochona denudata, Contracaecum microcephalum* (larva) and *Pomphorhynchus laevis* at *Alburnus scoranza* from Lake Dojran; *Allocreadium markewitchi, Ligula intestinalis* (larva), *Contracaecum microcephalum* (larva) at *Alburnus alburnus* from River Strumica.
Later, at *Alburnus belvica* from Lake Prespa were found the following parasites: *Myxobolus cyprini, M. dispar, M. müelleri, Trichodina sp., Dactylogyrus alatus f. typica, D. elegantis, D. minor, D. vistulae, Diplozoon paradoxum, Paradiplozoon homoion homoion, P. alburni, Posthodiplostomum cuticola* (larva), *Ligula intestinalis* (plerocercoid), *Cystidicoloides tenuissima, Raphidascaris acus* and *Ergasilus sieboldi* [7,8].
At *Alburnus scoranza* from Lake Ohrid were found the following parasites: *Bothriocephalus opsariichthydis, Cystidicoloides tenuissima, Raphidascaris acus* (larva) and *Ergasilus sieboldi* [9].
At *Alburnus thessallicus* from Reservoir Strezhevo are found *Raphidascaris acus* and *Ergasilus sieboldi* [10].

Figure 2. *Alburnus belvica* – original photo.

MATERIALS AND METHODS

Fish material from a total of 14 specimens of Prespa bleak - *Alburnus belvica* Karaman, 1924 from Lake Prespa (southwest N. Macedonia) were subjected to a parasitological investigation, by seasons from 2021 to 2023. The localities in Lake Prespa where the investigations were carried out were: Nakolec, Oteshevo and Kazan. 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 [11,12]. For the collection of parasite species, intestines of fish were examined using the stereomicroscope "Zeiss Stemi 305" and microscope "Zeiss Primovert" and parasites were removed. Identification was made throughout the morphology of parasites, using referent keys for determination [13,14,15].

RESULTS

During the parasitological investigations on Prespa bleak *(Alburnus belvica)* from Lake Prespa (N. Macedonia) 8 parasite species were found: *Gyrodactylus sp., Dactylogyrus fraternus* (Figure 3), *Dactylogyrus alatus f. typica* (Figure 4), *Dactylogyrus sphyrna* (Figure 5), *Posthodiplostomum cuticola* (larva) (Figure 6), *Cestoda gen. sp.* (larva) (Figure 7), *Raphidascaris acus* (larva) (Figure 8) and *Ergasilus sieboldi* (Figure 9).

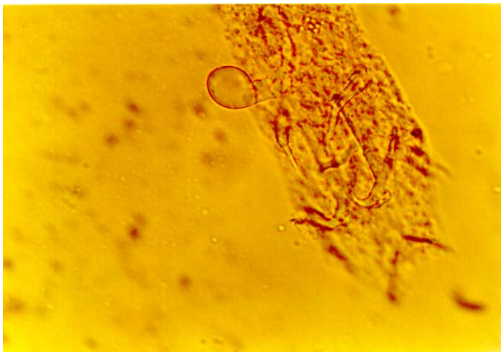

Figure 3. Dactylogyrus alatus f. typica – original photo.

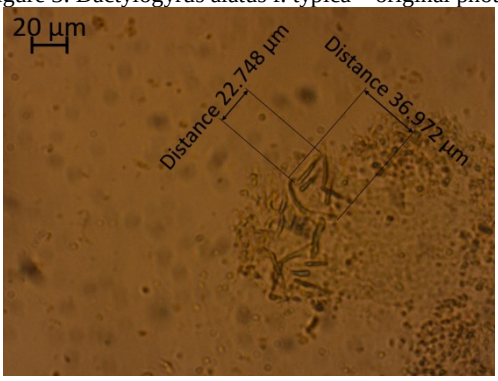

Figure 4. *Dactylogyrus fraternus* – original photo.

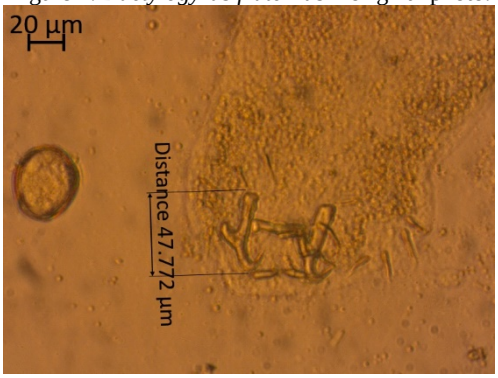

Figure 5. *Dactylogyrus sphyrna* – original photo.

Figure 6. *Posthodiplostomum cuticola* (larva)

Figure 7. *Cestoda gen. sp.* (larva) – original photo.

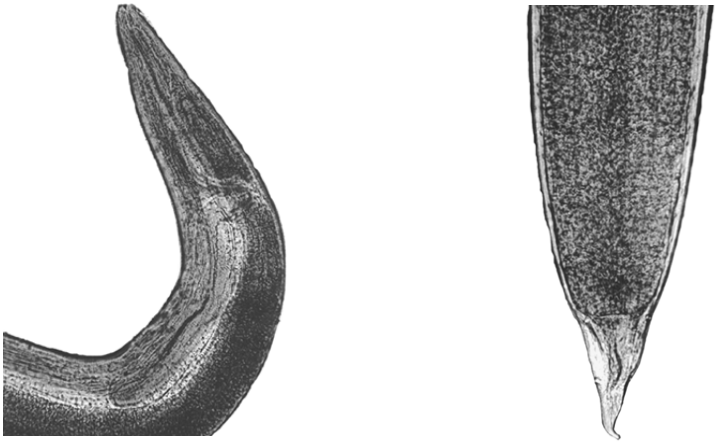

Figure 8. *Raphidascaris acus:* anterior end (left), posterior end (right) – original photo.

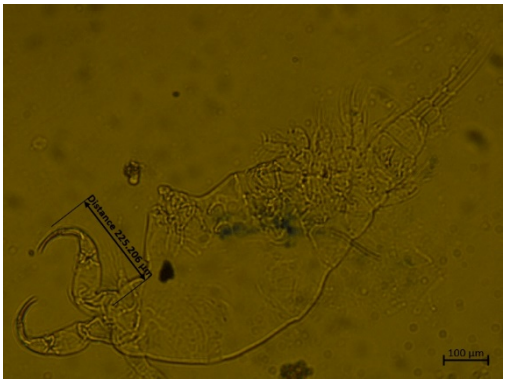

Figure 9. *Ergasilus sieboldi* – original photo.

The total prevalence of infestation was 100.0% and the highest prevalence was of *Dactylogyrus fraternus*, *Dactylogyrus Sphyrna* and *Posthodiplostomum cuticola* (larva) (found in 71,43% of Prespa bleak) and the lowest prevalence was with *Cestoda gen. sp.* (larva) (7.14%) (Table 1, Figure 12).
The average intensity of infestation was 4.41, and the highest level was that of *Cestoda gen. sp.* (larva) (20.0) and *Raphidascaris acus* (larva) (10.0) (Table 1, Figure 10).

Table 1. Parasite fauna of the Prespa bleak *(Alburnus belvica)* from Lake Prespa.

Parasite species	Prevalence		Intensity of infection
	No. of examined fish	% of infected fish	
Gyrodactylus sp.	14	42.86	6.67
Dactylogyrus alatus f. typica		14.29	3.50
Dactylogyrus fraternus		71.43	3.40
Dactylogyrus sphyrna		71.43	1.20
Posthodiplostomum cuticola (larva)		71.43	5.0
Cestoda gen. sp. (larva)		7.14	20.0
Raphidascaris acus (larva)		14.29	10.0
Ergasilus sieboldi		42.85	1,0
Total infection	14	100.0	4,41

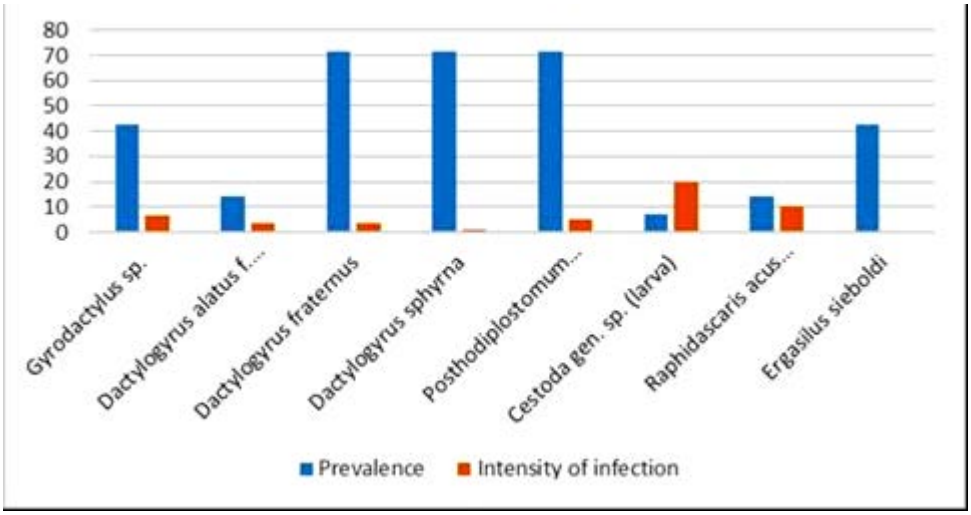

Figure 10. Parasite fauna of the Prespa bleak *(Alburnus belvica)* from Lake Prespa.

DISCUSSION

According to preliminary molecular research, we think it is a species of *Gyrodactylus laevis*, but additional research will be done in the near future.

For the larva of cestod, based on the analysis of morphological characteristics, we believe that it is a larva from the order Caryophyllidea. However, in general, larvae of cestods are often very poorly described by fish parasitologists and it is not possible to find more detailed information that would help a closer determination.

The parasite fauna of Prespa bleak *(Alburnus belvica)* from the Lake Prespa is in common with that of the fishes of the family Cyprinidae from the Balkan Peninsula and more widely [16,17,18,19,20,21,22,23].

The parasitofauna of *Alburnus belvica* is mostly freshwater, with one exception that is met both in marine and fresh waters (*Raphidascaris acus).*

One part of established parasites is with wide area of distribution and wide specter of hosts, like: *Gyrodactylus sp., Posthodiplostomum cuticola* (larva), *Raphidascaris acus* (larva) and *Ergasilus sieboldi*. Other part of established parasites are stenoparasites or on the border of stenoparasitism, like: *Dactylogyrus alatus f. typica, Dactylogyrus fraternus, Dactylogyrus sphyrna,*

Findings of *Gyrodactylus sp., Dactylogyrus fraternus* and *Cestoda gen. sp.* (larva) represented first finding for Prespa nase from Lake Prespa and N. Macedonia.

Among the parasite species found out in Prespa nase from Lake Prespa, the greatest pathological influence was associated with *Gyrodactylus sp., Dactylogyrus sphyrna* and and *Ergasilus sieboldi.*

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