



A STUDY OF FISH LICE (*ARGULUS* SP.) INFECTION IN FRESHWATER FOOD FISH

Aalberg, K.¹, Koščová, L.¹, Šmiga, Ľ.¹, Košuth, P.¹
Koščo, J.², Oros, M.³, Barčák, D.³, Lazar, P.¹

¹Department of Breeding and Diseases of Game and Fish
University of Veterinary Medicine and Pharmacy, Komenského 73, 041 81 Košice

²University of Prešov, Faculty of Human and Natural Sciences, 080 01 Prešov

³Institute of Parasitology, Slovak Academy of Sciences, Hlinkova 3, 040 01 Košice
The Slovak Republic

lubomir.smiga@uvlf.sk

ABSTRACT

Argulus sp., commonly referred to as fish lice, are crustacean ectoparasites of fishes. The hematophagous parasites attach to and feed off the integument of their hosts. Outbreaks of epizootics have been reported worldwide, causing mass mortalities and having serious economic implications for fish farms and culture efforts. *Argulus* fish lice may also serve as vectors of infectious diseases and as intermediate hosts of other parasites. Two native European species, *A. foliaceus* and *A. coregoni*, as well as the invasive Japanese fish louse *A. japonicus*, have previously been recorded in Slovakia. This study investigated samples collected at fish farms and culture sites of Common carp (*Cyprinus carpio* L.), Pike-perch (*Sander lucioperca* L.) and Brook trout (*Salvelinus fontinalis* M.) in Eastern Slovakia, as well as samples collected from live fish imported to the Slovak Republic. A quantitative description of the of *Argulus* sp. was recorded from each locality. Samples from Common carp were identified as the invasive *A. japonicus*, and samples from Pike-perch and Brook trout were identified as *A. foliaceus*. Evidence

of a mixed infection of Pike-perch with both *A. foliaceus* and *A. japonicus* was found in samples from Zemplínska Šírava, which was substantiated by electron microscopic examination. Morphometric characteristics were measured and averages and ranges produced for each species and sex.

Key words: *Argulus foliaceus*; *Argulus japonicus*; Common carp; crustacean ectoparasites; Pike-perch; mixed parasite infection

INTRODUCTION

Fish lice is common name for branchiurid ectoparasites of fish from the genus *Argulus* [11]. Although *Argulus* fish lice are widely distributed and able to parasitize and thrive off a wide range of host species, argulosis have rarely been found to have severe effects on naturally occurring fish populations [5, 27]. Here the low intensity of infection is typically insufficient to be associated with mortality or extensive tissue damage [10]. This occurs as a result of a com-

bination of the mechanical action of the attachment organs and the feeding apparatus of the argulid, and the chemical action of enzymes or toxins injected into the host fish by the feeding fish louse [31]. Primary lesions develop at the predilection sites; haemorrhagic spots may be seen on the fins and at the base of fins, the head, and non-respiratory surfaces of the gill cavity [5]. Argulosis may lead to secondary infections, have also been linked to the transmission of infectious and other parasitic disease [6, 31].

Argulosis typically occurs on fish farms, where high stocking densities facilitate parasite transmission, while factors such as overcrowding, capture, handling and confinement may act as stressors and negatively influence the host immune response [31].

The fish lice have a direct life cycle. After mating the female will leave the host fish and deposit eggs on solid surfaces in the immediate environment [31]. Occurrence of argulosis is seasonally dependent, parasites typically reach peak abundance during summer and autumn [10].

In Europe we can only find three species of *Argulus* parasitizing freshwater fishes, namely the native *A. foliaceus* and *A. coregoni*, and the invasive and now widely spread *A. japonicus* [10, 31]. Other European species of *Argulus* have been found on marine fishes [10, 21].

This study addresses the lack of knowledge of the present situation of these parasites in economically important species of fish in Slovakia. Three species have previously been recorded in Slovakia, *A. foliaceus*, *A. coregoni* and the invasive Japanese fish louse, *A. japonicus* [9].

MATERIAL AND METHODS

Common carps (*Cyprinus carpio* L.; Cypriniformes) and pike-perches (*Sander lucioperca* L.; Perciformes) were sampled from commercial culture ponds in Eastern Slovakia, and from live fish imported from the Czech Republic and Hungary. Brook trout (*Salvelinus fontinalis* M., Salmoniformes) was sampled from a small culture pond in Košice. In the time period 2013–2015 a total of 116 Common carps, 40 Pike-perches and 2 Brook trouts were dissected.

The fishes were dissected and examined as a part of routine screening during storage or harvesting, or as a part of a diagnostic procedure on fishes displaying clinical signs of disease. A complete parasitological dissection was performed, and age category, sex, standard length and body

weight was noted in the dissection protocol. The *Argulus* sp. fish lice were collected using forceps, and fixed in 4% formalin or 70% ethanol. Parasitological indices, such as prevalence (P; the number of hosts infected with 1 or more individuals of a particular parasite species, divided by the number of hosts examined for that parasite species), intensity of infection (ii; the number of individuals of a particular parasite species in a single infected host) and mean intensity (mi; the average intensity of a particular species of parasite among the infected members of a particular host species), and mean abundance (ma; the total number of individuals of a particular parasite species in a sample of a particular host species divided by the total number of hosts of that species examined) [1], were evaluated.

Examination of specimens was carried out using a stereomicroscope. Species determination was performed as described by previous authors [2, 22]. Morphometric measurements were taken on the fixed specimens.

RESULTS

Species determination of *Argulus* sp.

The investigated specimens of *Argulus* sp. were identified as *A. foliaceus* and *A. japonicus*. The fish lice obtained from Common carp was identified as *A. japonicus* and from Pike-perches both *A. foliaceus* and *A. japonicus* were identified. Mixed infection with both *A. foliaceus* and *A. japonicus* was observed in Pike-perches from Zemplínska Šírava. The fish lice collected from Brook trout was identified as *A. foliaceus*, some specimens had a body length and underdeveloped second maxillae consistent with the fifth developmental stage (Table 1).

Table 1. The species of genus *Argulus* found infecting carp (*Cyprinus carpio* L), Pike-perch (*Sander lucioperca* L.) and Brook trout (*Salvelinus fontinalis* M.)

Host species	Species of <i>Argulus</i>	Sampled locality
Common carp	<i>A. japonicus</i>	Hrhov, Perín, Import from Czech Republic
Pike-perch	<i>A. foliaceus</i>	Paľkov-Lúčky, Zálužice-Lúčky, Bátovce
	<i>A. foliaceus</i> and <i>A. japonicus</i>	Zemplínska Šírava
Brook trout	<i>A. foliaceus</i>	Botanical garden in Košice

Table 2. A quantitative assessment of the parasite populations found on carp (*Cyprinus carpio* L.)

Locality	P [%]	mi	ii	Ma
Hrhov (Winter)	11.1	3	3	0.33
Hrhov (Harvest)	38.5	19.6	7.30	7.54
Perin	6.3	9	9	0.56
Import from Czechia	19.4	2	1,3	0.39
Import from Hungary	8.7	3	3	0.26

P — prevalence; ii — intensity of infection
mi — mean intensity; ma — mean abundance

Table 3. A quantitative assessment of the parasite populations found on Pike-perch (*Sander lucioperca* L.)

Locality	P [%]	mi	ii	ma
Pařkov-Lůčky	100	80.3	40—144	80.3
Zálužice-Lůčky	80	4.5	3.6	3.6
Bátovce	100	32	17—53	32
Zemplínska Šírava	100	10.2	6.14	10.2

P — prevalence; ii — intensity of infection
mi — mean intensity; ma — mean abundance

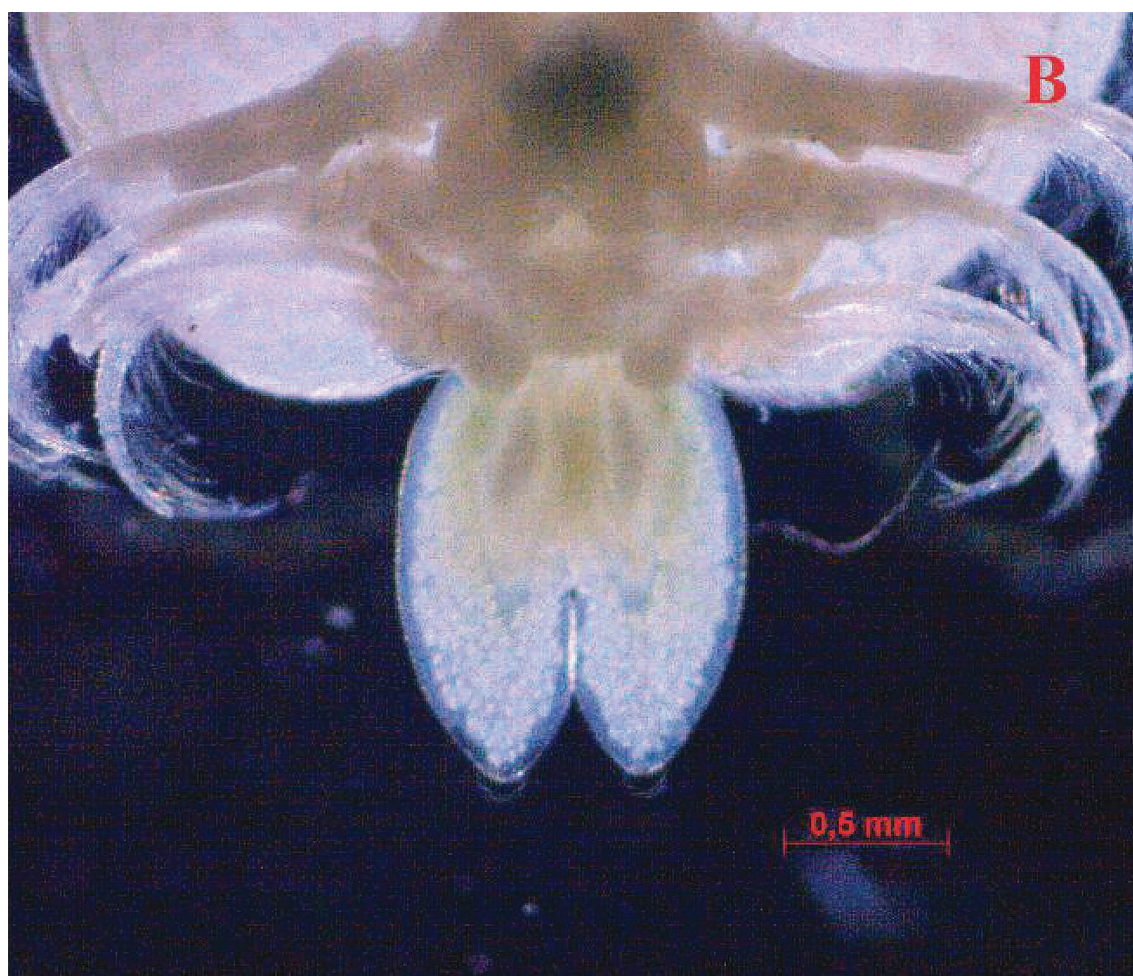


Fig. 1. Microscopic examination of *Argulus japonicus*
(A) — male on the right, female on the left, 0.8× magnification by stereomicroscope
(B) — abdominal lobes of male. Magn. × 2.0 (stereomicroscope)



Fig. 2. Microscopic examination of males of two species:
Argulus japonicus (left side) and *A. foliaceus* (right side)
 Magn. $\times 0.8$ (stereomicroscope)

Parasite populations found at sampled localities

The prevalence of *Argulus* infection recorded from carp varied among the sampled localities, ranging from 6.3 % to 38.5 %. The highest recorded prevalence of infection in carp was found in the pond Hrhov in the harvesting period (Table 2).

The prevalence in Pike-perch was very high, ranging from 80 % to 100 % in the sampled localities (Table 3).

Prevalence of *A. foliaceus* in Brook trout was 100 % with infection intensities ranged 25–30 and mean intensity of infection was 30 specimens per fish and mean abundance 30.

DISCUSSION

Species determination of *Argulus* sp.

The investigated specimens of *Argulus* sp. fish lice were identified as *A. foliaceus*, and *A. japonicus*.

The fish lice obtained from carp was identified as *A. japonicus*. All three European *Argulus* species have previously been recorded from carp in Slovakia [10], but only the

Japanese fish louse was identified from the sampled localities. Carp infections with *A. japonicus* have been described in several studies [16, 19, 30].

In the fish lice samples obtained from Pike-perches both *A. foliaceus* and *A. japonicus* was identified. All three of the European *Argulus* species have previously been recorded from Pike-perch in Slovakia [9], but *A. coregoni* was not found among the fish lice specimens. Perchid fishes are preferred hosts of *A. foliaceus* [23], and Pike-perch infection with *A. foliaceus* have been described by previous authors [14, 32].

In three of the sampled Pike-perch localities only *A. foliaceus* was present, while a mixed infection with both *A. foliaceus* and *A. japonicus* was observed in Pike-perches from Zemplínska Širava. Several cases of mixed *Argulus* sp. infections have been described, however the mixed infections in question involved different *Argulus* species and host fishes from our findings in Zemplínska Širava [4, 8, 20].

Morphologically the two species *A. foliaceus* and *A. japonicus* are very similar [19, 22], and it may be impossible to determine the species of certain specimens [22]. Fish lice from Zemplínska Širava had several characteristics consis-

tent with *A. japonicus*, however these traits are subject to variation [3]. Measurements of morphometric characteristics were found to be in range with findings of other authors [13, 18, 26, 28].

The fish lice collected from Brook trout was identified as *A. foliaceus*. Infection of Brook trout with *Argulus* sp. has not been previously recorded from Slovakia [9], however fish lice infection in this fish species have been recorded by other authors [3, 7]. *A. foliaceus* been found to infect other salmonid fish species [3, 12].

A. foliaceus from Brook trout was found to be significantly smaller than specimens obtained from Pike-perches, their body length was consistent with the sixth and seventh developmental stage [18]. Some specimens had a body length and underdeveloped second maxillae consistent with the fifth developmental stage [18].

Quantitative description of *Argulus* sp.

The prevalence of *Argulus* infection recorded from carp varied among the sampled localities, ranging from 6.3 % to 38.5 %.

The highest recorded prevalence of infection in carp was found in Hrhov in the harvesting period, greatly exceeding the prevalence from the same location during screening before and after wintering. This concurs with findings in other studies, where *Argulus* populations typically reach peak abundance during summer and autumn [6, 17].

The prevalence of infection in Pike-perch was very high, ranging from 80 % to 100 % in the sampled localities. Samples were collected in the summer and autumn, the period in which peak abundance is expected [6, 17].

The prevalence, mean intensity and abundance of *Argulus* sp. was higher in Pike-perches compared to Carp. Pike-perches are gregarious animals, where occurring in shoals may facilitate parasite transmission [29], however conflicting evidence of the effect of shoaling on *Argulus* infection exist [15]. The Zemplínska Šírava watercourse is one of the most severely PCB contaminated sites in Europe, and high levels of PCBs have been found in Pike-perches from this location previously [25]. PCBs have an immunosuppressive effect on fish and a positive correlation between PCB (polychlorinated biphenyl) pollution and abundance of ectoparasites in fish have been established [24].

The prevalence of infection in Brook trout was very high, samples were collected in the summer and autumn, the period in which peak abundance is expected [7, 26].

CONCLUSION

This study deals with *Argulus* fish lice infections of freshwater food fishes. *Argulus* fish lice are branchiurid ectoparasites capable of inflicting serious pathological effects on freshwater fishes. Little is known on the present status of fish lice in freshwater food fish in Slovakia. This study has shown that *Argulus* sp. are found parasitizing economically important species of fish in Slovakia, determined the species of fish lice are present and which species of fish they infect, and described the parasite populations found on infected fish species.

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