

**First finding of species *Alburnus arborella* (Bonaparte, 1841)
syn. *Alburnus alborella* (De Filippi, 1844)(Actinoptery GII:
Cyprinidae, Alburninae) in Buško Lake**

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Abstract

In this paper we present data about first findings of species *Alburnus arborella* (Bonaparte, 1841) syn. *Alburnus alborella* (De Filippi, 1844) (Actinoptery GII: Cyprinidae, Alburninae) in Buško Lake (Municipality Livno). In this report twenty – four specimens were caught during research period in two seasons in 2018. More specifically, trips to the catchment areas were made in spring-summer season from 12.06.2018 to 18.07.2018. and 22.11.2018. Determination of individuals was made on the basis of analysis of individual morphometric and meristic characters with the exact length and weight of the individuals. This is the first finding of this species probably brought and introduced by fishermen. The findings of this species in Bosnia and Herzegovina have so far been confirmed in the Neretva watercourse and in the Ričica river in the Republic of Croatia.

Keywords: *Alburnus arborella*, First finding, Busko lake Bosnia and Herzegovina, Meristic characters

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Introduction

In the earliest period of exploration of the ichthyofauna of Bosnia and Herzegovina, the first large-scale works were the records of Austro-Hungarian researchers, among them the "Süßwasserfische der Österr. Monarchie" von Jakob Heckel und Kner (1858). Mentioned authors (1858) provide an incomplete, but first, description of a large number of species from the Cyprinidae family in Lake Busko and the rivers of the Livno, Duvno and Sinj regions. The river basin district of Bosnia and Herzegovina is divided not only in hydrographic but also in climatic terms into two "water basins", the Black Sea and the Adriatic basin. This fact points to the occurrence of endemic forms in freshwater ecosystems, and to the need for a more detailed analysis and determination of the actual state of biodiversity of the living communities of the study area. This section lists and references numerous papers by researchers from our country and the surrounding area, as well as eminent, world-renowned names in the field of ichthyology, which represent a valuable contribution to ichthyofauna studies of biodiversity in Bosnia and Herzegovina. The chronologically distinguished works are those whose objectives are narrowly set with the task of determining the level of diversity of the ichthyofauna of the southwestern Bosnian karst area, which also includes the area of Buško Lake (Karaman, 1923; Protić, 1926/1927; Taler, 1951, 1954; Vuković, 1963, 1966,

1968, 1977; Aganović *et al.* 1974; Vuković and Kosorić, 1970, 1978). The continuation of cited papers is related to the period after formation of the Buško Lake accumulation and the somewhat modified ecological conditions of habitats in the investigated area (Mučibabić, 1973; Habeković *et al.*, 1987; Cvijović and Kosorić 1985; etc.). Kosorić *et al.* (1991) present the real possibilities of using water reservoirs in Bosnia and Herzegovina for production of fish, with the research in support of the familiarisation with endemic ichthyofauna in the Busko Lake area. The last twenty years were marked by the individual papers by authors Guzina, 2000; Dumanić, 2004; Bogut *et al.* 2007; Žujo Zekić, 2009; Škrijelj *et al.* 2015 and others.

The objective of the paper is based on the fact that 38 species of the *Alburnus* genus have been recorded in Europe and Western Asia (Bogutskaya *et al.*, 2000; Kottelat and Freyhof, 2007; Żulug and Freyhof, 2007). Systematic surveys of species of the *Alburnus* genus in the river basin district of Bosnia and Herzegovina and the region are related to the species description, *Alburnus alburnus* (Linnaeus, 1758) - zela, with distribution throughout the waters of Europe as it occurs in the waters of Bosnia and Herzegovina in the waters of the Black Sea basin (Drina, Bosnia and the tributaries of the Sava) and *Alburnus albidus* (Costa, 1838) - ukljeva, uklija, which is widespread in the watercourses of Italy and some

tributaries of the Adriatic (Soča, Neretva, Bijeli Drim, Bojana) and in Skadar Lake (Montenegro) in Skadar Lake, is a special endemic species of Skadar's *Alburnus scoranza* Bonaparte, 1845 and Ohrid Lake) in Ohrid is endemic to *Alburnoides ohridanus* (Karaman 1928). In Bosnia and Herzegovina inhabits the middle and lower reaches of the Neretva River and its tributaries (Sofradžija, 2009). According to Mrakovčić *et al.* (2006) provide only data for the coastal gobbler *A. albidus* (Costa, 1838) inhabiting the Adriatic rivers of northern and southern Italy, Croatia and Bosnia and Herzegovina (Mirna River, Butoniga Lake, and Krka, Zrmanja, Neretva and Baćinska Lakes). Kottelat and Freyhof (2007) provide details and a description of the *Alburnus arborella* species, for which they confirm distribution status, according to which this species inhabits the Adriatic catchment area from the Soča to the Ancona province (Slovenia, Switzerland and Italy), and the lower Zrmanja and Neretva rivers in Croatia and Bosnia and Herzegovina. It was introduced to the Ričica River in the Republic of Croatia to their knowledge. In nature, hybridization between the genera *Alburnus* spp. and *Squalius* spp. (*Alburnus* spp. X *Squalius* spp.), and the resulting hybrid individuals are generally fertile. Kottelat and Freyhof (2007) report a very common hybridization of *A. arborella* with the species *Squalius squalus* (formerly *Leuciscus chepalus albus*) in the rivers

where these two species live together. Therefore, our current research provides the first finding and confirmation of the introduction of this species into Lake Buško (Hercegbosanska County, Municipality Tomislavgrad-Municipality Livno). In addition to the distribution of this species, authors from the region have dealt with the issue of a valid name, namely whether it is the correct name of the species *A. arborella* (Bonaparte, 1841) or *A. alborella* (De Fillipi, 1844). Even the same authors find data in the Italian literature that keep the two names of the species synonymous, with the authors giving their critical review of this issue (Kottelat and Bianco, 2005). Buj *et al.* (2010) point out the fact that, despite the wide range of species of the *Alburnus* genus in the waters of the Adriatic basin, their taxonomy, systematics and current distribution are not well known and are not completely clear and conclusive. Genetic analyzes confirm the status of the population in the Neretva River basin as a separate species with a p-spacing of 1.8-2.2% relative to the newly described *A. arborella* species from the Zrmanja River. From the known fact that a total of four species from the genus *Alburnus* (*A. albidus*; *A. arborella* Bonaparte, 1841; *A. belvica* Karaman, 1924; *A. scoranza* Bonaparte, 1845) are recorded with habitat in the waters of the Adriatic catchment area (Italy, Switzerland, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Macedonia, Albania and Greece)

(Kottelat and Freyhof, 2007) outlines the aim of this scientific paper.

The fact that is pointing out contributes to the goal of the work done by Ketmaier *et al.* (2009) who, when studying Italian ichthyofauna, also refer to the species *A. arborella* (Bonaparte) as representative of the genus *Alburnus*, for which they point out that the taxonomy of this species has been a controversy since the end of the 19th century because *Alburnus arborella* was alternatively considered a subspecies *A. albidus* or European fishes *A. alburnus* (L.). Only recently the name of *A. arborella* has been formally confirmed (Kottelat and Bianco, 2005). The species was originally endemic to the Padano-Venetian district, but was largely transferred to the Tuscano-Latium district, following the rule that central Italian rivers are habitat for fish of northern Italian origin (Bianco, 1995b). Considering all the above facts, it is very important to determine the exact distributive status of the species *A. arborella* in the Adriatic catchment area through Bosnia and Herzegovina with potentially marked starting points as well as precisely located locations of its transfer of habitat and adaptation. Considering all the above facts, it is very important to determine the exact distributive status of the species *A. arborella* in the Adriatic catchment area through Bosnia and Herzegovina with potentially marked starting points as well as precisely located locations of its transfer of

habitat and adaptation. In this case, it is a new finding of the species *A. arborella* in Buško Lake (Hercegbosanska County, Municipality of Livno and Tomislavgrad, BIH).

Materials and methods

The fieldwork of the study was done for two seasons during 2018. The period of ichthyological research covered the spring - summer, 2018, and fall 2018 seasons.

The reasons for the longer stay and more exhaustive field work at the four designated catchment sites is caused by the fact that the surface of the water basin is large (the third largest of its kind in Europe). During the indicated period, the catch sites were processed 5-6 times during June and July 2018 and October and November 2018. Representative samples of ichthyofauna from aquatic reservoir Buško jezero were fished at four locations: L/ 1 - Prisoje - Old bridge; L/ 2 - Golinjevo; L/ 3 - Podgradina - Channel; L/ 4 Mukišnica (Figs. 1 to 3 and Table 1.).

Analyzed representative samples of the fish population needed to do this study were obtained by standard methods of fishing. For this purpose, two types of nets were used: filler nets, (10mm, 16mm, 28mm, 32mm and 50mm) and barracuda nets, (70mm, 80mm, 90mm, 100mm and 120mm) and an electric generator. During the fishing, attempts were made to avoid the selectivity of ichthyomaterials,

thanks to the available and diverse fishing gear. A total of 200-250m nets of different types and diameters were set up at each catch site (Table 2).

Table 1: General notes on sampling sites at the Busko lake hydroaccumulation area.

Number	Site label	Site name	Coordinates	Altitude (m)	Length of nets (m)	Average depth (m)
1.	L/1	Prisoje – Old bridge (Tomislavgrad)	N 43°41'117" EO 17°04'896"	702-712	200 -250	1,50
2.	L/2	Golinjevo (Livno)	N 43°41'520" EO 17°01'961"	702-712	200 -250	2,50
3.	L/3	Podgradina-Channel(Livno)	N 43°42'414" EO 16°50'085"	702-712	200-250	3,50
4.	L/4	Grabovica-Mukišnica (Tomislavgrad)	N 43°38'364" EO 17°04'616"	702-712	200-250	2,50

Table 2: Descriptive analysis of individual morphometric parameters in caught species.

Species	Average lenght (cm)	Average lenght (gr)	Max. lenght (cm)	Min. lenght (cm)	Min. Weight (gr)	Max. weight (gr)
<i>Silurus glanis</i>	55,9	1727,72	89	27	160	4950
<i>Carassius gibelio</i>	22,784	886,701	39	10	40	4655
<i>Cyprinus carpio</i>	32,134	1309,718	65	9	10	4000
<i>Tinca tinca</i>	15,083	169,166	20	10	14	440
<i>Lepomis gibossus</i>	8,98	16,428	16	5	3	97
<i>Sander lucioperca</i>	29,052	582,035	50	12	50	1615
<i>Alburnus arborella</i>	13,791	73,25	18	11	18	145
<i>Scardinius erythrophthalmus</i>	20,631	463,421	27	12	18	815
<i>Chondrostoma phoxinus</i>	13	22	15	15	14	30
<i>Salmo trutta</i>	47	1625	50	44	1100	2000
<i>Squalius tenellus</i>	n/a	n/a	n/a	n/a	n/a	n/a

The biosystematic determination of the fish caught was done according to the keys Vuković and Ivanović, 1971; Kottelat and Freyhof, 2007. In the implementation of descriptive statistics software program "SPSS for Windows 15.0", was used and it represented basis for the application of classical, especially actualized methods in the processing of ichthyological data (Fig. 1).

Results and discussion

Ichthyofauna exploration of Buško Lake has been carried out continuously since the very beginning of the announcement of the construction of artificial hydro-accumulation in the area of the former wetland bar ecosystem Busko Blato. The year of more comprehensive research was 1973 when, in the initial, elementary research assignment "Limnological studies of Buško blato reservoir,"

Mučibabić, (1973) encompassing broader aspects of biological research in the area of the waterways of the

Livno and Duvanjsko field, give results of the fauna status of fish in natural habitat conditions.



Figure 1: Cartographic presentation of the geographical position of research sites at the Buško Lake Figures 2 i 3. 2. Site L/3 Podgradina-Channel-Livno; 3. Site L/4 Mukišnica-Grabovica (Tomislavgrad); (Boškailo, 2018)

More recently, research assignments with the same issue have been highlighted in the work of the author Žujo Zekić (2004; 2009) with relevant results on the biodiversity of fishes of the Buško Lake and systematic reviews of endemic species (*Chondrostoma phoxinus* Heckel, 1843). The results of current research activities in the Buško Lake area are of recent date and covered all relevant facts, during the one-year, two-season and multi-day field trips. They present the current status of the qualitative composition of

ichthyopopulations based on the material recovered. The data obtained on the presence of other fish species and heterogeneity of ichthyofauna in the Lake Buško are summarized in tabular and graphical form (Table 1). Considering the new finding of the *A. arborella* species in Buško Lake and the status of individual endemic species, it will be significant from the point of view of conservation since the *Chondrostoma phoxinus* species is critically endangered (CR) according to the IUCN status in Croatia (Mrakovčić

et al., 2006) *A. arborella* species is first recorded in the Buško Lake area as an introduced (allochthonous) species with conservation status of LC (Least concern). Thus, this new finding of *A. arborella* is a contribution to the knowledge of the range expansion of this species and is the first of its kind for the Buško Lake area.

Analysis of ichthyofauna material collected in the Buško Lake area within the project “Inventory and monitoring

of the living communities of the Buško Lake aquatic ecosystem” revealed that there are 24 fishes belonging to the *A. arborella* species (Table 3. and Fig. 2.). *A. arborella* species (Bonaparte, 1841) syn. *A. alborella* (De Filippi, 1844) are distinguished and separated from other species of the *Alburnus* genus from the Adriatic basin by their observable and measurable morphometric and meristic features (Fig. 3.).

Table 3: Number of individuals within each species analyzed and associated ichthyomass.

Species	No. of individuals	Mass of individual fish species (gr)
<i>Silurus glanis</i>	25	43193
<i>Carassius gibelio</i>	265	234976
<i>Cyprinus carpio</i>	32	41911
<i>Tinca tinca</i>	12	2030
<i>Lepomis gibossus</i>	17	1265
<i>Sander lucioperca</i>	57	33176
<i>Alburnus arborella</i>	24	1758
<i>Scardinius erythrophthalmus</i>	19	8805
<i>Chondrostoma phoxinus</i>	2	44
<i>Salmo trutta</i>	4	6500
<i>Squalius tenellus</i>	1	1235
Ukupno	458	374893

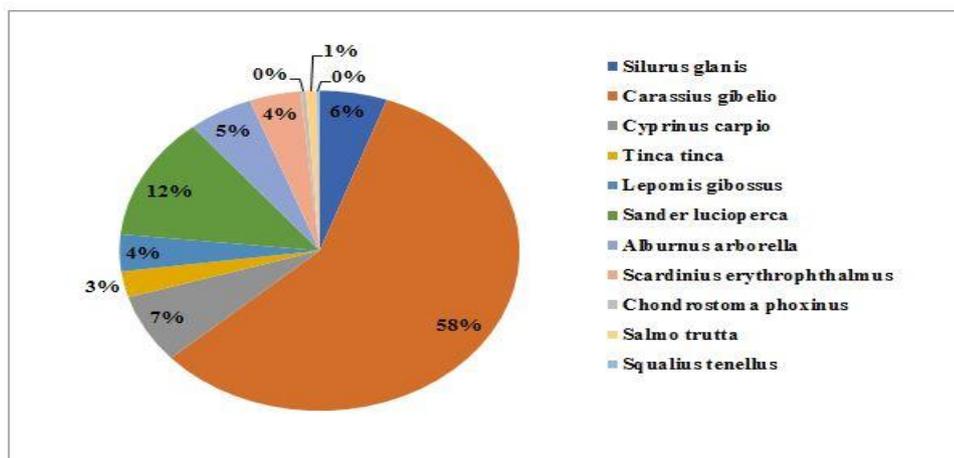


Figure 2: Percentage of individual species in the diversity of ichthyopopulations of the Buško Lake.



Figure 3: *Alburnus arborella* specimens at determination.

Body elongated and laterally flattened, where body height fits 4 to 5 times the length of body without tail fin. The scales are silver in color and are easily removed with a noticeable dark brown streak along the flanks of the body. The total body length is up to 20 cm with the formula D III 7-8, A III 12-15, V II 8, P 13-15, lateral line 48-52 scales (Vuković and Ivanović, 1971). According to the same authors, this species lives in large flocks and spawns from in coastal areas from late March to mid-July. Some minor discrepancies and discrepancies are noted by Kottelat and Freyhof (2007), who report spawning species of this species from May to August at temperatures above 15°C. The discrepancies are clear and with the

number of spokes in the dorsal fin 4-8, the number of scales in the lateral line is 40-47 +3. In anal fin 13-16 spokes, 16-22 gill arches.

Šorić (2006) gives an overall picture of the species through descriptions of other authors: Du (II) III (IV), Db 7-9, Au (II) III, Ab 10-17, Vu II, Vb 7-8, Pu I, Pb 13-17, Squ. sup. 7-11, ll 42-56, Squ. inf. 3-4 (5), Sp. br. 17-25, Vert. 37-45, D. ph. 2.5 – 5.2 (4.2, 5.3). Body is elongate, laterally compressed, with maximal length 160 to 180mm, rarely 200mm. Along the body side is stretched dark-brown line. Mouth superior a horizontal line from the lip of premaxillary reaches the upper part of eye. These data were compiled from Tortoneze (1970), Karaman (1924,

1928), Oliva (1950), Poljakov *et al.* (1958), Dimovski and Grupče (1971), Ivanović (1973), Šorić (1982, 1990 and data from this study), Rakaj (1995), pointing out that meristic characters in populations of this species from different localities essentially are not different. The biggest number of specimens has got 49 to 52 (77%) scales in II, with usual 8 to 9 (80%) horizontal scales rows above and 3 to 4 (95%) scales rows below. Dorsal fin with 8 (82%) and anal fin 13 to 14 (85%) branched rays. The first gill arch has 17 to 22 branchial spines in specimens from typical oligotrophic Ohrid Lake, 17 to 23 in Beli Drim, and 21 to 25 in specific carst Skadar Lake. Number of vertebrae in largest specimens varies from 38 to 42.

The morphometric characters of populations from Ohrid – Drim – Skadar basin demonstrate considerably variable. The length of head amounts from 18.6 to 24.6% of SL. Diameter oculi is 21.4 to 31.7% of cl. Greatest body depth 17.8 to 22.5% and minimum body depth 6.5 to 9.8% of SL. Depth of anal fin 9.6 to 14.8% of standard length.

According to the same author Šorić (2006) distribution Peninsula bleak in Adriatic basin is represented on Fig. 1. in his article. (Fig 1. *Distribution of Alburnus arborella* (block review)) p. 86. The triangles indicate localities of introductions inhabited are Po river system to Isonca (Italy), Soča and Mirna rivers (Slovenia), Zrmanja river (Dalmatia, Croatia), Narentana river

with tributaries (Bosna and Hercegovina), Skadar Lake, Morača river, Zeta river, Cijevna river, Šaško Lake (Montenegro), Beli Drim and its tributaries (Metohia, Serbia), Drim River, Ohrid Lake, Globočica Lake (Macedonia and 86 Albania). (Bianco, 1987; Karaman, 1924, 1928; Ivanović, 1968; Dimovski and Grupče, 1971; Povež *et al.*, 1990; Šorić, 1990; Rakaj, 1995). In this part of the paper, the very relationship of autochthonous and allochthonous fish species of Buško Lake is graphically presented, with an emphasis on introduced species which, in percentage values of abundance and ichthyomass, occupy a far greater proportion than indigenous species, especially endemic ones. Therefore, the analyzed species of *A. arborella* accounts for some 5% of the total number of allochthonous species of Buško Lake.

Conclusion

After investigating the diversity of fish populations of Buško Lake (Livno Municipality, Tomislavgrad Municipality, Canton of Herzegovina/Canton), 24 individuals were identified from the caught material and identified as belonging to the Cyprinidae family and the genus *Alburnus* Rafinesque, 1820. All individuals were found to belong to the species *Alburnus arborella* (Bonaparte, 1841). The finding of the species *A. arborella* (Bonaparte, 1841) in the area of Buško Lake is so far one of the 4 localities in Bosnia and Herzegovina, where

representatives of the above mentioned species have been noted, and it is also the first finding for Buško Lake. A review of the referenced literature and a systematic comparison of the state of fish communities before and after the formation of the Buško Lake hydroaccumulation makes clear and concise conclusions about the partial threat of endemic ichthyopopulations, as well as the pronounced natural occurrence of interspecific competition, which in this case is stimulated by man. There are no published papers of literature on the studies of this species in the area of Buško Lake and the surrounding watercourses of Livno and Duvanjsko field, so it is expected that this work will contribute to a more detailed knowledge of the diversity and distribution of the *Alburnus* genus in Bosnia and Herzegovina.

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