ASSESSMENT OF THE POPULATION STATUS OF GLOBALLY THREATENED CRAYFISH *ASTACUS ASTACUS* AND *AUSTROPOTAMOBIUS TORRENTIUM* IN THE LAKES PRESPA, OHRID AND RIVERS OF THE SHEBENIK - JABLLANICË NATIONAL PARK, ALBANIA

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ABSTRACT

Despite being internationally recognized as threatened, there are no comprehensive studies on the crayfish species *Astacus astacus* (Linnaeus, 1758) and *Austropotamobius torrentium* (Schrank, 1803) in Albanian's freshwaters. Existing research, primarily conducted by foreign researchers in the Albanian portions of Lakes Ohrid and Prespa. This study spans one year (2023-2024) and includes 7 monitoring stations within Lake Ohrid, 5 stations in Great Prespa, 2 stations in Small Prespa Lake, and 2 additional stations on the Qarrishta stream within the National Park Shebenik. The methodology used involves baited traps known as "LiNi-Trap". Alongside crayfish monitoring, water parameters such as pH, temperature, conductivity, PPM and dissolved oxygen were also measured. The study found *A. astacus* present only in Great Prespa and Ohrid lakes, while

A. torrentium was not detected in any of surveyed water bodies. In Lake Ohrid, *A. astacus* was observed at four of the seven monitoring stations in the Lin - Piskupat- Udenisht - Memelisht area, and in Great Prepsa Lake it found in three of five stations in the Kallamas - Gollomboc – Pustec area. The measured water parameters were within the optimal range values for species growth, suggesting that factors other than water quality, such as reduced rainfall, are contributing to the displacement of individuals to deeper habitats, potentially affecting their population numbers in monitored areas.

Keywords: Astacus astacus, Austropotamobius torrentium, Ohrid lake, Prespa lake,Shebenik, bait trap, monitoring

1. INTRODUCTION

In Europe, the genera Astacus and Austropotamobius comprise a total of 5 species: *Astacus astacus, Astacus leptodactylus*, *Astacus pachypus, Austropotamobius torrentium,* and *Austropotamobius pallipes* (Trožić-Borovac, 2011). According to Holdich (2002), while two of the four European crayfish species found in the Balkan Peninsula—*A. astacus* and *A. torrentium*are—are believed to be present in Albania, no studies on their distribution have been published to date, to the best of our knowledge.

Pârvulescu *et al*. (2011), asserts that crayfish taxa are vulnerable to various threats, including overexploitation, habitat modifications, water pollution, increasing pressure from invasive crayfish species, and the crayfish plague. Over the past few decades, stone crayfish declined significantly across their Europea range (Kouba *et al*., 2014), highlighting the need for comprehensive studies, including Albania. As noted by Lindqvist and Lathi (1983), noble crayfish engage in mating during autumn, and the duration of their life cycle is affected by the climate and habitat in which they live. The breeding season begins with a drop in temperature in autumn, while the maturation of testes and ovaries occurs between July and September (Lindqvist and Lathi 1983).

The noble crayfish, Astacus astacus (Linnaeus, 1758), from the genus Astacus, is widely distributed across Europe, both as a native species and through introductions in various regions (Souty-Grosset *et al*., 2006). According to the IUCN, A. astacus is classified as "vulnerable" (Edsman *et al*., 2010). Holdich *et al.*, (2009), and Kouba *et al*., (2014) describe it as the most widespread indigenous crayfish species in Europe, with a range that includes central and northern Europe, encompassing the North Sea, Baltic Sea, Black Sea, Adriatic Sea basins, and the Balkan Peninsula.

The assumption of *A. astacus* presence in Albania has primarily been based on records from transboundary water bodies outside the country (Mrugała 2017). Between 2004 and 2015, ichthyological studies conducted on major rivers across Albania investigated crayfish distribution, identifying *A. astacus* at two locations in Lake Ohrid. In addition to sightings in Lake Ohrid and the upper Devoll River, *A. astacus* populations have also been observed in the Albanian section of Lake Prespa (Đuretanović *et al.*, 2017). Earlier studies have consistently reported A. astacus presence in transboundary waters of neighboring countries and in several streams near Albania (Mrugała 2017).

The species *Austropotamobius torrentium* (Schrank, 1803) is classified as "data deficient" by the IUCN (Füreder *et al.*, 2010) and is recognized as a "priority species" under the Habitats Directive (European Communities, 1992). It has also been reported in Albania (Subchev 2011), with a specimen collected from the Fani i Madh River in the northern part of the country in 2003 (Subchev, 2011). The presence of *A. torrentium* has also been documented in the Montenegrin part of the Skadar Lake basin (Trontelj *et al.*, 2005) and is widespread in northern Greece, where its western distribution extends to the area around the city of Kastoria, near the Albanian border (Koutrakis *et al.*, 2007). Conservation policies for Astacus astacus and Austropotamobius torrentium include protections under the Bern Convention (1982) and the EU Habitats Directive (1992), which classify these species as part of the sensitive freshwater fauna in need of conservation.

In Albania, the Biodiversity Protection Law (No. 9587, 2006) mandates measures to preserve species and their habitats, and the National Biodiversity Strategy (2016-2020) aims to monitor and restore habitats where these species naturally occur.

This limited knowledge about the distribution of these two species underscores the need for further research to clarify their presence in the rivers of Shebenik National Park and the lakes of Ohrid and Prespa. Participation in this one-year study in these aquatic bodies is further encouraged by reports from local fishermen and residents indicating the presence of these species.

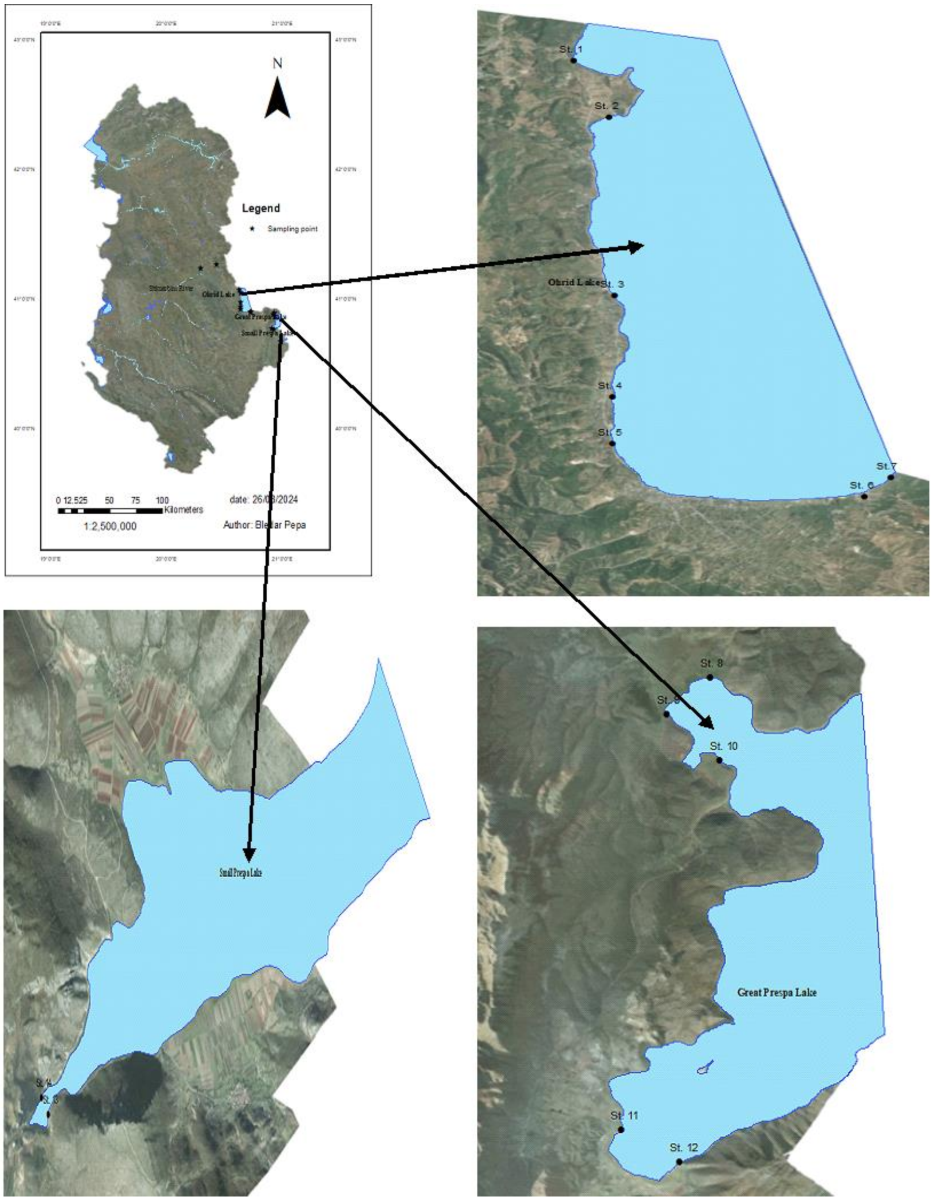
2. MATERIALS AND METHODS

2.1. Study area:

The study area encompasses the Prespa and Ohrid Lakes, along with rivers located within the Shebenik National Park. Seven monitoring stations were established along the shoreline of Lake Ohrid, five stations in Great Prespa Lake, two stations in Small Prespa, and two stations within Shebenik National Park. The sampling stations (Table 1) are positioned according to the coordinates in the table below, as as shown on the accompanying map (Map 1).

Table 1. Sampling stations and respective coordinates

No. Stacion	Name Stacion	Latitude	Longitude
St. 1	Lin	41.07213	20.62835
St. 2	Erlin Park, Lin	41.04986	20.63974
St. 3	Udenisht	40.96393	20.64607
St. 4	Memelisht	40.93349	20.64122
St. 5	Gur iKuq Station	40.92209	20.64151
St. 6	Drilon	40.90189	20.72227
St.7	Tushemisht	40.90116	20.71371
St. 8	Kallamas	40.88387	20.92434
St. 9	Gorica	40.86189	20.94099
St. 10	Gollomboç	40.7895	20.90823
St. 11	Pustec	40.76638	20.91859
St. 12	Zaroshka	40.76831	20.9264
St. 13	Tren Village 1	40.67400	20.99742
St. 14	Tren Village 2	40.68922	21.01108
St. 15	Allaj	41.22809	20.2936
St. 16	Qarrishta	41.26592	20.44122



Map 1. Sampling point in Ohrid Lake, Great Prespa Lake, Small Prespa Lake, and Shebenik National Park.

2.2. Methodology

In our study, we focused on sampling noble crayfish (*Astacus astacus*) and stone crayfish (*Austropotamobius torrentium*) in lakes and rivers. We consulted sampling and monitoring protocols developed in various countries, including Sweden (Edsman and Söderbäck 1999), the United Kingdom (Peay 2003), Poland (Strużyński 2015), and the UW-Madison Center for Limnology (2007). Following the protocols suggested by Larson & Olden (2016) in Field Sampling Techniques for Crayfish and the Protocol for Wisconsin Crayfish Sampling, WAV Version 2007, this study aims to detect the presence or absence of these two crayfish species and to estimate their population status using baited traps in deep water.

Site Selection: Both lakes and rivers were considered as ecological sampling sites. For lakes, the recommended sampling technique involved collecting crayfish along two transects on opposite sides of the lake. During the eight-month survey period, traps were typically placed near stones or tree roots along the shorelines. Traps were set each evening and retrieved the following morning after being left in the water for ten to twelve hours.

Setting of traps

In streams and rivers: Following our methodology, we set 5–10 traps at each sampling site. Traps were placed at least 10 meters apart at water depths ranging from 0.5 to 3.0 meters.

In lakes: The number of traps used depended on habitat characteristics and trap availability, with 10 traps recommended per lake (5 per transect, spaced 10 meters apart). We used LiNi traps (Westman *et al*., 1978), made of nylon netting with a mesh size of 0.5 cm. These traps featured openings and a designated area for securing bait. The dimensions of each trap were 60 cm in length, 20 cm in diameter, and 5 cm for the funnel opening.

Choosing a large number of monitoring stations and a high monitoring frequency is essential for obtaining a comprehensive, accurate, and representative understanding of environmental conditions. This approach is particularly beneficial for monitoring biodiversity, water quality, or ecological health. Key benefits include increased spatial coverage, higher temporal resolution, improved data accuracy and reliability, enhanced detection of emerging issues, and support for policy and conservation efforts.

3. RESULTS AND DISCUSSION

Summary of data on individuals collected in Lake Ohrid

Only the *Astacus astacus* species was found in the monitored habitats of Lake Ohrid. During our recent survey, a total of 92 crayfish individuals were collected. At the first station, 22 individuals were recorded; 8 individuals were recorded at the second station; and 43 individuals were recorded at the third station. No crayfish individuals were recorded at the other four stations. The highest number of individuals was recorded in June, while the lowest number was recorded in December. The male-to-female ratio was 61:3.

In the Lin-Memelisht segment, where the substrate and environmental conditions are more favorable, crayfish populations are more widely distributed. In other areas, where the substrate is primarily sandy, conditions are less suitable for crayfish. The absence of crayfish individuals at some stations may be influenced by factors such as urbanization, particularly in the Drilon area, and the presence of mining-related dams near Gur i Kuq Station. Mining waste can significantly impact water quality, introducing heavy metals and other toxic substances released during mineral extraction and processing. The presence of pollutants has created unsuitable conditions for crayfish, leading to environmental stress and reduced biodiversity in these areas. In June, warmer temperatures and abundant food resources stimulated crayfish activity and reproduction, resulting in the highest number of recorded individuals. In December, however, lower temperatures reduced crayfish activity, leading to a decrease in recorded numbers. The observed male-to-female ratio of 61:3 may reflect a natural population imbalance or seasonal variations in the behavior and availability of each sex (see Map 2, Table 2, and Figures 1 and 2).

Table 2: The number of individuals collected from the Ohrid Lake

Session	Month	Ohrid Lake							M	F	Total Month
		St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7			
Autumn 2023	October	2	2	4	1	0	0	0	9	0	9
	November	1	2	4	0	0	0	0	6	1	7
Winter 2023	December	0	0	3	0	0	0	0	3	0	3
Spring 2024	March	2	1	4	1	0	0	0	7	1	8
	April	3	2	4	1	0	0	0	9	1	10

	May	3	2	9	1	0	0	0	14	0	15
Summer 2024	June	4	3	7	1	0	0	0	15	0	15
	July	7	6	9	3	0	0	0	26	0	25
	Total St.	22	18	43	9	0	0	0			
	Total lake								**89**	**3**	**92**

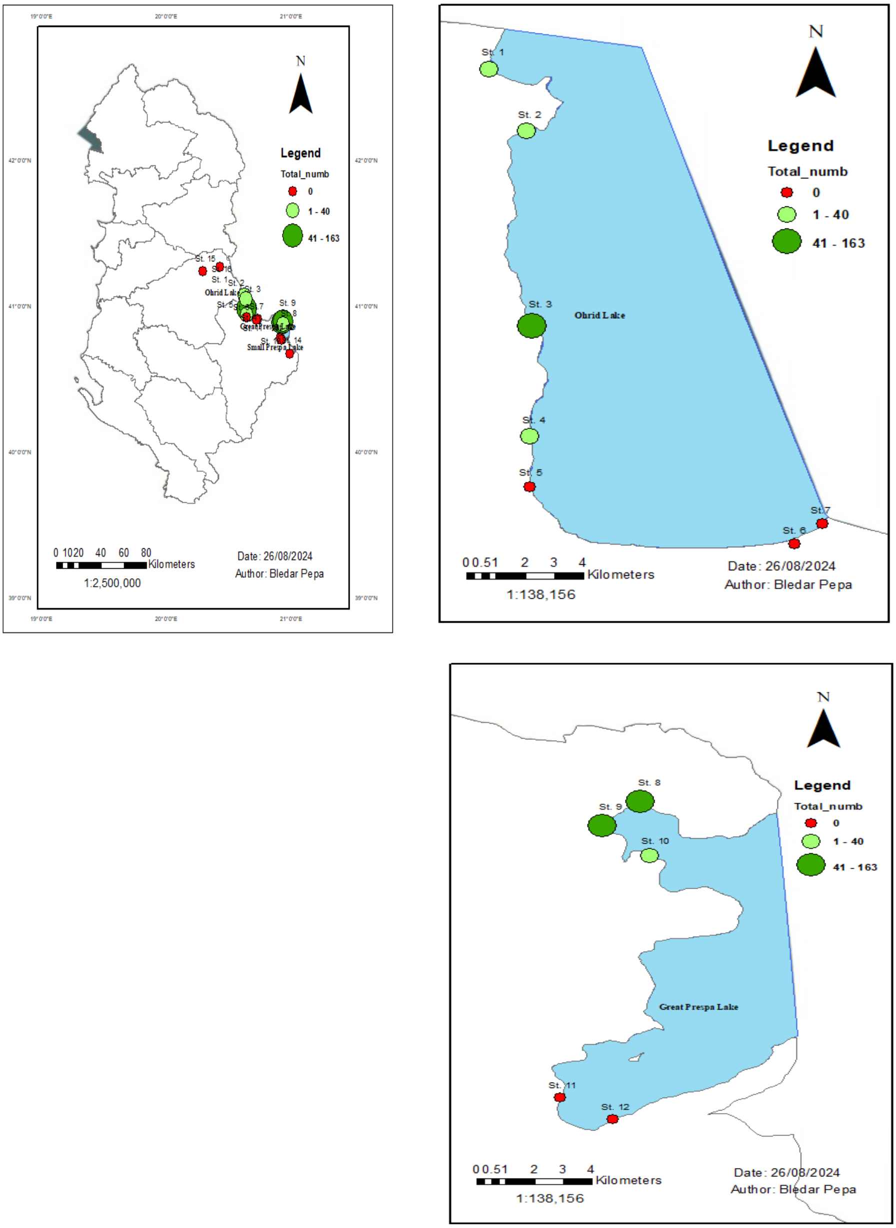
Summary of data on individuals collected in Lake Great Prespa

Only the *Astacus astacus* species was found in the waters of Prespa Lake. During crayfish population monitoring at five stations, a total of 137 individuals were recorded at the first station, 163 at the second, and 40 at the third. No individuals were found at the remaining two stations. The highest number of individuals was recorded in June, and the lowest in December. The male-to-female ratio was 333:7.

The absence of crayfish at stations 11 (Pustec) and 12 (Zaroshka) may be attributed to an unsuitable substrate characterized by psamal and lymal composition. Another likely factor affecting the crayfish population in Prespa Lake is severe water withdrawal, which has degraded the optimal crayfish habitat. Observations from the administration of Prespa National Park and local fishermen indicate a significant drop in lake water levels, possibly linked to reduced winter snowfall. This habitat degradation has created unfavorable conditions for crayfish survival and reproduction, impacting their population in these areas (see Map 2, Table 3, Figures 1 and 2).

Table 3. The number of individuals collected in Prespa Lake

Session	Month	Prespa Lake					M	F	Total Month
		St. 8	St. 9	St. 10	St. 11	St. 12			
Autumn 2023	October	9	16	5	0	0	29	1	30
	November	10	13	3	0	0	26	0	26
Winter 2023	December	6	9	4	0	0	19	0	19
Spring 2024	March	17	22	5	0	0	43	1	44
	April	20	20	3	0	0	40	1	43
	May	24	25	5	0	0	52	2	54
Summer 2024	June	23	26	7	0	0	54	2	56
	July	28	32	8	0	0	67	1	68
	Total St.	137	163	40	0	0			
	Total lake						**333**	**7**	**340**



Map 2. Distribution of the total number of individuals caught according to stations

No crayfish species were found in Small Prespa. The conversion of Small Prespa into a marsh has had negative consequences for animal populations such as crayfish (see Map 2). Habitat alteration is the primary reason for the disappearance of crayfish in this area, as marshes provide unsuitable conditions for their survival, leaving no viable environments for monitoring.

In the Qarrishta and Rapun Rivers, located within Shebenik National Park, no crayfish were found during the 8-month monitoring period. Surveys were conducted along transects covering nearly the entire length of both rivers, yet no evidence of crayfish presence was detected.

Distribution of individuals according to Time Series Plot in both lakes

Following the trend observed in the figure above, the Time Series Plots below show the monitoring data for each month. It is evident that Station 3, which is located in Lake Ohrid, as well as Stations 8 and 9, which belong to Lake Prespa, have the highest number of individuals. The peak in the number of individuals occurs during the summer, specifically in July (see Fig. 1).

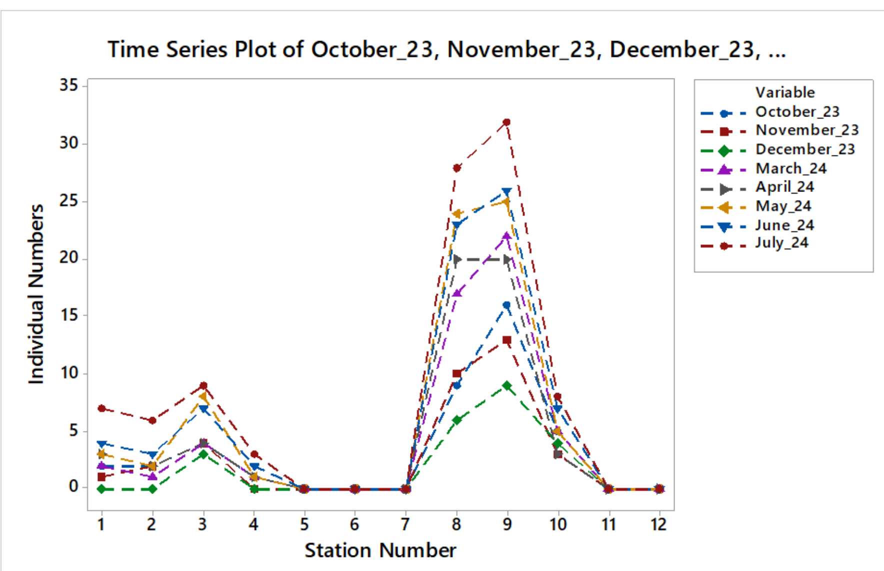


Fig. 1: Monthly distribution of individuals according to Time. Series Plot

Temperature range for crayfish A. astacus

During our monitoring, we have not found temperatures that are outside the critical conditions both in summer and winter (Fig. 2). The optimal temperature for *Astacus astacus* lies between 15°C and 25°C (Holdich, 2002).These temperatures are ideal for growth, reproduction, and overall health.Temperatures above 28°C to 30°C are generally stressful for the species, and long-term exposure to such heat can lead to a decline in growth, impaired immune function, and potential death. On the lower end, temperatures below 4°C to 6°C can cause the crayfish to become lethargic, reducing feeding and growth. If temperatures drop much lower, the crayfish may experience cold-induced mortality, especially if they lack sufficient shelter during the winter.

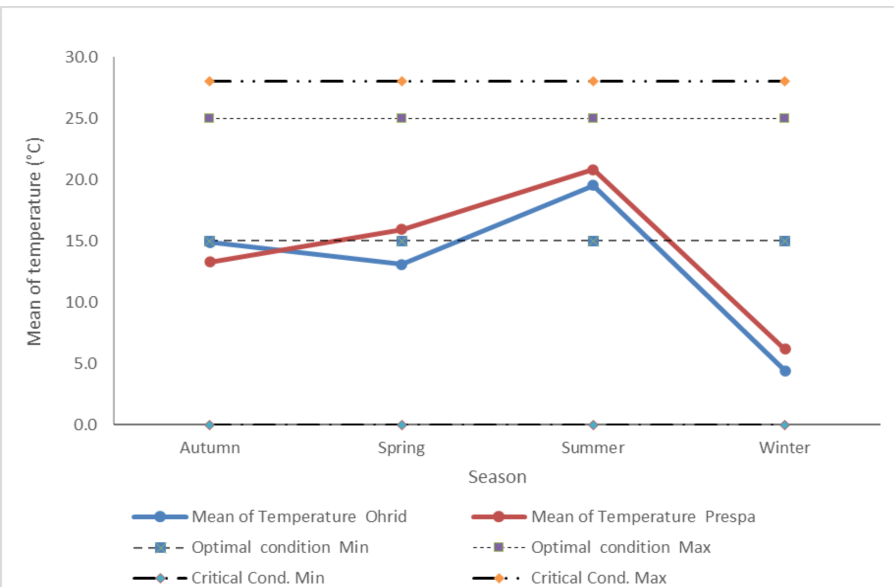


Fig.2: Average Temperature measured in both lakes and optimal condition for species *A. astacus*.

Descriptive statistics of morphological traits of captured and measured individuals in two lakes (Great Prespa and Ohrid)

In the descriptive analysis of the morphometric parameters measured in the crayfish individuals caught, the following average measurements were found for Ohrid and Prespa Lakes: average size—11.4 cm for Lake Ohrid and 10.1 cm for Lake Prespa; body width—2.39 cm for Lake Ohrid and

2.36 cm for Lake Prespa; abdomen length—3.59 cm for Lake Ohrid and 4.34 cm for Lake Prespa; antenna length—5.53 cm for Lake Ohrid and 6.30 cm for Lake Prespa; chelicera length—3.26 cm for Lake Ohrid and 4.30 cm for Lake Prespa; and average rostrum length—approximately 0.90 cm for both lakes. The largest coefficient of variation was observed in the length of the chelicerae, as the species exhibits anisometry in this organ. Crayfish individuals from Lake Prespa were found to be larger, which is reflected in the measurements of the abdomen, antennae, and chelicerae (see Table 4).

Table 4: Descriptive Statistics of Height, Width, Abdomen, Antenna, Chelicera, and Rostrum

Variable	Lake	Total Count	Mean	CV %	Minimum	Median	Maximum
Height	Ohrid	92	11.04	11.98	7.80	11.10	13.60
	Great Prespa	340	10.01	16.31	5.50	9.80	14.90
Width	Ohrid	92	2.39	14.24	1.70	2.30	3.20
	Great Prespa	340	2.36	24.52	1.00	2.30	3.90
Abdomen	Ohrid	92	3.59	7.38	2.90	3.60	4.30
	Great Prespa	340	4.34	21.40	2.00	4.45	6.80
Antenna	Ohrid	92	5.53	5.82	4.80	5.50	6.10
	Great Prespa	340	6.30	24.02	3.00	6.40	9.30
Chelicera	Ohrid	92	3.26	8.06	2.70	3.30	3.90
	Great Prespa	340	4.30	43.05	0.60	4.70	8.60
Rostrum	Ohrid	92	0.90	17.37	0.45	0.90	1.25
	Great Prespa	340	0.90	22.48	0.25	0.88	1.35

4. DISCUSSION

The study on the monitoring of two crustacean species, *Astacus astacus* and *Austropotamobius torrentium*, led to important conclusions regarding the status of these species in the Prespa and Ohrid lake regions, as well as in other areas.

Presence of Species: Only *Astacus astacus* was identified in the region, while *Austropotamobius torrentium* was not found during the study. *A. astacus* is present in Great Prespa Lake and Ohrid Lake but is absent from Small Prespa Lake and the Qarrishta and Rapun rivers, part of Shebenik National Park.

Geographical Extent: In Lake Ohrid, *A. astacus* was found in only 4 out of 7 monitoring stations, while in Great Prespa Lake, it was present in 3 out of 5 stations. The physico-chemical parameters of water, such as temperature and quality, were within the tolerance values for this species in both lakes.

Ratios and Dimensions: The male-to-female sex ratio (M/F) is 96% in both lakes. The largest individuals measured 14.9 cm, and the smallest were 5.50 cm, both of which were found in Lake Prespa.

Changes in Population: The monitoring revealed that *A. astacus* is present throughout the year, with an increase in the number of individuals during the summer months. However, in Lake Prespa, the number of individuals has decreased, likely due to a drop in the water level and the displacement of the habitat to deeper areas. In Lake Ohrid, the habitat of *A. astacus* has moved to depths exceeding 5 meters, making it more difficult to capture them with traps, though they are easier to catch with nets.

Threats and Impacts: *A. astacus* faces several threats, including habitat changes due to climate change, mining, and pollution from urban and agricultural areas. Fishing no longer poses a major threat, as fishermen typically return caught crayfish to the lake without harming the population.

Compared to other Balkan countries, Albania's research efforts are still in the early stages. While research is growing, much of the data on *Astacus astacus* and *Austropotamobius torrentium* are more detailed in countries like Croatia, Serbia, Bosnia (Jelić *et al.*, 2016), Bulgaria, Greece (Marković *et al.*, 2019), and Romania (Varga *et al.*, 2017). This study offers insights into how Albania compares to its Balkan neighbors in terms of the conservation of these species and highlights the ongoing challenges in the region.

Due to the absence of *A. astacus* on the Albanian Fauna Red List and the complete lack of information about the species in the IUCN Red List, it will be proposed that both institutions include *A. astacus* and *Austropotamobius torrentium* on these lists, along with the specific sites where they are found.

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