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DIVERSITY AND DYNAMICS OF COLLEMBOLA (HEXAPODA) AT SPRINGS AND TUFA BARRIERS IN PLITVICE LAKES, CROATIA, BASED ON LONG-TERM MONITORING USING EMERGENCE TRAPS

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Long-term sampling and monitoring programs often generate by-catch of non-target taxa, which are rarely analysed despite their potential to reveal previously undocumented biodiversity. In this study, we exploited by-catch from emergence traps, originally deployed for studying emerging aquatic insects, to investigate Collembola diversity of the Plitvice Lakes National Park. Collembola are ubiquitous and abundant soil microarthropods that inhabit numerous terrestrial and semi-aquatic habitats. However, aside from a single previous record, they have never been systematically studied in the Plitvice Lakes, and their diversity remains poorly known and largely overlooked in Croatia.

Samples from emergence traps were collected monthly from 2007 to 2022 at two karst springs and two tufa barriers, yielding 1,682 Collembola specimens. A total of 41 species from 21 genera and eight families were identified, including one genus newly recorded for Croatia (*Vertagopus*) and five species (*Desoria hiemalis* (Schött, 1893), *Desoria tigrina* (Tullberg, 1871), *Entomobrya corticalis* (Nicolet, 1842), *Vertagopus cinereus* (Nicolet, 1842), and *Willowsia platani* (Nicolet, 1842)). The order Entomobryomorpha dominated across sites. Springs were associated with higher specimen numbers, whereas tufa barriers exhibited greater species richness. Seasonal dynamics were evident, with peak abundances in spring and autumn and lowest numbers during winter. Non-metric multidimensional scaling ordination revealed very similar Collembola composition at two spring sites, reflecting their similar habitat characteristics.

Although emergence traps are not specifically designed for Collembola sampling, the dataset provides valuable insights into community composition, diversity and seasonal patterns of this group. Our study demonstrates that non-standardized sampling methods and by-catch analysis can significantly expand knowledge of understudied arthropod groups. This is the first study on Collembola communities in the Plitvice Lakes National Park, which also underscores the need for further targeted surveys and taxonomic research of this understudied group in Croatia.

Keywords: springtails, hexapoda, by-catch, non-target taxa, emergence traps, seasonal dynamics

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Tijekom dugotrajnih uzorkovanja i monitoring programa često se uz ciljane prikupljaju i druge taksonomske grupe. Taj sakupljeni materijal često ostaje neobrađen unatoč tome što njegovo proučavanje može rezultirati značajnim nalazima. U ovom istraživanju analizirali smo uzorke iz skupine Collembola koji su prikupljani uz pomoć emergencijskih klopki, postavljenih radi proučavanja emergirajućih kukaca u Nacionalnom parku Plitvička jezera. Collembola su česti i brojni sitni šesteronošci koji naseljavaju brojna kopnena i poluvodena staništa. Osim jednog nalaza, skupina Collembla nije nikada sustavno istraživana na Plitvičkim jezerima, a njihova je raznolikost u Hrvatskoj slabo poznata.

Uzorkovanje emergencijskim klopkama provodilo se od 2007. do 2022. godine na dva krška izvora i dvije sedrene barijere. Klopke su pražnjene jednom mjesečno, čime je prikupljeno 1683 jedinki Collembola. Utvrđena su ukupno 41 svojta iz 21 roda i osam porodica, uključujući prvi nalaz roda *Vertagopus* za Hrvatsku i pet novih vrsta: *Desoria hiemalis* (Schött, 1893), *Desoria tigrina* (Tullberg, 1871), *Entomobrya corticalis* (Nicolet, 1842), *Vertagopus cinereus* (Nicolet, 1842) i *Willowsia platani* (Nicolet, 1842). Red Entomobryomorpha dominirao je na svim lokalitetima. Na izvorima je zabilježen veći broj jedinki, dok je na sedrenim barijerama utvrđena veća brojnost vrsta. Utvrđena je sezonska dinamika, s najvećim brojnostima u proljeće i jesen te najmanjim tijekom zime. Nemetričko višedimenzionalno skaliranje pokazalo je grupiranje dvaju izvorskih lokaliteta, što odražava sličnost staništa u okolici izvora.

Iako emergencijske klopke nisu posebno namijenjene uzorkovanju Collembola, dobiveni podaci pružaju vrijedan uvid u sastav zajednice Collembola, raznolikost i sezonsku dinamiku. Naše istraživanje pokazuje da nestandardizirane metode uzorkovanja i analiza taksonomskih grupa koje nisu primarni cilj prikupljanja mogu značajno doprinijeti poznavanju slabije istraženih skupina člankonožaca. U sklopu ovog istraživanja napravljen je prvi preliminarni popis vrsta Collembola Nacionalnog parka Plitvička jezera, te se naglašava potrebu za daljnjim ciljanim istraživanjima i taksonomskim studijama ove slabo istražene skupine u Hrvatskoj.

Ključne riječi: skokuni, šesteronošci, slučajno sakupljanje, neciljne skupine, emergencijske klopke, sezonska dinamika

INTRODUCTION

Collembola are moderately diverse small terrestrial hexapods with nearly 9000 described species (Bellinger *et al.*, 2025). However, they are among the most abundant and widespread soil microarthropods. With densities of up to 1800 individuals per dm^3 of forest soil (Handschin, 1955), they are important members of soil communities and soil food webs (Hopkin, 1997; Potapov *et al.*, 2020). Collembola are found from the high Arctic to Antarctica in almost all (semi)terrestrial environments. They usually inhabit forest soils, meadows, marshes, tundra, deserts, but also live in tree canopies, caves, on snow, and along seashores, as well as on the surface of standing water (Hopkin, 1997). Their ability to colonize various microhabitats poses a challenge for a comprehensive assessment of Collembola communities (Rusek, 2001). Therefore, numerous sampling methods are used to explore their diversity and abundance.

Methods for collecting of Collembola include the use of Berlese-Tullgren funnels, Macfadyen extractors, flotation, pitfall traps, aspirators and hand collection, vegetation beating, air suction, malaise traps, stem eclectors, canopy fogging, sweep-netting, and bark brushing (Hopkin, 1997; Potapov *et al.*, 2020). Some methods target specific habitats and species, while others vary in their effectiveness. Therefore, for biodiversity surveys, several approaches are usually combined (Querner & Bruckner, 2010). Some of these methods are primarily designed for sampling other arthropod groups. For example, malaise traps are designed for catching flying insects, while canopy fogging is mostly used for the study of flying and arboreal arthropods in the tropics. As Collembola are ubiquitous in many different habitats, they are often collected by these methods as a by-catch—non-target species captured during sampling. Such by-catch is often left unstudied, unreported or even discarded, although its analysis can provide valuable data on abundance, distribution, and diversity of non-targeted groups (Buchholz *et al.*, 2011; Oberprieler *et al.*, 2019; Spears & Ramirez, 2015). Examples include inventory studies of Collembola by malaise traps (for an overview see Palacios-Vargas *et al.*, 2022) or descriptions of new species collected by this method (Oliveira *et al.*, 2019, Oliveira & Cipola, 2016).

In this paper, we focused on diversity, abundance and seasonal dynamics of Collembola collected from emergence traps in the Plitvice Lakes National Park in Croatia. We analyzed samples from springs and tufa barriers collected once a month over a period of 16 years. Emergence traps are typically used to collect adult insects as they emerge from soil or aquatic habitats. This is the first study of Collembola collected using this method and the first study of this group from the Plitvice Lakes National Park. The only published Collembola record from the Plitvice Lakes National Park is a description of new species *Pumilinura croatica* (Smolis and Skarzynski, 2004). The aim of this study was to analyze Collembola material collected as a by-catch from a long-term monitoring project to fill the knowledge gap regarding the species diversity of Collembola in Plitvice Lakes National Park and Croatia.

MATERIAL AND METHODS

The study was carried out in the Plitvice Lakes National Park, also recognized as the UNESCO World Heritage Site since 1979. Sixteen cascade lakes are interconnected with waterfalls and tufa barriers (Fig. 1) (Bočić *et al.*, 2023). Lake Kozjak is the largest and deepest lake, while the most important permanent karst springs are the springs of Crna rijeka, Bijela Rijeka, and the Plitvica spring (Čanjevac *et al.*, 2023).

For a long-term monitoring project of emerging aquatic insects, emergence traps were used over the period of 16 years, from 2007 until 2022, except for the site spring of Crna rijeka, where the samples were collected between 2007-2009, and between 2019-2022. The emergence traps were pyramid-shaped, 50 cm high, with a base area of 45 x 45 cm (Fig. 2; Fig. 3). The frame of the emergence traps was covered with a mesh (mesh size 1 mm^2) that extended to just above the bottom of the pyramid. The trap was slightly elevated from the riverbed. The plastic collecting container at the top was 10 cm wide and 10 cm high with a 3 cm wide opening. Fixative was 2% formaldehyde mixed with detergent to reduce surface tension. The containers were emptied at the end of each month and samples were preserved in 80% ethanol.

The samples from emergence traps were collected at four different sampling sites, two of which are springs and two are tufa barriers: spring of Bijela rijeka (N 44°49′57.6″ E 15°33′22.6″), spring of Crna rijeka (N 44°49′50.3″ E 15°36′38.1″), tufa barrier Labudovac (N 44°52′17″ E 15°35′59″) that connects lake Prošće and lake Okrugljak, and tufa barrier Kozjak-Milanovac (N 44°53′39″ E 15°36′32″) that connects lake Kozjak and lake Milanovac (Fig. 1). Abbreviations used for the sampling sites are as follows: spring Bijela rijeka (IBR), spring Crna rijeka (ICR), Labudovac tufa barrier (BL) and

Kozjak-Milanovac tufa barrier (BKM). Six emergence traps (P1-P6) were placed at IBR, ICR, and BKM, while seven traps (P1–P7) were placed at BL.

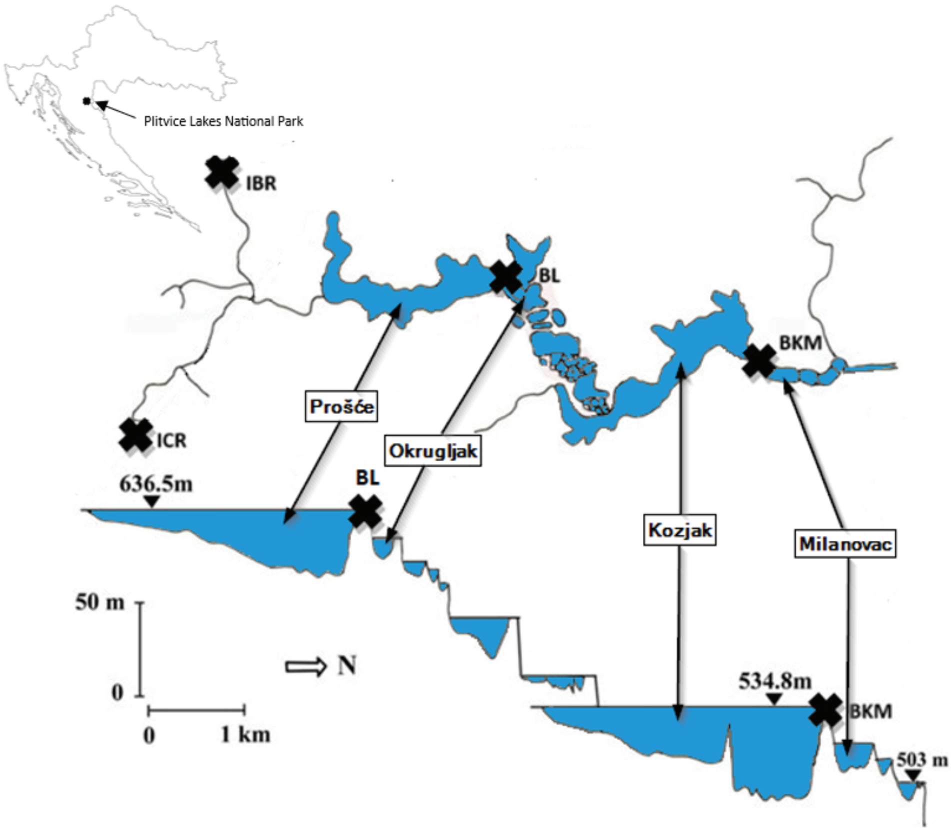

Fig. 1. Position of the Plitvice Lakes National Park in Croatia and map of sampling sites shown on the plan and profile of the lakes: spring Bijela rijeka (IBR), spring Crna rijeka (ICR), Labudovac tufa barrier (BL) and Kozjak-Milanovac tufa barrier (BKM).

Collembola were transferred to 96% ethanol (EtOH) and sorted to morphotypes with Zeiss Stemi 2000-C stereoscope. Selected specimens from each morphotype were cleared in lactic acid and 10% KOH, and mounted on permanent microscopic slides in Marc Andre II medium. The slides were studied under a Nikon Labophot microscope with phase contrast. Identification of species was based on morphological characters using relevant publications: Jordana (2012) for the family Entomobryidae, Potapov (2001) for the family Isotomidae and Thibaud *et al*. (2004) for the family Hypogastruridae, online keys (Bellinger *et al*., 2017), as well as other relevant taxonomic papers. The research was conducted at the Department of Biology, Faculty of Science, University of Zagreb, and the Croatian Natural History Museum. Cluster analysis and non-metric multidimensional scaling analysis (NMDS; Shepard, 1962; Kruskal, 1964) were conducted using Primer 7 (Clarke & Gorley, 2015), Bray-Curtis similarity was used (Bray & Curtis, 1957), and data were log-transformed (Clarke & Green, 1988).

Fig. 2. Pyramid-shaped emergence trap at the spring Bijela Rijeka. Photo by: M. Ivković

Fig. 3. Pyramid-shaped emergence trap at the Kozjak-Milanovac tufa barrier. Photo by: M. Ivković

Collected material is housed in the Collembola collection of the Croatian Natural History Museum. The complete dataset, encompassing sampling and identification data, and Collembola collection inventory numbers, is deposited at GBIF, the Global Biodiversity Information Facility, and is available at https://www.gbif.org/dataset/6584305f-866f-462a-b43d-6cba393ebf9f (Lukić *et al.*, 2026).

RESULTS

A total of 1682 Collembola specimens were collected, comprising 41 species belonging to 21 genera and eight families (Tab. 1). Out of the 41 species found, 36 were identified to species or genus level, while the remaining 5 were put in higher systematic categories. The most diverse family was Entomobryidae, represented by 15 species. One new genus (*Vertagopus* Börner, 1906) and five new species for Croatia were recorded: *Desoria hiemalis* (Schött, 1893), *Desoria tigrina* (Tullberg, 1871), *Entomobrya corticalis* (Nicolet, 1842), *Vertagopus cinereus* (Nicolet, 1842), and *Willowsia platani* (Nicolet, 1842). Some taxa were not identified to species level due to insufficient material, damaged specimens, or juvenile individuals. In addition, some genera require taxonomic revision, which hampers reliable species-level identification.

Tab. 1. Species abundance on studied locations (spring Bijela rijeka (IBR), spring Crna rijeka (ICR), Labudovac tufa barrier (BL) and Kozjak-Milanovac tufa barrier (BKM)).

	IBR	ICR	BL	BKM
SYMPHYPLEONA				
1. gen. sp.		1		
Katiannidae				
2. *Sminthurinus* sp.			3	
Bourletiellidae				
3. *Heterosminthurus* sp.				2

	IBR	ICR	BL	BKM
PODUROMORPHA				
Hypogastruridae				
4. *Ceratophysella armata* (Nicolet, 1842)		2	1	
5. *Ceratophysella* sp.1	1			
6. *Ceratophysella* sp.2	1			
7. *Hypogastrura socialis* (Uzel, 1891)	10	163	31	13
8. *Hypogastrura* sp.1	3	7		
9. *Hypogastrura* sp.2	2		2	
10. *Xenylla maritima* Tullberg, 1869		12	10	
Neanuridae				
11. gen. sp. 1			2	
12. *Friesea* sp.		1		1
ENTOMOBRYOMORPHA				
Tomoceridae				
13. *Tomocerus* sp.				2
14. *Tomocerus vulgaris* (Tullberg, 1871)		2	23	2
Isotomidae				
15. *Anurophorus laricis* Nicolet, 1842			3	6
16. *Desoria hiemalis* (Schött, 1893)	19	1		1
17. *Desoria tigrina* (Tullberg, 1871)	6			
18. gen. sp.1			1	
19. gen. sp.2				1
20. gen. sp.3	8	36	20	8
21. *Isotomurus* sp.	270	121	37	4
22. *Pseudisotoma sensibilis* (Tullberg, 1877)			1	
23. *Vertagopus cinereus* (Nicolet, 1842)	2	10	1	10
24. *Vertagopus* sp.	19	57	3	
Orchesellidae				
25. *Orchesella flavescens* (Bourlet, 1839)	6	10	1	
26. *Orchesella* sp.		5		
Entomobryidae				
27. *Willowsia buski* (Lubbock, 1870)				4
28. *Willowsia nigromaculata* (Lubbock, 1873)		2	31	21
29. *Willowsia platani* (Nicolet, 1842)		1	10	3
30. *Entomobrya corticalis* (Nicolet, 1842)		2	9	1
31. *Entomobrya dorsalis* Uzel, 1891	288	68	9	113
32. *Entomobrya* sp.1	5	6		8
33. *Entomobrya* sp.2	23	58	6	5
34. *Entomobrya* sp.3	2		1	
35. *Lepidocyrtus* sp.1	3			
36. *Lepidocyrtus* sp.2		1		1
37. *Lepidocyrtus* sp.3				2
38. *Lepidocyrtus* sp.4				3
39. *Lepidocyrtus* sp.5		16		2
40. *Lepidocyrtus* sp.6			1	5
41. *Lepidocyrtus* sp.7		1	1	6
No. of individuals per location	**668**	**583**	**207**	**224**
No. of species per location	**17**	**23**	**23**	**24**

The four sampling sites differred in the number of species and in the composition of the springtail community. The order Entomobryomorpha dominated the abundance in all locations. March and October were the months with the highest species abundance, and April was the month with the highest number of species. The lowest number of species and the lowest abundance were recorded in January and December (Tab. 2).

Tab. 2. Collembola species monthly occurrence.

	month											
	1	2	3	4	5	6	7	8	9	10	11	12
SYMPHYPLEONA												
1. gen. sp.									1			
Katiannidae												
2. *Sminthurinus* sp.					1					2		
Bourletiellidae												
3. *Heterosminthurus* sp.							2					
PODUROMORPHA												
Hypogastruridae												
4. *Ceratophysella armata* (Nicolet, 1842)			1	1						1		
5. *Ceratophysella* sp.1										1		
6. *Ceratophysella* sp.2											1	
7. *Hypogastrura socialis* (Uzel, 1891)	1	25	151	9	2	4	1	5	4	4	3	8
8. *Hypogastrura* sp.1		2		1	2		4	1				
9. *Hypogastrura* sp.2		1	3									
10. *Xenylla maritima* Tullberg, 1869	2		3		6	7			4			
Neanuridae												
11. gen. sp. 1				1				1				
12. *Friesea* sp.				1					1			
ENTOMOBRYOMORPHA												
Tomoceridae												
13. *Tomocerus* sp.											2	
14. *Tomocerus vulgaris* (Tullberg, 1871)			4	7	2	5	2		2	3	2	
Isotomidae												
15. *Anurophorus laricis* Nicolet, 1842		1	2	3	2	1						
16. *Desoria hiemalis* (Schött, 1893)		17	2							1		1
17. *Desoria tigrina* (Tullberg, 1871)				1	2					3		
18. gen. sp.1							1					
19. gen. sp.2		1										
20. gen. sp.3	1	4	8	12	13	5	5	4	2	13	4	1
21. *Isotomurus* sp.	15	36	67	24	15	21	1	12	24	47	131	39
22. *Pseudisotoma sensibilis* (Tullberg, 1877)				1								
23. *Vertagopus cinereus* (Nicolet, 1842)	1		13	7		1			1			
24. *Vertagopus* sp.	9	12	16	25	9	3			3	2		
Orchesellidae												
25. *Orchesella flavescens* (Bourlet, 1839)		1		2			2	6	3		3	
26. *Orchesella* sp.								5				
Entomobryidae												
27. *Willowsia buski* (Lubbock, 1870)								1		3		
28. *Willowsia nigromaculata* (Lubbock, 1873)		3	4	6	1	1	3	6	12	17		1
29. *Willowsia platani* (Nicolet, 1842)			1	2	2	1	4	4				
30. *Entomobrya corticalis* (Nicolet, 1842)		1			1	2	1	3	2		2	
31. *Entomobrya dorsalis* Uzel, 1891		9	23	30	18	2	3	97	109	170	15	2
32. *Entomobrya* sp.1	1			3	1		2	5	4		3	
33. *Entomobrya* sp.2	3	1	4	2	6	5	22	31	7	6	5	

	month											
	1	2	3	4	5	6	7	8	9	10	11	12
34. *Entomobrya* sp.3						1	2					
35. *Lepidocyrtus* sp.1				2	1							
36. *Lepidocyrtus* sp.2							1		1			
37. *Lepidocyrtus* sp.3							1	1				
38. *Lepidocyrtus* sp.4		1				1			1			
39. *Lepidocyrtus* sp.5		1	1		1	1	10		3	1		
40. *Lepidocyrtus* sp.6		1		2		1		1			1	
41. *Lepidocyrtus* sp.7		1		1	2		1			3		
No. of individuals per month	**33**	**118**	**303**	**143**	**87**	**62**	**68**	**183**	**184**	**277**	**172**	**52**
No. of species per month	**8**	**18**	**16**	**22**	**19**	**17**	**19**	**16**	**18**	**16**	**12**	**6**

Springs had a higher species abundance recorded than tufa barriers. The lowest number of species (17) but the highest abundance (668) was recorded at the spring of Bijela rijeka. At the spring of Crna rijeka 583 individuals of 23 species were recorded. Labudovac tufa barrier also had 23 species but the lowest abundance (207). Kozjak-Milanovac tufa barrier had the highest number of species (24 species and 224 individuals) (Tab. 1).

Entomobrya dorsalis Uzel, 1891 was the most numerous species at the tufa barrier Kozjak-Milanovac and at the spring of Bijela rijeka. At the spring of Crna rijeka, the most numerous species was *Hypogastrura socialis* (Uzel, 1891), and at tufa barrier Labudovac it was *Isotomurus* sp.

The NMDS analysis (Bray–Curtis, log(X+1)) showed differences in Collembola assemblages among the studied sites. Samples from Bijela rijeka (IBR) and Crna rijeka (ICR) formed a relatively tight and partially overlapping cluster, indicating similar community composition and relatively consistent assemblage structure within these spring habitats. In contrast, samples from the Labudovac (BL) and Kozjak–Milanovac (BKM) tufa barriers were more dispersed, reflecting greater heterogeneity in these habitats. The twodimensional solution had a stress value of 0.20, which is acceptable for interpreting broad ecological patterns (Fig. 4).

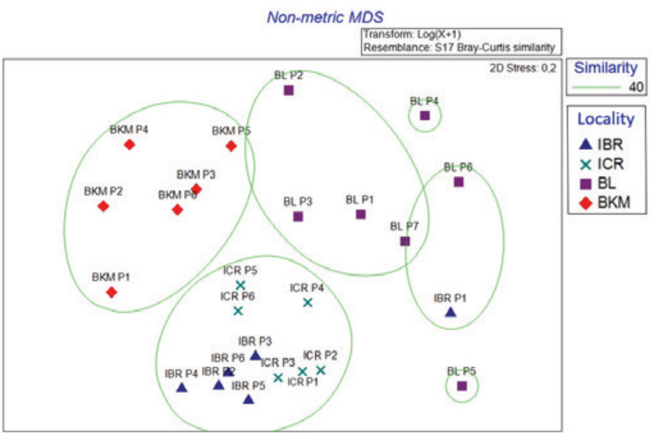

Fig. 4. Non-metric multidimensional scaling analysis (NMDS) based on Collembola species and number of specimens recorded in individual emergence traps at the investigated locations (spring Bijela rijeka (IBR), spring Crna rijeka (ICR), Labudovac tufa barrier (BL) and Kozjak-Milanovac tufa barrier (BKM)). Emergence traps were labelled P1–P6 at IBR, ICR, and BKM, and P1–P7 at BL.

DISCUSSION

Long-term sampling and monitoring is an invaluable source of data on diversity patterns and population dynamics (Henry *et al.*, 2008; Magurran *et al.*, 2010). The experimental setup of our long-term study was focused on the diversity and seasonal patterns of emerging aquatic insects (Radošević *et al.*, 2025; Dorić *et al.*, 2023, 2024; Klarin *et al.*, 2024, Pozojević *et al.*, 2023). Over 16 years, a substantial number of Collembola were caught as a by-catch, enabling the first insight into their diversity of the Plitvice Lakes National Park. We identified 41 species out of which one genus and five species are new for Croatia (Bogojević, 1968). In our study, we demonstrated that by-catch analyses and non-standardized collecting methods can be a valuable source of data on the diversity of non-target groups during long-term monitoring studies (Spears & Ramirez, 2015). Given the limited number of sampling sites and the non-standardized methodology, our checklist certainly represents only a fraction of the total Collembolan diversity of the Plitvice Lakes National Park. Newly recorded species for Croatia highlight the need for further systematic studies of Collembola in the Plitvice Lakes National Park, but also elsewhere in Croatia, where this group is still understudied.

Tufa barriers and the surfaces of springs are unusual sites for Collembola sampling. Collembola collected by emergence traps might be carried to the trap by water currents, brought by the wind or can live on tufa and surrounding vegetation. Due to prolonged use, moss and tufa formed on some of the emergence traps (Fig. 3), possibly serving as a microhabitat where Collembola could live and breed, and end up in the trap. In order to get into the plastic container at the top of the trap, Collembola had to climb up the plastic mesh, either from the inside or the outside, since they are smaller than the mesh size. Emergence traps are therefore a selective technique for Collembola sampling as only those forms that readily climb up are collected, similar to malaise traps (Palacios-Vargas *et al.*, 2022). This may explain why only a few individuals of the order Symphypleona have been collected during 16 years of sampling, although many species of this order live on the surface of the freshwater (Bretfeld, 1999). In addition, the composition of the recorded Collembola fauna may have been influenced by the use of formaldehyde as a preservative. Studies have demonstrated that formaldehyde can significantly affect arthropod catches in pitfall traps, potentially introducing bias into community composition assessments (Pekar, 2002; Jureková *et al.*, 2019; Bruckner & Ott, 2024; Tuf *et al.*, 2025).

This study represents the only long-term systematic Collembola sampling in Croatia carried out up to date. Although the sampling methodology has its limitations, and was not designed for Collembola sampling, this large dataset provides insight into the seasonal dynamics and abundances of this arthropod group. As expected, the lowest number of Collembola was collected during the cold winter months (January and December), both at tufa barriers and springs. Sampling sites however differed in the numbers of collected specimens. More Collembola were collected at springs than at tufa barriers. This may be due to the denser surrounding, riparian, and emergent vegetation at the springs, as Collembola in general prefer more humid and shaded habitats (Hopkin, 1997). This might especially be the case for the spring of Crna rijeka, which was sampled for only seven years but yielded almost the same number of specimens as at the spring Bijela rijeka. Spring of Crna rijeka has denser canopy coverage that creates shade, while the spring of Bijela rijeka is much more open and illuminated (Ivković *et al.*, 2015). A greater number of specimens at springs is not followed by a higher species diversity, which is recorded at the tufa barriers. The reason for this may be that (1) moss and tufa on barriers are inhabited by more numerous Collembola species, (2) water flow might drift more diverse species composition to the tufa barriers, or (3) more species are drifted to the traps by the wind as tufa barriers are more exposed to the wind than the springs. In the NMDS analysis, the spring sites were grouped into a single cluster, exhibiting a very similar species composition, in contrast to the sites on the tufa barriers. Such patterns indicate that the spatial arrangement of the sampling sites have contributed to differences in the structure of Collembola community. Longitudinal positioning of the sites from two springs to upper tufa barrier and lower tufa barrier in barrage lake system of Plitvice Lakes evidently influenced changes in community structure of Collembola due to geographical distance between sites. This was already noticed in several other insect groups, such as various Diptera families (Ivković *et al.*, 2012, 2014; Ivanković *et al.*, 2019), as well as Ephemeroptera (Vilenica *et al.*, 2017) and Plecoptera (Ridl *et al.*, 2018).

Our study demonstrates that analyzing by-catch of the long-term sampling programs can provide valuable data for the understudied arthropod groups. Using a non-standardized method for Collembola sampling, we recorded species new for Croatia and compiled a preliminary checklist of this group for the Plitvice Lakes National Park. Future targeted Collembola sampling, along with further identification of specimens collected within this study, will contribute to a more comprehensive checklist. The present study also underlines that Collembola are a poorly studied arthropod group in Croatia, highlighting tthe great potential for the discovery of numerous species new to the country.

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