J. Insect Biodivers. Syst. 10 (3), 547–555

https://jibs.modares.ac.ir

OPEN ACCESS

Tarbiat Modares University Press | Research Article | https://doi.org/10.61186/jibs.10.3.547 | **ISSN**: 2423-8112

Entomological Society of Iran | Faunistic | *https://zoobank.org/urn:lsid:zoobank.org:91105775-0E97-412D-A578-DB4B20E3B148*

New findings and an updated checklist of Araneidae (Arachnida: Araneae) from Kosovo

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ABSTRACT. In this paper, we provide additional data on the orb-weaver spider fauna (Araneae: Araneidae) of Kosovo. Three species are reported for the first time from this country: *Araneus grossus* (C.L. Koch, 1844), *Argiope lobata* (Pallas, 1772) and *Cyclosa oculata* (Walckenaer, 1802). In consideration of the findings and the updated checklist of Araneidae in this study, the documented number of spider species in Kosovo has now increased to 251. Given that the spider fauna of Kosovo is still not fully explored, our study emphasizes the necessity of ongoing exploration to better comprehend the diversity of spider species within the region.

Keywords: Orb-weaver spider, fauna, diversity, Balkan Peninsula

Received: 26 February, 2024

Accepted: 19 April, 2024

Published: 03 July, 2024

Subject Editor: Alireza Zamani

Citation: Ibrahimi, K., Islami, B., Kastrati, B., Geci, D., Bilalli, A. & Ibrahimi, H. (2024) New findings and an updated checklist of Araneidae (Arachnida: Araneae) from Kosovo. *Journal of Insect Biodiversity and Systematics*, 10 (3), 547–555.

INTRODUCTION

The spider family Araneidae is a diverse group, globally comprising 191 genera and more than 3,100 described species (World Spider Catalog, 2024). Among the araneid genera, *Argiope* Audouin, 1826 accounts for 88 species, *Araneus* (Clerck, 1757) for 558 and *Cyclosa* (Menge, 1866) for 176 (World Spider

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Catalog, 2024). In Kosovo, Araneidae comprises 16 genera and 28 species (Vrenozi & Jäger, 2013, Geci & Naumova, 2021a, 2021b; Grapci-Kotori et al., 2022; Berisha & Geci, 2023; Geci et al., 2023). In this country, *Argiope* and *Cyclosa* are currently represented by a single species each, and *Araneus* by five. A total of 248 spider species are currently listed for Kosovo, but considering that Kosovo's spider fauna is poorly known, this number is expected to increase dramatically (Vrenozi & Jäger, 2013; Mammola et al., 2018, Geci & Naumova, 2021a, 2021b; Grapci-Kotori et al., 2022; Berisha & Geci, 2023; Geci et al., 2023). This study's aim is to present new findings for the Araneidae spider fauna of Kosovo and to update the local species list for this family.

MATERIAL AND METHODS

The specimens were collected by hand. *Araneus grossus* (C.L. Koch, 1844) was found in a rocky area, and although *Argiope lobata* (Pallas, 1772) and *Cyclosa oculata* (Walckenaer, 1802) were both found in a meadow, the collection site for the former was dry and sunnier. The material were preserved in 70% alcohol, and examined using an Olympus SZX16 stereomicroscope equipped with a GXCAPTURE camera and identified based on Nentwig et al. (2024). The copulatory organs were dissected and boiled in 10% KOH. The map (Fig. 1) was created using QGIS 3.34 and is based on a topographic map layer retrieved from Kosovo Geoportal under a Creative Commons license. All the examined material are deposited in the collection of the Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina "Hasan Prishtina", Prishtinë, Kosovo.

RESULTS

Three new records of the Araneidae from Kosovo are presented: *Araneus grossus* (C.L. Koch, 1844), *Argiope lobata* (Pallas, 1772) and *Cyclosa oculata* (Walckenaer, 1802).

Taxonomic hierarchy

Class Arachnida Lamarck, 1801

Order Araneae Clerck, 1757

Family Araneidae Clerck, 1757

Genus *Araneus* Clerck, 1757

***Araneus grossus* (C.L. Koch, 1844)** (Fig. 2)

Material examined. 1♀, KOSOVO, Veriq, Istog municipality (42°45'19.37''N, 20°33'12.71''E), 15-V-2021; 1♀, KOSOVO, Bistricë e Shalës, Leposaviq municipality (43°1'48.23''N, 20°53'25.51''E), 12-VII-2023; 1♀, KOSOVO, Selacë, Mitrovicë municipality (43°01'48.23''N, 20°53'25.51''E), 8-VI-2023, Coll. Donard Geci.

Distribution. West Palaearctic: Europe to Central Asia (World Spider Catalog, 2024).

Diagnostic note. *Habitus*: Carapace light brown, with pale margins. Opisthosoma dorsally distended, yellowish-brown, with brown pattern. Tubercles with a yellowish hue. Eye region mostly yellow, with dense bright hairs. Chelicerae brown. Legs brown, indistinctly annulated. Body length: female: 15–25 mm (Nentwig et al., 2024). *Epigyne*: Scapus covers the genital openings, joined to a basal zone that covers the copulatory ducts and the spermathecae made up of several sclerites. Laterally, the base of the epigyne is flanked by a pair of lamellae. In ventral view, the length and wrinkles of the scapus vary among individuals of the same species, perhaps due to a different folding of it. The scapus is always long and wide. Epigyne is very dark due to intense sclerotization (Morano & Mora-Rubio, 2021) (Figs 2A–C).

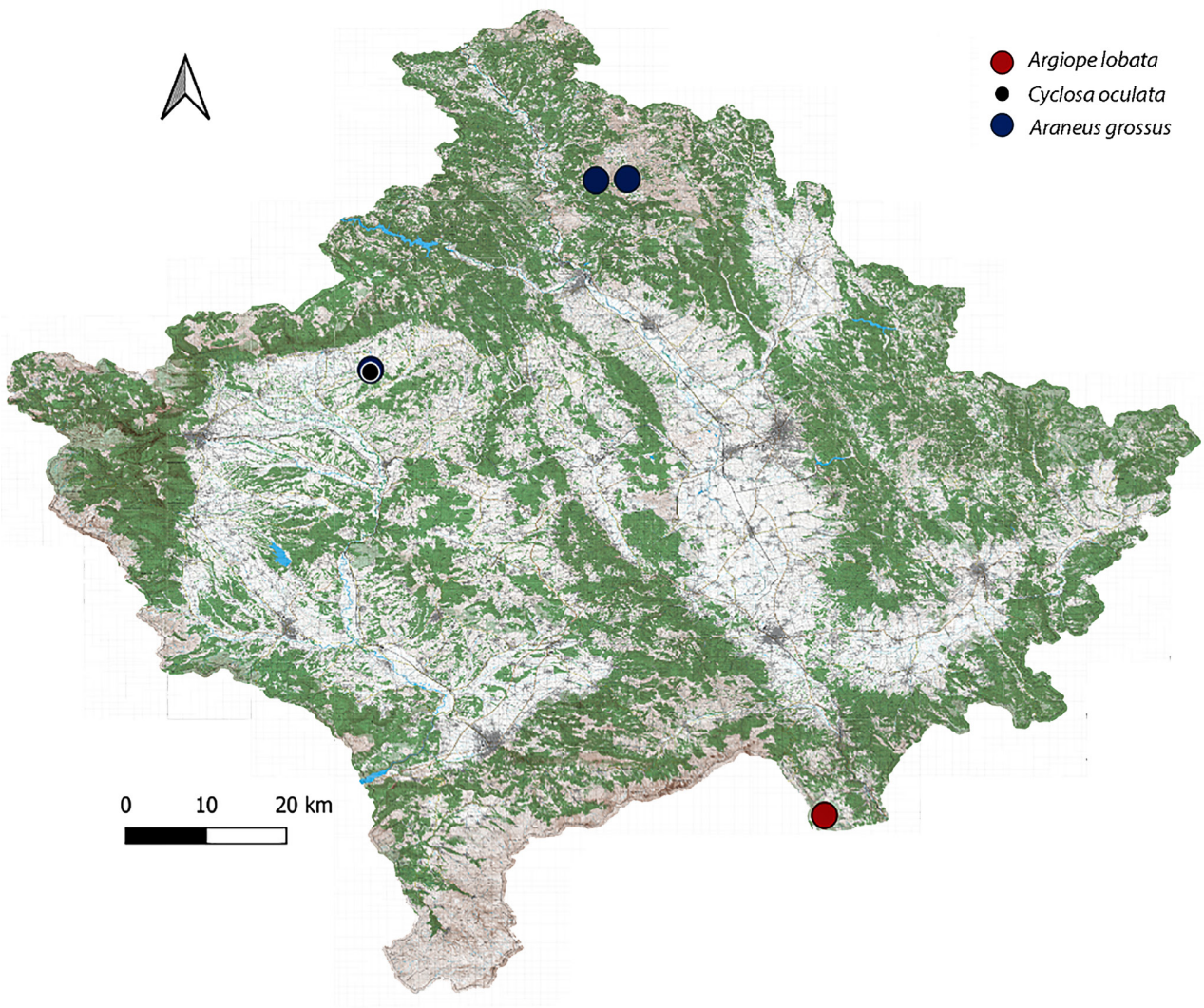

Figure 1. Collection localities of the newly recorded spirders, *Argiope lobate* (Pallas, 1772), *Cyclosa oculata* (Walckenaer, 1802) and *Araneus grossus* (C.L. Koch, 1844) in Kosovo.

Genus *Argiope* Audouin, 1826

Argiope lobata (Pallas, 1772) (Fig. 3)

Material examined. 1♀, KOSOVO, Kërvenik, Hani i Elezit municipality (42°06'38.16''N, 21°13'56.03''E), 30-VIII-2023, Coll. Krenare Ibrahimi, Blertina Islami, Blearta Kastrati.

Distribution. Old World: Southern Europe to Central Asia and China, Northern Africa, Tanzania, South Africa, Myanmar (World Spider Catalog, 2024).

Diagnostic note. *Habitus*: Carapace shiny silver. Opisthosoma longer than wide, unicoloured silver-grey, ventrally darker, lobed laterally. Lobes with brownish contrasting colouration. Legs yellowish-brown and annulated with black markings. Body length female: 16.8–25.5 mm (Nentwig et al., 2024). *Epigyne*: Anterior median scape present, forming a median septum and joining to posterior short basal septum (Figs 3A–E).

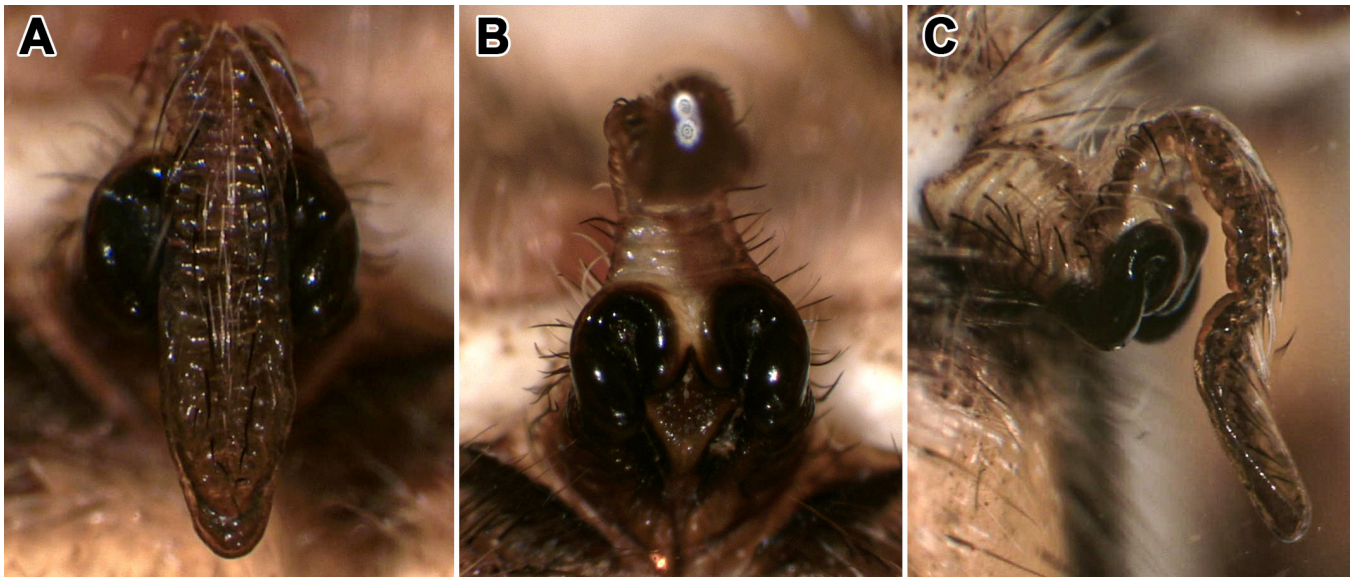

Figure 2. *Araneus grossus* (C.L. Koch, 1844), epigyne. **A.** Ventral view; **B.** Posterior view; **C.** Lateral view.

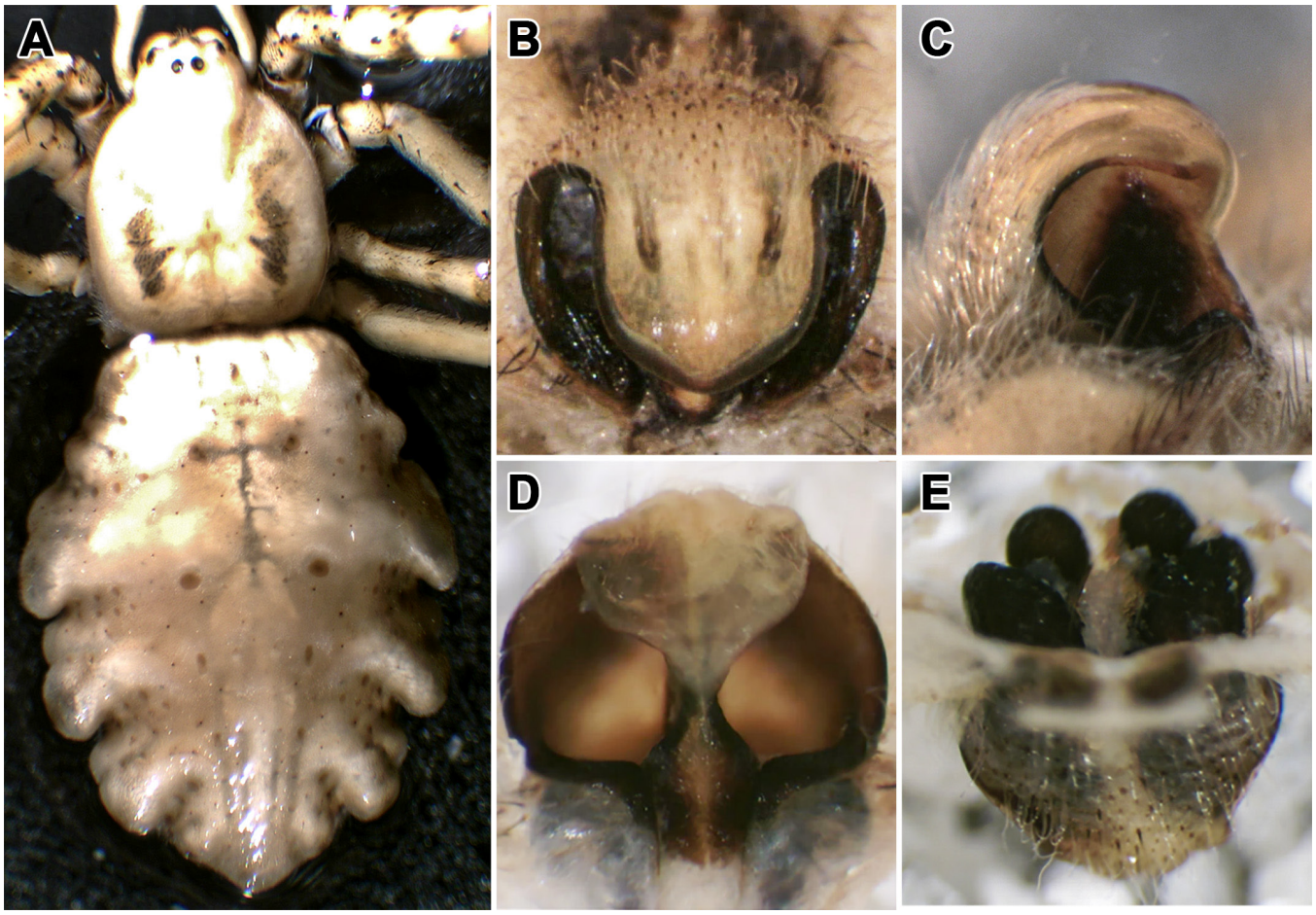

Figure 3. *Argiope lobata* (Pallas, 1772), female. **A.** General habitus, dorsal view; **B–E.** Epigyne; **B.** Ventral view; **C.** Lateral view; **D.** Posterior view; **E.** Dorsal view.

Genus *Cyclosa* Menge, 1866

Cyclosa oculata (Walckenaer, 1802) (Fig. 4)

Material examined. 1♂, KOSOVO, Veriq, Istog municipality (42°45'08.89''N, 20°33'10.47''E), 21-VII-2021, Coll. Donard Geci.

Distribution. Europe, Caucasus, Russia (to far East), Central Asia, China; introduced to Hawaii (World Spider Catalog, 2024).

Diagnostic note. *Habitus*: Carapace brownish-black. Opisthosoma dark red to brownish-black, with bright pattern, posteriorly with three protuberances dorsally, anteriorly with two. *Male palp*: with rectangular-shaped bent distal apophysis, bearing a very long tip. Median apophysis distally with 2 stout jags. Embolus long and robust (Nentwig et al., 2024) (Figs 4A–D).

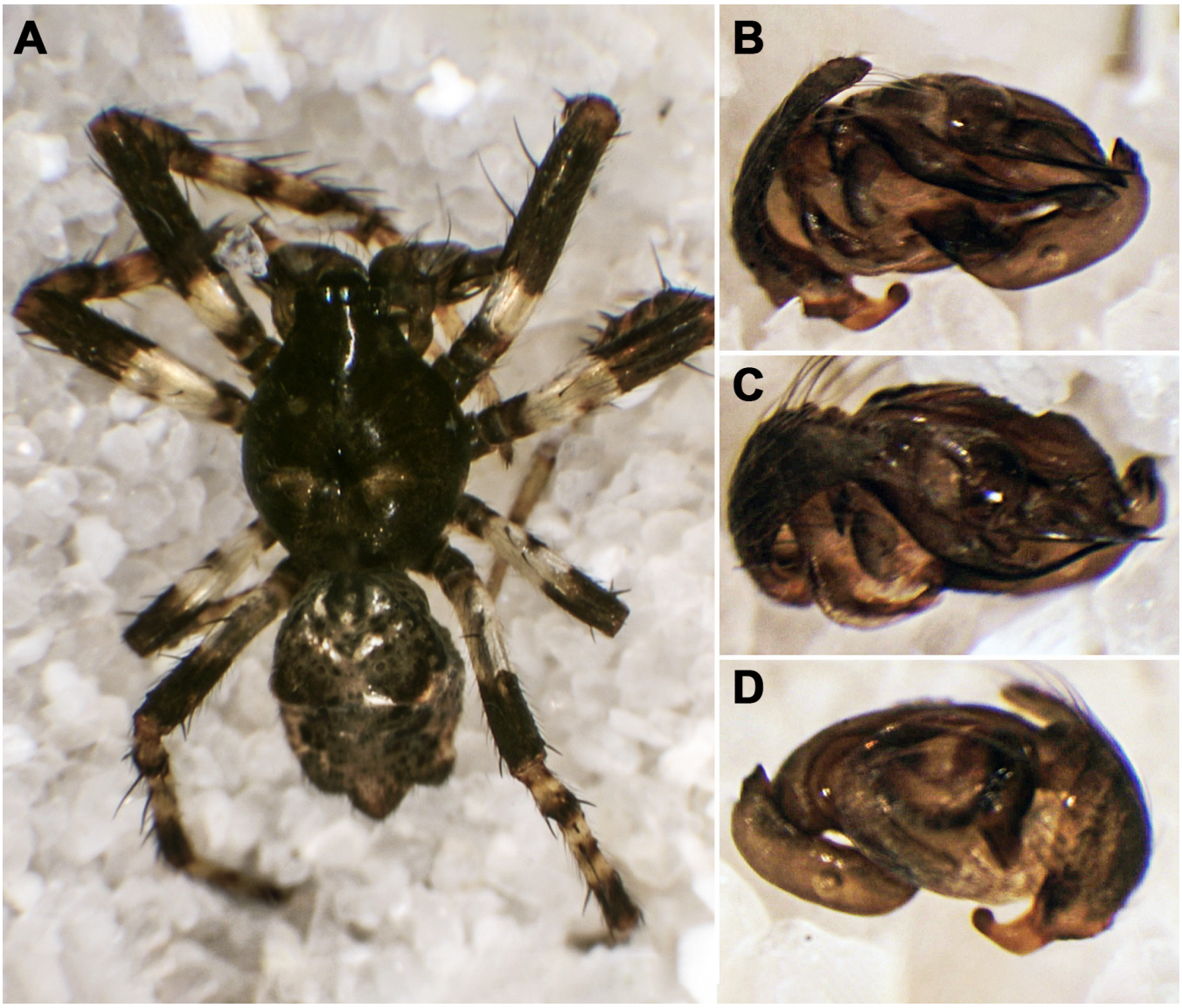

Figure 4. *Cyclosa oculata* (Walckenaer, 1802). **A.** General habitus, dorsal view; **B–D.** Palp; **B.** Prolateral view; **C.** Dorsal view; **D.** Retrolateral view.

DISCUSSION

Including the new findings, spiders of the family Araneidae in Kosovo are represented by 15 genera and 31 species (Table 1). The existing distributional data provide insight into their local biodiversity, but without specific data on their distribution within Kosovo, it is difficult to determine in which areas they are more abundant. The number of spiders known from Kosovo is slowly increasing, and the current tally stands at 251 species, which includes the three recent findings. Most of the reported araneid species are also found in the neighboring countries, which indicates a wide distribution of the species of this family in the Balkans (Nentwig et al., 2024).

Araneus grossus has been found in several European countries, mainly in the Mediterranean Basin (Albania - Deltshev et al., 2011; Vrenozi, 2012; Blick, 2018; Montenegro - Nentwig et al., 2024; Bulgaria - Blagoev et al., 2018; Croatia - Milosevic, 2002; North Macedonia - Komnenov, 2014, and Greece - Nentwig et al., 2024; Cyprus - Bosmans et al., 2019, and Portugal - Branco et al., 2019). The specimens were found predominantly in warm sunny areas, with a herbaceous layer, similar to our observations.

Table 1. Updated list of Araneidae from Kosovo.

No.	Species	References
1	*Aculepeira ceropegia* (Walckenaer, 1802)	Vrenozi & Jäger (2013)
2	*Agalenatea redii* (Scopoli, 1763)	Vrenozi & Jäger (2013); Deltshev et al. (2003)
3	*Araneus angulatus* Clerck, 1757	Vrenozi & Jäger (2013)
4	*Araneus circe* (Audouin, 1826)	Vrenozi & Jäger (2013)
5	*Araneus diadematus* Clerck, 1757	Grapci-Kotori et al. (2022)
6	*Araneus grossus* (C.L. Koch, 1844)	Current study
7	*Araneus marmoreus* Clerck, 1757	Geci et al. (2023)
8	*Araneus quadratus* Clerck, 1757	Geci & Naumova (2021b)
9	*Araniella alpica* (L. Koch, 1869)	Vrenozi & Jäger (2013)
10	*Araniella cucurbitina* (Clerck, 1757)	Vrenozi & Jäger (2013); Deltshev et al. (2003)
11	*Araniella opisthographa* (Kulczyński, 1905)	Vrenozi & Jäger (2013)
12	*Argiope bruennichi* (Scopoli, 1772)	Geci et al. (2023)
13	*Argiope lobata* (Pallas, 1772)	Current study
14	*Cyclosa conica* (Pallas, 1772)	Vrenozi & Jäger (2013)
15	*Cyclosa oculata* (Walckenaer, 1802)	Current study
16	*Gibbaranea bituberculata* (Walckenaer, 1802)	Geci & Naumova (2021b)
17	*Gibbaranea gibbosa* (Walckenaer, 1802)	Vrenozi & Jäger (2013)
18	*Gibbaranea omoeda* (Thorell, 1870)	Vrenozi & Jäger (2013)
19	*Hypsosinga albovittata* (Westring, 1851)	Vrenozi & Jäger (2013)
20	*Hypsosinga pygmaea* (Sundevall, 1831)	Vrenozi & Jäger (2013)
21	*Hypsosinga sanguinea* (C.L. Koch, 1844)	Vrenozi & Jäger (2013)
22	*Larinioides patagiatus* (Clerck, 1757)	Geci & Naumova (2021b)
23	*Larinioides suspicax* (O. Pickard-Cambridge, 1876)	Geci & Naumova (2021b)
24	*Leviellus thorelli* (Ausserer, 1871)	Geci & Naumova (2021b)
25	*Mangora acalypha* (Walckenaer, 1802)	Vrenozi & Jäger (2013)
26	*Neoscona adianta* (Walckenaer, 1802)	Geci et al. (2023)
27	*Neoscona byzanthina* (Pavesi, 1876)	Geci & Naumova (2021a)
28	*Nuctenea umbratica* (Clerck, 1757)	Geci & Naumova (2021b)
29	*Singa hamata* (Clerck, 1757)	Vrenozi & Jäger (2013)
30	*Zilla diodia* (Walckenaer, 1802)	Geci & Naumova (2021b)
31	*Zygiella keyserlingi* (Ausserer, 1871)	Vrenozi & Jäger (2013)

The same pattern of distribution was also documented for *Argiope lobata* (Albania - Deltshev et al., 2011; Vrenozi, 2012; Blick, 2018; Bulgaria - Blagoev et al., 2018; Malta - Pfliegler et al., 2017; Cyprus - Bosmans et al., 2019; Montenegro - Nentwig et al., 2024; Portugal - Branco et al., 2019; Croatia - Milosevic, 2002; North Macedonia - Komnenov, 2014, and Greece (Nentwig et al., 2024). The specimens of *Argiope lobata* were predominantly found in the environments characterized as sunny and dry areas, similar to our observation. A smaller range of distribution has been documented for *Cyclosa oculata* (Albania - Deltshev et al., 2011; Vrenozi, 2012; Blick, 2018; Bulgaria - Blagoev et al., 2018; North Macedonia - Blagoev, 2002, and Greece - Helsdingen et al., 2018), its occurrences were mainly in the warmer regions, as in Kosovo. Notably, Bosnia and Herzegovina is the only Balkan country, where these three species have not been reported to date. Currently, *Cyclosa oculata* is not known from Montenegro, Croatia, Cyprus, and Portugal, whereas *Araneus grossus* and *Argiope lobata* are not known in Slovenia. For the future studies concerning this family in Kosovo and the Balkans, it would be beneficial to investigate the ecological preferences and distribution patterns of species. This could entail conducting systematic surveys across various habitats within the country and neighboring Balkan countries to ascertain the specific distribution of these spiders and to understand the factors influencing their presence in different areas.

AUTHOR'S CONTRIBUTION

The authors confirm their contribution to the paper as follows: K. Ibrahimi, B. Islami, and B. Kastrati: Field work and collecting the specimens; K. Ibrahimi, B. Islami and D. Geci: Identification of specimens, photography, and writing the manuscript; H. Ibrahimi, and A. Bilalli: Writing, and reviewing. All authors approved the final version of the manuscript.

FUNDING

This research is supported by The European Society of Arachnology through the European Arachnid Biodiversity Research fund.

AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in the Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina "Hasan Prishtina", Prishtinë, Kosovo under the name 'Spiders of Kosovo' and are available, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study only included plants and arthropod material, and all required ethical guidelines for the treatment and use of animals were strictly adhered to in accordance with international, national, and institutional regulations. No human participants were involved in any studies conducted by the authors for this article.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

ACKNOWLEDGMENTS

We extend our sincere thanks to the anonymous peer reviewers whose dedication and expertise significantly enriched this manuscript. Their thoughtful feedback and rigorous assessment played an indispensable role in shaping the final version of this work. Our deepest appreciation goes to the Editor-in-Chief, and the Subject Editor of the journal, for their invaluable support and guidance throughout the review process.

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یافته‌های جدید و چک‌لیست به‌روز عنکبوت‌های خانواده Araneidae (Arachnida: Araneae) کوزوو

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| **تاریخ دریـافت:** ۰۷ اسفند ۱۴۰۲ | **تاریخ پذیرش:** ۳۱ فروردین ۱۴۰۳ | **تاریخ انتشار:** ۱۳ تیر ۱۴۰۳ |

چکیـــده: در این مقاله، ما اطلاعات بیشتری از فون عنکبوت‌های گردباف (Araneae: Araneidae) در کشور کوزوو ارایه کردیم. سه گونه شامل *Araneus grossus* (C.L. Koch, 1844)، *Argiope lobata* (Pallas, 1772) و *Cyclosa oculata* (Walckenaer, 1802) برای اولین بار از این کشور گزارش شدند. با توجه به یافته‌های جدید و اطلاعات مندرج در فهرست به‌روز شده عنکبوت‌های خانواده Araneidae در این مطالعه، تعداد کل گونه‌های عنکبوت در کوزوو به ۲۵۱ افزایش یافته است. با توجه به اینکه فون عنکبوت‌های کوزوو هنوز به طور کامل بررسی نشده، این مطالعه بر اهمیت بررسی مستمر برای درک بهتر تنوع گونه‌های عنکبوتی در منطقه تأکید دارد.

واژگـان کلیدی: عنکبوت گردباف، فون، تنوع، شبه‌جزیره بالکان