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Checklist

First barcode-assisted annotated checklist of owlflies (Neuroptera, Myrmeleontidae, Ascalaphidae) of Georgia with the first record of genus *Deleproctophylla* Lefèbvre, 1842

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Abstract

The present study aims to provide an updated checklist of the owlfly subfamily Ascalaphidae Lefèbvre, 1842, with the first records of the genus *Deleproctophylla* Lefèbvre, 1842, from the country. The new records give an improved understanding of owlfly distribution within the country. The record of the genus *Deleproctophylla* in Georgia is based on a single female specimen of *D. australis* (Fabricius, 1787).

Key words: biodiversity, Caucasus, DNA barcoding, new records, Sakartvelo

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Introduction

Named after the custodian of the Hades' orchard, owlflies (Ascalaphidae) are the predaceous insects of the order Neuroptera, both in the imaginal and larval stages (Devetak 2007), consisting of less than 500 species worldwide, with the highest diversity in tropical and subtropical regions (Devetak and Janžekovič 2012). Based on phylogenomic results, a new classification for the antlions was proposed, which synonymizes Ascalaphidae with Myrmeleontidae and divides the family into four subfamilies (Ascalaphinae, Myrmeleontinae, Dendroleontinae, and Nemoleontinae) (Machado et al. 2019). This classification is based on a single publication, which is not unanimously supported (Badano et al. 2017; Michel et al. 2017; Jones 2019; Jones and Badano 2021), as it is believed that further studies are needed to confirm or reject this position, and that, for the time being, the Ascalaphidae should be retained as a family.

Most of the European species are univoltine or semivoltine; in some cases, like *Bubopsis*, the whole cycle lasts more than two years in nature, with the overwintering stage always represented by larvae (Badano et al. 2014). The first data on owlflies in Georgia was published just after World War II (Shengelia 1947). Then, Zakharenko and Krivokhatsky (1993), list one species (*Libelloides macaronius*) from Georgia and *Deleproctophylla australis* (!) from the Caucasus (without specifying location and references). In general studies, such as the European Monograph of Neuropterida (Aspöck et al. 1980) and the Catalog of Neuropterida of the Western Palearctic (Aspöck et al. 2001), owlflies are generally reported from Georgia (*L. macaronius*) or even more broadly from the Caucasus (*Deleoroctophylla variegata* (Klug, 1834)). Until now, two genera consisting of three species were recorded from Georgia. Despite the recent studies on Ascalaphidae and Neuroptera in general in recent years (Duelli et al. 2015; Dobosz et al. 2017; Dobosz et al. 2018; Kerimova et al. 2023), *D. australis* (Fabricius, 1787) has always eluded collectors. Finally, we present the first record of this genus from Georgia, along with the specimens' photographs, collecting information, a distribution map, and the results of DNA barcoding for each studied species.

Materials and methods

Sample collection and preparation

Most of the examined specimens were collected within the framework of the Caucasus Barcode of Life (CaBOL) project (https://ggbc.eu/) by entomological nets during the day, by hand, or in the light traps in the 2021-2023 period. Collected specimens were preserved in 96% ethanol, stored in a freezer under -22˚C at the scientific collections of Ilia State University, or kept dry in the personal collection of the first author.

The part of the species was determined in accordance with the key by Aspöck et al. (1980). Photographs of the live specimens were taken using a Canon EOS 5D Mark II camera equipped with a Canon EF 100mm f/2.8L Macro IS USM. Photographs of the preserved specimens were done using a Canon EOS 60D camera with a Canon EF 60 mm f/2.8 Macro USM lens. The digital images were then processed in Zerene Stacker version 1.04 image stacking software and Adobe Photoshop CS6.

In recent decades, the role and contribution of citizen scientists in the field of entomology has been highly acknowledged. In entomology, their contributions to our comprehension of patterns and processes have been impressive for hundreds of years. Gathering information and collaborating across disciplines, volunteers have helped shape our understanding of this complex field (Gardiner and Roy 2021; Kittelberger et al. 2021), including discoveries of Neuroptera species new to science (Winterton et al. 2012) as well as defining their distributional patterns (Parenta et al. 2022). The present survey is not the first of its kind in Georgia, since citizen scientists have already contributed to local faunistic and distributional research (Iankoshvili and Tarkhnishvili 2021). Accordingly, it would have been unreasonable to neglect publicly available and valuable data from online platforms and databases such as iNaturalist and Georgian Biodiversity Database (GBD) (Tarkhnishvili et al. 2013), or specialized local groups on Facebook, as we attempted to compile the deposited data in the species list given below.

The distribution map for studied species and sampling localities was created using QGIS v. 3.22.10.

DNA processing

Some of the collected specimens were submitted to the DNA barcoding pipeline at Ilia State Unviersity. DNA was extracted from whole samples using the Quick-DNA Magbead Plus Kit (Zymo Research). Partial sequences of cytochrome oxidase subunit I (COI) were amplified by polymerase chain reaction (PCR) using the primer pairs LCOI490-JJ and HCO2198-JJ (Astrin and Stüben 2008). Thermal conditions included denaturation at 95 °C for 1 min, followed by the first cycle set (15 cycles): 94 °C for 30 s, annealing at 55 °C for 1 min (–1 °C per cycle) and extension at 72 °C for 1:30 min. Second cycle (25 cycles set): 94 °C for 35 s, 45 °C for 1 min, 72 °C for 1:30 min, followed by 1 cycle at 72 °C for 3 min, and the final extension step at 72 °C for 5 min. PCR amplicons were visualized on 1% agarose gels using 1.7 µl of PCR product. The unpurified PCR products were sequenced in both directions at the Beijing Genomics Institute (Hong Kong, CN) using the amplification primers. Sequence analysis was performed using Geneious Prime 2022.1.1 (http://www.geneious.com). Extracted DNA was deposited in the scientific collections of Ilia State University, Tbilisi, Georgia, and aliquots will be deposited at LIB Biobank at Museum Koenig, Bonn, Germany, while the sequences have been submitted to Barcode of Life Data System (BOLD) databases. The newly obtained DNA barcodes of COI sequences were checked against the BOLD Systems database (http://www.boldsystems.org/index.php). Barcode Index Number (BIN) (Ratnasingham and Hebert 2013) for the sequenced taxa and their nearest neighbor in BOLD Systems (if they had a BIN) are also given. For the calculation of sequence differentiation, we used *p*-distance as performed in the BOLD Systems.

Abbreviations

BOLD – Barcode of Life Data Systems
CaBOL – Caucasus Barcode of Life
GBD – Georgian Biodiversity Database
ILIAUNI – Ilia State University, Tbilisi, Georgia
INat – iNaturalist
JLGT – Private Collection of Lasha-Giorgi Japaridze, Telavi, Georgia
ŁM – Private Collection of Łukasz Matuszewski, Poznań, Poland
USMB – Upper Silesian Museum in Bytom, Poland
WGFB – Wildlife in Georgia Facebook group
ZIN – Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia

Results

In total, the data of 128 specimens was collected, comprising four species from three genera. We were able to obtain five quality barcodes (658 bp in length, with no stop codons, indels, or deletions) for all four species. Barcode information is given under each barcoded species listed below. The list is given in alphabetical order. An asterisk (*) is used to indicate species first recorded in Georgia.

Family Ascalaphidae Lefèbvre, 1842

Genus *Bubopsis* McLachlan, 1898

Bubopsis hamata (Klug, 1834)

Bubopsis hamatus – Dobosz et al. 2017, 2018; Kerimova et al. 2023

Material examined. GEORGIA • 1 larvae (Fig. 1); Tbilisi, Dighomi Vill.; 41.7806°N, 44.7054°E; 697 m a.s.l.; *Paliurus spina-christi* dominated shrubland, leaf litter; Seropian A.; 2 Apr 2014; GBD • 1 larvae; Mtskheta-Mtianeti, Mtskheta mun., vicinity of Saskhori quarry; 41.8384°N, 44.5463°E; steppe, under rock; Seropian A.; 20 Apr 2023; personal observation • 1♀ (Fig. 2); 41.7780°N, 44.7051°E; 693 m a.s.l.; *Paliurus spina-christi* dominated shrubland; Seropian A.; 27 Jun 2021; GBD • 1♂, 1♀; 41.7780°N, 44.7051°E; 693 m a.s.l.; *Paliurus spina-christi* dominated shrubland; leg. Japaridze L-G.; 29 Jun 2021; JLGT (Figs 5-6) • 1♀; Shida Kartli, Gori; 41.9852°N, 44.1079°E; 612 m a.s.l.; steppe; Bulbulashvili N.; 16 Aug 2019; GBD • 2♂♂, 3♀♀; Kakheti, Dedoplistskaro mun., Vashlovani NP, Mijniskure; 41.1111°N, 46.6469°E; 94 m a.s.l.; semidesert, light trap; leg. Vähätalo L., Vähätalo A.; 28 Jun 2023; JLGT • 3♀♀; 5 Jun 2023; CaBOL-IDs 1035852, 1035853, 1035854 • 11♂♂, 38♀♀; 41.1111°N, 46.6467°E; 88 m a.s.l.; at light; leg. Dobosz R.; 23 Jun 2019; USMB • 1♂; 41.1111°N, 46.6467°E; 88 m a.s.l.; at light; leg. Dobosz R.; 24 Jun 2019; USMB • 2♂♂, 2♀♀; 41.1111°N, 46.6467°E; 93 m a.s.l.; UV lamp; leg. Greń C.; 23 Jun 2022; USMB • 1♂; Vashlovani NP; 41.1825°N, 46.4687°E; 648 m a.s.l.; semidesert; rbeunen; 28 Jun 2012; INat • 1♂; Chachuna Managed Reserve, Dalis Mta Reservoir; 41.2843°N, 45.9032°E; 325 m a.s.l.; semidesert, light trap; leg. Vähätalo L., Vähätalo A.; 30 Jun 2023; JLGT • 1♀; 41.2667°N, 45.9°E; 341 m a.s.l.; at light; leg. Matuszewski Ł.; 14-15 Jun 2018; ŁM • 1♀; Dalis Mta Hotel; 41.284286°N, 45.903164°E; 360 m a.s.l.; at light; leg. Greń C.; 10 Jul 2017; USMB • 1♂; 360 m a.s.l.; at light; leg. Dobosz R.; 26 Jun 2019; USMB • 1♀; Chachuna Managed Reserve; 41.2206°N, 45.9722°E; 250 m a.s.l.; netting; 96% ethanol; leg. Dobosz R.; 17 Jul 2023; ILIAUNI.

Additional material. GEORGIA• 1♀; Kakheti, Dedoplistskaro mun., Vashlovani NP, Mijniskure; 41.1001°N, 46.6333°E; 97 m asl; leg. Wąsala R.; 20–21 Aug 2015; Dobosz et al. (2017) • 2♂♂, 3♀♀; 41.1130°N, 46.6481°E; leg. Dobosz R.; 100 m a.s.l.; Dobosz et al. (2018) • 2♀♀; Chachuna Managed Reserve, Dalis Mta Hotel; 41.2843°N, 45.9032°E; 360 m a.s.l.; leg. Dobosz R.; 24 May 2017; • 2♂♂, 1♀; leg. Dobosz R.; 24 May 2017.

Barcoding. Two nearly identical barcodes were obtained from the specimens with CaBOL-IDs 1035852 and 1035854 (BOLD:AEG4998, *p*-distance 0.15%) with the nearest neighbors in BOLD Systems *B. hamata* and *B. andromache* (BOLD:AEG4998, maximum *p*-distance 0.16%) from the unknown country of origin.

Remarks. *Bubopsis hamata* is a species with a distribution ranging from northeastern Africa to West Asia (Hölzel 2004), and the Caucasus (Dobosz et al. 2017). From the neighboring countries, this species is known to occur in Armenia, Azerbaijan, Turkey, and Dagestan (Dobosz et al. 2017). From Georgia, this species is also reported by Kerimova et al. (2023). *Bubopsis hamata* is the only species of local owlflies with a crepuscular lifestyle (Aspöck et al. 1980). For species distribution within the country, see Fig. 12.

Figures 1. *Bubopsis hamata* (Klug, 1834); third instar larvae.

*Genus *Deleproctophylla* Lefèbvre, 1842

Deleproctophylla australis (Fabricius, 1787)

Material examined. GEORGIA • 1♀ (Fig. 7); Tbilisi, Lisi lake vicinity; 41.7573°N, 44.7183°E; 677 m. a.s.l.; dry slope with xerophytic vegetation; leg. Makharadze G. and Rostiashvili I.; 2 Jul 2023; CaBOL-ID 1035917; JLGT.

Barcoding. A single barcode was obtained from the specimen with CaBOL-ID: 1035917 (BOLD:AEG2372) with the nearest neighbor in BOLD Systems *D. variegata* (BOLD:AEG2372, *p*-distance 0.16%) from Azerbaijan (Nakhchivan, Ordubad) (Kherimova et al. 2022).

Remarks. *Deleproctophylla australis* exhibits considerable variability, especially the wing pattern in individual populations, which often lacks front-wing spots, making it challenging to identify the species using the key in Aspöck et al. (1980). Generally, *D. australis* is significantly larger than the similar species *Deleproctophylla variegata*. Also, specimens of *D. variegata* collected in Kyrgyzstan, from the collections of the Upper Silesian Museum in Bytom are smaller. *Deleproctophylla australis* has extensive brownish-red spots on both wings below the pterostigma. It happens that the spot on the forewing is missing, but the spot on the hindwing remains always brownish red. The spots on the hind wing of *D. variegata* are darker brownish black (visibly darker than in *D. australis*). Sometimes the wing is slightly smoky toward the base. There are also differences in the pattern of the pronotum and thorax. In the Upper Silesian Museum in Bytom collection, the two species show considerable, in the

Figures 2–4. Images of live specimens of studied owlflies. **2:** *Bubopsis hamata* (Klug, 1834), female; **3:** *Libelloides ustulatus* (Eversmann, 1850), male; **4:** *Libelloides macaronius* (Scopoli, 1763), male.

case of the above features, differences. In *D. variegata* specimens from other regions, such as Kyrgyzstan or Afghanistan, the wing membrane is smokey and the specimens are a little darker than the others, but these are more just colour variations. In Georgia, both of the species are highly likely to occur.

Prior to our work, there were no barcodes for the properly identified *D. australis* in BOLD Systems (or in GenBank). We assume that the very small *p*-distance between *D. australis* and *D. variegata* might be attributed to the potential misidentification of the specimen whose molecular data were mined from GenBank. Such cases are not uncommon and require an individual approach to address the issue, considering the possibility that the observed morphological differences could be indicative of a single species with variations across isolated populations.

Deleproctophylla australis is an element of the Mediterranean fauna that has previously never been reported in the Caucasus region. The nearest known report of the species lies in Edirne, Turkey (Popov 1977; Háva 2000; Canbulat 2007). Háva (2000), not knowing the publication by Alexi Popov, quotes the same specimens from the collection of the National Museum in Prague. In a European monograph of Neuropterida (Aspöck et al. 1980) and a Catalog of Neuropterida of the Western Palearctic (Aspöck et al. 2001) the authors incorrectly listed *D. australis* from Anatolia, which is a very broad geographical term, suggesting the occurrence of this species in almost the entire territory of Turkey, while it occurs in its European part near the border with Bulgaria. This species, most likely incorrectly, was recorded from the Caucasus and Middle Asia (Zakharenko and Krivokhatsky 1993). This information is not commented on in any publications by Zakharenko, Krivokhatsky, or other authors. For species distribution within the country, see Fig. 12.

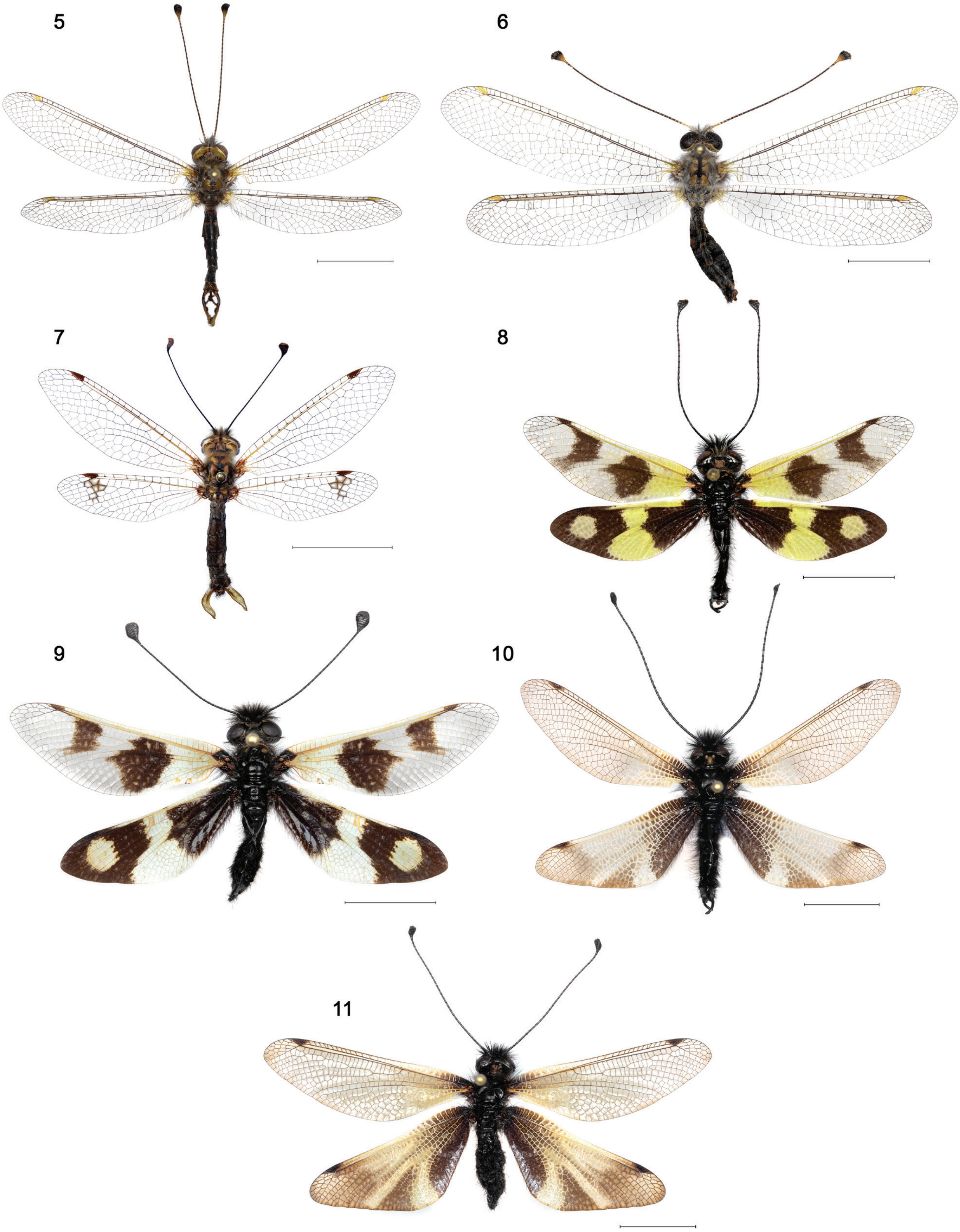
Genus *Libelloides* Schaeffer, 1766

Libelloides macaronius **(Scopoli, 1763)**

Ascalaphus kolyvanensis – Shengelia 1947 (syn.)
Libelloides macaronius kolyvanensis – Kerimova et al. 2023
Libelloides macaronius kolyvanensis, morpha typica – Krivokhatsky et al. 2018
Libelloides macaronius kolyvanensis, morpha alba – Krivokhatsky et al. 2018
Libelloides macaronius – Zakharenko and Krivokhatsky 1993, Aspöck et al. 2001, Dobosz et al. 2018

Material examined. GEORGIA • 1♂; Kvemo Kartli, Tetritskaro mun., E of Koda Vill.; 41.5700°N, 44.8075°E; 940 m a.s.l.; Czyzewski S.; 10 Jun 2023; INat • 1♀; Rustavi, Ialguja; 41.5232°N, 45.0431°E; 320 m a.s.l.; steppe; Tarkhnishvili D.; GBD • 1♂, 1♀ (in copula); Shida Kartli, Kaspi mun., Khovle Vill.; N41.9003°, E44.2404; 714 m a.s.l.; forest meadow; Bulbulashvili N.; 29 Jun 2021; INat • 1♂; Gori; 41.9627°N, 44.0967°E; 873 m a.s.l.; forest edge; Seropian A.; 16 Jun 2019; GBD • 1♀; Kaspi mun., Kodistskaro Vill.; 42.0305°N, 44.3525°E; 793 m a.s.l.; Bulbulashvili N.; 25 Jun 2020; GBD • 1 specimen; Chachubeti Vill.; 41.8465°N, 44.2677°E; 964 m a.s.l.; meadow; Sanakoeva A.; 1 Aug 2018; GBD • 1♂ (Fig. 3); Tbilisi, Dighomi Vill.; 41.7801°N, 44.6930°E; 776 m a.s.l.; *Paliurus spina-christi* dominated shrubland; leg. Seropian A., Japaridze L-G.; 14 May 2022; JLGT • 2♀♀; leg. Japaridze L-G., Seropian A.; 17 May 2022; JLGT • 3♀♀, 4♂♂ (Fig. 8); Lisi Lake; 41.7567°N, 44.7291°E; 688 m a.s.l.; steppe; leg. Makharadze G.; 18 Jun 2021; JLGT • 1♀, 1♂ (in copula); Napetvrebi; 41.7368°N, 44.6482°E; 1115 m a.s.l.; Shermadini Z.; 17 Jun 2022; WGFB • 1♀ (Fig. 9); Kojori; 41.6660°N, 44.6768°E; 1317 m. a.s.l.; meadow; leg. Makharadze G.; 18 Jun 2023; JLGT. • 1♂; Tbilisi; 41.7808°N, 44.6979°E; 721 m a.s.l.; steppe; leg. Seropian A.; 9 Jun 2021; CaBOL-ID 1010290 • 1♂; Kakheti, Dedoplistskaro mun., Vashlovani NP; 41.1925°N, 46.4489°E; 648 m a.s.l.; semidesert; Paposhvili T.; GBD • 3♀♀; Vashlovani NP, Pantishara canyon; 41.2372°N, 46.3653°E; 360 m a.s.l.; netting; leg. Królik R.; 17 Jun 2021; USMB • 1♂; Chachuna Managed Reserve, Dalis Mta Reservoir; 41.2667°N, 45.9°E; 341 m a.s.l.; netting; leg. Matuszewski Ł.; 14-15 Jun 2018; ŁM • 1♂; Sagarejo mun., David Gareja; 41.5211°N, 45.3885°E; 902 m a.s.l.; steppe; Songhulashvili Z.; 12 Jun 2016; GBD • 1♀; Samtskhe-Javakheti, Akhaltsikhe mun., near Atskuri; 41.7583°N, 43.2113°E; 890 m a.s.l.; Chubinidze M.; 8 Jul 2022; WGFB • 1 specimen; N of Minadze Vill.; 41.6214°N, 43.0566°E; 959 m a.s.l.; GBD • 1♀; Mtskheta-Mtianeti, Mtskheta, Jvari monastery vicinity; 41.8385°N, 44.7332°E; 608 m a.s.l.; steppe; leg. Japaridze L-G.; 15 Jun 2019; JLGT.

Additional materia. GEORGIA • 1♂, 1♀, 1ex. (abdomen missing); Mtskheta, Dedoplistskaro (Tsiteltskaro), Borjomi (Shengelia 1947) • 1♂, 1♀; Borjomi; Tyflis [Tbilisi]; ZIN (Krivokhatsky et al. 2018) • Dzmoba station (Eastern Georgia), Transcaucasus Railway; ZIN (Krivokhatsky et al. 2018) • 1♀; Mtschet [Mtskheta], prope. Tiflis [Tbilisi]; 17 Jul 1915; Mus. Caucasus (Kerimova et al. 2023) • 1♂; road from Borjomi, 5 km NE of Atskuri; 41.7585°N, 43.2112°E; 890 m a.s.l.; meadow; leg. Dobosz R.; 29 May 2017; 4♂♂, 1♀; 2 km S of Minadze, near Akhaltsikhe; 41.6216°N, 43.0571°E; 958 m a.s.l.; meadow; leg. Dobosz R.; 29 May 2017 (Dobosz et al. 2018) • 3♀♀; Tsarsk. Kolodez, Sighnaghi; 41.6111°N, 45.9271°E; leg. Uvarov B.; 10 Jun 2015; Mus. Caucasus. No 94-15 (Kerimova et al. 2023).



Figures 5–11. Images of preserved specimens of studied owlflies. **5–6:** *Bubopsis hamata* (Klug, 1834), male and female; **7:** *Deleproctophylla australis* (Fabricius, 1787), female; **8–9:** *Libelloides macaronius* (Scopoli, 1763), male and female; **10–11:** *Libelloides ustulatus* (Eversmann, 1850), male and female. Scale bars = 10 mm.

Barcoding. A single barcode was obtained from the specimen with CaBOL-ID 1010290 (BOLD:ACD2658). The identification via COI subunit was not straightforward, as the nearest neighbor in BOLD Systems *L. coccajus* (Denis & Schiffermüller, 1775) (BOLD:ACD2658, *p*-distance 1.07%) is from France. The second-best match is *L. macaronius* from Cyprus (BOLD:ACD2658, *p*-distance 1.22%).

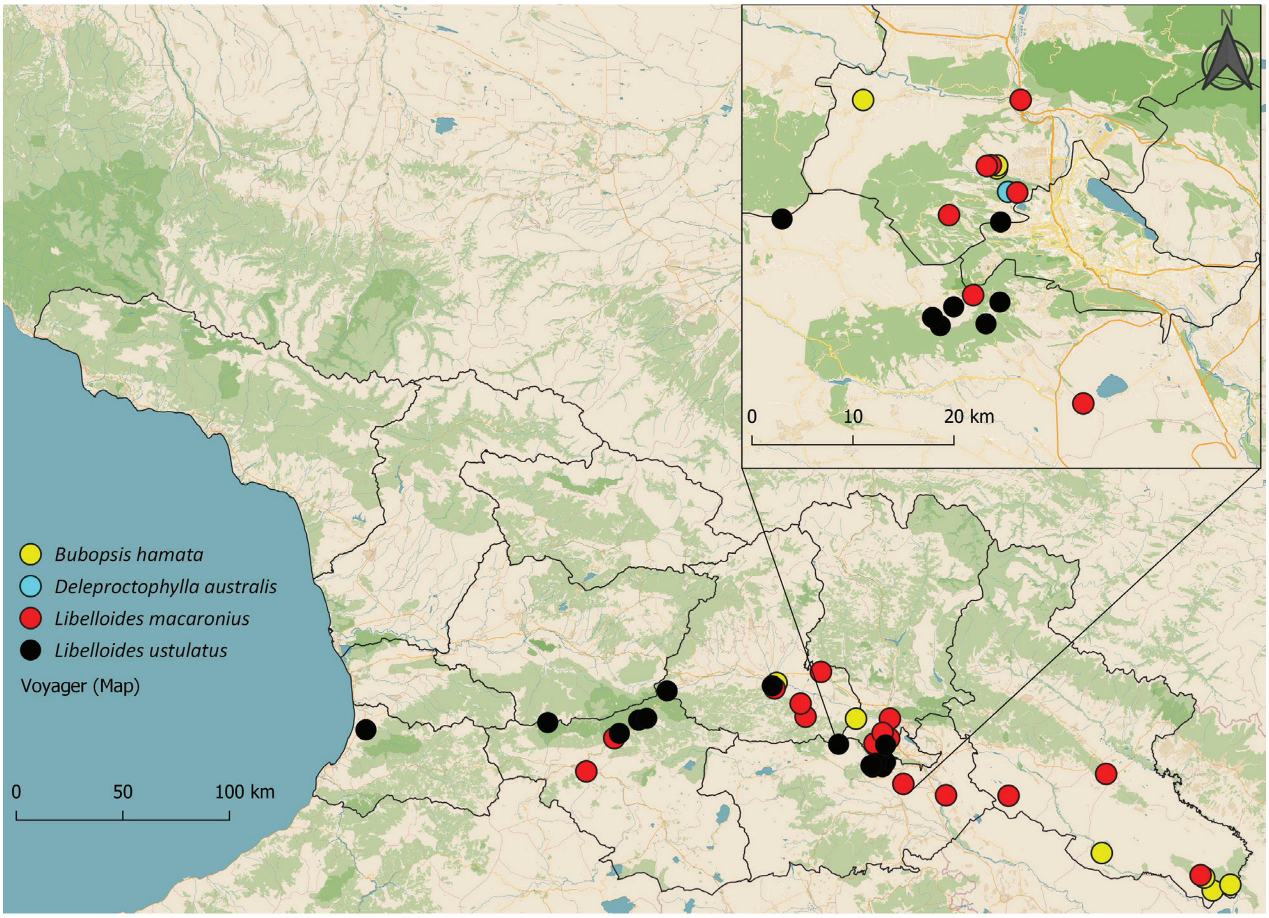
Remarks. A highly variable species that requires revision. Of the numerous described subspecies and color varieties, there are currently three recognized taxa (Oswald 2023). An attempt to organize the taxonomy of *L. macaronius* of Crimea and related species from the Western Palearctic was made by Krivokhatsky et al. (2018). Unfortunately, in the taxonomy of this group, he adopted criteria that were inconsistent with the Code of Zoological Nomenclature, hence, despite many valid conclusions regarding population variability, they cannot be included in the taxonomy. In the Caucasus region, there is great variability within this species, which is also visible in the illustrations presented in this paper, e.g., Fig. 8 typical colored specimen, Fig. 9 white colored form (in Krivokhatsky (2018) [respectively] *Libelloides macaronius kolyvanensis* (Laxmann, 1770) m. typica and *Libelloides macaronius kolyvanensis* (Laxmann, 1770) m. alba).

Libelloides macaronius is a species with an expansive Ponto-Mediterranean distribution (Devetak 2007). It is the most widespread local species, reported from Georgia and all neighboring countries (Zakharenko and Krivokhatsky 1993; Aspöck et al. 2001). For species distribution within the country see Fig. 12.

Libelloides ustulatus **(Eversmann, 1850)**

Libelloides ustulatus – Dobosz et al. 2017
Libelloides hispanicus ustulatus – Devetak et al. 2019

Material examined. GEORGIA • 1♀; Kvemo Kartli, Tetritskaro mun., E of Elpia Vill.; 41.6462°N, 44.6286°E; 940 m a.s.l.; shtepbraiter; 29 May 2022; INat • 1♂, 1♀; Birtvisi Natural Monuments; 41.62°N, 44.5306°E; 1150 m a.s.l.; netting; leg. R. Zamorski; 31 May 2022; USMB • 2♂♂; leg. R. Dobosz; 31 May 2022; USMB • 1♂; leg. Ł. Matuszewski; 31 May 2022; USMB • 1♀; netting; 96% ethanol; leg. Ł. Matuszewski; 1 Jun. 2022; ILIAUNI • 1♀; Shida Kartli, Gori; 41.9734°N, 44.0840°E; 803 m a.s.l.; meadow at forest; N. Bulbulashvili; 15 May 2021; INat • 1♀; Adigeni mun., Tashiskari Vill.; 41.9523°N, 43.5034°E; 742 m a.s.l.; meadow at the forest; Z. Khachidze; 12 May 2016; WGFB • 1♂; Samtskhe-Javakheti, Adigeni mun., Zekari Pass, N of Abastumani; 41.8224°N, 42.8443°E; 2172 m a.s.l.; jhskevington; 11 Jun. 2019; INat • 1♀; Abastumani; 41.7927°N, 41.8404°E; 1893 m. a.s.l.; 23 Jun. 2018; leg. T. Klenovsek; BOLD Systems • 1♀; Borjomi mun., Kvabiskhevi Vill.; 41.7780°N, 43.2394°E; 940 m a.s.l.; meadow; I. Goliadze; 12 May 2011; WGFB • 1♀; Zanavi Vill; 41.8872°N, 43.4325°E; 800 m a.s.l.; netting; leg. A. Lasoń; 18 May 2019; USMB • 3♀♀, 4♂♂ (Fig. 10); Tbilisi, Kiketi; 41.6556°N, 44.6537°E; 1177 m a.s.l.; meadow at the forest; leg. G. Makharadze; 23 May 2023; JLGT • 1♂ (Fig. 4); A. Seropian; 17 May 2021; GBD • 1♂; 41.6389°N, 44.6378°E; 1166 m a.s.l.; meadow at the forest; leg. Makharadze G.; 17 May 2021; CaBOL-ID 1010385 • 2♂♂ (Fig. 11); Nutsubidze plateau; 41.7306°N, 44.7094°E; 702 m a.s.l.; artificial pine planting; leg. A. Seropian &



Figures 12. The distributional map of Georgian owlflies (Ascalaphidae) discussed in the main text.

L-G. Japaridze; 1 May 2020; JLGT • 1♂; Kojori; 41.6406°N, 44.6920°E; 1332 m a.s.l.; meadow; leg. L-G. Japaridze & S. Tchkoidze; 26 May 2023; JLGT • 1♂; 41.6598°N, 44.7086°E; 1276 m a.s.l.; forest edge, tree branch; N. Melikishvili; 8 May 2021; WGFB • 1♂; Mtskheta-Mtianeti, Mtskheta; 41.8333°N, 44.7°E; 558 m a.s.l.; leg. J. Kadlec; 18 May 2018; USMB.

Additional material. GEORGIA • 3♂♂, 1♀; W Tbilisi, N Naosari, NE Manglisi; 41.7333°N, 44.4500°E; 1814 m a.s.l.; leg. M. Snižek; 14 May 2014; Dobosz et al. (2017) • 1♀; Abastumani (Lesser Caucasus Mountains); 41.792694°N, 42.840417°E; 1893 m; coniferous forest, meadow; 23 Jun. 2018; Devetak et al. (2019) • 2♀♀, 1♂; Borjomi; 41.8400°N, 43.3908°E; leg. P. Winogradow; 5 Jun. 1911; 1♂ (white morph); Borjomi, Likani; 41.8324°N, 43.3463°E; leg. A. Wasilinin; 4 May 1912; Kerimova et al. (2023).

Barcoding. A single barcode was obtained from the specimen with CaBOL-ID 1010385 (BOLD: AEG2795) identical to the nearest neighbor in the BOLD Systems *L. ustulatus* (Eversmann, 1850) from Georgia, Abastumani (BOLD: AEG2795).

Remarks. *Libelloides ustulatus* was synonymized with *L. hispanicus* Rambur, 1842, by Navás (1912). Due to the extraordinary morphological similarity of the *hispanicus* and *ustulatus* taxa, convergence at the subspecies level was postulated (Aspöck et al. 1980). At the same time, due to the disjunctive nature of the distribution of these two species, some authors raise *L. hispanus ustulatus* to the species level (Aspöck and Aspöck 1994; Szirák 1998; Aspöck et al.

2001; Canbulat 2007). *Libelloides ustulatus* is a species with a Caucaso-Anatolian distribution (Dobosz et al. 2017; Dobronosov et al. 2023). Unlike other local owlfly species, *L. ustulatus* occurs mainly in forest meadows at higher altitudes. For species distribution within the country, see Fig. 12.

Discussion

Based on the distribution pattern (Fig. 12), it is evident that three species, specifically *Bubopsis hamata*, *Deleproctophylla australis*, and *Libelloides macaronius*, are primarily distributed within the arid habitats of the central and southeastern regions of Georgia. In contrast, the predominant population of *L. ustulatus* is concentrated along the Meskheti Range, extending to the vicinity of Tbilisi, at altitudes ranging from 700 to 2200 m a.s.l. There is a strong likelihood that the Caucasian owlfly (*L. ustulatus*) also inhabits the subalpine belt within the northern mountainous regions of Georgia. After analyzing the collected data, local owlflies can be classified into two conditional groups: late spring-late summer species, which include *L. macaronius*, *B. hamata*, and *D. australis* (flight period V-VIII), and late spring-early summer species represented solely by *L. ustulatus* (flight period V-VI). Typically, this species flies in May, but at high altitudes (> 2000 m a.s.l.) can be observed until the end of June. Our data corresponds to the species phenology given in Aspöck et al. (1980), except for *L. ustulatus*, which is treated as a subspecies of *L. hispanicus*.

To gain a more comprehensive understanding of the actual distribution and biological aspects of these sparsely studied and infrequently observed owlfly species (except for *L. macaronius*) within the local ecosystem, further extensive research is needed. It is also worth noting that there is no description of the larval stages available for *B. hamatus* and *L. ustulatus*.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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