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New data on millipedes (Diplopoda) from the highlands of the Central Caucasus

Новые данные по двупарноногим многоножкам (Diplopoda) высокогорий Центрального Кавказа

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KEY WORDS: taxonomy, fauna, iconography, altitudinal distribution.
КЛЮЧЕВЫЕ СЛОВА: таксономия, фауна, иконография, высотное распространение.

ABSTRACT. New and already published faunistic data on the millipedes of the Central Caucasian highlands are compiled. These include 16 species from 13 genera, 4 families and four orders. New information on the altitudinal distribution of some species, as well as iconographies for all new records are presented.

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РЕЗЮМЕ. Приведены результаты обобщений новых и литературных данных по диплоподам высокогорий Центрального Кавказа. Они включают 16 видов из 13 родов, 4 семейств и четырех отрядов. Приведена новая информация о высотном распространении некоторых видов. Для всех новых находок дана иконография.

Introduction

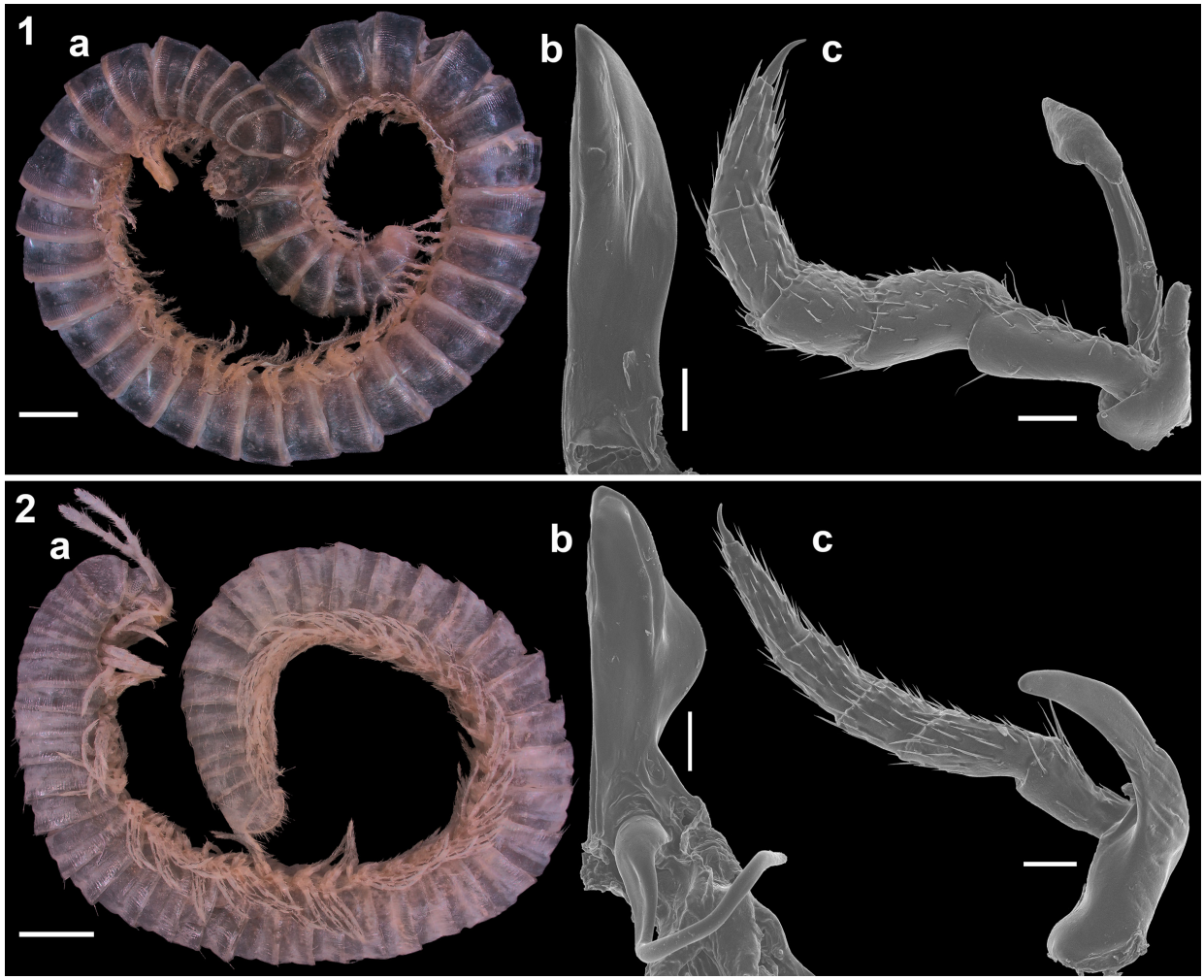
The Caucasus is a powerful mountain ecosystem lying between the Black Sea and the Caspian Sea. The highest part is the Central Caucasus, located between Mt Elbrus in the northwest and Mt Kazbek in the southeast [Gvozdetsky, Golubchikov, 1987]. The northern slopes of the Central Caucasus belong to Russia's republics of Kabardino-Balkaria and North Ossetia – Alania. The southern slopes lie in the territory of Georgia. The largest valley glaciers of the Caucasus are located there [Gvozdetsky, 1954].

Studies on the fauna of Caucasian diplopods have recently progressed considerably. In particular, many millipede group have been revised, and several regional lists compiled [Kokhia, Golovatch, 2018, 2020; Zuev, 2021; Vagalinski, Golovatch, 2021; Antić, Makarov, 2016; Evsyukov *et al*., 2016, 2018, 2021, 2022; Golovatch, Antipova, 2022; Vagalinski *et al*., 2023; Zuev *et al*., 2023; Golovatch, 2021, 2023; Golovatch *et al*., 2016, 2024, etc.]. However, no special studies on the diplopods in the highlands of the Caucasus (more than 2000 m a.s.l.) have been carried out yet. The present contribution summarizes the millipede fauna of the highlands of the Central Caucasus, based fresh material coming from the republics of Karachaevo-Cherkessia and Kabardino-Balkaria, as well as published random records.

Material and methods

The material underlying the present contribution, all stored in 75% ethanol, has been fully donated to the collection of the Don State Technical University (DSTU), Russia. Photographs were taken using a Zeiss StereoDiscovery V.20 microscope. SEM micrographs were taken using a Hitachi SU3500 scanning electron microscope (FRC IBSS, Sevastopol). After examination, SEM material was removed from stubs and returned to alcohol.

All images were processed using Adobe Photoshop 2020 software.



Figs 1–2. Habitus (**a**), promeres of gonopods (**b**) and 2nd legs (**c**) of the millipede genus *Julus* from the Central Caucasus: 1 — *Julus kubanus* Verhoeff, 1921; 2 — *J. subalpinus* Lohmander, 1936. Scale bars: 1 mm (**a**); 0.1 mm (**b**, **c**).

Рис. 1–2. Габитус (**a**), промеры гонопод (**b**) и ноги 2-й пары (**c**) некоторых двупарноногих многоножек рода *Julus* с Центрального Кавказа: 1 — *Julus kubanus* Verhoeff, 1921; 2 — *J. subalpinus* Lohmander, 1936. Масштаб: 1 мм (a); 0,1 мм (**b**, **c**).

Taxonomy

Order Glomerida
Family Glomeridae
Trachysphaera costata (Waga, 1857)

REMARKS. This Eastern European to Eastern Mediterranean species is widely distributed also in the Near East and Caucasus region, previously recorded from Stepantsminda (= Kazbegi), Georgia at 2000 m a.s.l. [Golovatch, 1990].

Order Julida
Family Julidae
Byzantorhopalum rossicum (Timotheew, 1897)

REMARKS. A very common Eastern Mediterranean to Eastern European species widely distributed in the Caucasus [Vagalinski, Golovatch, 2021]. It has been recorded from Tsey, North Ossetian Nature Reserve at 2190–2295 m a.s.l. [Golovatch, Antipova, 2022].

Chaetoleptophyllum flexum Golovatch, 1979

REMARKS. A widespread species endemic to the Caucasus within Georgia, Abkhazia, and South Ossetia. As regards the highland of the Central Caucasus, it has been recorded from Gurshevi, Georgia, 2000–2200 m a.s.l. [Evsyukov *et al.*, 2020].

Cylindroiulus placidus (Lignau, 1903)

REMARKS. Endemic to the western Caucasus, widespread from the Krasnodar Province in the north to Abkhazia and southern Georgia in the south, and from the Black Sea coast in the west to North Ossetia – Alania in the east [Lohmander, 1936; Read, 1992; Chumachenko, 2016; Golovatch, Antipova, 2022].

Julus jedryczkowskii Golovatch, 1981

REMARK. Endemic to the Republic of North Ossetia – Alania, encountered at 650–3200 m a.s.l. [Golovatch, 1981; Evsyukov *et al.*, 2018; Golovatch, Antipova, 2022].

Julus kubanus Verhoeff, 1921

Fig. 1.

MATERIAL. 1 ♂, Kabardino-Balkaria, Adyl-Su valley, Kashkatash Glacier foreland, N 43.21385°, E 42.686481°, 2385 m a.s.l., a 91-year old moraine with *Salix* sp., *Betula* spp. and sparse *Pinus* spp., 16.VII.–3.VIII.2023; 1 ♂, 1 juv., Karachaevo-Cherkessia, Dombay, Alibek Glacier foreland, N 43.296366°, E 41.547579°, 2110 m a.s.l., 12-year old surface since glacier retreat, shrub stage, *Betula* sp., *Salix* sp., sparse

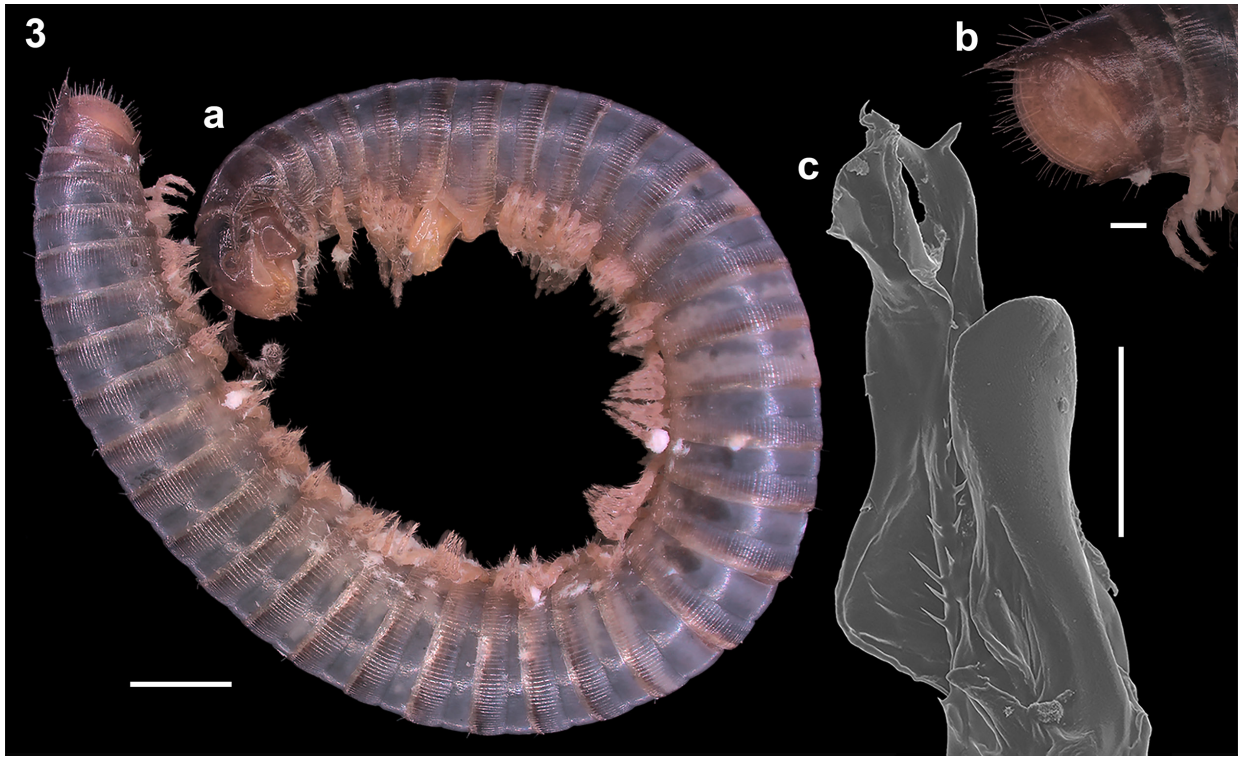


Fig. 3. Habitus (**a**), epiproct (**b**) and gonopod (**c**) of *Omobrachyiulus caucasicus* (Karsch, 1881) from the Central Caucasus. Scale bars: 1 mm (**a**); 0.2 mm (**b**); 0.1 mm (**c**).

Рис. 3. Габитус (**a**), эпипрокт (**b**) и гонопод (**c**) *Omobrachyiulus caucasicus* (Karsch, 1881) с Центрального Кавказа. Масштаб: 1 мм (**a**); 0,2 мм (**b**); 0,1 мм (**c**).

Calamagróstis sp., pitfall traps, 15–25.VII.2024, M. Antipova et al. leg.; 2 ♂♂, 3 ♀♀, same region, N 43.296382°, E 41.550659°, 2069 m a.s.l., 17–18-year old surface since glacier retreat, clumps of *Calamagróstis* sp., *Betula* sp. undergrowth, 15–25.VII.2024; 2 ♂♂, 2 subadult ♂♂, 6 ♀♀, same region, N 43.296954°, E 41.553878°, 2010 m a.s.l., 69-year old surface since glacier retreat, *Betula* sp. forest with Fabaceae, 15–25.VII.2024, all M. Antipova et al. leg.

REMARKS. A widespread species endemic to the northwestern Caucasus: Krasnodar Province, Adygea, Karachaevo-Cherkessia, North Ossetia – Alania, and Chechen republics, as well as Abkhazia. The altitudinal distribution of this species ranges from lowlands to above 2000 m a.s.l. [Evsyukov *et al.*, 2018; Zuev *et al.*, 2023; Golovatch, 2023; Golovatch *et al.*, 2024].

Julus subalpinus Lohmander, 1936
Fig. 2.

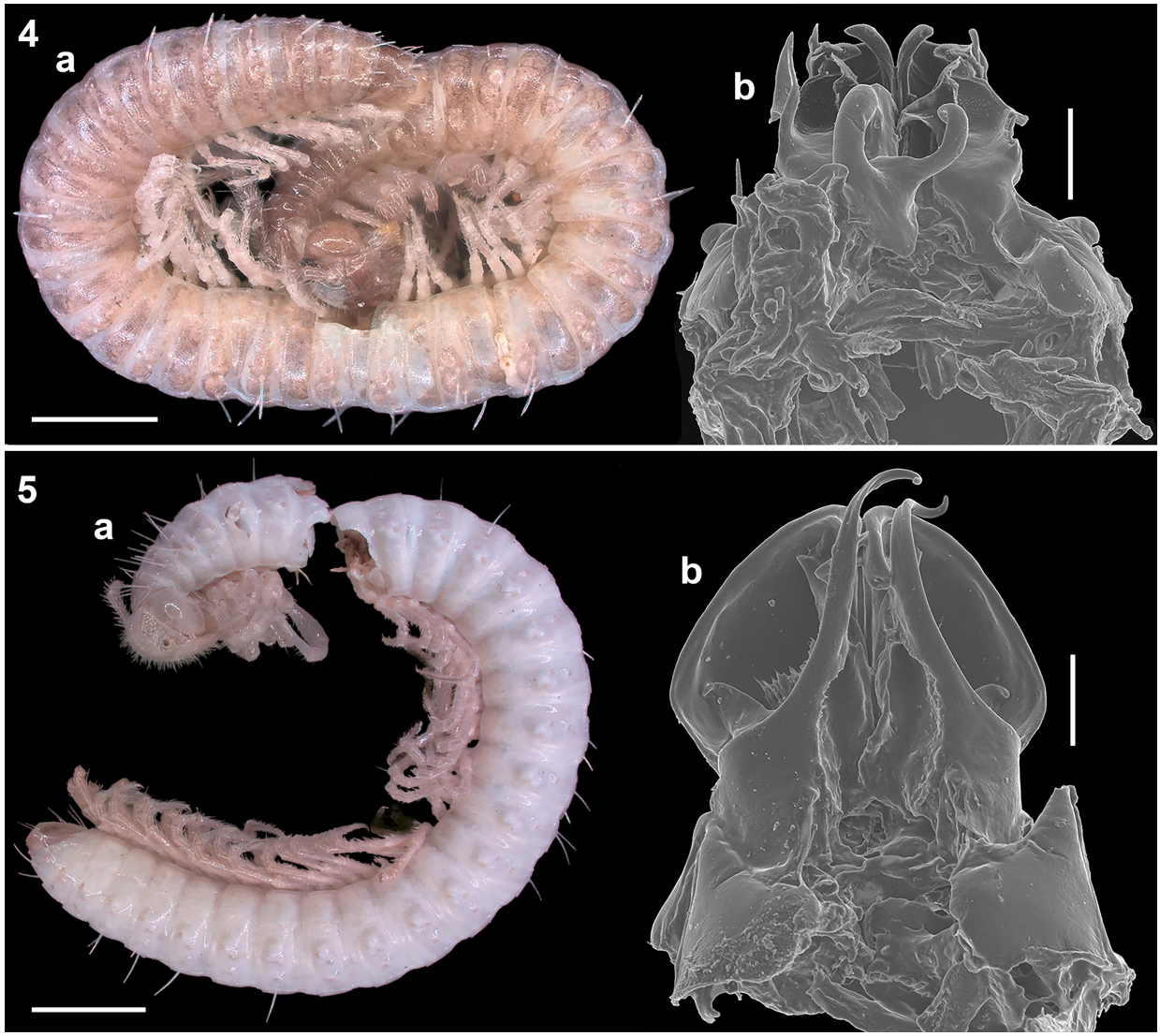
MATERIAL. 1 ♂, 2 ♀♀, 1 juv., Kabardino-Balkaria, right side of Mizhirghi Valley, N 43.09245°, E 43.17398°, 2664 m a.s.l., moss under wet rocks, 26.VII.2022; 1 ♂, 1 ♀, Russia, Kabardino-Balkaria, Verkhnyaya Balkaria, Khashkhasu Stream, N 43.112222°, E 43.505833°, 1790 m a.s.l., under rocks by stream, 28.VII.2022, all M. Antipova leg.; 12 ♂♂, 7 ♀♀, Kabardino-Balkaria, Adyl-Su valley, Kashkatash Glacier foreland, N 43.21234°, E 42.687471°, 2488 m a.s.l., side moraine with *Betula* spp., 16.VII.–5.VIII.2023; 7 ♂♂, 5 ♀♀, same region, N 43.216152°, E 42.686028°, 2308 m a.s.l., a 112-year old moraine of mixed forest with dominating *Pinus* spp., 16.VII.–3.VIII.2023; 14 ♂♂, 4 ♀♀, same region, N 43.217998°, E 42.685711°, 2277 m a.s.l., a 150-year old moraine of *Pinus* spp., 16.VII–3.VIII.2023; 20 ♂♂, 3 ♀♀, same region, N 43.215512°, E 42.686213°, 2322 m a.s.l., a 96-year old moraine of mixed forest with dominating *Betula* spp., 16.VII–3.VIII.2023, all. M. Antipova et al. leg.; 1 ♂, 5 ♀♀, same region, E slope of side moraine, N 43.210602°, E 42.687565°, 2596 m a.s.l, *Rhododendron* sp., litter and under stones, 17.VII.2023, M. Antipova, O. Makarova leg.; 1 ♀, Kabardino-Balkaria, Adyl-Su valley, near stream on the way to Bashkara Glacier, N 43.216879°, E 42.709781°, 2452 m a.s.l., 21.VII.2023, M. Antipova leg.

REMARKS. Endemic to the western Caucasus within the Krasnodar Province, North Ossetia – Alania, and Kabardino-Balkaria. One of the high-montane millipede species from the Caucasus, previously recorded at altitudes ranging from 600 to above 2000 m a.s.l. [Evsyukov *et al.*, 2018; Golovatch *et al.*, 2025].

Omobrachyiulus caucasicus (Karsch, 1881)
Fig. 3.

MATERIAL. 23 ♂♂, 6 ♀♀, Kabardino-Balkaria, Adyl-Su valley, Kashkatash Glacier foreland, N 43.21234,° E 42.687471°, 2488 m a.s.l., side moraine with *Betula* spp., 16.VII–5.VIII.2023; 2 ♂♂, 1 ♀, same region, N 43.21385°, E 42.686481°, 2385 m a.s.l., 91-year old moraine with *Salix* sp., *Betula* spp. and sparse *Pinus* spp., 16.VII.–3.VIII.2023; 8 ♂♂, 16 ♀♀, same region, N 43.215512°, E 42.686213°, 2322 m a.s.l., 96-year old moraine of mixed forest with dominating *Betula* spp., 16.VII–3.VIII.2023; 17 ♂♂, 6 ♀♀, same region, N 43.216152°, E 42.686028°, 2308 m a.s.l., 112-year old moraine of mixed forest with dominating *Pinus* spp., 16.VII.–3.VIII.2023; 1 ♂, 23 ♀♀, 3 juv., same region, N 43.217998°, E 42.685711°, 2277 m a.s.l., 150-year old moraine of *Pinus* spp., 16.VII–3.VIII.2023; 10 ♂♂, 8 ♀♀, same region, N 43.211484°, E 42.686428°, 2520 m a.s.l., 36-year old moraine with young *Betula* spp., *Salix* sp., *Pinus* spp., 17.VII.–5.VIII.2023, all M. Antipova et al. leg.; 9 ♀♀, 4 juv., same region, N 43.211079°, E 42.685406°, 2545 m a.s.l., 36-year old moraine with sparse herbaceous vegetation, 17.VII–5.VIII.2023, D. Palatov leg.

REMARKS. Subendemic to the Caucasus, widespread across Ciscaucasia (including Dagestan), Georgia, Armenia and Azerbaijan, also present in northern and northwestern Iran, and northeastern Turkey. Recorded from lowlands to the



Figs 4–5. Habitus (**a**) and gonopods (**b**) of the millipede family Anthroleucosomatidae from the Central Caucasus: 4 — *Acanthophorella chegemi* Antić et Makarov, 2016; 5 — *Caucaseuma glabroscutum* Antić et Makarov, 2016. Scale bars: 1 mm (**a**); 0.1 mm (**b**).

Рис. 4–5. Габитус (**a**) и гоноподы (**b**) многоножек семейства Anthroleucosomatidae с Центрального Кавказа: 4 — *Acanthophorella chegemi* Antić et Makarov, 2016; 5 — *Caucaseuma glabroscutum* Antić et Makarov, 2016. Масштаб: 1 мм (**a**); 0,1 мм (**b**).

high-montane about 2400 m a.s.l. [Vagalinski, Golovatch, 2021; Evsyukov *et al.*, 2023; Golovatch, 2023].

The above freshly collected samples show morphological differences from the typical form [Vagalinski, Golovatch, 2021] in the shape of the epiproct (Fig. 3b).

Order Chordeumatida
Family Anthroleucosomatidae
Acanthophorella chegemi Antić et Makarov, 2016
Fig. 4.

MATERIAL. 2 ♂♂, Kabardino-Balkaria, Bezenghi Glacier foreland, N 43.10635°, E 43.13156°, 2145 m a.s.l., 14-year old surface since glacier retreat, mound with willow-herb and *Vica* sp., pitfall traps, 26.VII.2022, M. Antipova leg.

REMARKS. Endemic of the Caucasus Major. Described from Upper Chegem, Kabardino-Balkaria. Probably, a high-mountain species known from altitudes ranging 1700–2200 m a.s.l. [Antić, Makarov, 2016].

Alpinella waltheri Antić et Makarov, 2016

REMARKS. Presently, this local Caucasian endemic is only known from Pass Abano, border between the Kakheti and Tusheti regions of Georgia, 2860 m a.s.l. [Antić, Makarov, 2016].

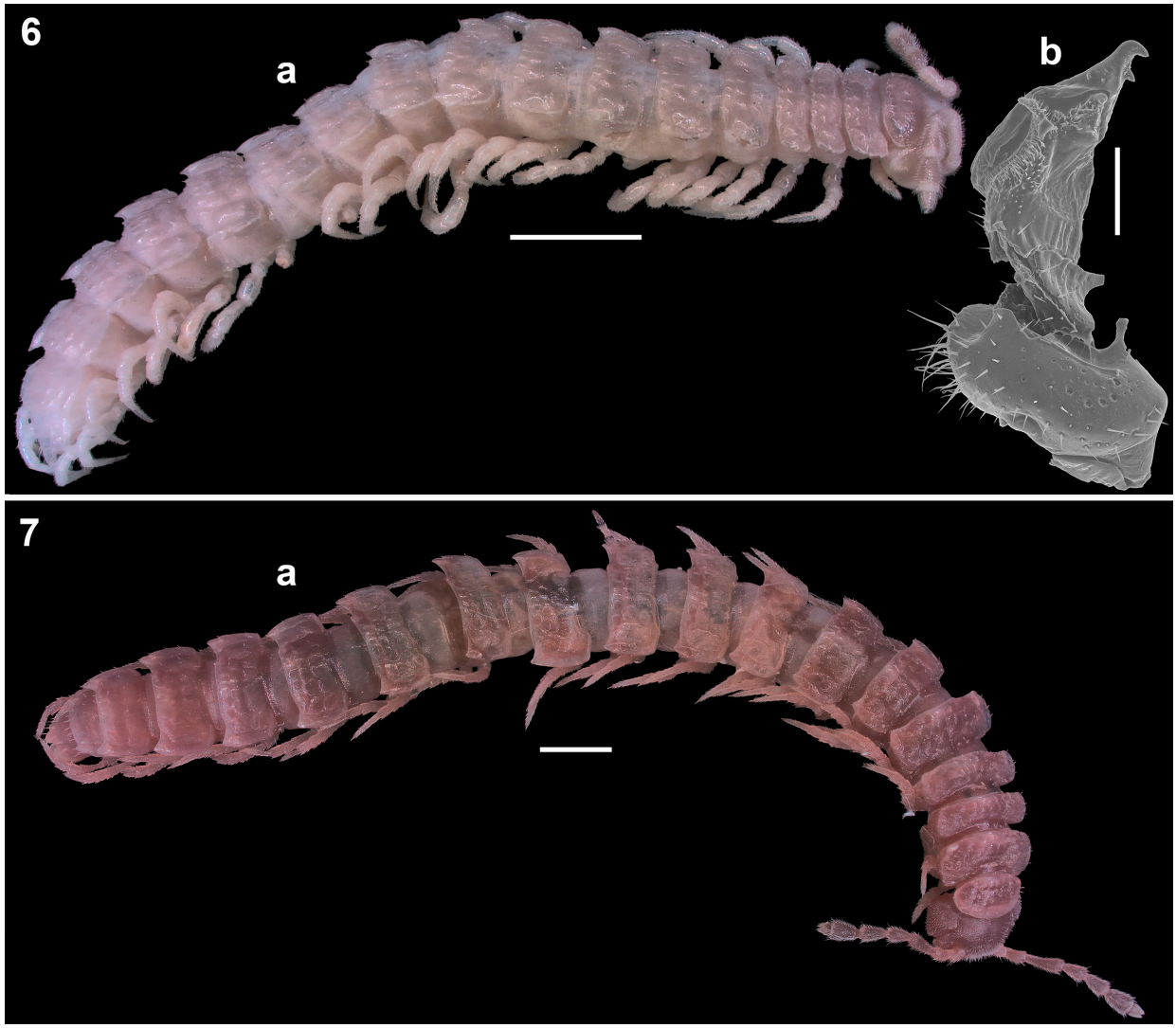
Caucaseuma glabroscutum Antić et Makarov, 2016
Fig. 5.

MATERIAL. 1 ♂, Kabardino-Balkaria, Adyl-Su valley, Kashkatash Glacier foreland, N 43.21385°, E 42.686481°, 2385 m a.s.l., 91-year old moraine with *Salix* sp., *Betula* spp. and sparse *Pinus* spp., 16.VII.–3.VIII.2023, M. Antipova et al. leg.

REMARKS. Endemic of the Caucasus Major, previously recorded only from Karachaevo-Cherkessia from altitudes ranging 2000–2150 m a.s.l. [Antić, Makarov, 2016]. Above is the highest record of this species.

Caucaseuma variabile Antić et Makarov, 2016

REMARKS. This species endemic to the Western and Central Caucasus has previously been recorded from Stepantsninda,



Figs 6–7. Habitus (**a**) and gonopod (**b**) of the millipede family Polydesmidae from the Central Caucasus: 6 — *Brachydesmus kalischewskyi* Lignau, 1915; 7 — *Polydesmus abchasius* Attems, 1898. Scale bars: 1 mm (**a**); 0.1 mm (**b**).

Рис. 6–7. Габитус (**a**) и гонопод (**b**) многоножек семейства Polydesmidae с Центрального Кавказа: 6 — *Brachydesmus kalischewskyi* Lignau, 1915; 7 — *Polydesmus abchasius* Attems, 1898. Масштаб: 1 мм (**a**); 0,1 мм (**b**).

Georgia, above 2000 m a.s.l. and from Alagir, North Ossetia – Alania, 1700–1800 m a.s.l. [Antić, Makarov, 2016].

Dentatosoma magnum Antić et Makarov, 2016

REMARKS. This species is endemic to the Western Caucasus within the Krasnodar Province of Russia, Abkhazia and western Georgia. In the Central Caucasus, it has been recorded from the timber-line and subalpine meadows above Kherkhvashi, Svaneti at 1900–2200 m a.s.l. [Antić, Makarov, 2016].

Metamastigophorophyllon hamatum Antić et Makarov, 2016

REMARKS. Endemic to the Western Caucasus: Krasnodar Province and Adygea (both Russia), Abkhazia and western Georgia. Previously recorded from the timber-line and subalpine meadows above Kherkhvash, Svaneti at 1900–2200 m a.s.l. [Antić, Makarov, 2016].

Order Polydesmida
Family Polydesmidae
Brachydesmus kalischewskyi Lignau, 1915

Fig. 6.

MATERIAL. 1 ♂, Kabardino-Balkaria, Verkhnyaya Balkaria, Khashkhasu Stream, N 43.112222°, E 43.505833°, 1790 m a.s.l., under rocks by stream, 28.VII.2022; 1 ♂, Kabardino-Balkaria, Adyl-Su valley, N 43.216101°, E 42.6934°, 2270 m a.s.l., cold depression with moss, 22.VII.2023, all M. Antipova leg.; 1 ♂, 13 ♀♀, 20 juv., Kabardino-Balkaria, Kashkatash N 43.21234, E 42.687471, 2488 m a.s.l., side moraine with *Betula* spp., 16.VII.–5.VIII.2023, M. Antipova et al. leg. 1 juv. ♂, Kabardino-Balkaria, Adyl-Su valley, Kashkatash Glacier foreland, N 43.211079°, E 42.685406°, 2545 m a.s.l., 36-year old moraine with sparse herbaceous vegetation, 17.VII–5.VIII.2023, D. Palatov leg.

REMARKS. Subendemic of the Caucasus region, widespread in the Russian Caucasus (Krasnodar and Stavropol provinces, Adygea, Karachaevo-Cherkessia, Kabardino-Balkaria, North Ossetia – Alania, Dagestan and Chechnya), Azerbaijan, Georgia, Armenia, eastern Turkey and northwestern Iran. Previously recorded from lowland deciduous forests to subalpine

meadows [Golovatch *et al.*, 2016, 2024; Golovatch, 2021, 2023; Evsyukov *et al.*, 2022; Zuev *et al.*, 2023]. Only morph B of this highly polymorphous species has been recorded from both Kabardino-Balkaria and Karachaevo-Cherkessia [Golovatch *et al.*, 2016].

Polydesmus abchasius Attems, 1898
Fig. 7.

MATERIAL. 1 ♀, Kabardino-Balkaria, Adyl-Su valley, Kashkatash Glacier foreland, N 43.211484°, E 42.686428°, 2520 m a.s.l., 36-year old moraine with young *Betula* spp., *Salix* sp., *Pinus* spp., 17.VII.–5.VIII.2023, M. Antipova et al. leg.

REMARKS. Endemic to the northern and northwestern Caucasus: Krasnodar Province, Adygea (both Russia), Abkhazia and Georgia. Recorded at altitudes ranging from 90 to 1600 m a.s.l. [Golovatch *et al.*, 2016, 2021; Kokhia *et al.*, 2020; Golovatch, 2021; Evsyukov *et al.*, 2022]. Above is the highest record of this species.

Conclusion

As many as 16 species from 13 genera, four families and four orders of Diplopoda have been recorded so far from the highlands of the Central Caucasus. Most of these species show broad altitudinal distribution ranges and primarily inhabit the forest zones. This agrees with the common wisdom that the millipedes are mainly associated with forests, ranging from the temperate nemoral and coniferous forests in the north to the tropical rainforests in the south [Golovatch 1997a, 1997b]. Probably only species of the family Anthroleucosomatidae are really high-montane, such as *Acanthophorella chegemi* recorded at altitudes ranging 1700–2200 m a.s.l., or *Caucaseuma glabroscutum* at 2000–2385 m a.s.l. [Antić, Makarov, 2016; original data]. However, the highest world record belongs to *Nepalmatoiulus ivanloebli* Enghoff, 1987 and *Nepalozonium trimaculatum* Shelley, 1996, both found in Nepal at 4800 m a.s.l. [Enghoff 1987; Shelley, 1996; Shelley, Golovach, 2011].

Compliance with ethical standards

CONFLICT OF INTEREST: The authors declare that they have no conflict of interest.

Ethical approval: No ethical issues were raised during our research.

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