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## A Comprehensive Checklist with Annotations of Millipedes (Myriapoda: Diplopoda) in the Stavropol Territory, Northern Caucasus, Russia

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### ABSTRACT

This study consolidates existing knowledge on the millipede fauna (Diplopoda) of the Stavropol Territory and examines their distribution patterns across the region. The analysis draws from research spanning over a century (1897–2021) and incorporates previously unpublished records from the Stavropol Territory and North Ossetia–Alania. A total of 27 millipede species have been identified, representing twenty genera, 8 families, and 5 orders. Notably, *Polydesmus stuxbergi* Attems, 1907 was reported for the first time in the Caucasus. Among the recorded species, 14 are endemic to the Caucasus, with *Vegrandosoma tabacarui* Antić et Makarov, 2016 and *Omobrachiulus zuevi* Vagalinski, 2021 currently known only from the Stavropol Territory. The highest species diversity is concentrated in the southwestern region, where the Shpakovskiy District (including Stavropol City) supports 24 species. Other districts with significant diversity include Kochubeevskiy (12 species), Predgorniy (11 species), Georgievskiy (10 species), and Aleksandrovskiy (7 species). This distribution is related to the presence of forested areas, which are limited to only 1.6% of the region's total land area. Due to the restricted forest cover, many millipede species, especially those exclusive to the Stavropol Upland, may be vulnerable and require conservation measures.

**Keywords:** Ciscaucasia, Fauna, Distribution, Faunistic records

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### Introduction

The Diplopoda, a class within the Myriapoda, ranks as the third-largest group of terrestrial arthropods, following insects and arachnids. Currently, over 11,000 species have been formally described [1], though some estimates suggest their true diversity may exceed 80,000 species [2]. These arthropods are primarily mesophilic, thriving in the leaf litter of both temperate and tropical forests. They contribute significantly to soil development by breaking down plant material and decomposing animal waste [2]. Additionally, their limited dispersal ability makes them a valuable model group for zoogeographical research [3].

The Stavropol Territory spans 66,160 km<sup>2</sup> and is primarily situated in central Ciscaucasia, Russia. Its western boundary aligns with the Azov-Kuban Lowland, while the eastern edge extends along the Terek-Kuma Lowland. The northern limit is defined by the Kumo-Manych Depression, and the southern border reaches the foothills of the Greater Caucasus. The landscape is predominantly open, with steppe and forested steppe characterizing the western areas, while semi-desert conditions prevail in the east. Over 80% of the land has undergone significant human modification, primarily for agricultural use, with forests covering only about 1.6% of the region. The most extensive wooded areas are concentrated in the southern and western districts, where precipitation levels are

higher. Notable forests include the Beshtaugorskiy forest, mountain forests near Kislovodsk in the Predgorniy District, wooded areas on Mount Strizhament, and forests near Stavropol in the Shpakovskiy District. Additionally, riparian forests can be found along the Kuban, Zelenchuk, Terek, and Kuma rivers.

Historically, knowledge of the Diplopoda fauna in the Stavropol Territory remained limited, with available data dispersed across a handful of publications [4-10]. A preliminary review emerged relatively recently [11], documenting 19 species of diplopods. Subsequent studies have explored different groups of millipedes native to the Caucasus [12-18]. This has significantly expanded the documented species list for the region, aligning it with updated taxonomic classifications and increasing the total to 27 species. Additionally, previously unreported records and details regarding the distribution of diplopods in the region have been included.

## Materials and Methods

The species list was assembled using published records spanning from 1897 to 2021. Additionally, this study incorporates specimens collected between 2017 and 2019 in the Stavropol Territory and the Republic of North Ossetia–Alania. All newly obtained specimens have been preserved in the author's collection. The documented distribution and previously known occurrences of each species within the Stavropol Territory are also provided.

## Results and Discussion

### *Order Polyxenida*

#### *Family Polyxenidae*

##### *Genus Propolyxenus Silvestri, 1948*

##### *Propolyxenus argentifer* (Verhoeff, 1921)

Type Locality: Azerbaijan.

Distribution: Found in Georgia [19], Russia (Caucasus), Azerbaijan, Iran, and possibly Turkey and Southern Europe [17].

Occurrence in the Stavropol Territory: Documented in Shpakovskiy, Kirovskiy, and Predgorniy districts [17].

Notes: Initially described from specimens collected across the Caucasus and Southern Europe [20]. Recent taxonomic assessments suggest that populations in Southern Europe may represent cryptic species, requiring molecular studies for confirmation [17]. The species *Polyxenus trivittatus* Verhoeff, 1941 and *P. sokolowi* Lignau, 1924, previously identified in the Caucasus, are now recognized as junior synonyms of *Propolyxenus argentifer* [17]. Within the Stavropol Territory, it inhabits wormwood-forb steppes and pine plantations.

### *Order Glomerida*

#### *Family Doderiidae*

##### *Genus Trachysphaera Heller, 1858*

##### *Trachysphaera costata* (Waga, 1857)

Type Locality: Poland.

Distribution: Recorded in Albania, Bosnia-Herzegovina, Bulgaria, the Czech Republic, Germany, Greece, Croatia, Hungary, Montenegro, Poland, Romania, Serbia, Slovenia, Slovakia, and Ukraine [21]. Also present in Crimea, the Caucasus region of Russia, Georgia, Abkhazia, Azerbaijan, Armenia, Turkey, and Iran [22-24].

Occurrence in the Stavropol Territory: Found in Shpakovskiy, Predgorniy, and Kochubeevskiy districts [11]. A newly recorded population includes three females collected near Alexandrovskoe, Tomuzlovsky Forest (Alexandrovskiy District) on March 19, 2017, by R.V. Zuev.

Notes: This species primarily inhabits forested environments, frequently residing in soil, under bark, or within decomposing wood. In the Stavropol Territory, populations appear to reproduce through parthenogenesis.

### *Order Polydesmida*

#### *Family Paradoxosomatidae*

##### *Genus Strongylosoma Brandt, 1833*

##### *Strongylosoma kordylamythrum* Attems, 1898

Type Localities: Abkhazia, Azerbaijan.

Distribution: Occurs in Russia (Caucasus), Azerbaijan, Georgia, and Iran [7, 9, 10, 13, 25].

Occurrence in the Stavropol Territory: Recorded in Shpakovskiy, Predgorniy, Kochubeevskiy, and Alexandrovskiy districts [7, 9, 11, 13].

Notes: This species is widespread in the forests of the Stavropol Territory. Its northernmost distribution reaches the Don River's mouth (Rostov-on-Don Region) and the Kumo-Manych Depression in Kalmykia. Further expansion northward remains a possibility, as ornithochory has been observed in *S. kordylamythrum* within Ciscaucasia [9].

Genus *Oxidus* Cook, 1911

*Oxidus gracilis* (C.L. Koch, 1847)

Type Locality: Austria.

Distribution: Cosmopolitan [21].

Occurrence in the Stavropol Territory: Documented in Stavropol City [11].

Notes: Originally of Oriental origin, this anthropochoric species has established populations in Georgia and the Krasnodar Territory [7, 26]. In the Stavropol Territory, its presence has been confirmed only within the greenhouse of the Stavropol Botanical Garden, with a single specimen observed in an adjacent outdoor area [11].

Family Polydesmidae

Genus *Polydesmus* Latreille, 1802/03

*Polydesmus muralewiczii* Lohmander, 1936

Type Locality: Psebai, North Caucasus.

Distribution: Found in the Caucasus region of Russia [14] and Georgia [27].

Occurrence in the Stavropol Territory: Recorded in Shpakovskiy District [11], as well as in Georgievskiy and Andropovskiy districts [14].

Notes: This species inhabits forb steppes and forested areas.

*Polydesmus stuxbergi* Attems, 1907

Type Locality: Crimea.

Distribution: Present in Crimea [28], southern Ukraine [29], and southern European Russia [10].

Occurrence in the Stavropol Territory: A newly documented occurrence includes one male and eleven females collected in a broadleaved forest on Mount Mashuk, near Pyatigorsk City (Predgorniy District) on May 22, 2019, by D.S. Stanovov.

Notes: This marks the first confirmed presence of this species in both the Stavropol Territory and the Caucasus. Research by Evsyukov and Golovach [10] suggests that specimens from the Rostov-on-Don Region display slight variations in gonopod structure compared to those from Crimea. However, the gonopods of the Pyatigorsk male match the original description [28].

Genus *Brachydesmus* Heller, 1858

*Brachydesmus assimilis* Lohmander, 1936

Type Locality: Georgia.

Distribution: Found in Georgia, Azerbaijan, Armenia, and the Caucasus region of Russia [7, 14].

Occurrence in the Stavropol Territory: Identified in Kochubeevskiy District [11] and Kirovskiy District [14].

Notes: This species is considered rare within the Stavropol Territory, having been observed exclusively in floodplain forests.

*Brachydesmus kalischewskyi* Lignau, 1915

Type Locality: Abkhazia.

Distribution: Documented in Russia (Caucasus), Abkhazia, Georgia, Azerbaijan, Armenia, and Iran [14, 24].

Occurrence in the Stavropol Territory: Found in Shpakovskiy, Georgievskiy, and Predgorniy districts [11].

Notes: This widely distributed Caucasian species is known for its polymorphic nature. Only morph B, corresponding to *B. karawajewi* Lohmander, 1928 [11]—a junior synonym of *B. kalischewskyi* [14]—has been recorded in the Stavropol Territory.

*Brachydesmus superus* Latzel, 1884

Type Locality: Prater, near Vienna, Austria.

Distribution: Subcosmopolitan [21], occurring in European Russia [21], the Caucasus [14], southwestern Siberia [30], and Abkhazia [14].

Occurrence in the Stavropol Territory: Documented in Shpakovskiy and Predgorniy districts [11, 14].

*Notes:* This species, known for its widespread anthropochoric dispersal, appears to have been introduced to the region [11].

*Order Julida*

*Family Blaniulidae*

*Genus Archiboreoiulus Brolemann, 1921*

*Archiboreoiulus pallidus (Brade-Birks, 1920)*

*Type Locality:* England.

*Distribution:* Recognized as a sub-cosmopolitan species [31], with records in the European part of Russia [24, 31] and the Caucasus [11].

*Occurrence in the Stavropol Territory:* Confirmed in Stavropol City [11].

*Notes:* This species is closely associated with human-altered environments.

*Genus Nopoiulus Menge, 1851*

*Nopoiulus kochii (Gervais, 1847)*

*Type Locality:* England.

*Distribution:* Found worldwide [8, 31].

*Occurrence in the Stavropol Territory:* Documented in multiple districts, including Shpakovskiy, Georgievskiy, Kochubeevskiy, Kirovskiy, Alexandrovskiy, Grachevskiy, and Krasnogvardeyskiy [8, 11].

**New records:** Additional specimens (2 males, 4 females) were collected from a forested area on Mount Mashuk (Predgornyi District) between September 5–9, 2019, by R.V. Zuev. Another set (2 males, 7 females) was gathered from the same site on May 22, 2019, by D.S. Stanovov.

*Notes:* This species is widely distributed and commonly found. In most parts of its range, it consists of parthenogenetic populations. However, in the Caucasus and Stavropol Territory, bisexual populations predominate, indicating that the species is naturally established in this region [8].

*Family Nemasomatidae*

*Genus Nemasoma C.L. Koch, 1847*

*Nemasoma caucasicum (Lohmander, 1932)*

*Type Locality:* Georgia.

*Distribution:* Recorded in Russia (Caucasus), Abkhazia, Georgia, Azerbaijan, Armenia, and Turkey [7, 32, 33].

*Occurrence in the Stavropol Territory:* Found in Shpakovskiy, Georgievskiy, Kochubeevskiy, and Predgornyi districts [9, 11].

*Notes:* This species is abundant in the region, often found beneath tree bark, frequently coexisting with *Nopoiulus kochii* [11]. It is likely dispersed by birds [9].

*Family Julidae*

*Genus Julius Linnaeus, 1758*

*Julus colchicus Lohmander, 1936*

*Type Locality:* Abkhazia, Georgia.

*Distribution:* Present in Abkhazia, Georgia, Turkey, and the Caucasus region of Russia [7, 15, 27, 34–36].

*Occurrence in the Stavropol Territory:* Recorded in Shpakovskiy, Georgievskiy, Kochubeevskiy, and Alexandrovskiy districts [11, 15].

**New record:** A single male specimen was collected from a forested area 6 km southwest of Bekeshevskaya (Predgornyi District) on April 18, 2017, by R.V. Zuev.

*Notes:* This is the most frequently encountered *Julus* species in the Caucasus. It thrives in deciduous and mixed forests, as well as alpine and subalpine meadows [15]. Within the Stavropol Territory, it is found in floodplain forests, forb steppes, and tree-lined shelterbelts.

*Julus lindholmi Lohmander, 1936*

*Type Locality:* Abkhazia.

*Distribution:* Documented in Abkhazia, Georgia, and the Caucasus region of Russia [7, 15, 27, 34, 37–39].

*Occurrence in the Stavropol Territory:* Found in Shpakovskiy District [15].

*Notes:* This species, native to the Caucasus, is uncommon throughout its known range, which includes the Stavropol Territory, Karachaevo-Cherkessia, Abkhazia, Svanetia, and central Georgia [15, 39].

*Genus Cylindroiulus Verhoeff, 1894*

*Cylindroiulus pterophylacum Read, 1992*

*Type Locality:* Russia: Guseripl, Adygea.

*Distribution:* Present in Abkhazia, Georgia, and the Caucasus region of Russia [11, 24, 40, 41].

*Occurrence in the Stavropol Territory:* Found in Shpakovskiy and Kochubeevskiy districts [11].

*Notes:* This species, characteristic of the western and central Caucasus, is mainly associated with forested environments in the region, where it can sometimes be quite abundant [11].

*Cylindroiulus arborum Verhoeff, 1928*

*Type Locality:* Hungary.

*Distribution:* Native to Europe [31, 42].

**New Record:** Three males and three females were collected in the Caucasus region of Russia, within the Republic of North Ossetia–Alania, Mozdokskiy District, near Komarovo, in Alborovskiy Forest. The specimens were found in a broadleaf forest along the Terek River floodplain on April 29, 2017, by R.V. Zuev.

*Occurrence in the Stavropol Territory:* Documented in Shpakovskiy District [11].

*Notes:* Within this region, its presence has only been confirmed near Stavropol City. Additional findings may be expected in floodplain forests along the Terek River, particularly in Kurskiy District.

*Genus Kubaniulus Lohmander, 1936*

*Kubaniulus gracilis Lohmander, 1936*

*Type Locality:* Russia: Adygea?

*Distribution:* Found in the Caucasus region of Russia [16].

*Occurrence in the Stavropol Territory:* Recorded in Shpakovskiy and Georgievskiy districts [11].

*Notes:* This species has been observed in Adygea and the Krasnodar Territory [7, 16]. Earlier studies on the millipede fauna of the Stavropol Territory mistakenly identified this species as *Chaetoleptophyllum flexum* Golovatch, 1979 [11], due to similarities in morphology and size. However, *C. flexum* is unlikely to be present in this region, as its range is confined to Transcaucasia, including Georgia, Abkhazia, and South Ossetia [16].

*Genus Brachyiulus Berlese, 1884*

*Brachyiulus jawlowskii Lohmander, 1928*

*Type Locality:* Ukraine.

*Distribution:* Occurs in Moldova, Romania, Poland, Ukraine, and the European parts of Russia [10, 31, 43, 44], as well as southwestern Siberia, Kazakhstan [30], and Abkhazia [45].

*Occurrence in the Stavropol Territory:* Found in Shpakovskiy District [11].

*Notes:* Within this region, this species is closely associated with human-influenced habitats [11].

*Genus Byzantorhopalum Verhoeff, 1930*

*Byzantorhopalum rossicum (Timotheew, 1897)*

*Type Localities:* Ukraine, Crimea, Russia: Caucasus [4].

*Distribution:* Found across Ukraine, Crimea, Bulgaria, Greece, Georgia, Azerbaijan, and parts of Russia, including the central and southern European regions as well as the Caucasus [4, 7, 31, 43, 45, 46].

*Occurrence in the Stavropol Territory:* Documented in multiple districts, including Shpakovskiy, Georgievskiy, Kochubeevskiy, Alexandrovskiy, Grachevskiy, Andropovskiy, Predgorniy, Novoalexandrovskiy, Novoselitskiy, Blagodarnenskiy, and Apanasenkovskiy [4, 11, 45].

*Notes:* This species is widespread across the region, thriving in forested areas, steppe landscapes, and environments influenced by human activity.

*Genus Omobrachiulus Lohmander, 1936*

*Omobrachiulus caucasicus (Karsch, 1881)*

*Type Locality:* Borjom, Georgia.

*Distribution:* Recorded in Russia's Caucasus region, Georgia, Azerbaijan, Armenia, Turkey, Iran, and Greece [7, 35, 45, 47].

*Occurrence in the Stavropol Territory:* Reported in Shpakovskiy, Georgievskiy, Kochubeevskiy, Alexandrovskiy, Andropovskiy, Predgorniy, and Kirovskiy districts [9, 11, 45]. **New Record:** A single female specimen was collected in Kurskiy District, near Galyugaevskaya, in a broadleaf forest among leaf litter on April 29, 2017, by R.V. Zuev.



*Notes:* This species is restricted to forested areas and tree-lined habitats. Previously, it was misidentified in the region as *Megaphyllum brachyurum* (Attems, 1899) [11], which is now recognized as a junior synonym of *O. caucasicus* [45].

*Omobrachiulus faxifer* Vagalinski, in Vagalinski et Golovatch, 2021

*Type Locality:* Adygea, Russia.

*Distribution:* Found within the Caucasus region of Russia [45].

*Occurrence in the Stavropol Territory:* Documented in Shpakovskiy District [45].

*Notes:* Native to northwestern and western Ciscaucasia [45], this species is frequently encountered in forests around Stavropol City. Additional research may reveal a broader range within the region.

*Omobrachiulus zuevi* Vagalinski, in Vagalinski et Golovatch, 2021

*Type Locality:* Russia: Stavropol.

*Distribution:* Currently only known from the original collection site.

*Occurrence in the Stavropol Territory:* Found in Shpakovskiy District [45].

*Notes:* This species is unique to the Stavropol Upland, though further studies may indicate a wider presence.

*Genus Unciger* Brandt, 1841

*Unciger transsilvanicus* (Verhoeff, 1899)

*Type Locality:* Romania.

*Distribution:* Found in Austria, Bulgaria, the Czech Republic, Hungary, Moldova, Poland, Romania, Serbia, Slovakia, Ukraine, and the southern European parts of Russia [10, 31, 48].

*Occurrence in the Stavropol Territory:* Recorded in Shpakovskiy and Georgievskiy districts [10, 11].

*Notes:* Lohmander previously described *U. kubanus* Lohmander, 1936 [7], though its taxonomic status remains uncertain. If future studies confirm *U. kubanus* as a distinct species, then populations in the Stavropol Territory may need reassessment under that classification.

*Genus Rossiulus* Attems, 1927

*Rossiulus kessleri* (Lohmander, 1927)

*Type Locality:* Ukraine.

*Geographical Range:* Found across Belarus, Ukraine, and the European portion of Russia, including the Caucasus region [7, 31, 44].

*Presence in the Stavropol Territory:* Recorded in Shpakovskiy, Georgievskiy, Kochubeevskiy, Alexandrovskiy, Grachevskiy, Predgorniy, and Blagodarnenskiy districts [7, 9, 11].

*Recent Collection:* A single female specimen was documented in Trunovsky District near Klyuchevskoe, within a steppe environment, on May 23, 2018, by R.V. Zuev.

*Remarks:* This species is among the most frequently encountered millipedes in the area, inhabiting forests, steppe landscapes, and human-modified environments.

### *Tribe pachyiulini*

#### *Undetermined genus and species*

*Presence in the Stavropol Territory:* Found in Kochubeevskiy District [18].

*Remarks:* Since only a single female specimen has been collected, the precise classification of this enigmatic Pachyiulini species remains unresolved. Additional specimens are necessary for accurate identification [18].

### *Order chordeumatida*

#### *Family anthroleucosomatidae*

*Genus Caucaseuma* Strasser, 1970

*Caucaseuma variabile* Antić et Makarov, 2016

*Type Locality:* Russia: North Ossetia.

*Geographical Range:* Documented in Russia and Georgia [12].

*Presence in the Stavropol Territory:* Identified in Stavropol City.

*Remarks:* Within the studied region, this species has been observed exclusively in the Stavropol Botanical Garden. Additionally, female specimens exhibiting similar morphological traits have been found near Nevinnomyssk in Kochubeevskiy District. However, male specimens are required to confirm the species and genus with certainty.

### *Genus vegrandosoma*

*Vegrandosoma tabacarui* Antić et Makarov, 2016

*Type Locality*: Russia: Stavropol City.

*Geographical Range*: Currently documented only from its original collection site [12].

*Presence in the Stavropol Territory*: Found in Stavropol City [12].

*Remarks*: As the smallest known member of the Anthroleucosomatidae family [12], this species has been recorded solely in the forests of the Stavropol Upland. However, it is highly probable that it also occurs in other parts of the region, awaiting further documentation.

The updated assessment, incorporating newly collected data, now identifies 27 distinct diplopod species inhabiting the Stavropol Territory. These species are distributed across twenty genera, 8 families, and 5 orders. Among them, 14 species are either endemic or subendemic to the broader Caucasus region, with two likely restricted to the Stavropol Upland.

Regarding species diversity, the most abundant groups within the studied area, as well as across the Caucasus, are Julida and Polydesmida, comprising sixteen and seven species, respectively. In contrast, Chordeumatida is represented by only two species, while Polyxenida and Glomerida each account for a single species.

**Table 1.** Species diversity of Diplopoda of the Stavropol Territory per administrative district.

№	District	No. of species	№	District	No. of species
1.	Alexandrovskiy	7	14.	Kurskiy	1
2.	Andropovskiy	3	15.	Levokumskiy	0
3.	Apanasenzovskiy	1	16.	Mineralovodskiy	0
4.	Arzgirskiy	0	17.	Neftekumskiy	0
5.	Blagodarnenskiy	2	18.	Novoalexandrovskiy	1
6.	Budennovskiy	0	19.	Novoselitskiy	1
7.	Georgievskiy	10	20.	Petrovskiy	0
8.	Grachevskiy	3	21.	Predgorniy	11
9.	Izobilnenskiy	0	22.	Sovetskiy	0
10.	Ipatovskiy	0	23.	Stepnovskiy	0
11.	Kirovskiy	4	24.	Trunovskiy	1
12.	Kochubeevskiy	12	25.	Turkmenskoy	0
13.	Krasnogvardeyskiy	1	26.	Shpakovskiy (including Stavropol City)	24

As shown in **Table 1**, the highest diversity of diplopod species is concentrated in the southern and western areas of the region. The Shpakovskiy District, including Stavropol City, hosts the greatest number with 24 recorded species, followed by Kochubeevskiy with 12, Predgorniy with 11, Georgievskiy with 10, and Aleksandrovskiy with 7. Data for some districts remain incomplete or absent, yet a noticeable pattern emerges: the majority of diplopod species are closely associated with forested environments, particularly in areas where woodlands are relatively extensive for the region. Given that forests cover a mere 1.6% of the total land area, many diplopod species appear to be at risk and may require conservation efforts, particularly those believed to be endemic to the Stavropol Upland.

## Conclusion

Our research has confirmed that the millipede fauna of the Stavropol Territory currently consists of at least 27 species. Notably, *Polydesmus stuxbergi* is being documented in the Caucasus for the first time. Previous records of *Chaetoleptophyllum flexum* from this region were incorrect and pertained to *Kubaniulus gracilis*.

A significant portion of the identified species are endemic to the Caucasus. Additionally, two species—*Omobrachyiulus zuevi* and *Vegrandosoma tabacarui*—are presently known only from the Stavropol Upland, though future studies may reveal a broader distribution or new notable findings. The highest concentration of millipede species is observed in the western and southern areas of the region, a pattern that aligns closely with the presence of forested landscapes.

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