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Review of the millipedes of the Sikhote-Alin State Nature Biosphere Reserve (Far East of Russia), with detection of the morphological variability of Diplomaragna terricolor (Attems, 1899) (Diplopoda)

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Abstract. The millipede fauna of the Sikhote-Alin State Nature Biosphere Reserve (Far East, Russia) is reviewed, at present containing 17 recognizable species from 15 genera, 9 families and 5 orders. A brief historical account and new faunistic records as well as a key to all Diplopoda taxa presently known from the Sikhote-Alin State Nature Biosphere Reserve are provided. Morphological variability of *Diplomaragna terricolor* (Attems, 1899) is revealed and analyzed, including the material from other territories of the Primorsky Krai and Khabarovsky Krai. The species diversity of Diplopoda within the reserve is mapped.

Keywords: diplopods, faunistics, variability, key, new faunistic records, Russian Far East.

Обзор двупарноногих многоножек Сихотэ-Алинского природного биосферного заповедника (Дальний Восток России) с обнаружением морфологической изменчивости *Diplomaragna terricolor* (Attems, 1899) (Diplopoda)

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Аннотация. Представлен обзор фауны двупарноногих многоножек Сихотэ-Алинского государственного природного биосферного заповедника, которая к настоящему времени включает 17 видов из 15 родов, 9 семейств и 5 отрядов. Приведены краткая история исследований, новые фаунистические находки и ключ для определения всех таксонов Diplopoda, известных к настоящему времени с территории Сихотэ-Алинского заповедника. Выявлена и проанализирована с привлечением материала из других территорий Приморского и Хабаровского краев морфологическая изменчивость *Diplomaragna terricolor* (Attems, 1899). Распространение видов в пределах заповедника нанесено на карту.

Ключевые слова: диплоподы, фаунистика, изменчивость, ключ, новые фаунистические находки, Дальний Восток России.

Introduction

The Sikhote-Alin State Nature Biosphere Reserve is the largest specially protected natural area in the south of the Russian Far East. It was founded in 1935. The reserve is located on the eastern and western slopes of the central Sikhote-Alin mountain range. The main part of the reserve territory is located within two administrative districts of the Primorsky Krai: Terneysky (eastern macroslope) and Krasnoarmeysky (western macroslope). A small portion of the south-west segment (natural landmark Abrek) belongs to the Dalnegorsky District. The Sikhote-Alin State Nature Biosphere Reserve extends from the coast of the Sea of Japan more than 90 kilometers inland. Currently, the area of its territory is more than 400.000 ha, including sea area.

Mountain slopes of different steepness occupy up to 80% of the reserve territory. The gentle and wide western slopes and short steep eastern ones distinguish the Sikhote-Alin relief. Medium-high mountains with elevations of 500–800 m a.s.l. are dominants in the reserve territory; the highest point is the Glukhomanka Mountain (1598 m a.s.l.). Leveled areas occupy little (about 20%) of the reserve territory; these are mainly river and stream valleys. The density of the reserve hydrographic network is on average 0.7–0.9 km per 1 km^2. The majority of the rivers are located on the eastern macroslope. Serebryanka, Dzhigitovka and Taiezhnaya are the largest rivers. The flow of these rivers is fast, there are many rocky rapids, and sometimes small waterfalls. The largest river of the western macroslope of the middle Sikhote-Alin is the Kolumbe, it belongs to the Amur River basin. It is a calmer river with extensive stretches of deep water and wide swampy valleys.

The monsoon climate is caused by the interaction of marine and continental air masses. The western and eastern macroslopes within the Sikhote-Alin Nature Biosphere Reserve differ substantially by the main climate parameters. The climate of the eastern macroslope is characterized by high humidity due to the constant influence of the Sea of Japan and the Pacific Ocean. The climate of the isolated from marine influence western macroslope is more continental (Vasiliev et al. 1985; Pimenova 2016a; 2016b).

97% of the reserve's area is covered by forests. *Pinus koraiensis*, *Picea ajanensis* and *Quercus mongolica* are the dominant tree species of forest ecosystems. They occupy more than 70% of the forest vegetation of the reserve (Pimenova 2016c).

Knowledge of the millipede fauna of the Sikhote-Alin State Nature Biosphere Reserve is still patchy and incomplete. The first data on diplopods of the territory derive from the paper by Mikhaljova (1990) in which one new species was described. Later she described two other new species (Mikhaljova 1997a). The review of the millipede fauna of Siberia and the Far East of Russia refers to 10 species recorded in the Sikhote-Alin Biosphere Reserve (Mikhaljova 1993). One of these species (*Diplomaragna kuruma* Mikhaljova, 1997) was transferred to *Pacifiosoma* (Mikhaljova 2000). Also, another additional species was mentioned from the reserve territory (Mikhaljova 1997b). In addition, the first ecological observations of general millipede abundance and of the species composition in oakwood ecosystems of the Sikhote-Alin Biosphere Reserve appeared as well (Gromyko 1990). Data on some millipedes are contained in the general survey of the reserve's invertebrates (Gromyko, Potikha 2006). The regional reviews by Mikhaljova (1998; 2004; 2017) include information on the distribution ranges of diplopod species occurring in the Sikhote-Alin Biosphere Reserve.

Material and methods

All material treated here is deposited in the collections of the Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia (FSCB). Specimens are kept in 70–75% ethanol. In the process of studying the material, the gonopods and some other parts were dissected from the males and mounted in glycerin as temporary micropreparations. Specimens were studied and il-

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lustrated using standard stereomicroscopic (MBS–1) and drawing equipment (RA–6).

SEM micrographs were prepared at the Centre of Collective Use "Biotechnology and Gene Engineering" of the FSCB using a Merlin 62–15 scanning electron microscope. Mounts for SEM were made through air-drying after the transfer to acetone via 96% alcohol, mounting on stubs, and coating with carbon. After the examination, SEM material was removed from stubs and returned to alcohol.

The family-level classification adopted here is that of Shelley (2003). Publication and synonymy lists of each species include the literature references for the Sikhote-Alin State Nature Biosphere Reserve only.

All the natural landmarks in the Sikhote-Alin Nature Reserve are areas of its territory traditionally designated; they are tied to the reserve's cordons and include parts of the basins of the main rivers or large streams (Pimenova 2016d).

The natural landmarks:

1, 2. Abrek: floodplain of the Upolnomochenny Stream (45°09′402″N, 136°46′721″E); same locality, floodplain of the Skrytaya River (45°06′290″N, 136°45′319″E);

3, 4, 5. Blagodatnoe: upper reaches of the Sukhoy Stream (44°58′57″N, 136°31′09″E); same locality, environs of the Blagodatnoe Lake (44°57′12″N, 136°32′48″E); Ozerny Stream (44°57′51″N, 136°29′46″E);

6. Kunaleika: floodplain of the Khanov Stream (44°53′825″N, 136°20′241″E);

7. Kuruma: floodplain of the Kuruma River (44°54′937″N, 136°12′752″E);

8. Nevidimka: floodplain of the Lianovaya River (44°55′575″N, 136°05′505″E);

9. Kabany: floodplain of the Kabany Stream (45°06′36″N, 135°51′59″E);

10. surroundings of the Glukhomanka Mountain: upper reaches of the Irtysh Stream (45°10′07″N, 135°47′48″E);

11. Sporny: upper part of the Serebryanka River, floodplain of the Sporny Stream (45°09′427″N, 135°54′154″E);

12. Zymoveyny: Zymoveyny Stream, floodplain of the Serebryanka River (45°08′317″N, 136°18′935″E);

13. Beloborodovsky: upper reaches of the Yasnaya River (45°16′594″N, 136°23′934″E);

14. Yasnaya: floodplain of the Zabolochennaya River (45°19′619″N, 136°28′381″E);

15. Solontsovy: floodplain of the Zabolochennaya River, Solontsovy Stream (45°18′877″N, 136°28′578″E);

16. Ust-Solontsovy: Solontsovy Stream (45°24′750″N, 136°30′542″E);

17. Sakhalinsky: floodplain of the Sakhalinsky Stream (45°28′231″N, 136°14′277″E);

18. Nechet: floodplain of the Krivoy Stream (45°29′974″N, 136°32′775″E).

Results and discussion

Order **Polyxenida Verhoeff, 1934**
Family **Polyxenidae Lucas, 1840**
Genus ***Polyxenus*** **Latreille, 1802/1803**

Polyxenus **sp.**

Polyxenus sp. — Mikhaljova 1993: 34; 2004: 41; 2017: 35; Ganin 1997: 124; 2011: 341; Gromyko, Potikha 2006: 232.

Material. Russia: 6 specimens (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve, Yasnaya, *Quercus* forest, 28.05.1985, leg. M. N. Gromyko.

Remarks. This material still requires a closer determination. At present, only the family Polyxenidae and the genus *Polyxenus* Latreille, 1802/1803 are known from the Asian part of Russia: *Polyxenus* sp. belonging to the *Polyxenus shinoharai* Ishii, 1983 group was recorded in Lazovsky District, Primorsky Krai (M. Short's [Deakin University, Australia] personal communication).

Above material is a second find of representatives of Polyxenida taxa in the territories lying between the Ural Mountains in the west and the Pacific Ocean in the east. These specimens most likely belong to the same genus and species group. The reason that we venture to determine these specimens as belonging to *Polyxenus* is geographical evidence.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Yasnaya.

Oder **Polyzoniida Cook, 1895**
Family **Polyzoniidae Newport, 1844**
Genus ***Angarozonium* Shelley, 1998**

***Angarozonium bonum* (Mikhaljova, 1979)**
Polyzonium bonum — Gromyko 1990: 63; Mikhaljova 1993: 4, Map 1; Ganin 1997: 123.
Angarozonium bonum — Mikhaljova 1998: 15, Figs. 36–41, Map 2; Ganin 2011: 340, 344.

Material. Russia: 1♂, 1♀ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe, *Quercus* forest with *Corylus*, 24.07.1986; 1♂, 2 ♀ (FSCB), Kabany, *Pinus koraiensis* forest with *Betula costata*, 13.08.1986; 2♀, 2 juv. (FSCB), Zimoveyny, *Pinus koraiensis* forest with *Larix*, 24.08.1979, all leg. M. N. Gromyko.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai).

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe, Kabany, Yasnaya, Zimoveyny.

Order **Julida Brandt, 1833**
Family **Julidae Leach, 1814**
Genus ***Pacifiiulus* Mikhaljova, 1982**

***Pacifiiulus amurensis* (Gerstfeldt, 1859)**
Pacifiilus imbricatus (sic!) — Gromyko 1990: 66.
Pacifiiulus imbricatus — Mikhaljova 1993: 12, Map 2; Ganin 1997: 123.
Pacifiiulus amurensis — Ganin 2011: 340, 344.

Material. Russia: 1♀ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe, environs of Blagodatnoe Lake, *Quercus* forest, 44°57′14″N, 136°32′50″E, 13.05.2016; 2♂, 1♀ (FSCB), Blagodatnoe, Sukhoy Stream (upper reaches), 600–700 m a.s.l., 44°58′57″N, 136°31′09″E, 9–10.07.2020; 1♀, 1 juv., 1 fragment (FSCB), Sakhalinsky, Sakhalinsky Stream (upper reaches), 45°41′47″N, 136°37′13″E, 30.05.2020; 1♀ (FSCB), Kuruma, floodplain of Kuruma River, 44°91′52″N, 136°21′18″E, 6–9.06.2020; 1♀ (FSCB), Abrek, Upolnomochenny Stream, 45°15′89″N, 136°77′75″E, 29.06–1.07.2020; all leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai, Jewish Autonomous Oblast, Amur Oblast), Siberia (Republic of Altai, southern part of Krasnoyarsky Krai, Republic of Khakassia, Republic of Tyva, Zabaikalsky Krai, Republic of Buryatia); Northeast China.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Abrek, Blagodatnoe, Kunaleika, Kuruma, Nechet, Sakhalinsky, Solontsovy, Yasnaya, Zimoveyny.

Family **Mongoliulidae Pocock, 1903**
Genus ***Koiulus* Enghoff, Jensen et Mikhaljova, 2017**

***Koiulus interruptus* Enghoff, Jensen et Mikhaljova, 2017**

Material. Russia: 1♂, 1♀, 1 juv. (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve, Zimoveyny, floodplain of the Serebryanka River, Zimoveyny Stream, 45°08′29″N, 136°18′33″E, 26.10.2015; leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai).

Remarks. This species has hitherto been only known from the southern part of the Khabarovsky Krai (upper course of Ko River and environs of Zolotoy village). So, it is new to the fauna of the Sikhote-Alin State Nature Biosphere Reserve.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Zimoveyny.

Genus ***Kopidoiulus* Attems, 1909**

***Kopidoiulus continentalis* Golovatch, 1979**
Kopidoiulus continentalis — Mikhaljova 1997b: 146.

Material. Russia: 1♂ (FSCB), Primorski Krai, Sikhote-Alin State Nature Biosphere Reserve: Zimoveyny, *Pinus koraiensis* forest with *Larix*, 24.08.1978; 1♀ (FSCB), Zimoveyny, *Pinus koraiensis* forest with *Larix*, 25.09.1979; 1 juv. (subadult male) (FSCB), Zimoveyny, watershed between the Zimoveiny and Sukhoy streams, *Pinus koraiensis* forest with *Quercus*, 20.05.1980; 1♀ (FSCB), Sporny Stream, *Picea* forest, 19.08.1981, all leg. M.N. Gromyko; 1♂ (FSCB), Beloborodovsky, Yasnaya River (upper reaches), 45°29′39″N, 136°38′29″E, 18–20.05.2016. 2♀ (FSCB), Dalnegorsky Dis-

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trict, near Glukhomanka Mts., Irtysh Stream (upper reaches), 45°17′0324″N, 135°77′78″E, 18.09.2015; all leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai); Northeast China.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Beloborodovsky, Solontsovy, Sporny, Yasnaya, Zimoveyny + near Glukhomanka Mts., Dalnegorsky District.

Genus ***Skleroprotopus* Attems, 1901**

***Skleroprotopus coreanus* (Pocock, 1895)**

Skleroprotopus coreanus — Mikhaljova 1993: 15; Ganin 1997: 123; 2011: 340, 344.

Material. Russia: 1♀ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Zimoveyny, *Pinus koraiensis* with *Quercus* forest, 28.08.1978; 1♀ (FSCB), Zimoveyny, valley *Pinus koraiensis* forest, 13.09.1978, all leg. M. N. Gromyko; 2♂, 1♀, 1 juv. (FSCB), Beloborodovsky, Yasnaya River (upper reaches), 45°29′39″N, 136°38′29″E, 18–20.05.2016; 1♀ (FSCB), Sakhalinsky, Sakhalinsky Stream (upper reaches), 45°41′47″N, 136°37′13″E, 30.05.2020; 1♀ (FSCB), Abrek, Skrytaya River floodplain, 45°09′82″N, 136°69′08″E, 3–5.07.2020, all leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai, Jewish Autonomous Oblast, Amur Oblast); Korea.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Abrek, Beloborodovsky, Blagodatnoe, Kuruma, Nevidimka, Sakhalinsky, Ust-Solontsovy, Yasnaya, Zimoveyny.

Order **Chordeumatida Pocock, 1894**
Family **Diplomaragnidae Attems, 1907**
Genus ***Orientyla* Mikhaljova, 2000**

***Orientyla dahurica* (Gerstfeldt, 1859)**

Material. Russia: 1♂ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve, Sporny, Serebryanka River (upper reaches), environs of Bromleevskaya Izba, 45°19′40″N, 135°99′01″E, 31.07.–2.08.2020, leg. M. E. Sergeev.

Distribution. Russia: Siberia (eastern part of Zabaikalsky Krai, border between Zabaikalsky Krai and Amur Oblast), Far East (Primorsky Krai, southern part of Khabarovsky Krai, Jewish Autonomous Oblast, Amur Oblast); North Korea.

Remarks. This is the first record of *O. dahurica* in the Sikhote-Alin State Nature Biosphere Reserve.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Sporny.

Genus ***Pacifiosoma* Mikhaljova, 2000**

***Pacifiosoma kuruma* (Mikhaljova, 1997)**

Diplomaragna kuruma Mikhaljova 1997a: 125, Figs. 4–5.

Diplomaragna kuruma — Mikhaljova 1998: 36, Figs. 123–124, Map 8.

Pacifiosoma kuruma — Mikhaljova 2000: 170; 2004: 156, Figs. 367–368, Map 20; 2017: 193, Figs 407–408, Map 26; Ganin 2011: 345.

Distribution. Russia: Far East (Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve).

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Kuruma.

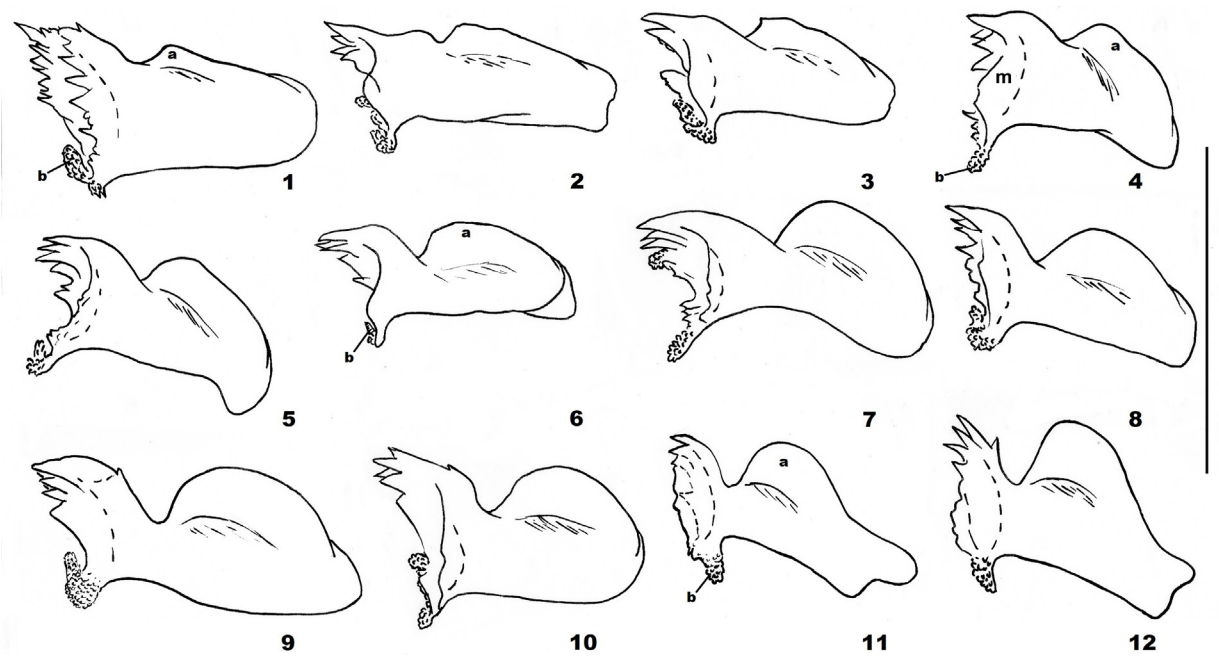
Genus ***Diplomaragna* Attems, 1907**

***Diplomaragna terricolor* (Attems, 1899)**

Figs 1–24

Diplomaragna terricolor — Mikhaljova 1993: 29; 1998: 27, Figs. 86–87, Map 6.

Material. Russia: 1♂ (FSCB), Primorsky Krai: Ussuriysky Nature Reserve, mixed forest, litter, 25.09.1977; 2♂, 1♀ (FSCB), Vladivostok, Okeanskaya Station, forest, litter, 26.04.1980; 2 ♂ (FSCB), near Vladivostok, Popova Island, forest litter, 27.09.1980, all leg. E. V. Mikhaljova; 1♂, 4♀ (FSCB), Anuchinsky District, near 35 km NW of Arseniev, forest, August 1986, leg. V. D. Bakurov; 2♂ (FSCB), Chuguevsky District, Verkhneussuriysky Research Station, ca. 43°50′N, 134°15′E, 31.07.–5.08.1998, leg. Yu. M. Marusik; 1♂ (FSCB), Khasansky District, about 6 km NW of Zanadvorovka village, Gusevsky Mine, mixed forest on slope, litter, 18.08.2002, leg. E. V. Mikhaljova; 1♂, 2♀, fragments (FSCB), Kedrovaya Pad Nature Reserve, forest, pitfall traps, 13.06.2004, leg. V. N. Kuznetsov; 1♂ (FSCB), Shkotovs-



Figs. 1–12. *Diplomaragna terricolor* (Attems, 1899). Variation in structure of the posterior angiocoxal process of posterior gonopod. *1* — from Anuchinsky District, Primorsky Krai; *2* — from Mt. Ko, Khabarovsky Krai; *3* — from Vladivostok, Okeanskaya Station, Primorsky Krai; (1st copy); *4* — from Vladivostok, Okeanskaya Station, Primorsky Krai; (2st copy); *5* — from Kedrovaya Pad Nature Reserve, Primorsky Krai; *6* — from Popova Island, Primorsky Krai; (1st copy); *7* — from Ussuriysky Nature Reserve, Primorsky Krai; *8* — from Lazovsky Nature Reserve, Primorsky Krai; *9* — from Sikhote-Alin Nature Biosphere Reserve (floodplain terrace, Yasnaya River), Primorsky Krai; *10* — from Chuguevsky District, Verkhneussuriysky Research Station, Primorsky Krai; *11* — from Popova Island, Primorsky Krai; (2st copy); *12* — from Sikhote-Alin Nature Biosphere Reserve, Blagodatnoe, Ozerny Stream, Primorsky Krai; **a** — apical outgrowth; **b** — finger-shaped process; **m** — mesal protrusion. Scale in mm (0.5)

Рис. 1–12. *Diplomaragna terricolor* (Attems, 1899). Вариации структуры заднего ангиококсального отростка заднего гонопода: *1* — из Анучинского района Приморского края; *2* — с горы Ко в Хабаровском крае; *3* — из Владивостока, станция Океанская (1-й экземпляр); *4* — из Владивостока, станция Океанская (2-й экземпляр); *5* — из заповедника Кедровая Падь в Приморском крае; *6* — с острова Попова в Приморском крае (1-й экземпляр); *7* — из Уссурийского заповедника в Приморском крае; *8* — из Лазовского заповедника в Приморском крае; *9* — из Сихотэ-Алинского заповедника (надпойменная терраса реки Ясная) в Приморском крае; *10* — из Чугуевского района (Верхнеуссурийский научно-исследовательский стационар) в Приморском крае; *11* — с острова Попова в Приморском крае (2-й экземпляр); *12* — из Сихотэ-Алинского заповедника (урочище Благодатное, ключ Озёрный) в Приморском крае; **a** — вершинный вырост; **b** — пальцевидный отросток; **m** — срединный выступ. Масштаб в мм (0.5)

ky District, environs of Anisimovka, Litovka Mt., about 100 m a.s.l., *Pinus koraiensis* forest, 11.09.2006, leg. A. A. Rodionov; 2♂, 2♀ (FSCB), Sikhote-Alin Nature Biosphere Reserve, Blagodatnoe, Ozerny Stream, 29.09.2015, leg. M. E. Sergeev.

Material re-examined. Russia: 1♂, 1♀, 1 juv. (FSCB), Primorsky Krai: Churuevsky District, Verkhneussuriysky Research Station, *Picea* forest, litter, 2.09.1975, leg. E. V. Mikhaljova (specimens published by Mikhaljova 1997a); 1♂ (FSCB), Vladivostok, Okeanskaya Station, forest, litter, 8.05.1977, leg. E. V. Mikhaljova (specimen published by Mikhaljova 1997a); 1♂ (FSCB), Ussuriysky Nature Reserve, *Picea* forest, 20.05.1977, leg. E. V. Mikhaljova (spec-

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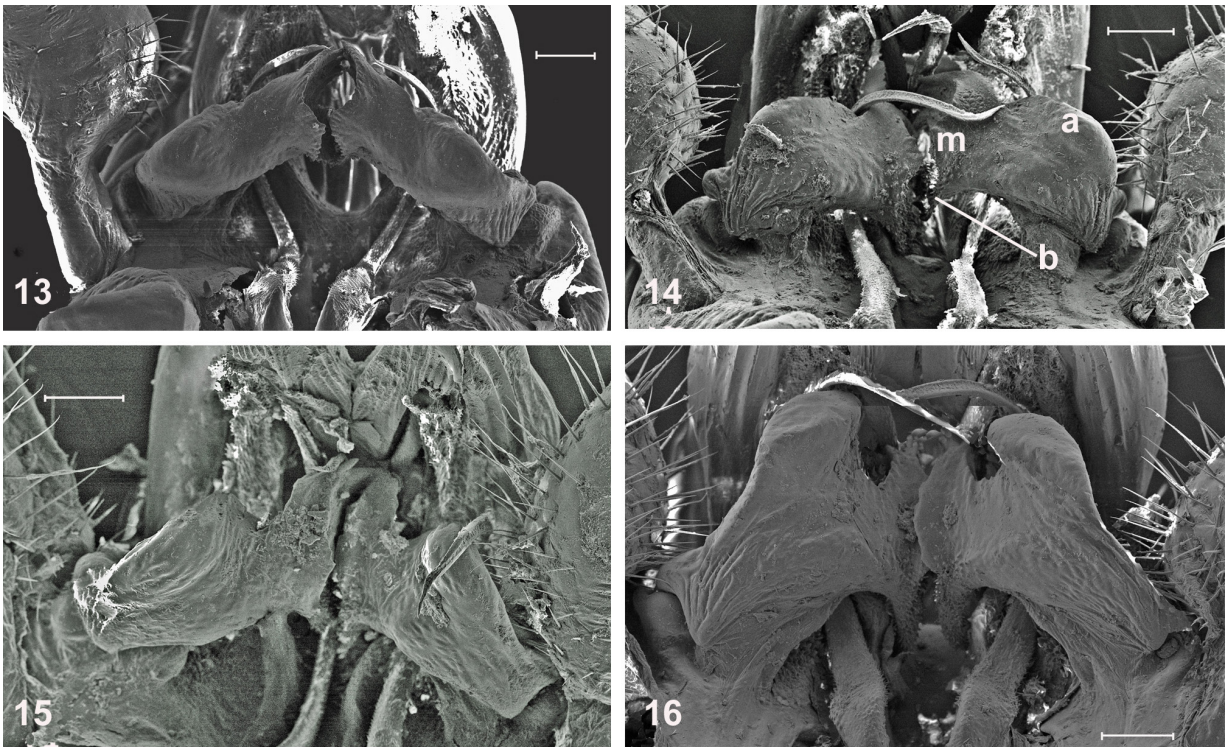
imen published by Mikhaljova 1997a); 1♂, 2 juv. (FSCB), Ussuriysky Nature Reserve, *Abies holophylla* forest, 26.10.1977, leg. R. Fedorova (specimens published by Mikhaljova 1997a); 1♂, 1♀ (FSCB), near Vladivostok, Popova Island, *Quercus*, *Tilia*, *Betula*, *Acer*, etc., forest, litter, 9.10.1979, leg. E. V. Mikhaljova (specimens published by Mikhaljova 1993); 2♂, 1♀ (FSCB), near Vladivostok, Popova Island, *Quercus*, *Tilia*, *Betula*, *Acer*, etc., forest, litter, 7.09.1980, leg. E. V. Mikhaljova (specimens published by Mikhaljova 1993); 1♂, 3 juv. (FSCB), Sikhote-Alin Nature Biosphere Reserve, floodplain terrace, Yasnaya River, valley *Betula* forest, 5.06.1984, leg. M. N. Gromyko (specimens published by Mikhaljova 1993); 1♂, 1 juv. (FSCB), Gamova Peninsula, environs of Telyakovsky Cape, leaved forest, near stream, litter, 17.06.2003, leg. E. V. Mikhaljova (specimens published by Mikhaljova and Marusik 2004); 1♂, 1♀ (FSCB), Lazovsky Nature Reserve, Amerika Cordon, 15.05.2007, leg. S. A. Shabalin (specimens published by Mikhaljova 2009); 1♂, 7 ♀ (IBSS), Khabarovsky Krai: Sikhote-Alin, Mt. Ko, 1000 m, 6.07.2007, leg. P. V. Budilov (specimens published by Mikhaljova 2016)

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai).

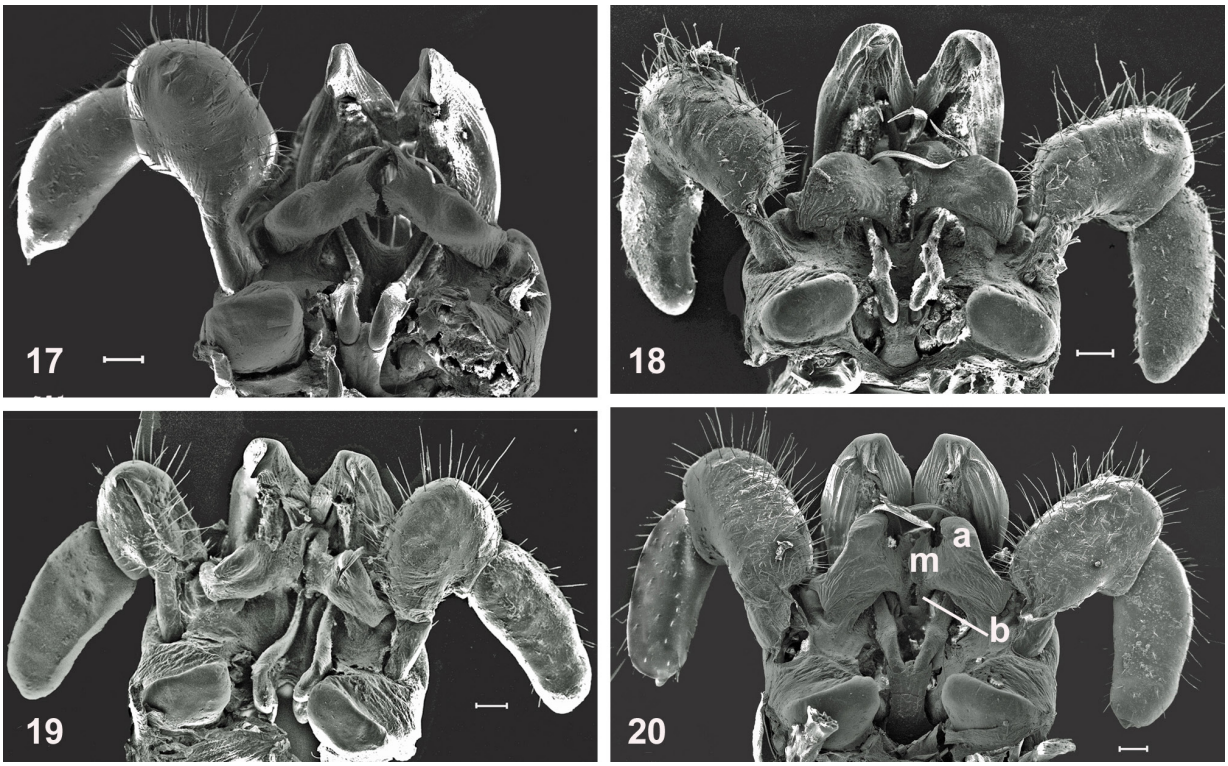
Remarks. This species was originally described from the environs of Vladivostok, Russia (Attems 1899). Later, based on topotype material, a re-description of this species was provided (Shear 1990).

In the course of our study of males of *D. terricolor* from the Blagodatnoe of the Sikho-



Figs. 13–16. *Diplomaragna terricolor* (Attems, 1899). Posterior angiocoxal processes of posterior gonopods. *13* — from Mt. Ko, Khabarovsky Krai; *14* — from Vladivostok, Okeanskaya Station, Primorsky Krai; *15* — from Lazovsky Nature Reserve, Primorsky Krai; *16* — from Sikhote-Alin Nature Biosphere Reserve, Blagodatnoe, Ozerny Stream, Primorsky Krai; **a** — apical outgrowth; **b** — finger-shaped process; **m** — mesal protrusion. Scales: 100 μm

Рис. 13–16. *Diplomaragna terricolor* (Attems, 1899). Задние ангиококсальные отростки задних гоноподов: *13* — с горы Ко в Хабаровском крае; *14* — из Владивостока, станция Океанская; *15* — из Лазовского заповедника в Приморском крае; *16* — из Сихотэ-Алинского заповедника (урочище Благодатное, ключ Озёрный) в Приморском крае; **a** — вершинный вырост; **b** — пальцевидный отросток; **m** — срединный выступ. Масштабы: 100 μm



Figs. 17–20. *Diplomaragna terricolor* (Attems, 1899). Gonopods, caudal view. *17* — from Mt. Ko, Khabarovsky Krai; *18* — from Vladivostok, Okeanskaya Station, Primorsky Krai; *19* — from Lazovsky Nature Reserve, Primorsky Krai; *20* — from Sikhote-Alin Nature Biosphere Reserve, Blagodatnoe, Ozerny Stream, Primorsky Krai; **a** — apical outgrowth; **b** — finger-shaped process; **m** — mesal protrusion. Scales: 100 μm

Рис. 17–20. *Diplomaragna terricolor* (Attems, 1899). Гоноподы, вид сзади: *17* — с горы Ко в Хабаровском крае; *18* — из Владивостока, станция Океанская; *19* — из Лазовского заповедника в Приморском крае; *20* — из Сихотэ-Алинского заповедника (урочище Благодатное, ключ Озёрный) в Приморском крае; **a** — вершинный вырост; **b** — пальцевидный отросток; **m** — срединный выступ. Масштабы: 100 μm

te-Alin Reserve, the unusual structure of their gonopods has been revealed (see Figs 16, 20). The gonopods differs in the configuration of the posterior angiocoxal processes with the very high apical oval outgrowths (**a**) (vs not high apical oval outgrowth according to the original description and re-description by Shear) and with broad mesal protrusions (**m**) carrying finger-shaped processes (**b**) directed to body dorsum (vs finger-shaped processes directed strictly forward according to the re-description by Shear).

Additional investigation of males of this species from different territories of the Primorsky and Khabarovsky Krai allowed discovering of the specific variations in the gonopod structure of *D. terricolor*. The basic diagnostic characters of *D. terricolor* are the configuration of the posterior gonopod's posterior angiocoxal process with arms and outgrowths of different size, and the architecture of the colpocoxite distal part. The above material appears to show certain variation exactly in the configuration of the posterior angiocoxal process. Thus, the apical oval outgrowth (**a**) of posterior angiocoxal process ranges from very low to very high (Figs. 1–16). Also, the finger-shaped process (**b**) is straight (Figs. 11, 12, 16) or more (Figs. 1–3, 5–6, 8–9, 13) or less (Figs. 4, 7, 10, 14, 15) strongly curved forward; its length varies too.

In addition, the variation of the coxal process of the male leg 11 (**p**) is revealed. Thus, its size ranges from small to large (Figs. 21–24). An increase in the size of this coxal process correlates with an increase in the size of

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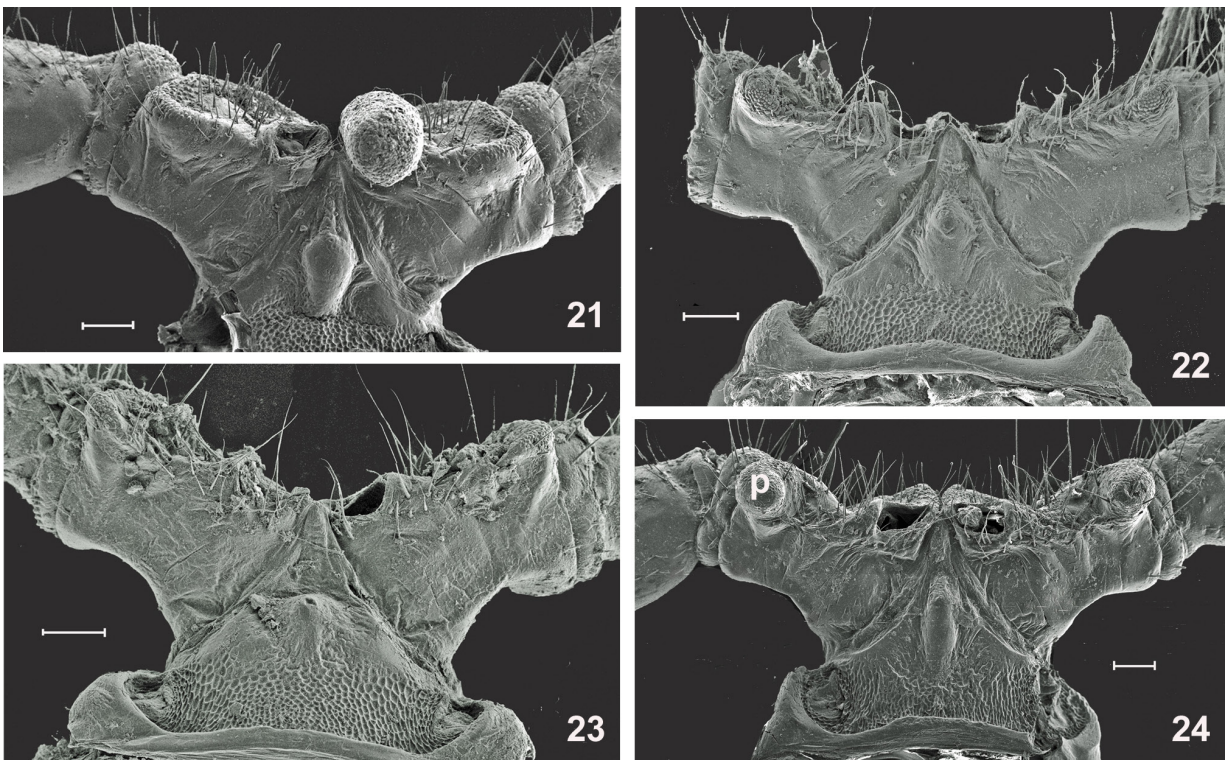
the apical oval outgrowth (**a**) (see Figs. 13 and 21; 16 and 24). Moreover, we can distinguish two distinct extreme forms of the gonopods + male coxae 11. The first form (males from the Anuchinsky District of the Primorsky Krai and from the environs of Ko Mountain, the Khabarovsky Krai): a very low apical oval outgrowth (**a**) of the posterior angiocoxal process, a strongly curved forward process **b**, a small coxal process of leg 11 (Figs. 1, 2, 13, 17, 21). The second form (males from the Blagodatnoe, Sikhote-Alin Nature Reserve,): a very high apical oval outgrowth (**a**) of the posterior angiocoxal process, straight (directed to dorsum) process **b**, large coxal process of leg 11 (Figs. 12, 16, 20, 24). The differences between these extreme forms are linked by a complete series of transitions. At that, the gonopods of a male from the floodplain terrace of the Yasnaya River (Sikhote-Alin Reserve) (Fig. 9) belong to an intermediate transitional form in contrast to the second extreme gonopod form of the males from Blagodatnoe (Sikhote-Alin Reserve). It should be noted that the second gonopod form and forms close to one are more common for males of the eastern part of the Primorsky Krai. While the first gonopod form and forms close to one were mainly recorded in males from the central and southern parts of the Primorsky Krai as well as in the male from the south of Khabarovsky Krai. However, both forms can occur together. For example, males of two opposite forms (Figs. 6, 11) were found together in the same locality of the Popova Island, south of Primorsky Krai.



Figs. 21–24. *Diplomaragna terricolor* (Attems, 1899). Coxae of male leg pair 11, front view. *21* — from Mt. Ko, Khabarovsky Krai; *22* — from Vladivostok, Okeanskaya Station, Primorsky Krai; *23* — from Lazovsky Nature Reserve, Primorsky Krai; *24* — from Sikhote-Alin Nature Biosphere Reserve, Blagodatnoe, Ozerny Stream, Primorsky Krai; **p** — coxal process. Scales: 100 μm

Рис. 21–24. *Diplomaragna terricolor* (Attems, 1899). Коксы 11-й пары ног самца, вид спереди: *21* — с горы Ко в Хабаровском крае; *22* — из Владивостока, станция Океанская; *23* — из Лазовского заповедника в Приморском крае; *24* — из Сихотэ-Алинского заповедника (урочище Благодатное, ключ Озёрный) в Приморском крае; **p** — коксальный отросток. Масштабы: 100 μm

The species is rather variable. However, the present material being unrepresentative, we have preferred not to make conclusion on the nature of variability. An investigation of this phenomenon is a very considerable project in itself, which can only be realized in future with further accumulation of abundant, representative material and using molecular genetic methods too. Now, it can only be assumed that the morphological variability of this species is due to the different ecological conditions of the eastern, southern and central territories of the Primorsky Krai and the Khabarovsky Krai.

Also, it is necessary to add to the description of *D. terricolor* the presence of a process on the male coxa 11 since this character was omitted in the re-description of *D. terricolor* (see Shear 1990).

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe, Yasnaya.

***Diplomaragna zimoveinaya* Mikhaljova, 1997**

Diplomaragna zimoveinaya Mikhaljova 1997a: 123, Figs. 1–3.

Diplomaragna zimoveinaya — Mikhaljova 1998: 28, Figs. 88–90, Map 6; 2000: 175; 2004: 140, Figs. 330–332, Map 18; 2017: 169, Figs. 363–365, Map 24; Ganin 2011: 340.

Material. Russia: 1♂ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve, Zimoveyny, *Pinus koraiensis* with *Larix* forest, 24.08.1978, leg. M. N. Gromyko.

Distribution. Russia: Far East (Primorsky Krai, Sikhote-Alin Nature Biosphere Reserve).

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Kunaleika, Solontsovy, Zimoveyny.

Family **Caseyidae Verhoeff, 1909**

Genus ***Underwoodia* Cook & Collins, 1895**

***Underwoodia kurtschevae* Golovatch, 1980**

Underwoodia kurtschevae — Mikhaljova 1993: 17; Gromyko 1990: 63; Shelley 1993: 175; Ganin 1997: 123; 2011: 340, 344.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai including Bolshoy Shantar Island, Jewish Autonomous Oblast, Amur Oblast, Kamchatka Peninsula, Sakhalin Island, Moneron Island, Kuriles: Zeleny, Shikotan, Kunashir, Iturup, Urup, Chirpoi, Ketoi); North Korea.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe, Kabany, Kunaleika, Kuruma, Nechet, Nevidimka, Solontsovy, Sporny, Yasnaya, Zimoveyny.

Order **Polydesmida Pocock, 1887**
Family **Xystodesmidae Cook, 1895**
Genus ***Levizonus* Attems, 1898**

***Levizonus distinctus* Mikhaljova, 1990**

Levizonus distinctus Mikhaljova 1990: 134, fig. 1.

Levizonus distinctus — Mikhaljova 1993: 33; 1998: 53, Figs. 200–204, Map 12; 2004: 245, Figs. 612–616, Map 32; 2017: 295, Figs. 660–663, Map 43; Ganin 2011: 341.

Levizonus distinatus (sic!) — Ganin 1997: 124; Gromyko, Potikha 2006: 232.

Material. Russia: 1♂, 1 juv. (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Zimoveyny, *Pinus koraiensis* with *Rhododendron*, 22.08.1978; 1♂, 1♀ (FSCB), Ust-Solontsovy, burnt *Pinus koraiensis* with *Quercus* forest (5 year old), 4.06.1983; 1♂, 2♀, 12 juv., 2 fragments (FSCB), Yasnaya, valley *Betula* forest, floodplain terrace, 24.06.1984, all leg. M.N. Gromyko; 1♂, 1♀ (FSCB), Abrek, floodplain of Skritaya River, 45°09′82″N, 136°69′08″E, 3–5.07.2020; 1♂ (FSCB), Sporny, Serebryanka River (upper reaches), environs of Bromleevskaya Izba, 45°19′40″N, 135°99′01″E, 31.07.–2.08.2020, all leg. M.E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve).

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Abrek, Nechet, Ust-Solontsovy, Solontsovy, Sporny, Yasnaya, Zimoveyny.

***Levizonus malewitschi* Lokschina et Golovatch, 1977**

Levizonus malewitschi — Gromyko 1990: 63; Mikhaljova 1993: 33; Ganin 1997: 124; 2011: 341.

Distribution. Russia: Far East (Primorsky Krai).

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Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe.

Family **Paradoxosomatidae Daday, 1889**
Genus ***Sichotanus* Attems, 1914**

***Sichotanus eurygaster* (Attems, 1898)**
Sichotanus eurygaster — Gromyko 1990: 66; Mikhaljova 1993: 30; Ganin 1997: 124; 2011: 341.

Material. Russia: 1♀ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Yasnaya, floodplain of Zabolochennaya River, 2.07.2015; 12♂ (FSCB), Yasnaya, floodplain of Zabolochennaya River, forest, pitfall traps, 44°53′25″N, 136°20′18″E, 3–5.07.2015; 1♂ (FSCB), Beloborodovsky, Yasnaya River (upper reaches), 45°29′39″N, 136°38′29″E, 18–20.05.2016; 1♀ (FSCB), Sporny Stream (upper reaches), 29.06.2017; 1juv. (FSCB), Sporny, Serebryanka River (upper reaches), environs of Bromleevskaya Izba, 45°19′40″N, 135°99′01″E, 31.07.–2.08.2020; 1♂ (FSCB), Sakhlinsky, Sakhalinsky Stream (upper reaches), 45°41′47”N, 136°37′13”E, 30.05.2020; 2♂, 1♀ (FSCB), Kuruma, floodplain of Kuruma River, 44°91′52″N, 136°21′18″E, 6–9.06.2020; 1♂ (FSCB), Abrek, floodplain of Skrytaya River, 45°09′82″N, 136°69′08″E, 3–5.07.2020; 1♀ (FSCB), Blagodatnoe, Sukhoy Stream (upper reaches), 600–700 m a.s.l., 44°58′57″N, 136°31′09″E, 9–10.07.2020; all leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai, Jewish Autonomous Oblast); North and South Korea; Northeast China.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Abrek, Beloborodovsky, Blagodatnoe, Kuruma, Sakhalinsky, Solontsovy, Sporny, Yasnaya.

Genus ***Cawjeekelia* Golovatch, 1980**

***Cawjeekelia koreana* (Golovatch, 1980)**
Cawjeekelia koreana — Mikhaljova 1993: 30; Ganin 1997: 124; 2011: 341.

Material. Russia: 1♂ (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Kuruma, 44°91′52″N, 136°21′18″E, 7.05.2017; 1♂, 1♀ (FSCB), Blagodatnoe, Sukhoy Stream (upper reaches), 600–700 m a.s.l., 44°58′57″N, 136°31′09″E, 9–10.07.2020, all leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai, Amur Oblast); North Korea.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Blagodatnoe, Kuruma.

Family **Polydesmidae Leach, 1815**
Genus ***Epanerchodus* Attems, 1901**

***Epanerchodus polymorphus* Mikhaljova et Golovatch, 1981**

Material. Russia: 4♂ (morpha *simplificata*), 2♀, 1 juv. (FSCB), Primorsky Krai, Sikhote-Alin State Nature Biosphere Reserve: Kuruma, floodplain of Kuruma River, 44°91′52″N, 136°21′18″E, 6–9.06.2020, leg. M. E. Sergeev.

Distribution. Russia: Far East (Primorsky Krai); North Korea.

Remarks. This is the first record of *Epanerchodus polymorphus* in the Sikhote-Alin State Nature Biosphere Reserve.

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Kuruma.

Genus ***Uniramidesmus* Golovatch, 1979**

***Uniramidesmus dentatus* Mikhaljova, 1979**
Uniramidesmus dentatus—Mikhaljova 1993: 32; Ganin 1997: 124; 2011: 341.

Distribution. Russia: Far East (Primorsky Krai, southern part of Khabarovsky Krai, ?Amur Oblast).

Occurrences in the natural landmarks of the Sikhote-Alin State Nature Biosphere Reserve: Kuruma.

Conclusion

At present, 17 species from 15 genera, 9 families and 5 orders of Diplopoda are known from the Sikhote-Alin State Nature Biosphere Reserve. This is 36.9% of the total number of millipede species inhabiting the Pimorsky Krai. Three species are new to the reserve fauna. Rather this pattern expresses the degree of diplopod fauna study.

Generally, the reserve fauna of Diplopoda is relatively original. At the species level, the endemism amounts to at least 18.2% of the

total number of millipede species occurring there. Three species (*Levizonus distinctus*, *Diplomaragna zimoveinaya*, *Pacifiosoma kuruma*) are known from the Sikhote-Alin State Nature Biosphere Reserve only. Most of the species that populate the Sikhote-Alin State Nature Biosphere Reserve can be attributed to the Manchurian distribution pattern, which includes the Primorsky Krai, the southern part of the Khabarovsky Krai, the Amur Oblast, the Jewish Autonomous Oblast, Northeast China, and Korea. Only three species (*Orientyla dahurica* as well as parthenogenetic *Pacifiiulus amurensis* and *Underwoodia kurtschevae*) show wider distributions; both *O. dahurica* and *P. amurensis* are also known from Siberia while *U. kurtschevae* also from the Kamchatka Peninsula.

Underwoodia is a genus showing a trans-Beringian distribution pattern (Golovatch 1980). *Orientyla* and *Pacifiiulus* are endemic to the Asian part of Russia.

The order Polydesmida is definitely dominant in the diplopod fauna of the reserve. It is represented by three families, five genera and six species. Families Paradoxosomatidae and Polydesmidae include the species being quite common in the southern part of the Russian Far East and the adjacent territories. However, family Xystodesmidae is represented by both *Levizonus distinctus*, endemic to the reserve, and by *Levizonus malewitschi* known from the central-eastern part of the Primorsky Krai only. The orders Polyzoniida and Polyxenida are the smallest; they include one species each.

The distribution of Diplopoda in the Sikhote-Alin State Nature Biosphere Reserve (Map) shows four of the species (*Sichotanus eurygaster*, *Underwoodia kurtschevae, Sklerotoprotopus coreanus, Pacifiiulus amurensis*) as being common and occurring at 8–10 natural landmarks of the reserve. Three species (*Levizonus distinctus, Kopidoiulus continentalis*, *Angarozonium bonum*) are recorded in 4–7 natural landmarks. The remaining species tend to be more local in distribution. Of course, our map is provisional, reflecting the state of the art and the distribution of collecting efforts.

Millipedes occur in most of the biotopes, only excluding the steppe sea terrace within the natural landmark of Blagodatnoe (Gromyko, Potikha 2006). Millipede abundance is a variable characteristic. Thus, it ranges from 0.2 to 4.1 ind./m^2 in different dry *Quercus* forests, and from 23.3 to 57.1 ind./m^2 in different humid *Quercus* forests (Gromyko 1990). *Levizonus distinctus* is the most numerous species; its maximum numbers (more 30 ind./m^2) were registered in the valley with *Pinus koraiensis* forests (Gromyko, Poltikha 2006).

Key to Diplopoda orders, families, genera and species occurring in the Sikhote-Alin State Nature Biosphere Reserve

1(2) Cuticle soft, not impregnated with calcites. Head, most of pleura and telson with bundles of hollow serrate setae (= trichomes) ..... order **Polyxenida**, family **Polyxenidae**, genus *Polyxenus*, *Polyxenus* sp.

2(1) Cuticle hard, impregnated with calcites. Complex trichomes absent, body bare or with simple setae **3**

3(4) Head very small, elongated anteriorly into a rostrum. Body strongly flattened dorsoventrally, without paraterga and macrochaetae ..... order **Polyzoniida**, family **Polyzoniidae**, genus *Angarozonium*, *A. bonum*.

4(3) Head larger, more or less ovoid, devoid of a rostrum. Body more or less cylindrical, with paraterga and 3+3 macrochaetae **5**

5(14) Telson with a pair of spinnerets ..... order **Chordeumatida**

6(13) Each metatergite with paraterga ..... family **Diplomaragnidae**

7(8) Colpocoxites of posterior gonopods flattened on sides, not sagittally. Lateral sheath process present ..... Genus *Orientyla, O. dahurica*

8(7) Colpocoxites of posterior gonopods different, if flattened, then frontocaudally. Lateral sheath process absent **9**

9(12) Gonopod anterior angiocoxal processes present ..... genus *Diplomaragna*

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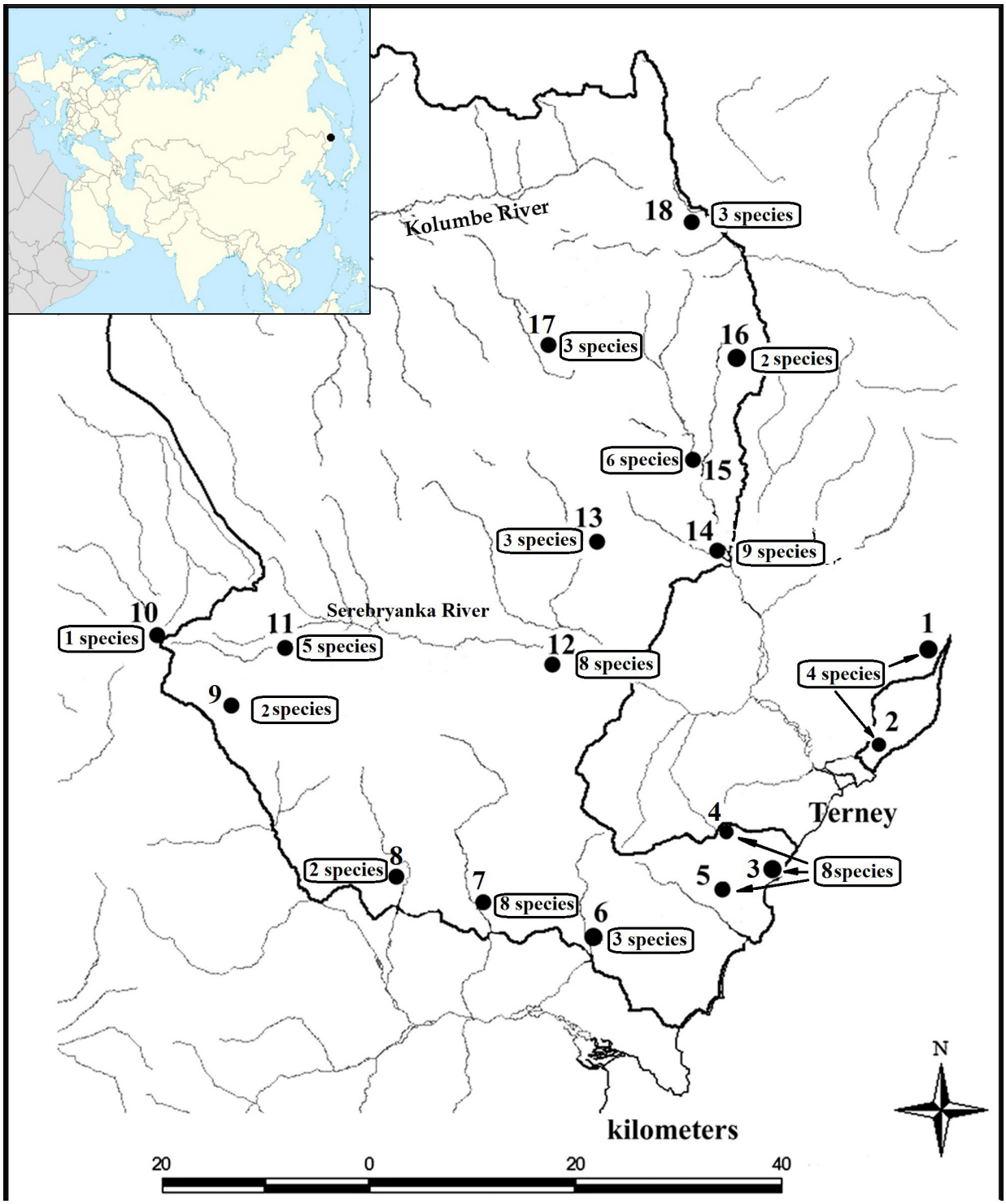

Map. Species diversity of Diplopoda within the Sikhote-Alin State Nature Biosphere Reserve. The numbers of the natural landmarks (1–18) are explained in the "Material and Methods section"

Карта. Видовое разнообразие двупарноногих многоножек в Сихотэ-Алинском заповеднике. Номера урочищ (1–18) поясняются в разделе «Материал и методы»

10(11) Posterior angiocoxal process of posterior gonopod like a caudally convex plate with an undulate edge, devoid of teeth. Body length 12–12.5 mm ..... *D. zimoveinaya*

11(10) Posterior angiocoxal process of posterior gonopod large, with broad mesal denticle protrusions. Body length 20–22 mm ..... *D. terricolor*

12(9) Gonopod anterior angiocoxal processes absent ..... genus *Pacifiosoma, P. kuruma*
13(6) Each metatergite without paraterga ..... family **Caseyidae**, genus *Underwoodia, U. kurtschevae*
14(5) Telson without a pair of spinnerets **15**
15(26) Metatergites with paraterga. Eyes absent. Adult body with 20 segments, including telson ..... order **Polydesmida**
16(19) Paraterga well-developed, serrate at lateral margin, without peritremata. Body relatively slender; metaterga relatively flat, with three transverse rows of bosses. Gonopod coxites fused medially ..... family **Polydesmidae**
17(18) Paraterga broad. Body relatively large (adults >15 mm long) ..... genus *Epanerchodus, E. polymorphus*
18(17) Paraterga narrow. Body relatively small (adults <15 mm long) ..... genus *Uniramidesmus, U. dentatus*
19(16) Paraterga relatively poorly-developed, with peritremata, non-serrate at lateral margin. Body stout, metaterga strongly convex, arched, without rows of bosses. Gonopods free from each other basally **20**
20(23) Adults poorly pigmented: whitish to yellowish with or without brown dorsal pattern. Gonopods simple, without conspicuous solenomere branch ..... family **Xystodesmidae**, genus *Levizonus*
21(22) Apex of gonopod telopodite like two plates placed perpendicular to each other; one of the plates serrate at outer margin ..... *L. malewitschi*
22(21) Apex of gonopod telopodite different. Solenomere with a large horn basally ..... *L. distinctus*
23 (20) Adults strongly pigmented: brown to dark brown with yellow peritremata. Gonopods complex, with an evident solenomere branch ..... family **Paradoxosomatidae**
24(25) Peritremata of midbody segments poorly demarcated ventrally. Gonopod solenomere flagelliform ..... genus *Sichotanus, S. eurygaster*
25(24) Peritremata of midbody segments evidently demarcated ventrally. Gonopod solenomere different ..... genus *Cawjeekelia, C. koreana*
26(15) Metatergites without paraterga, body subcylindrical Eyes present. Adult body with more than 30 segments ..... order **Julida**
27(28) Surface of metazonites completely striate ..... family **Julidae**, genus *Pacifiiulus, P. amurensis*
28(27) Surface of metazonites clearly striate only below ozopore level ..... family **Mongoliulidae**
29(30) Male leg 7 with very long coxal process covering with spinose setae, large ..... genus *Skleroprotopus, S. coreanus*
30(29) Male leg 7 without very long coxal process covering with spinose setae, small ... **31**
31(32) Posterior gonopod divided from the basis into two equally long branches ..... genus *Koiulus, K. interruptus*
32(31) Posterior gonopod not divided from the basis into two equally long branches ..... genus *Kopidoiulus, K. continentalis*

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