

On the genus *Trachelipus* Budde-Lund, 1908 (Isopoda: Oniscidea: Trachelipodidae) from the Caucasus

О роде *Trachelipus* Budde-Lund, 1908 (Isopoda: Oniscidea: Trachelipodidae) на Кавказе

Konstantin B. Gongalsky¹, Vasily A. Kolevatsky^{1,2},

Daria M. Kuznetsova¹, Dmitry A. Medvedev¹

К.Б. Гонгальский¹, В.А. Колеватов², Д.М. Кузнецова¹, Д.А. Медведев¹

¹ A.N. Severtsov Institute of Ecology and Evolution of Russian Academy of Sciences, Leninsky pr., 33, Moscow, 119071, Russia.
E-mail: gongalsky@gmail.com

² M.V. Lomonosov Moscow State University, Leninskie Gory, 1, Moscow, 119234, Russia.

KEY WORDS: Isopoda, Oniscidea, *Trachelipus*, COI, barcoding, woodlouse, Caucasus.

КЛЮЧЕВЫЕ СЛОВА: Isopoda, Oniscidea, *Trachelipus*, COI, баркодирование, мокрица, Кавказ.

ABSTRACT. Four species of woodlice belonging to the family Trachelipodidae, *Trachelipus lencoranicus* Borutzky, 1976 from Azerbaijan, *T. pieperi* Schmalfuss, 1986 from Iran, as well as *T. armenicus* Borutzky, 1976 and *T. nassonovi* Borutzky, 1976 from Armenia are re-described. *T. azerbaijdzhanus* Schmalfuss, 1986 syn.n. is considered junior synonym of *T. lencoranicus*. This is the first record of both *T. armenicus* and *T. pieperi* from Russia, and *T. nassonovi* from Azerbaijan. Diagnostic features of these species as well as affinities within the genus *Trachelipus* Budde-Lund, 1908 based on molecular markers (COI gene) are provided.

How to cite this paper: Gongalsky K.B., Kolevatsky V.A., Kuznetsova D.M., Medvedev D.A. 2023. On the genus *Trachelipus* Budde-Lund, 1908 (Isopoda: Oniscidea: Trachelipodidae) from the Caucasus // *Arthropoda Selecta*. Vol.32. No.3. P.293–314. doi: 10.15298/arthscl.32.3.06

РЕЗЮМЕ. Приводится переописание четырех видов мокриц из семейства Trachelipodidae: *Trachelipus lencoranicus* Borutzky, 1976 из Азербайджана, *T. pieperi* Schmalfuss, 1986 из Ирана, *T. armenicus* Borutzky, 1976 и *T. nassonovi* Borutzky, 1976 из Армении. *T. azerbaijdzhanus* Schmalfuss, 1986 syn.n. признается младшим синонимом *T. lencoranicus*. Это первая находка *T. armenicus* и *T. pieperi* для России и *T. nassonovi* для Азербайджана. Приведены диагностические признаки этих видов, а также родство внутри рода *Trachelipus* Budde-Lund, 1908 на основе молекулярных маркеров (ген COI).

The genus *Trachelipus* Budde-Lund, 1908 comprises more than 50 species [Schmalfuss, 2004; Boyko *et al.*, 2008], and rather variable [Tomescu *et al.*, 2015] which makes species identification problematic. In cen-

tral and southern Europe, the genus was thoroughly revised by Ch. Schmidt [1997]. At the same time, a vast diversity of this genus can be found in regional faunas, like the Caucasus [Kuznetsova, Gongalsky, 2012; Schmalfuss, Khisametdinova, 2015], with new species recently discovered [Gongalsky, 2017].

A study of local fauna of the Republic of Dagestan, Russia (eastern Caucasus) resulted in findings of several species belonging to the genus *Trachelipus*. A comparison of the specimens with the most relevant literature [Borutzky, 1976; Schmalfuss, 1986] resulted in overlapping descriptions. Borutzky [1976] described *Trachelipus lencoranicus* from the south of Republic of Azerbaijan, while Schmalfuss [1986] described *T. azerbaijdzhanus* and *T. pieperi* from Iran. The descriptions of *T. lencoranicus* and *T. azerbaijdzhanus* provided by the authors are very similar. Thus, a request to Dr. Helmut Schmalfuss, why did he separate his species from the similar one resulted in a kind reply that he had not been familiar with the paper by E.V. Borutzky [1976] (Schmalfuss, pers. comm.). Unfortunately, Dr. Evgenii V. Borutzky (1897 – August 1, 1976) had died by the time his paper was published, and was not able to share it with colleagues.

The issue of “Byulleten Moskovskogo Obshchestva Ispytatelei Prirody” with the description of *T. lencoranicus* was sent to production on September 13, 1976 and published on November 24, 1976. So, E.V. Borutzky has not seen the proof of the paper and (most probably, see below) did not finalize the manuscript himself. This caused two problems with the descriptions which jumbled several important things in this paper [Borutzky, 1976]:

(I) Type material at the Zoological Museum of Moscow University (ZMMU): (i) The holotype of *T. lencoranicus* (ZMMU, museum number Mc-930) is described in the paper as *T. armenicus*; (ii) *T. lenco-*

ranicus is described based on the slide marked as “*T. lencoranicus*, paratype” (ZMMU, no museum number); (iii) The slide marked as “*Trachelipus armenicus* sp. n.” (ZMMU, museum number Mc-929) is not described in the paper.

(II) Publication: (i) Figure 2, page 140 “*Trachelipus (Trachelipus) armenicus* sp. n.” actually shows the drawings of *T. lencoranicus*; (ii) Figure 3, page 141 “*Trachelipus (Trachelipus) lencoranicus* sp. n. ♂” actually shows the drawings of *T. armenicus*.

So, by a lucky coincidence, the holotypes are designated correctly and drawings made from the correct slides, and only descriptions were provided from the wrong slides. Based on the International Code of Zoological Nomenclature [1999], the holotype has a priority above a description, so no action is needed to change species names.

Due to the aforementioned problems and a chance to study fresh material, these two species are re-described. Moreover, *T. lencoranicus* is sympatric with *T. pieperi*, and its re-description is also provided. In his paper, Borutzky [1976] also described *T. nassonovi* Borutzky, 1976. By the time of this paper, *T. nassonovi* was only known as undescribed series of specimens with the name *Porcellio nassonovi* (nomen nudum) mentioned by A.N. Korčagin in reports of A.P. Bogdanov [Bogdanov, 1886, 1888]. We found this species in fresh collections of Dr. N.Yu. Snegovaya from Azerbaijan, so we provide its re-description.

Materials and methods

Morphological analysis

Sampling of *T. pieperi* and *T. lencoranicus* was done by Dr. D.I. Korobushkin and his colleagues in the forest ecosystems at the Caspian Sea shores in Dagestan in 2020–2021. Sampling of *T. armenicus* was done by D.M. Kuznetsova and Dr. E.A. Galoyan in Armenia in 2022. Sampling of *T. nassonovi* was done by Dr. N. Snegovaya in Azerbaijan in 2021. Above specimens were collected by hand and fixed in 96% ethanol. Paratypes of *T. azerbaijzhanus* and *T. pieperi* were kindly lent by Dr. A. Allspach from Senckenberg Museum of Natural History and returned after the examination therein.

Processing and dissections were done by using a Leica MZ8 binocular microscope. Micro preparations of diagnostic body appendages were done in euparal (Carl Roth GmbH). Line drawings were executed with the help of an Olympus BX41 microscope supplied with an Olympus U-DA camera lucida. The fresh material is deposited in the collection of the Zoological Museum of Moscow University, Russia (ZMMU), and partly retained in the private collection of the first author (A.N. Severtsov Institute of Ecology and Evolution of Russian Academy of Sciences, Moscow, Russia), as indicated below. Terminology used in the species description is mainly based on Vandel [1960].

Phylogenetic analysis

To confirm the difference between species, a phylogenetic analysis was undertaken. For molecular genetic analy-

sis, 1 specimen of *T. lencoranicus*, 2 specimens of *T. pieperi* and 2 specimens of *T. armenicus* from Republic of Dagestan, Russia, 1 specimen of *T. armenicus* from Armenia were taken. Specimens of *T. nassonovi* from Azerbaijan were not used due to repeatedly unsuccessful attempts to extract DNA. A closely related species of the genus was used too: *T. lignai* (Verhoeff, 1918) from the surroundings of Gagra, Abkhazia. In the phylogenetic construction, a number of species from GenBank (Table 1) were used as out-group taxa.

To isolate total DNA, pereopods 4 or 5 were used from individuals fixed alive in 96% ethanol. Total cellular DNA was isolated using the Diatom DNA Prep 100 kit (Isogen, Russia). For the analysis of genetic variability, fragments of the mtDNA COI locus were used. mtDNA was amplified with primers HCO2198/LCO1490 [Folmer *et al.*, 1994]. The polymerase chain reaction was carried out on a Bio-Rad T 100 thermocycler (Bio-Rad, USA) in a specially selected temperature regime: the initial denaturation of 95 °C was 5 min; annealing of 93 °C for 35 seconds, 45 °C for 40 seconds, 72 °C for 40 seconds (40 cycles), the final elongation of 72 °C lasted for 7 minutes. For the PCR, a set of reagents for the amplification of “5x Mas Mix-2025” manufactured by Dialat Ltd (Moscow, Russia) was used. The 10 µl reaction mixture contained 2 µl total DNA, 2 µl mix and 1 µl of each primer. The amplification products were separated by electrophoresis in 1.5% agarose gel in 1x TBE and visualized with ethidium bromide. The DNA sequence was determined with a forward primer on an ABI 3500 genetic analyzer from Applied Biosystems, USA.

The resulting sequences were aligned using BioEdit v. 5.0.9 [Hall, 1999]. The obtained mtDNA COI gene fragments were used in phylogenetic analysis. The locus of COI mtDNA of *Trachelipus rathkii* (Brandt, 1833), *T. aegaeus* (Verhoeff, 1907), *T. nodulosus* (C. Koch, 1838), *T. ratzeburgii* (Brandt, 1833) obtained from GenBank (NCBI) (Table 1) were used. As an outgroup, the following genera were selected: *Nagurus* (*N. carinatus* (Dollfus, 1905) — ON212542); *Armadillidium* (*A. vulgare* (Latreille, 1804) — MK236040, MK236030, MN810733, HM385158); *Tylos* (*T. ponticus* Grebnitzky, 1874 — MT521213; *T. granulatus* Krauss, 1843 — MK603421, MK603422, MK603423, *T. granuliferus* Budde-Lund, 1885 — AB763452, AB763461, AB763465).

Genetic distances (p-distance) between species were calculated using the MEGA X [Kumar *et al.*, 2018] software package. Genetic relationships were reconstructed based on the obtained sequences and GenBank (NCBI) data on the basis of the [T92+G+I; +G, parameter = 0.94] molecular evolution model [Tamura, 1992], chosen by the Maximum Likelihood (ML), Neighbor-Joining (NJ) [Saitou, Nei, 1987] and Maximum Parsimony (MP) [Nei, Kumar, 2000] methods, with the calculation of bootstrap support for branch nodes (1000 repetitions). The construction of a phylogenetic tree based on the Bayes principle and the evaluation of branching supports (10,000 repetitions) were carried out in MEGA X package.

Mapping

Locations of the species findings were mapped using ArcMap 10.4. ETOPO1 Global Relief Model was used as a base map material [NOAA, 2009].

Table 1. Haplotypes of species of the genus *Trachelipus* Budde-Lund, 1908 used in the phylogenetic analysis.
Таблица 1. Гаплотипы видов рода *Trachelipus* Budde-Lund, 1908, использованные в филогенетическом анализе.

| Species | Internal / GenBank No | Locality | Data source |
|--|-----------------------|---|---------------------------------|
| <i>Trachelipus aegaeus</i> (Verhoeff, 1907) | EF027396 | Greece, Vouraikos — 500 m, Peloponnisos | Parmakelis <i>et al.</i> , 2008 |
| | EF027400 | Greece, Chelmos Mt — 900 m, Peloponnisos | |
| | EF027449 | Greece, Proussos — 600 m, Sterea Ellada | |
| | EF027450 | | |
| <i>Trachelipus armenicus</i> Borutzky, 1976 | g54 | Russia, Daghestan, Trkal (41.716750° N 47.969750° E) | this study |
| | g55 | | |
| | g79 | Armenia, Hovhannavank (40.338764° N 44.388663° E) | this study |
| <i>Trachelipus lencoranicus</i> Borutzky, 1976 | g8 | Russia, Dagestan, Samur forest (41.815833° N 48.578611° E) | this study |
| <i>Trachelipus lignaui</i> (Verhoeff, 1918) | g28 | Abkhasia, Pitsunda (43.165052° N 40.416458° E) | this study |
| <i>Trachelipus nodulosus</i> (C. Koch, 1838) | MN810588 | Germany, Badlands (50.88° N 10.84° E) | Raupach <i>et al.</i> , 2022 |
| <i>Trachelipus pieperi</i> Schmalfuss, 1986 | t38 | Russia, Dagestan, Samur forest (41.815833° N 48.578611° E) | this study |
| | t39 | | |
| <i>Trachelipus rathkii</i> (Brandt, 1833) | MN810872 | Germany, Apfelstaedt bei Ingersleben (50.92° N 10.95° E) | Raupach <i>et al.</i> , 2022 |
| | MN810814 | Germany, Saxony-Anhalt, Hohe Garbe / Alandniederung (53.02° N 11.62° E) | |
| | MT521239 | Germany, North Rhine-Westphalia, Koeln (50.9833° N 7.0599° E) | |
| | MT521165 | Germany, Saxony, Landkreis Bautzen, Bautzen (51.1804° N 14.4349° E) | |
| <i>Trachelipus ratzeburgii</i> (Brandt, 1833) | MN810717 | Germany, Seeberg Wald (50.91° N 10.72° E) | Raupach <i>et al.</i> , 2022 |
| | MT521111 | Germany, Bavaria, Wank 3 km NE Garmisch-Partenkirchen (47.506° N 11.148° E) | |
| | MT521128 | Germany, Bavaria, Landkreis Garmisch-Partenkirchen (47.4921° N 11.0958° E) | |
| | MT521145 | Germany, Bavaria, 2 km WNW Gaishofen, 8 km ESE Vilshofen (48.61° N 13.304° E) | |

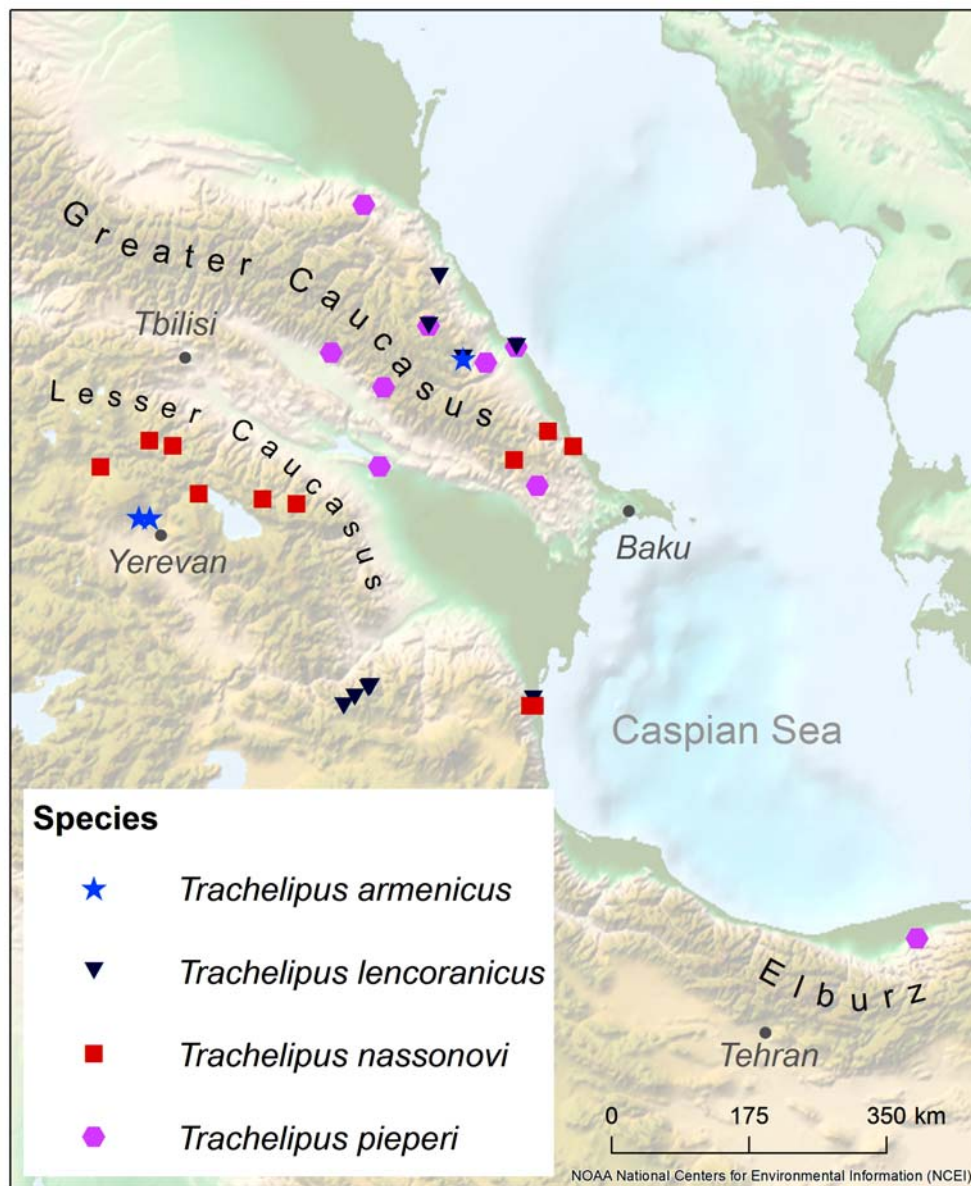


Fig. 1. Findings of four studied species of the genus *Trachelipus* Budde-Lund, 1908.

Рис. 1. Находки четырех изученных видов рода *Trachelipus* Budde-Lund, 1908.

Results

Taxonomy

Class Malacostraca Latreille, 1802
Order Isopoda Latreille, 1817
Family Trachelipodidae Strouhal, 1953
Genus *Trachelipus* Budde-Lund, 1908

Trachelipus lencoranicus Borutzky, 1976
Figs 2–5.

Trachelipus azerbaijani Schmalzfuss, 1986 **syn.n.**
Material (Fig. 1). *Trachelipus lencoranicus*. Holotype: ♂ (ZMMU, Mc-930), [Azerbaijan], Lenkoran, forest stripe No. 7,

sample 13, 26.IV.1963, collector not specified. [The slide with appendages bears the same museum number but marked as: “*Tracheoniscus lencoranicus* Borutzky”]

Russia, Republic of Dagestan (private collection of K. Gongalsky), collectors not specified: 1 ♂, Magaramkentsky District, Samursky National Park, 14.IV–1.VI.2019; 1 ♂, Dakhadayeysky District, Itsari, 3.VII.2019; 2 ♂♂, 9 ♀♀, Sergokalinsky District, Myurego, 16.IX.2019; 3 ♂♂, 1 ♀, Khivsky District, Trkal, X. 2021. K. Gongalsky leg.; 1 ♂, City of Makhachkala, Turaly, X. 2021. K. Gongalsky leg.

1 ♂ (private collection of F. Byzov), Russia, Republic of Dagestan, Magaramkentsky District, Samursky National Park, sampling date not specified, Govorov leg.

Azerbaijan: Astara, Toradi, 13–16.VI.2016, N. Snegovaya leg., 1 ind. (38.5713° N 48.5648° E); Kedabek Distr. 1.X.2019, N. Snegovaya leg., 8 ind. (40.5992° N 45.7923° E); Kedabek, Novoi-vanovka, 7.X.2015, N. Snegovaya leg., 2 ind. (40.5992° N 45.7923° E); Kedabek, Novosaratovka, 6.X.2015, N. Snegovaya leg., 3 ind.

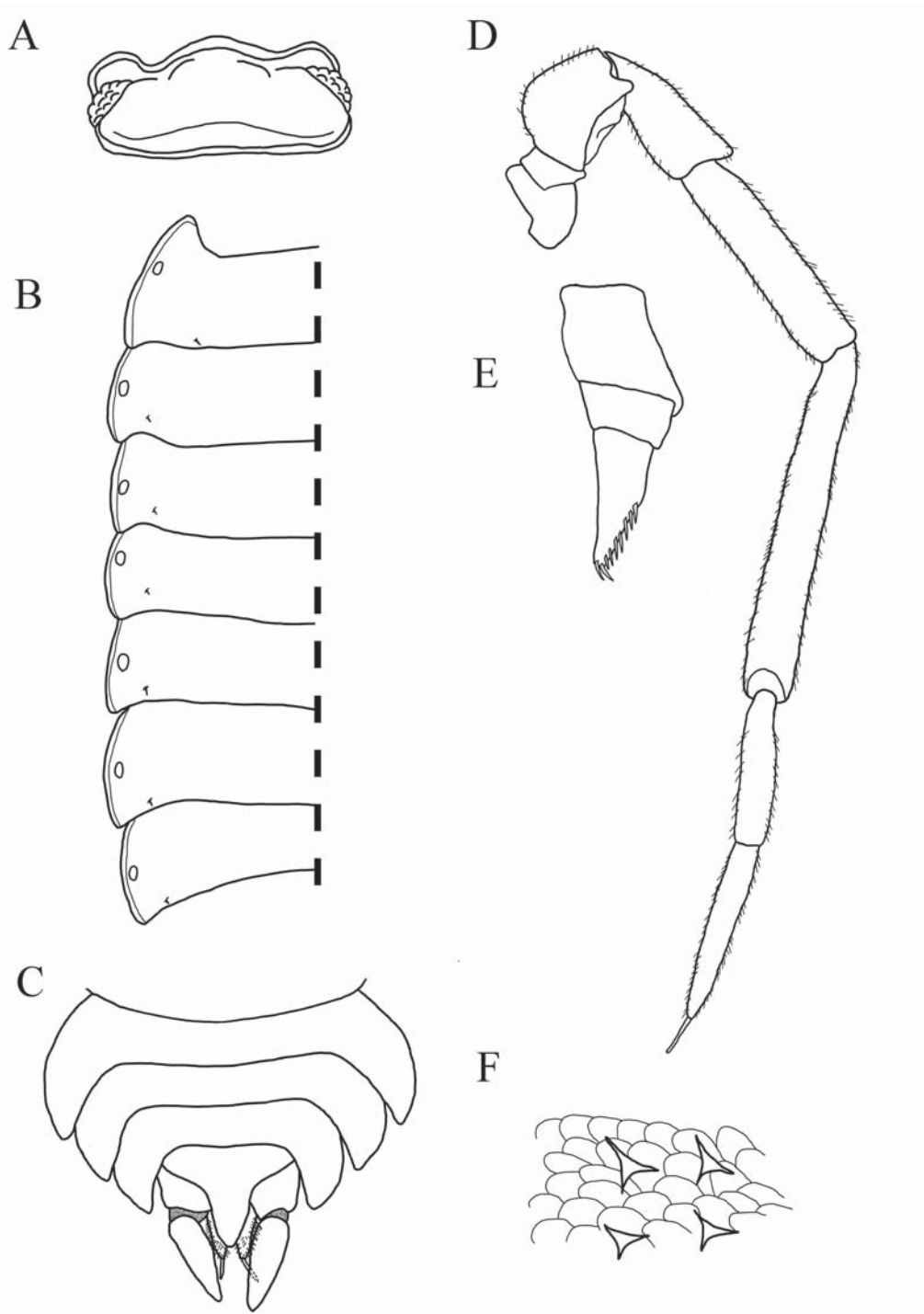


Fig. 2. *Trachelipus lencoranicus* Borutzky, 1976: A — head; B — pereon epimera with noduli laterales and glandular pore fields; C — pleon, telson and uropods; D — antenna; E — antennula; F — dorsal scale-setae.

Рис. 2. *Trachelipus lencoranicus* Borutzky, 1976: A — голова; B — эпимеры переяна с noduli laterales и поровыми полями; C — плеон, тельсон и уроподы; D — антенна; E — антеннула; F — дорзальные сеты.

(40.4992° N 45.6747° E); Masally, forest, 11.X.1969, A. Bogachev leg. (?), 2 ind. (38.8923° N 48.6281° E); Kedabek, Novosaratovka, 6.X.2015, N. Snegovaya leg., 1 ind. (40.4992° N 45.6747° E); Balaken, Jijikhana, 1.VI.2021, N. Snegovaya leg., 1 ind. (41.6786° N 46.4925° E); Nakhichevan, Ordubad, Mezre, 2.V.2018, N. Snegovaya leg., 7 ind. (39.0519° N 45.9234° E); Astara, Motlayatag,

Anboba, 27–29.V.2019, N. Snegovaya leg., 2 ind. (38.5968° N 48.6618° E); Ordubad, Pazmari, 12.VII.2021, N. Snegovaya leg., 1 ind. (39.0417° N 46.0319° E); Kedabek, Novoivanovka, no sampling date, N. Snegovaya leg., 4 ind. (40.5554° N 45.4820° E); Zakatala, Kebeleba, 12.VI.2020, N. Snegovaya leg., 2 ind. (41.6418° N 46.6305° E); Gakh, Gakhbash, 20.VI.2020, N. Snegovaya leg., 2

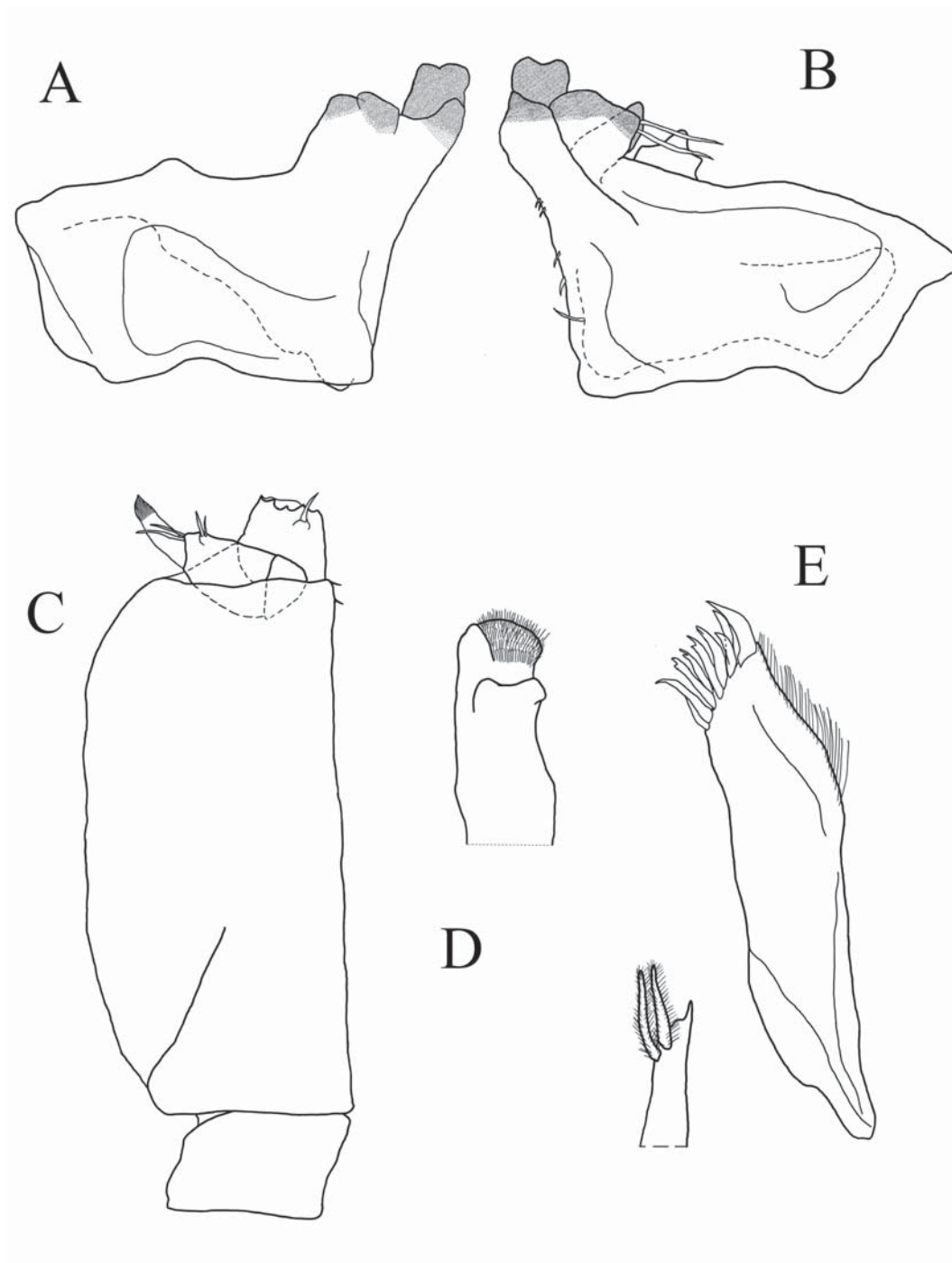


Fig. 3. *Trachelipus lencoranicus* Borutzky, 1976: A — left mandible; B — right mandible; C — maxilliped; D — maxilla; E — maxillula.

Рис. 3. *Trachelipus lencoranicus* Borutzky, 1976: A — левая мандибула; B — правая мандибула; C — максиллула; D — максилла; E — максиллипед.

ind. (41.4396° N 46.9783° E); Lankaran, Apo-Bilyasar, 18.V.2021, N. Snegovaya leg., 9 ind. (38.6669° N 48.7338° E); Zakatala, Kebeloba, 1.IX.2021, N. Snegovaya leg., 1 ind., (41.6418° N 46.6305° E); Lankaran, Byurdzhali, Azdilisy, 13–14.X.2021, N. Snegovaya leg., 18 ind. (38.6675° N 48.7862° E).

Trachelipus azerbaijani Schmalzfuss, 1986. Paratype (SMF 12241), ♂, dissected for this study: Iran, Azerbaijan Sharqi, Arasbaran Wildlife Refuge bei Kalybar, Makidi, 1600–1700 m, Eichen-

buchenwald. 11.VI.1978. L. Martens, H. Pieper leg. Paratypes: 2 ♂♂, 3 ♀♀ (SMF 12241), same locality, date and collectors.

DIAGNOSIS. Antennal flagellum with the articles of equal length; male exopod of pleopod 1 with outer margin not convex in the proximal part; and male carpus of pereopod 7 with a prominent dorsal crest, widest in the middle of carpus.

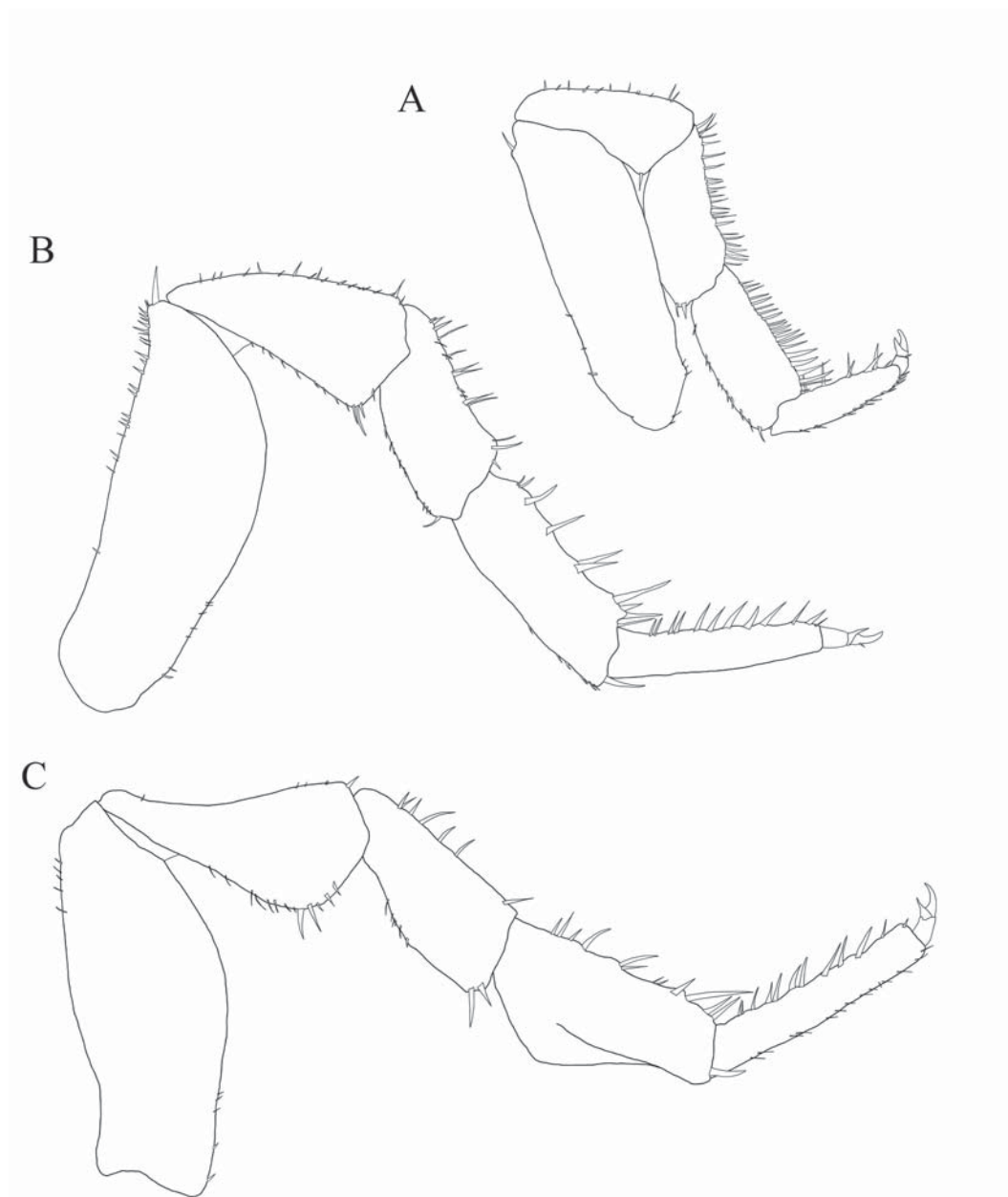


Fig. 4. *Trachelipus lencoranicus* Borutzky, 1976: A — pereopod 1; B — pereopod 6; C — pereopod 7.

Рис. 4. *Trachelipus lencoranicus* Borutzky, 1976: A — перепод 1; B — перепод 6; C — перепод 7.

TYPE LOCALITY: Azerbaijan, Lankaran (38.75° N, 48.81° E).

RE-DESCRIPTION. *Somatic characters.* Body length: males and females 7.0–13.0 mm. Body colour light- or dark brown with scattered yellow spots, forming white stripe on proximal part of epimeres. Males darker than females. Exopods of uropods dark. Dorsal surface of cephalon and tergites smooth. Rear edge of tergites with long tubercle, which goes to epimeres. Posterior margin of coxal plates on segments 1–3 deeply sinuous (Fig. 2B). Dorsal surface covered with Y-shaped scale-setae (Fig. 2F). Glandular pore fields large, oval-shaped and almost reach lateral margin (Fig. 2B). Body relatively elongated; pleon forms continuous margin with pereon (Fig. 2B). Noduli lateralis

located close to posterior edge of tergites, on pereonite 1 much more centrally (Fig. 2B). Cephalic lobes well developed. Lateral lobes shorter than median. Median lobe with its distal edge semi-circular (Fig. 2A). Telson triangular, sinuous on sides. Telson protrudes beyond propodites of uropods (Fig. 2C).

Appendages. Antennula with three articles (Fig. 2E); first article wide and long; second article two times shorter as first; third almost as long as first and narrow, bearing tuft of aesthetascs at apex. Antenna reaching rear margin of pereonite 3; flagellum with two articles, of equal length. Flagellum as long as fifth segment of antenna (Fig. 2D).

Left mandible (Fig. 3A) with pars incisiva with two teeth; basal to lacinia hairy lobe with two penicils; molar

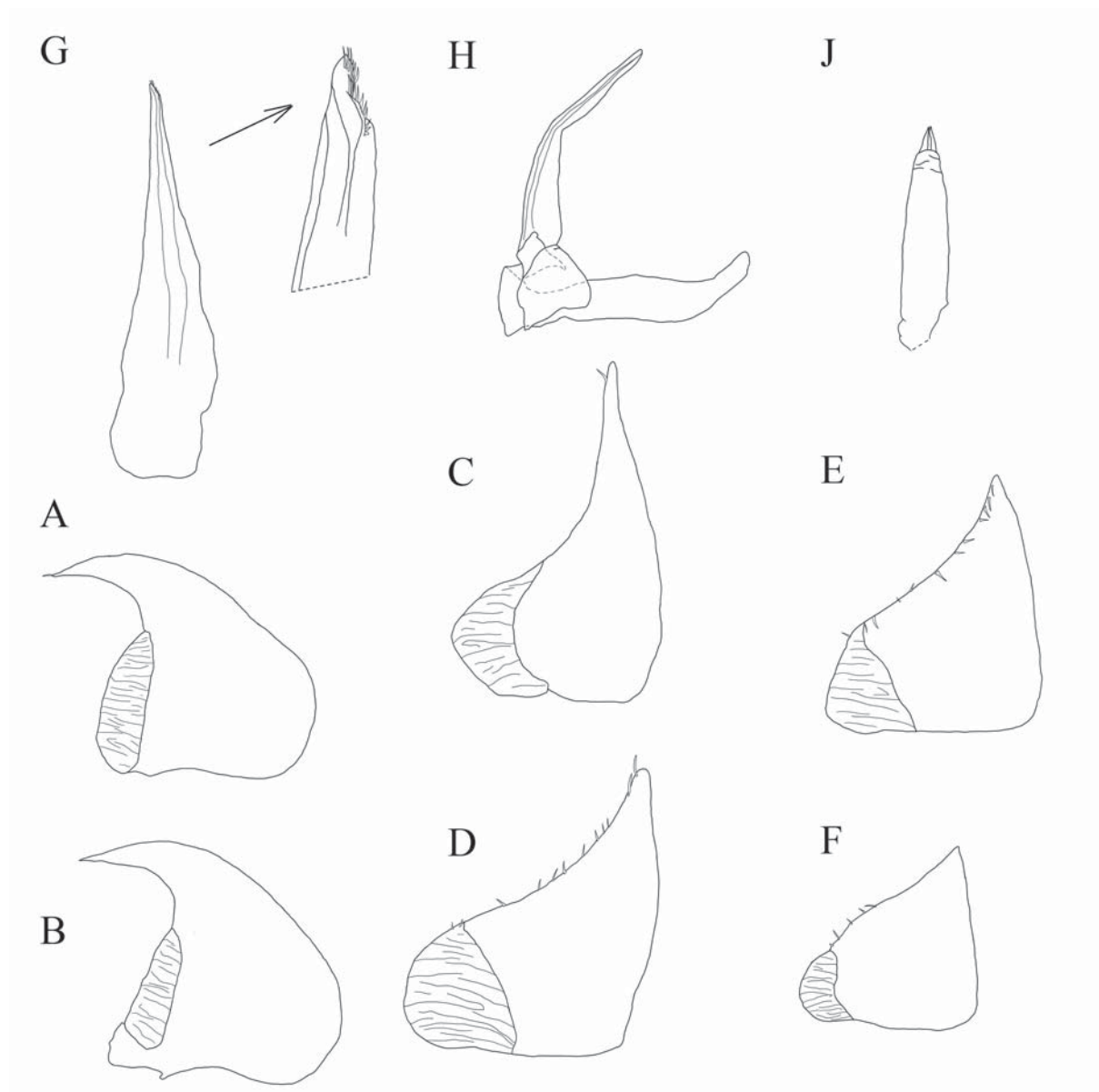


Fig. 5. *Trachelipus lencoranicus* Borutzky, 1976: A, B — exopod of pleopod 1 of two different individuals; C — exopod of pleopod 2; D — exopod of pleopod 3; E — exopod of pleopod 4; F — exopod of pleopod 5; G — endopod of pleopod 1; H — endopod of pleopod 2; J — genital papilla.

Рис. 5. *Trachelipus lencoranicus* Borutzky, 1976: A, B — экзопод плеопода 1 двух разных особей; C — экзопод плеопода 2; D — экзопод плеопода 3; E — экзопод плеопода 4; F — экзопод плеопода 5; G — эндопод плеопода 1; H — эндопод плеопода 2; J — генитальная папилла.

penicil consisting of tuft of plumose setae. Right mandible (Fig. 3B) with pars incisiva with three teeth; hairy lobe with one penicil; molar penicil as in left. Maxillula (Fig. 3E): medial corner of inner endite with two strong penicils. Apical edge of outer endite bearing ten teeth. Six medial teeth slenderer, with cleft tips. Maxilla with bilobate edge, medial half of apical edge of inner lobe with dense brush of short hairs (Fig. 3D). Maxilliped with outer corner of endite with two acute tips and large spine near the inner corner (Fig. 3C). Basal article of palp with two large spines. Tip of distal article of palp consisting of brush of spines. Pleopods with all exopods bearing uncovered lungs. Uropods (Fig. 2C)

with exopods flattened and oval shaped, with three relatively large spines on apex.

Male: Pereopods (Fig. 4A–C). Ischium of pereopod 7 with ventral margin slightly concave. Carpus with prominent dorsal crest, widest in proximal part (Fig. 4C).

Genital papilla with shape typical of genus (Fig. 5J). Exopod of pleopod 1 (Fig. 5A, B) with long and narrow distal part bent outwards; outer margin straight, not convex in proximal part. Endopod of pleopod 1 with dorsal furrow and row of spines gradually elongated (Fig. 5G). Exopod of pleopod 2 triangular with concave outer margin (Fig. 5C); endopod much longer than exopod, narrow, with parallel

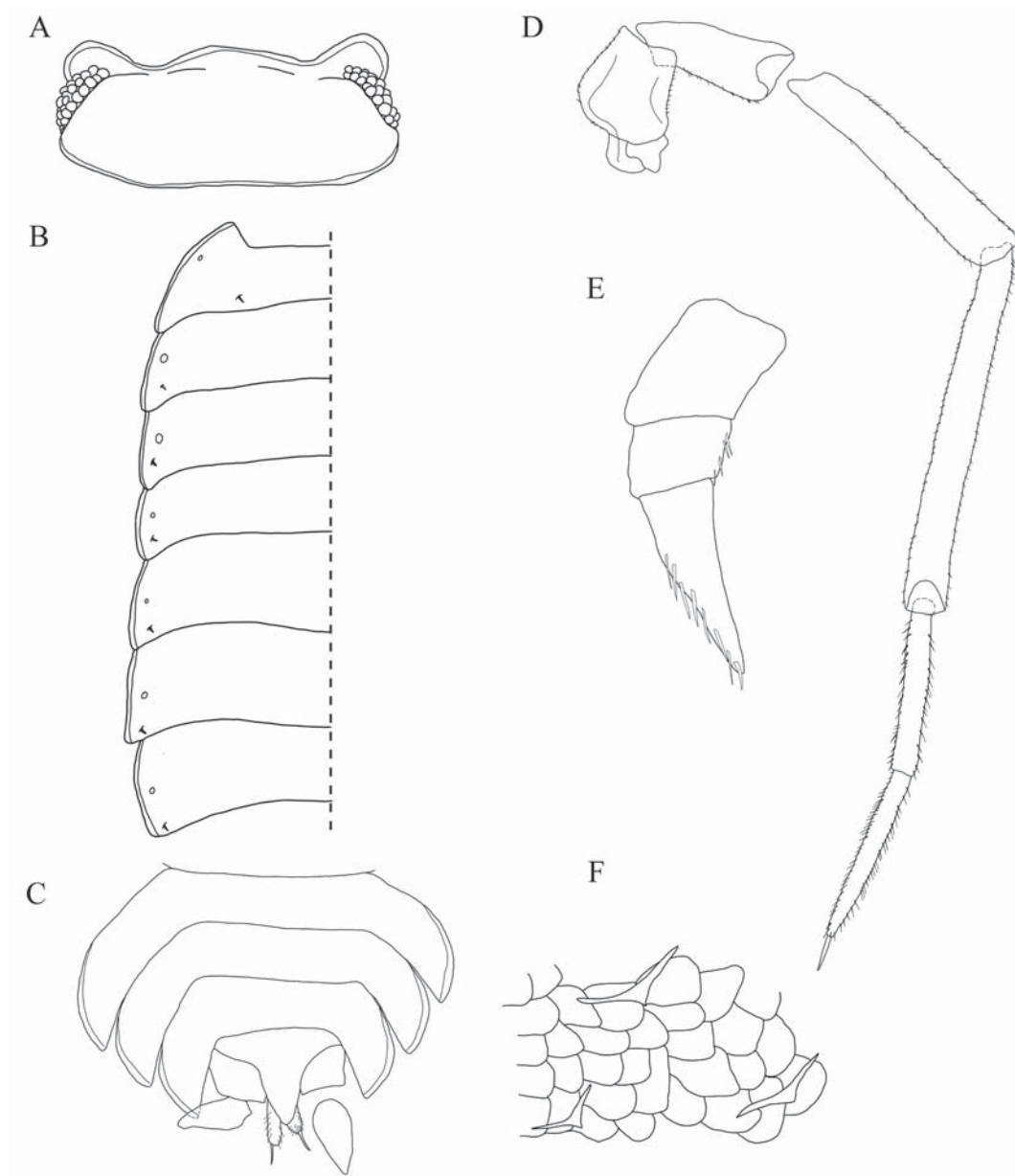


Fig. 6. *Trachelipus pieperi* Schmalzfuss, 1986: A — head; B — pereon epimera with noduli laterales and glandular pore fields; C — pleon, telson and uropods; D — antenna; E — antennula; F — dorsal scale-setae.

Рис. 6. *Trachelipus pieperi* Schmalzfuss, 1986: а — голова; б — эпимеры перейона с noduli laterales и поровыми полями; в — плеон, тельсон и уropоды; д — антенна; е — антеннула; ф — дорзальные сетки.

sides (Fig. 5H). Exopod of pleopods 3–5 (Fig. 5D–F) triangular, slightly decreasing in size from third to fifth.

REMARK. This species is the closest to *T. armenicus*, but it differs in the following: (i) more developed tracheal field, with the outer edge covering more than a half of length of outer margin; (ii) with straight posterior end of distal outgrowth of exopodite of pleopod 1; (iii) ischium of pereopod 7 club-shaped and angular crest only in distal part of carpopous (in *T. armenicus* ischiopodite 7 of the male pereopod is not club-shaped, but the ridge on the carpopodite runs along the entire upper edge); (iv) much shorter male uropods exopod. Similar exopodites are found in *T. taborskyi* (Frankenberger, 1960) from Turkey [Borutzky, 1976].

DISTRIBUTION. The species has been found around Lankaran. It is a common species in Talysh Mountains and piedmont forests (Borutzky, 1976) and in the areas to the south of the Caspian Sea (Fig. 1).

Trachelipus pieperi Schmalzfuss, 1986 Figs 6–9.

MATERIAL (Fig. 1). Paratype (SMF 12234), ♂, dissected for this study: Iran, Mazandaran Noor- Reservat bei Noor (=Suldeh), Laubwald auf Meereshöhe. 29.VI.1978. L. Martens, H. Pieper leg. Paratypes: 2 ♂♂, 2 ♀♀, (SMF 12229), 1 ♀, (SMF 12234), same locality, date and collectors.

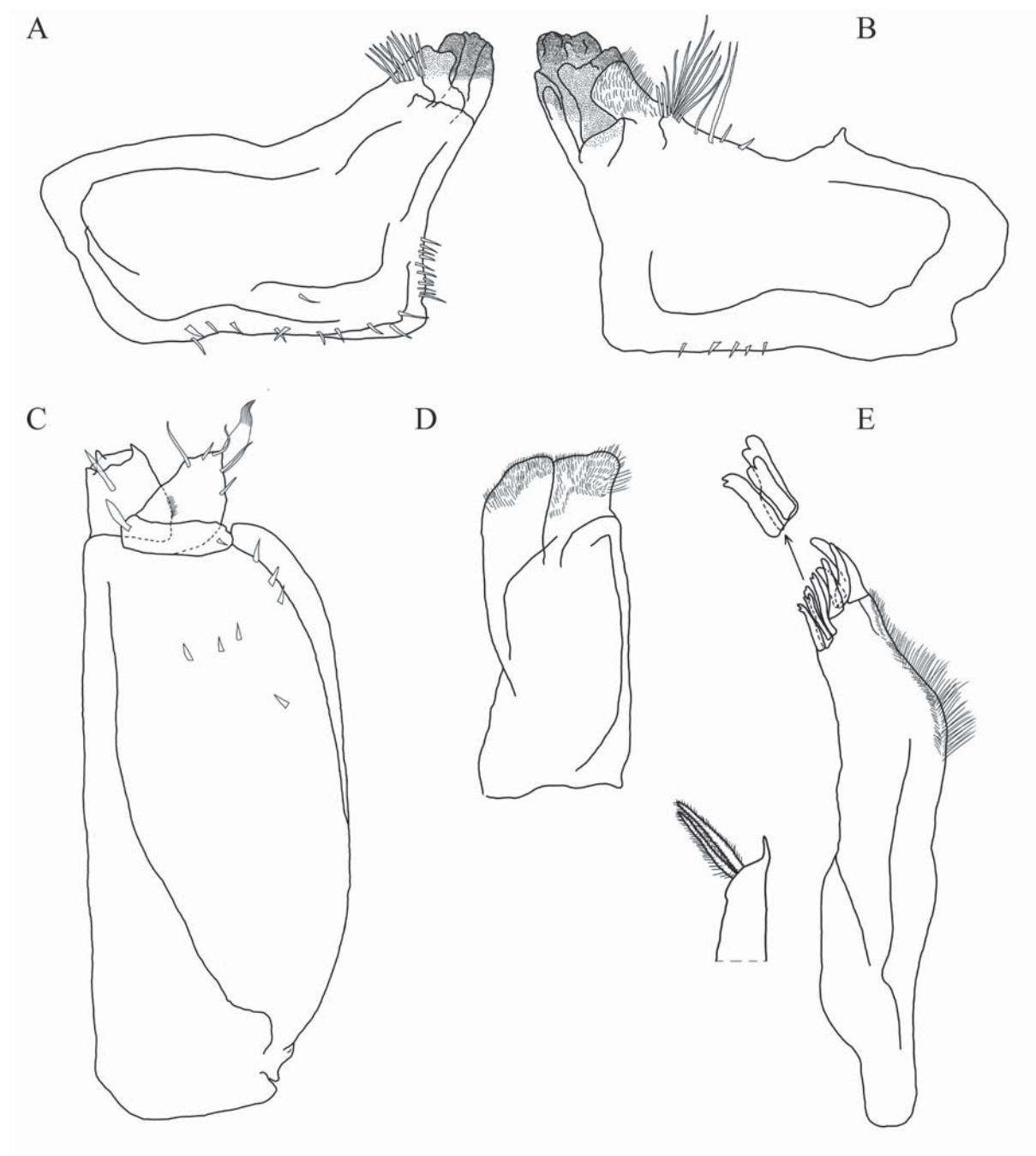


Fig. 7. *Trachelipus pieperi* Schmalzfuss, 1986: A — left mandible; B — right mandible; C — maxilliped; D — maxilla; E — maxillula.

Рис. 7. *Trachelipus pieperi* Schmalzfuss, 1986: A — левая мандибула; B — правая мандибула; C — максиллипед; D — максилла; E — максиллула.

Russia, Republic of Dagestan (private collection of K. Gongalsky), collectors not specified: 53 ♂♂, 26 ♀♀, Magaramkentsky District, Samursky National Park, 14.IV–1.VI.2019; 2 ♀♀, Kazbekovsky District, Dubki, 3.IV.2018; 5 ♀♀, Dakhadayevsky District, Itsari, 3.VII.2019; 1 ♀, Suleyman-Stalsky District, Svkh Gereikhanova, X.2021, K. Gongalsky leg.

3 ♂♂, 2 ♀♀ (private collection of F. Byzov), Republic of Dagestan, Samursky National Park, 10–26.V.2021. D. Osipov leg.

Azerbaijan: Gakh, Ilisu, 30.V–1.VI.2016, N. Snegovaya leg., 19 ind. (41.4695° N 47.0614° E); Zagalata State Reserve, Katsmali, 10.VI.2015, N. Snegovaya leg., 3 ind. (41.7683° N 46.4621° E);

Mingechaur, 13–14.V.2015, N. Snegovaya leg., 1 ind. (40.7835° N 47.0166° E); Zagalata State Reserve, 11.VII. 2015, N. Snegovaya leg., 1 ind; Golustan Distr., Sundu vil., 22.IV. 2021, N. Snegovaya leg., 1 ind. (40.6143° N 48.8207° E).

DIAGNOSIS. Antennal flagellum with the articles of equal length; male exopod of pleopod 1 with outer margin not convex in proximal part; and male carpus of pereopod 7 with prominent dorsal crest, widest in middle of carpus.

TYPE LOCALITY: Iran, Mazandaran Province, Alasht (36.06° N, 52.91° E).

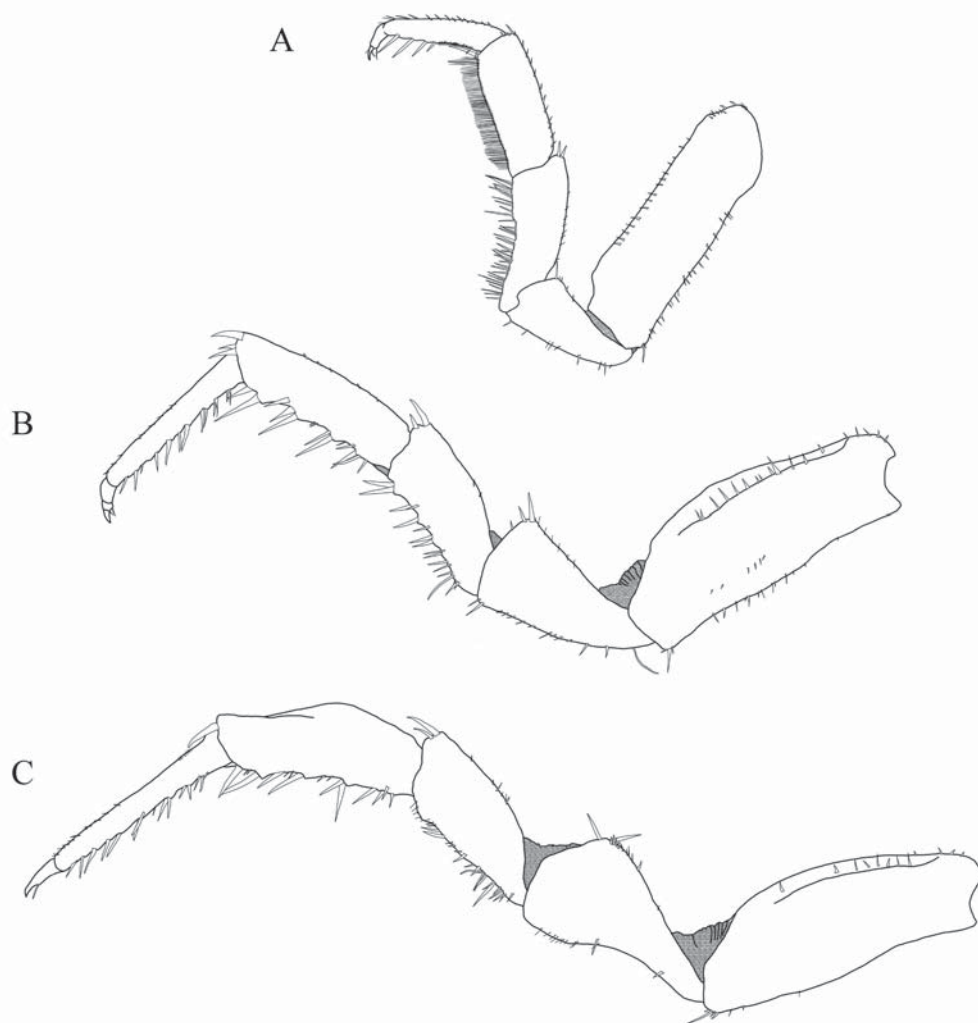


Fig. 8. *Trachelipus pieperi* Schmalzfuss, 1986: A — pereopod 1; B — pereopod 6; C — pereopod 7.

Рис. 8. *Trachelipus pieperi* Schmalzfuss, 1986: A — перепод 1; B — перепод 6; C — перепод 7.

RE-DESCRIPTION. Somatic characters. Maximum body length 16.5 mm. Body color dark brown-violet. At base of coxal plates of pereonal segments 2–7 there white or yellow spots, longer on segments 5–7. Females lighter than males. Dorsal surface of cephalon and tergites lightly tuberculated. The dorsal surface covered with Y-shaped scale-setae (Fig. 6F). Glandular pore fields round-shaped and located from lateral margin of tergites at distance exceeding their diameter (Fig. 6B). Body relatively elongated; pleon forms continuous margin with pereon (Fig. 6B). Noduli laterales located close to outer edge of pereon, except for tergite 1 (Fig. 6B). Head as in *Trachelipus rathkii* Brandt, 1838, with blunter angle between lateral and central lobes (Fig. 6A). Posterior margin of coxal plates on segments 1–3 sinuous, and on segments 4–7 curved (Fig. 6B). Telson triangular, sinuous on sides. Telson protrudes beyond propodites of uropods (Fig. 6C).

Appendages. Antennula with three articles (Fig. 6E); first article wide and long; second article two times shorter as first; third slightly longer than first bearing tuft of aes-

thetascas at apex. Antenna reaching rear margin of pereonite 3; flagellum with two articles, basal article slightly longer than terminal article (Fig. 6D).

Left mandible (Fig. 7A) with pars incisiva with two teeth; basal to the lacinia is a hairy lobe with two penicils; molar penicil consisting of 12–14 plumose setae. Right mandible (Fig. 7B) with pars incisiva with three teeth; hairy lobe with one penicil; molar penicil as in the left. Maxillula (Fig. 7E): medial corner of inner endite with two strong penicils. Apical edge of outer endite bearing 10 teeth that are divided into two groups, the 6 medial teeth are slenderer, with 4–5 cleft tips and four lateral spines are stouter with simple tips. Maxilla with bilobate edge, the medial half of the apical edge of inner lobe with dense brush of short hairs (Fig. 7D). Maxilliped with outer corner of endite with two acute tips and large spine near the inner corner (Fig. 7C). Basal article of palp with two large spines. Tip of the distal article of palp consisting of brush of spines. Pleopods with all exopods bearing uncovered lungs. Uropods (Fig. 6C) with exopods flattened and oval shaped, with three relatively large spines on apex.

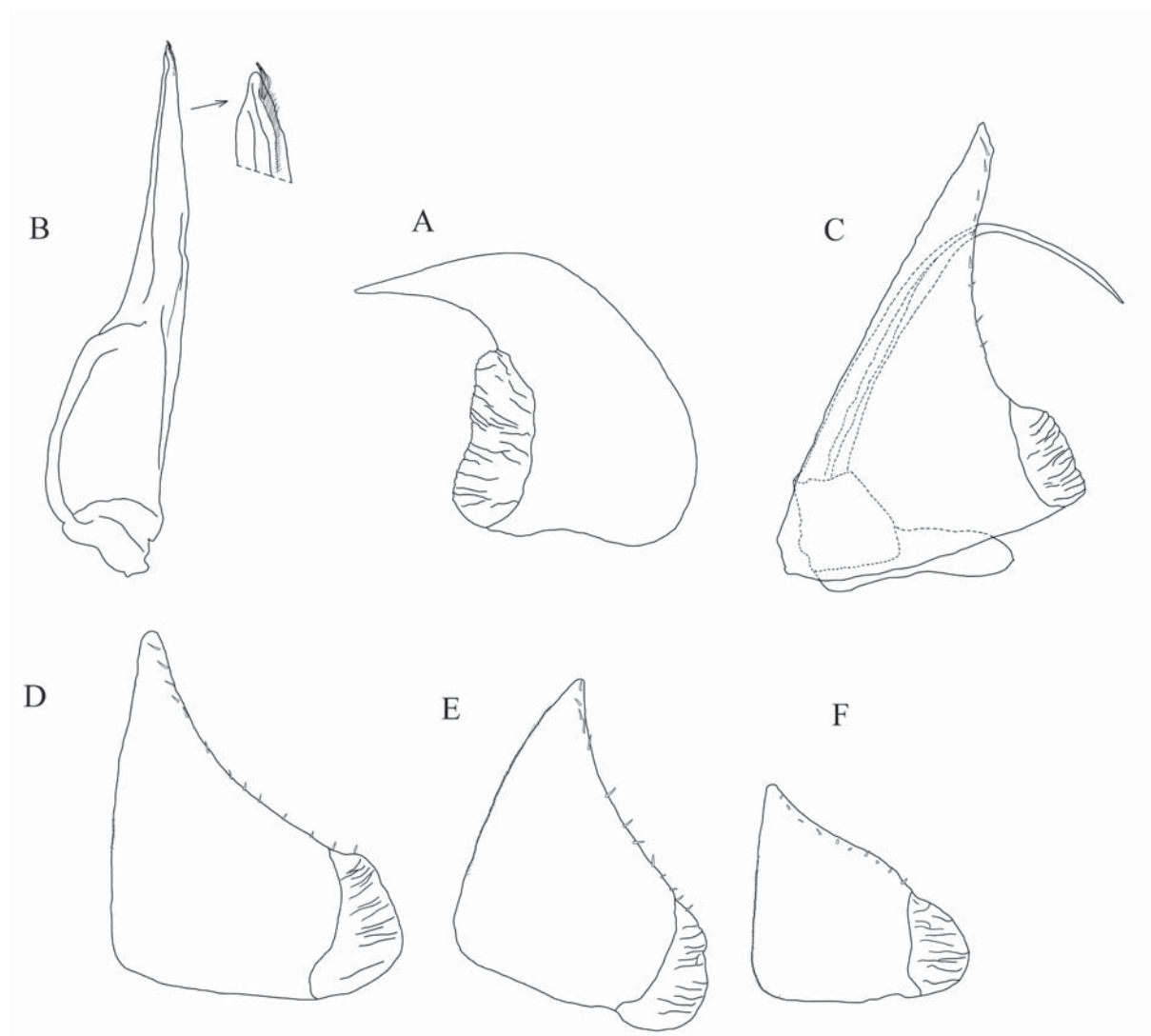


Fig. 9. *Trachelipus pieperi* Schmalfuss, 1986: A — exopod of pleopod 1; B — endopod of pleopod 2; C — exopod and endopod of pleopod 2; D — exopod of pleopod 3; E — exopod of pleopod 4; F — exopod of pleopod 5.

Рис. 9. *Trachelipus pieperi* Schmalfuss, 1986: A — экзопод плеопода 1; B — эндопод плеопода 1; C — экзопод и эндопод плеопода 2; D — экзопод плеопода 3; E — экзопод плеопода 4; F — экзопод плеопода 5.

Male: Pereopods (Fig. 8A–C). Carpus and merus of pereopods 1–3 with brush. Carpus and merus 4–7 only with two powerful rows of spikes. Ischium of pereopod 7 with ventral margin slightly concave. The carpus 7 has prominent dorsal crest, widest proximal to middle (Fig. 8C).

Genital papilla of shape typical of genus. Exopod of pleopod 1 (Fig. 9A) with long and narrow distal part bent outwards; outer margin convex in proximal part. Endopod of pleopod 1 with dorsal furrow and with row of spines which become longer the closer to the tip they are (Fig. 9B). Pleopod 2: exopod triangular with concave outer margin (Fig. 9C); endopod much longer than exopod, narrow, with parallel sides (Fig. 9C). Exopod of pleopods 3–5 (Fig. 9D–F) triangular, slightly decreasing in size from third to fifth.

REMARK. The species is assigned to the genus *Trachelipus* since it has five pairs of uncovered pleopodal lungs and flagellum of antennae consisting of two articles. Among species inhabiting eastern and central Caucasus, this species

has several distinguishing features: (i) location of noduli laterales at a distance from the lateral margin of pereionites larger than their diameter; (ii) specific shape of male exopod of pleopod 1.

DISTRIBUTION. The species has been originally found on the southern coast of the Caspian Sea in Iran [Schmalfuss, 1986; Kashani, 2018]. Now we report it from the western coast of the Sea, in Azerbaijan and Russia (Republic of Dagestan). It occupies broadleaved forests across its range.

Trachelipus armenicus Borutzky, 1976 Figs 10–13.

Material (Fig. 1). Holotype: ♂ (ZMMU Mc-929), Armenia, Byurakan, S slope of Alagez. 3.VI.1956. L. Zimina leg.

1 ♂ (private collection of K. Gongalsky), Armenia, Aragatsotn district. The edge of the Kasagh Gorge, remains of a stone building

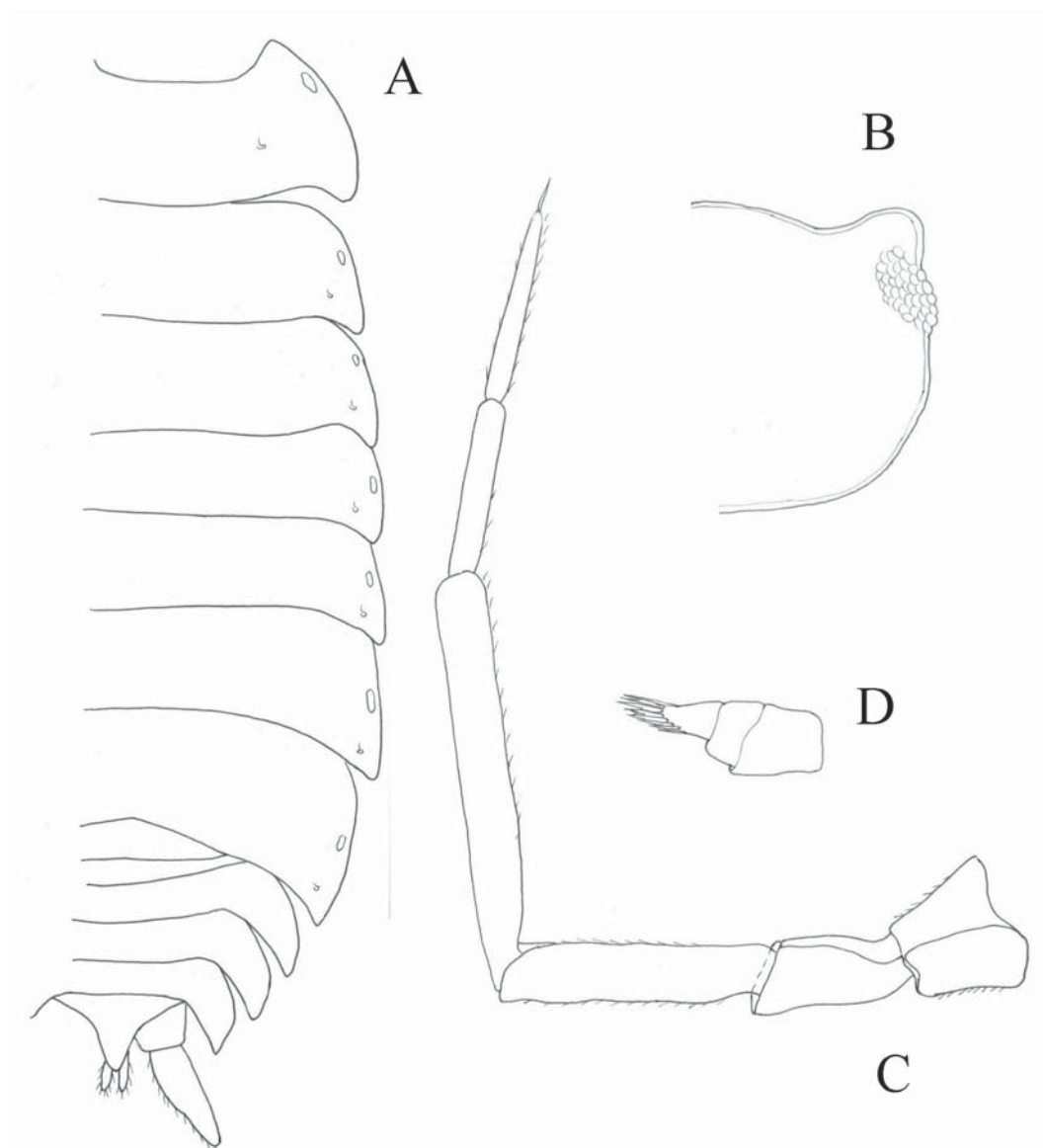


Fig. 10. *Trachelipus armenicus* Borutzky, 1976: A — pereon epimera with noduli lateralis and glandular pore fields and pleon, telson and uropods; B — head; C — antenna; D — antennula.

Рис. 10. *Trachelipus armenicus* Borutzky, 1976: а — эпимеры переиона с noduli lateralis и поровыми полями, плеон, тельсон и уropоды; В — голова; С — антенна; D — антеннула.

on the Hovhannavank Monastery courtyard (40.338764° N, 44.388663° E). 10.IV.2022. D. Kuznetsova leg. 2 ♂♂, 4 ♀♀, Armenia, Byurakan (40.34° N, 44.26° E). 14.VII.2022. E.A. Galoyan leg. 2 ♂♂, 3 ♀♀, Russia, Republic of Dagestan, Khivsky District, Trkal (41.716750° N 47.969750° E), X.2021. K. Gongalsky leg.

DIAGNOSIS. Antennal flagellum with the articles of equal length; male exopod of pleopod 1 with a long distal process parallel to base of segment directed outwards; and male carpus of pereopod 7 with prominent dorsal crest, widest in middle of carpus.

TYPE LOCALITY: Armenia, Byurakan (40.34° N, 44.26° E).

RE-DESCRIPTION. *Somatic characters.* Body length: males 9.0–11.0 mm, females 9.0–15.0 mm. Body colour brown with scattered yellow spots, forming white stripe on proximal part of epimeres. Yellow stripe on rear corners of

rear segments. Exopods of uropods dark. Dorsal surface of cephalon with indistinct tuberosity. Two transverse ridges clearly protrude behind frontal suture. Pereion tergites smooth. Rear edge of tergites with long tubercle, which goes to epimeres. Pereion epimeres with very small bumps. Posterior margin of coxal plates on segments 1–3 deeply sinuous (Fig. 10A). Dorsal surface covered with Y-shaped scale-setae. Glandular pore fields large, oval-shaped and almost reach lateral margin (Fig. 10A). Body relatively elongated; pleon forms continuous margin with pereon (Fig. 10A). Noduli lateralis located close to posterior edge of tergites, on pereonite 1 much more centrally (Fig. 10A). Cephalic lobes small, evenly rounded in front. Middle lobe protrudes forward as slightly rounded angle; obtuse angle between it and lateral lobes (Fig. 10B). Telson triangular, sinuous on sides. Telson protrudes beyond propodites of uropods (Fig. 10A).

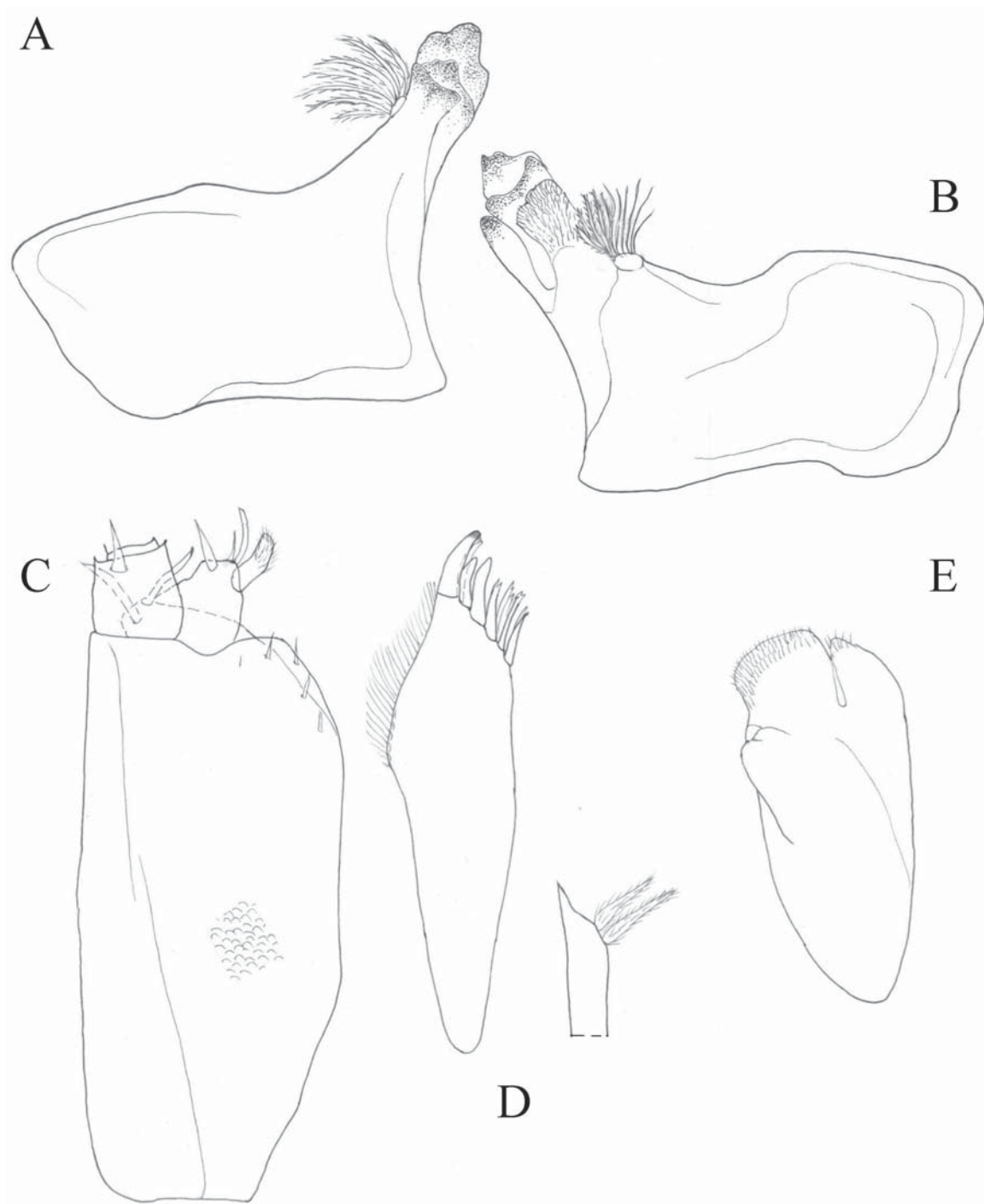


Fig. 11. *Trachelipus armenicus* Borutzky, 1976: A — left mandible; B — right mandible; C — maxilliped; D — maxillula; E — maxilla.

Рис. 11. *Trachelipus armenicus* Borutzky, 1976: A — левая мандибула; B — правая мандибула; C — максиллипед; D — максиллула; E — максилла.

Appendages. Antennula with three articles (Fig. 10D); first article wide and long; second article two times shorter as first; third almost as long as first and narrow, bearing tuft of aesthetascs at apex. Antenna reaching middle of pereonite 3; flagellum with two articles, of equal length. Flagellum as long as fifth segment of antenna (Fig. 10C).

Left mandible (Fig. 11A) with pars incisiva with two teeth; basal to the lacinia is hairy lobe with 2 penicils; molar penicil consisting of tuft of plumose setae. Right mandible (Fig. 11B) with pars incisiva with three teeth; hairy lobe with one penicil; molar penicil as in left. Maxillula (Fig. 11D): medial corner of inner endite with two strong penicils.

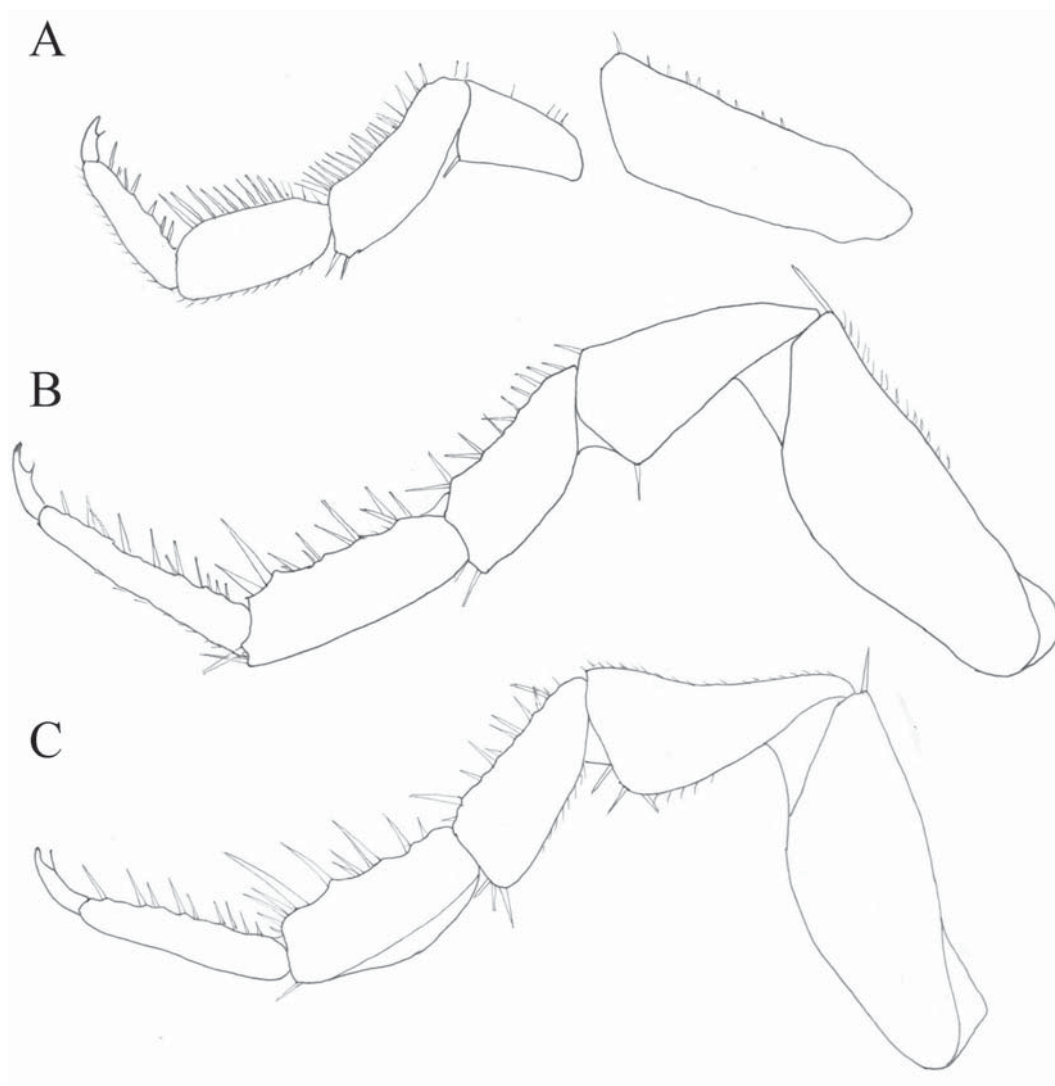


Fig. 12. *Trachelipus armenicus* Borutzky, 1976: A — pereopod 1; B — pereopod 6; C — pereopod 7.

Рис. 12. *Trachelipus armenicus* Borutzky, 1976: A — переопод 1; B — переопод 6; C — переопод 7.

Apical edge of outer endite bearing ten teeth. Six medial teeth slenderer, with cleft tips. Maxilla with bilobate edge, medial half of apical edge of inner lobe with dense brush of short hairs (Fig. 11E). Maxilliped with outer corner of endite with two acute tips and large spine near inner corner (Fig. 11C). Basal article of palp with two large spines. Tip of distal article of palp consisting of brush of spines. Pleopods with all exopods bearing uncovered lungs. Uropods (Fig. 10A) with exopods flattened and oval shaped, with three relatively large spines on apex.

Male: Pereopods (Fig. 12A–C). Ischium of pereopod 7 with ventral margin slightly concave. Carpus has prominent dorsal crest, widest in middle of carpus (Fig. 12C).

Genital papilla of shape typical of genus. Exopod of pleopod 1 with long distal process parallel to base of segment directed outwards (Fig. 13A). Pointed end of outgrowth curves somewhat backward and extends beyond outer margin of exopodite. Edge of pseudotrachea smooth. Endopod of pleopod 1 with dorsal furrow and with row of spines which become longer the closer to tip they are (Fig. 13B).

Pleopod 2: exopod triangular with concave outer margin (Fig. 13C); endopod much longer than exopod, narrow, with parallel sides (Fig. 13C). Exopod of pleopods 3–5 (Fig. 13D–F) triangular, slightly decreasing in size from third to fifth.

REMARK. This species is the closest to *T. ensiculatorum* (Verhoeff, 1949) from ~~Sakam~~ (E Turkey), but in *T. armenicus* this segment is slenderer, with an almost straight rather than rounded inner margin and a thinner and longer distal process [Borutzky, 1976].

DISTRIBUTION. The species has been found around Yerevan, Armenia, where it is a common species [Borutzky, 1976]. Now we report it also from Dagestan, Russia.

Trachelipus nassonovi Borutzky, 1976
Figs 14–17.

Porcellio Nasonowii Korčagin in Bogdanov, 1886: column 307 (n.nud.)

Porcellio Nassonowii Korčagin in Bogdanov, 1888: column 284 (n.nud.)

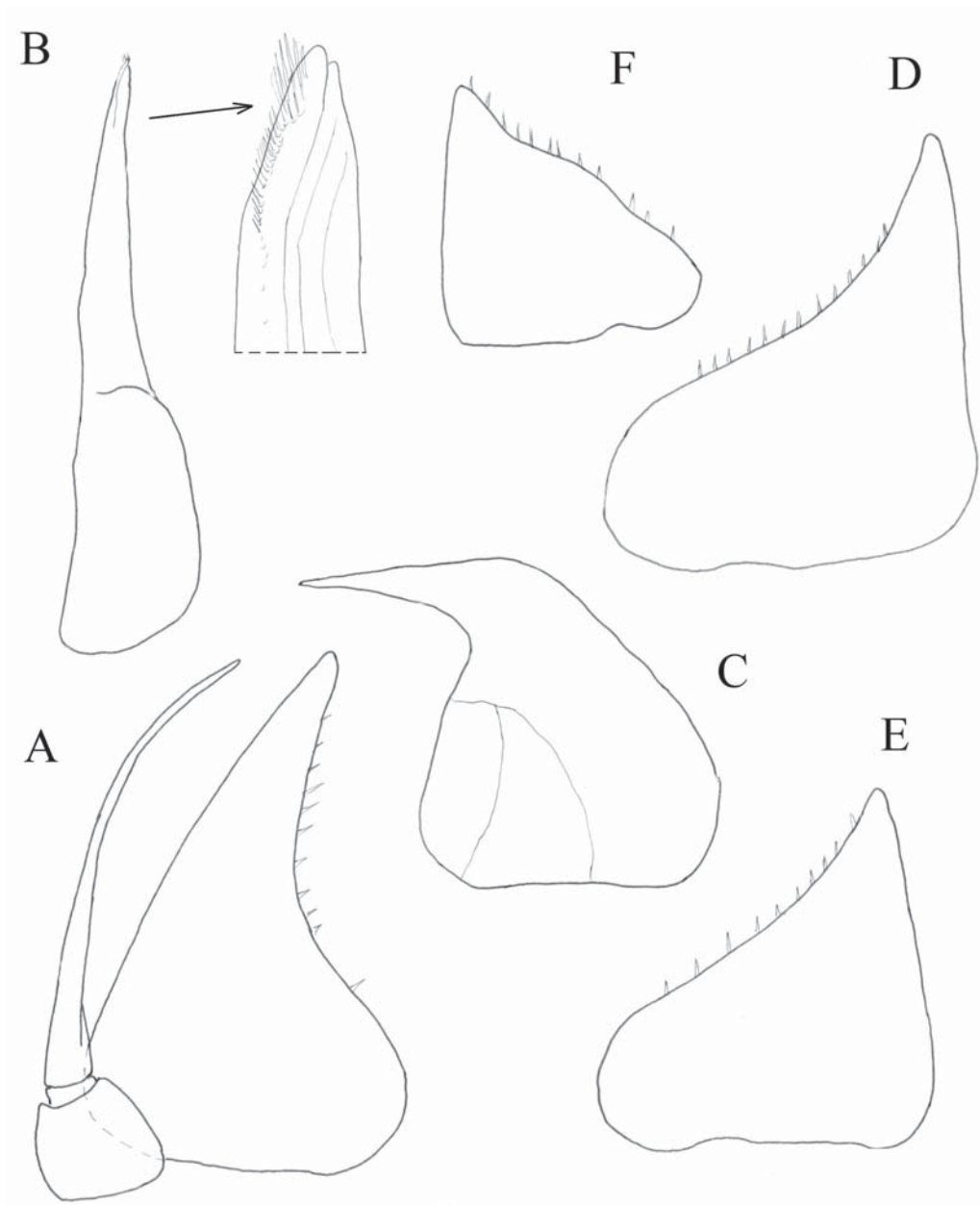


Fig. 13. *Trachelipus armenicus* Borutzky, 1976: A — exopod of pleopod 1; B — endopod of pleopod 2; C — exopod and endopod of pleopod 2; D — exopod of pleopod 3; E — exopod of pleopod 4; F — exopod of pleopod 5.

Рис. 13. *Trachelipus armenicus* Borutzky, 1976: A — экзопод плеопода 1; B — эндопод плеопода 1; C — экзопод и эндопод плеопода 2; D — экзопод плеопода 3; E — экзопод плеопода 4; F — экзопод плеопода 5.

Trachelipus nassonovi (Korčagin, 1888): Borutzky, 1976: 137–139, fig.1(1–10)

MATERIAL (Fig. 1). Holotype (not seen): ♂ (ZMMU Mc-237), Armenia, Aleksandropol [=Gyumri]. VIII.1885. Nassonov leg.

Azerbaijan, N. Snegovaya leg.: Shemakha, Demirchi (40.8402° N 48.5529° E), 3.V.2017; Siyazan Distr., Beshbarmak (40.9585° N 49.2274° E), IV.2015; Kedabek, Novosaratovka (40.4992° N 45.6747° E), 6.X.2015; Siyazan, Galaalty settlement (41.0876° N 48.9408° E), 17–19.V. 2017; Lankaran, Apo-Bilasar (38.6669° N 48.7338° E), 18.V.2021; Lankaran, Byurdzhali, Azdilis (38.6675° N 48.7862° E), 13–14.X.2021.

DIAGNOSIS. Antennal flagellum with the articles 2 to 3 ratio; male exopod of pleopod 1 with long distal process parallel to basal segment directed outwards; and male carpus of pereopod 7 with prominent dorsal bicuspid crest.

TYPE LOCALITY: Armenia, Gyumri (40.47° N 43.50° E).

RE-DESCRIPTION. *Somatic characters*. Body length: males 9.0–15.0 mm, females 10.0–16.0 mm. Body colour brown with scattered small yellow spots, forming white stripe on proximal part of epimeres. Yellow stripe widens on rear corners of rear segments. Exopods of uropods dark.

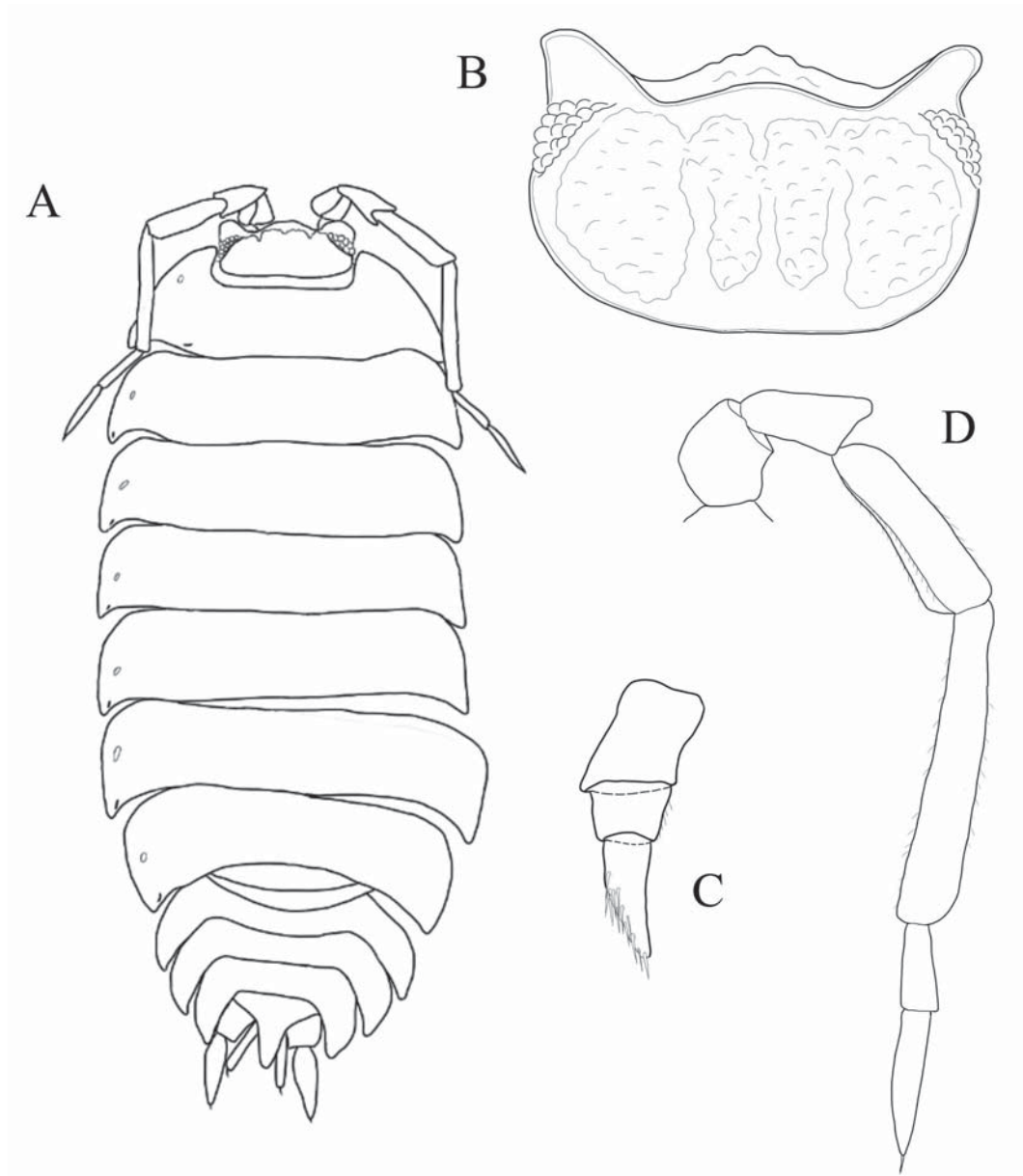


Fig. 14. *Trachelipus nassonovi* Borutzky, 1976: A — pereon epimera with noduli laterales and glandular pore fields; B — head; C — antennula; D — antenna.

Рис. 14. *Trachelipus nassonovi* Borutzky, 1976: A — эпимеры перейона с noduli laterales и поровыми полями; B — голова; C — антеннула; D — антенна.

Dorsal surface of cephalon with smooth but distinct tuberosity. Pereon tergites smooth. Rear edge of tergites with long tubercle, which goes to epimeres. Posterior margin of coxal plates on segments 1–3 deeply sinuous (Fig. 14A). Dorsal surface covered with Y-shaped scale-setae. Glandular pore fields large, oval-shaped, located at distance of 1–2 diameters from lateral margin (Fig. 14A). Body relatively wide; pleon forms continuous margin with pereon (Fig. 14A). Noduli lateralis located close to posterior edge of tergites, on pereonite 1 much more centrally (Fig. 14A). Cephalic lobes well-developed, rounded on top, curved outside. Middle lobe protrudes forward as slightly rounded angle; obtuse angle between it and lateral lobes (Fig. 14B). Telson trian-

gular, sinuous on sides. Telson protrudes beyond propodites of uropods (Fig. 14A).

Appendages. Antennula with three articles (Fig. 14D); first article wide and long; second article two times shorter as first; third almost as long as first and narrow, bearing tuft of aesthetascs at apex. Antenna reaching middle of pereonite 3; flagellum with two articles, of ratio two to three. Flagellum shorter than fifth segment of antenna (Fig. 14D).

Left mandible (Fig. 15A) with pars incisiva with two teeth; basal to lacinia is hairy lobe with two penicils; molar penicil consisting of tuft of plumose setae. Right mandible (Fig. 15B) with pars incisiva with three teeth; hairy lobe with one penicil; molar penicil as in left. Maxillula (Fig.

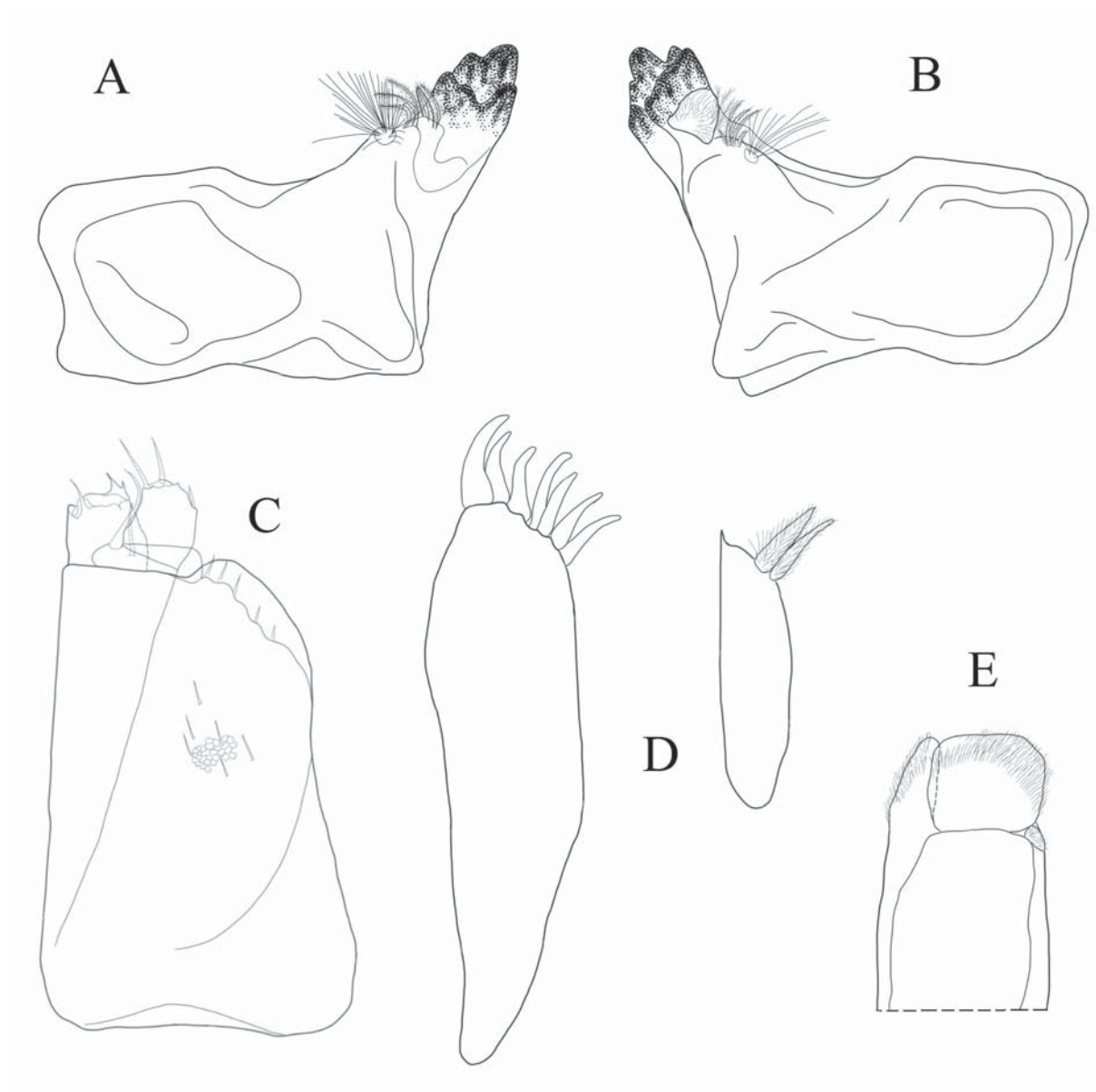


Fig. 15. *Trachelipus nassonovi* Borutzky, 1976: A — left mandible; B — right mandible; C — maxilliped; D — maxilla; E — maxillula.

Рис. 15. *Trachelipus nassonovi* Borutzky, 1976: A — левая мандибула; B — правая мандибула; C — максиллипед; D — максилла; E — максиллула.

15D): medial corner of inner endite with two strong penicils. Apical edge of outer endite bearing ten teeth. Six medial teeth are slenderer, with cleft tips. Maxilla with bilobate edge, medial half of apical edge of inner lobe with dense brush of short hairs (Fig. 15E). Maxilliped with outer corner of endite with two acute tips and large spine near inner corner (Fig. 15C). Basal article of palp with two large spines. Tip of distal article of palp consisting of brush of spines. Pleopods with all exopods bearing uncovered lungs. Uropods (Fig. 14A) with exopods flattened and oval shaped, with 3 relatively large spines on apex.

Male: Pereopods (Fig. 16A–C). Ischium of pereopod 7 with ventral margin slightly concave. Carpus with prominent bicuspid dorsal crest (Fig. 16C).

Genital papilla of shape typical of genus (Fig. 17H). Exopod of pleopod 1 with distal process parallel to base of segment directed outwards (Fig. 17A). Pointed end of outgrowth curves somewhat backward and extends beyond outer margin of exopodite. Edge of pseudotrachea smooth. Endopod of pleopod 1 with dorsal furrow and with row of spines which become longer the closer to tip they are (Fig. 17B). Pleopod 2: exopod triangular with concave outer margin (Fig. 17C); endopod much longer than exopod, narrow, with parallel sides (Fig. 17C). Pleopod 3–5: exopods (Fig. 17D–F) triangular, slightly decreasing in size from third to fifth.

REMARKS. Borutzky [1976] erroneously treated the authorship of *Trachelipus nassonovi* as (Korčagin, 1888). Correct affiliation should be *T. nassonovi* Borutzky, 1976.

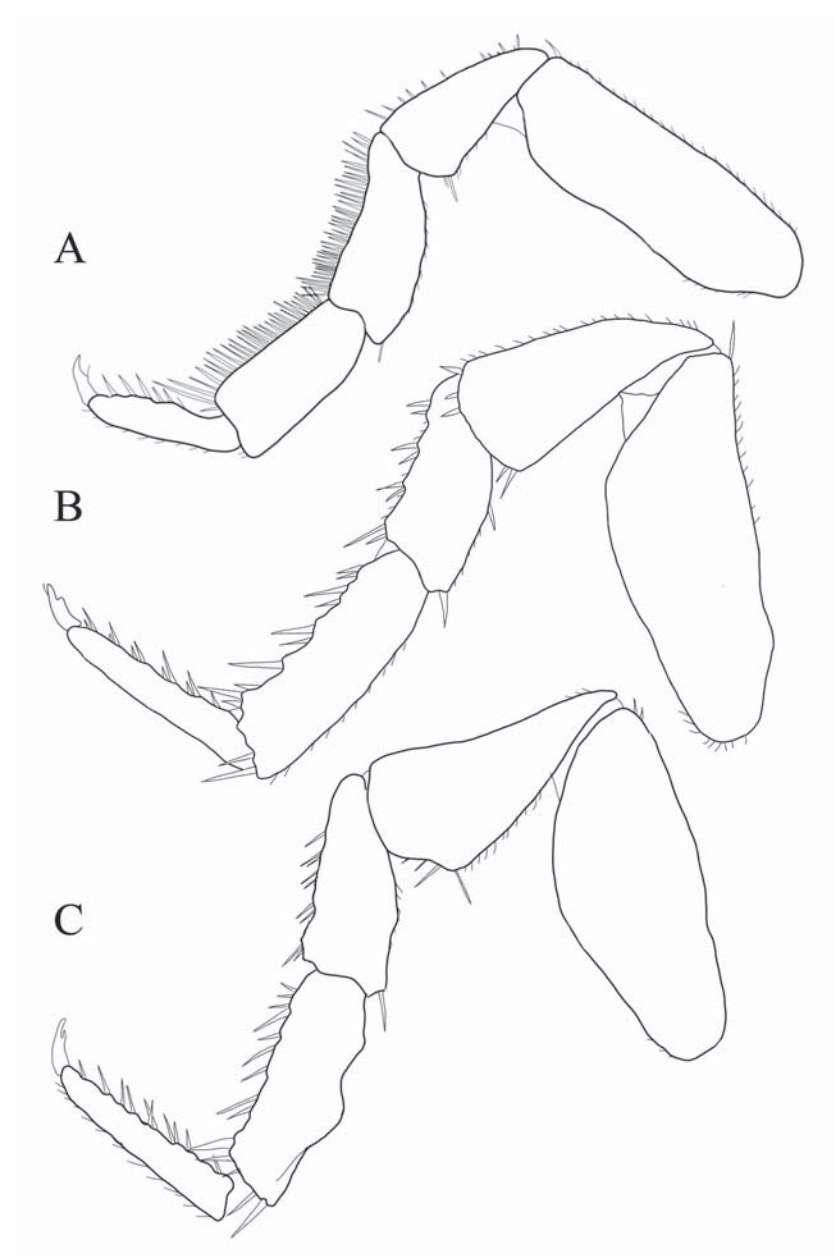


Fig. 16. *Trachelipus nassonovi* Borutzky, 1976: A — pereopod 1; B — pereopod 6; C — pereopod 7.

Рис. 16. *Trachelipus nassonovi* Borutzky, 1976: A — перепод 1; B — перепод 6; C — перепод 7.

This species is the closest to *Trachelipus arcuatus* (Bude-Lund, 1885) from, but in *T. nassonovi* the outer margin of pleopod of exopod I is with wider notch; medial lobe is better developed; and the shape of carpus VII is different [Borutzky, 1976].

DISTRIBUTION. The species has been found in Armenia and Azerbaijan (Fig. 1).

Phylogenetic relationships between the studied species

As a result of studying of a fragment of the mitochondrial locus COI with a length of 553 bp., 1 haplo-

type of *T. lencoranicus*, 2 haplotypes of *T. pieperi*, 3 haplotypes of *T. armenicus*, and 1 haplotype of *T. lignai* were revealed for the first time. The minimum genetic distance among species of the genus *Trachelipus* was found between *T. lencoranicus* and *T. pieperi* (p-distance — 0.048, model T92 — 0.055), and the maximum between *T. armenicus* and *T. ratzeburgii* (p-distance — 0.18, model T92 — 0.252).

Reconstruction of phylogenetic relationships, including related species were carried out by various methods, showed common features in the topology. A high level of support was found only for the branch

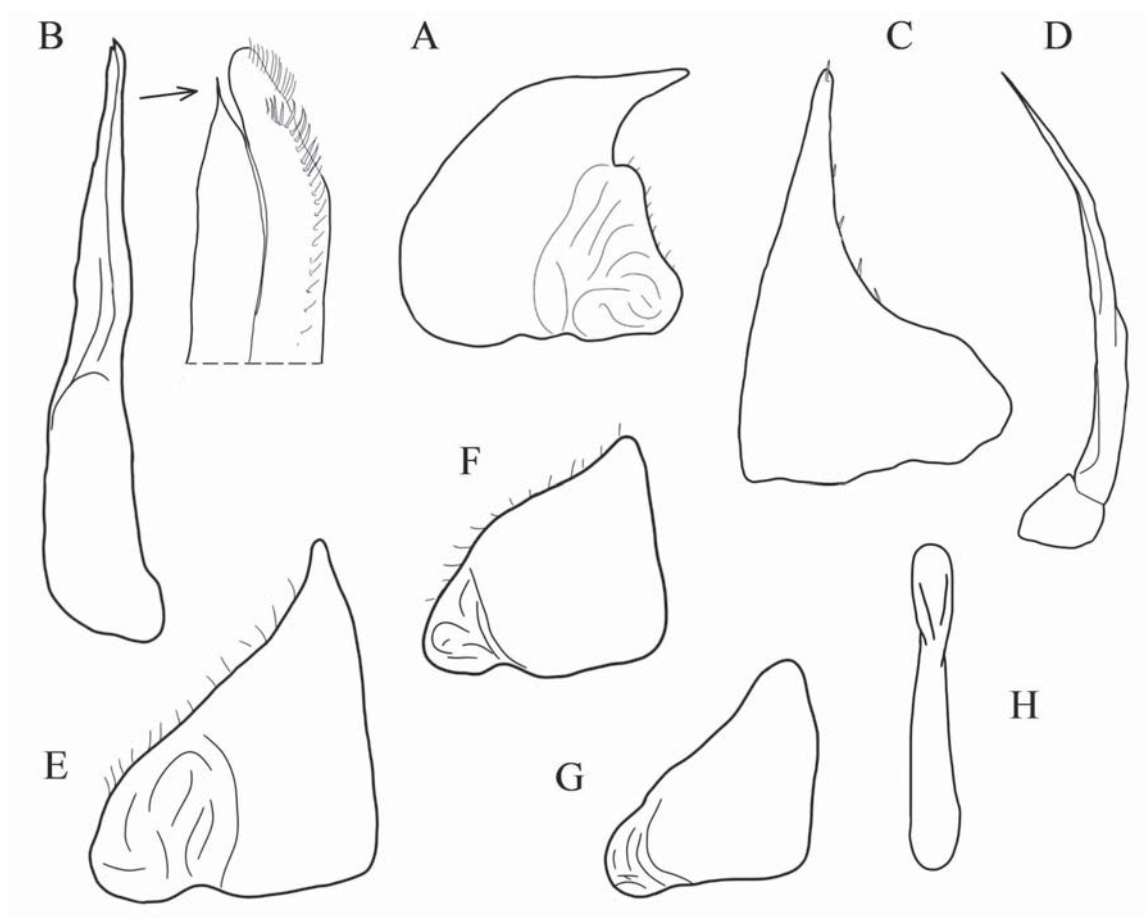


Fig. 17. *Trachelipus nassonovi* Borutzky, 1976: A — exopod of pleopod 1; B — endopod of pleopod 1; C — exopod of pleopod 2; D — endopod of pleopod 2; E — exopod of pleopod 3; F — exopod of pleopod 4; G — exopod of pleopod 5; H — genital papilla.

Рис. 17. *Trachelipus nassonovi* Borutzky, 1976: А — экзопод плеопода 1; В — эндопод плеопода 1; С — экзопод плеопода 2; D — эндопод плеопода 2; E — экзопод плеопода 3; F — экзопод плеопода 4; G — экзопод плеопода 5; H — генитальная папилла.

Table 2. Interspecies genetic distances of species of the genus *Trachelipus* Budde-Lund, 1908 (p-distances in lower left part; distances of molecular evolution model T92+G+I (+G parameter = 0.94) in upper right part).
Таблица 2. Межвидовые генетические дистанции видов рода *Trachelipus* Budde-Lund, 1908 (p-дистанции в нижней левой части; дистанции модели молекулярной эволюции T92+G+I (параметр +G = 0,94) в верхней правой части).

| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>Trachelipus lencoranicus</i> | | 0.055 | 0.125 | 0.132 | 0.181 | 0.178 | 0.202 | 0.228 |
| <i>Trachelipus pieperi</i> | 0.048 | | 0.109 | 0.127 | 0.187 | 0.158 | 0.208 | 0.213 |
| <i>Trachelipus rathkii</i> | 0.091 | 0.078 | | 0.120 | 0.114 | 0.127 | 0.147 | 0.182 |
| <i>Trachelipus armenicus</i> | 0.107 | 0.100 | 0.088 | | 0.182 | 0.141 | 0.196 | 0.252 |
| <i>Trachelipus aegaeus</i> | 0.131 | 0.130 | 0.074 | 0.130 | | 0.164 | 0.219 | 0.206 |
| <i>Trachelipus nodulosus</i> | 0.136 | 0.121 | 0.092 | 0.112 | 0.120 | | 0.224 | 0.238 |
| <i>Trachelipus lignaui</i> | 0.156 | 0.155 | 0.107 | 0.150 | 0.149 | 0.165 | | 0.213 |
| <i>Trachelipus ratzeburgii</i> | 0.169 | 0.156 | 0.126 | 0.180 | 0.149 | 0.174 | 0.160 | |

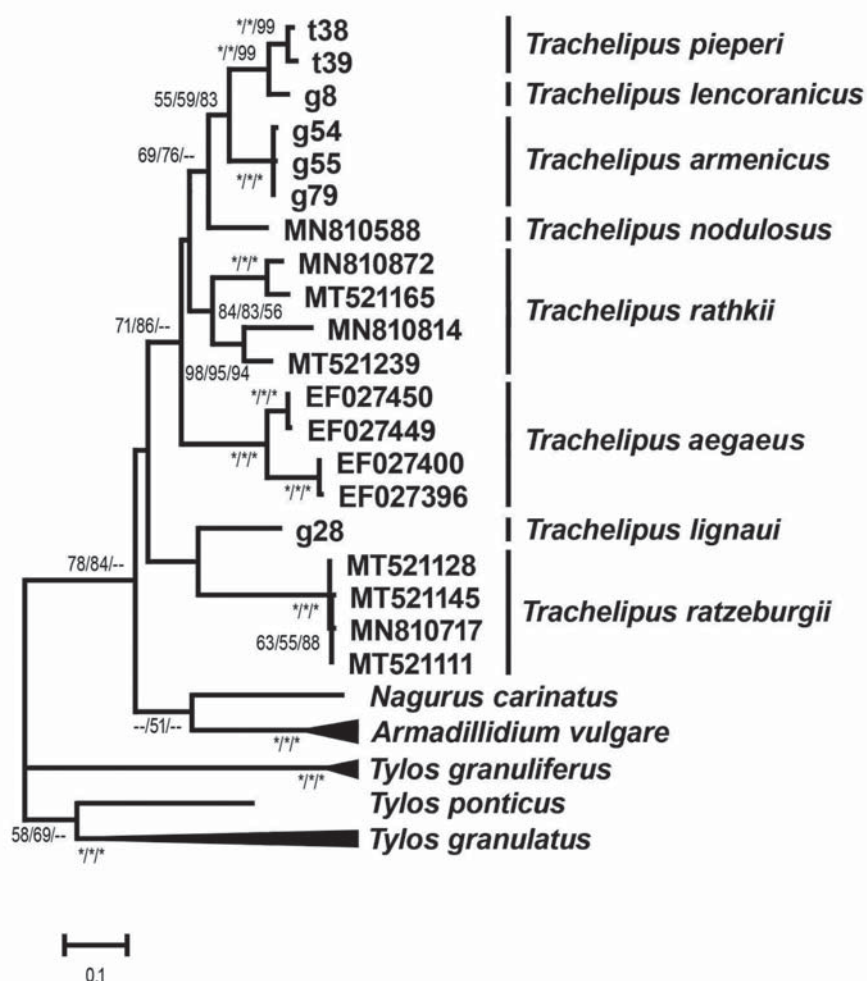


Fig. 18. Reconstruction of the phylogenetic relationships of species among the genus *Trachelipus* Budde-Lund, 1908 based on the variability of COI gene fragment (553 bp). Length of bars is based on the genetic distances between haplotypes. Bootstrap values [Felsenstein, 1985] calculated by three methods are indicated as NJ/ML/MP (see Material and Methods): “*” — 100%, “—” or no value, <50%.

Рис. 18. Реконструкция филогенетических взаимоотношений видов рода *Trachelipus* Budde-Lund, 1908 по изменчивости фрагмента гена COI (553 п.н.). Длина столбцов основана на генетических расстояниях между гаплотипами. Значения начальной загрузки [Felsenstein, 1985], рассчитанные тремя методами, обозначаются как NJ/ML/MP (см. Материалы и методы): «*» — 100%, «—» или отсутствие значения, <50%.

nodes of individuals of the same species in cases where the species was represented by several specimens. Regardless of the method of constructing phylogenetic trees, the level of support for the formation of many branches is low (less than 75%) (Fig. 18), it becomes impossible to describe the nature of phylogenetic relationships at this level of reliability. The main reasons for the observed pattern are the high variability of the selected marker and the small number of species presented in the work (8 out of approximately 50 species [Boyko *et al.*, 2008]).

Acknowledgements. The authors are grateful to Dr. Andreas Allspach (Senckenberg, Germany) for lending material from Senckenberg Museum; Dr. Natalia Yu. Snegovaya (Baku, Azerbaijan) for extensive collections in Azerbaijan,

Dr. Daniil I. Korobushkin for collecting material in Dagestan and Dr. Eduard A. Galoyan for collecting material in Armenia; Philipp S. Byzov for lending material from Dagestan (all — Moscow, Russia). We thank Kirill G. Mikhailov, Philipp S. Byzov (both — Moscow, Russia) and Stefano Taiti (Firenze, Italy) for their advice on the nomenclature of *Trachelipus nassonovi*.

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Responsible editor K.G. Mikhailov