New Carabodidae (Acari: Oribatida) of Georgia

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New samples from different regions of Georgia contribute to the knowledge of Carabodidae species in this region. *Austrocarabodes folicieisetus georgiensis* subsp. n. and *Carabodes djaparidzae* sp. n., are described as new taxa for the Georgian fauna. A regional form of the Nearctic *Carabodes granulatus* Banks, 1895 is described. It is the first Palaearctic record of the species, collected in litter and soil of *Carpinus-Fagus* forest in Western Georgia. *A. f. georgiensis* subsp. n. occurs in a semi-desert region of Eastern Georgia, *C. djaparidzae* sp. n. was found in a *Carpinus* forest in Eastern Georgia. The characters of the species are discussed and compared with those of similar species in these genera.

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**Introduction**

The Carabodidae is a large and globally distributed family of oribatid mites with about 34 genera (Mahunka 1986, 1987) and many species. Three genera of Carabodidae have been recorded from Georgia: *Austrocarabodes* Hammer, 1966, *Carabodes* C. L. Koch, 1835 and *Odontocephus* Berlese, 1913, with 17 species in total (see Shtanchaeva 2001). Research carried out recently in different regions of Georgia provided additional knowledge on the taxonomy and distribution of these mites (Weigmann & Murvanidze 2003). In this paper we describe a new species (*Carabodes djaparidzae* sp. n.) and a new subspecies (*Austrocarabodes folicieisetus georgiensis* subsp. n.) and additionally, a regional form of the Nearctic *Carabodes granulatus* Banks, 1895. This paper contributes to a revision of the regional fauna of Georgia, a region which links three Palaearctic biogeographical regions (Caucasian region, partly alpine – Turkish and Iranian regions, subtropic to tropic) and, therefore, is of high biogeographical interest. This revision includes critical discussion of earlier descriptions of Caucasian species and of Georgian records of species described from other regions originally.

**Material and methods**

The material was collected by soil samples; the mites were extracted by use of modified Berlese-funnels. The animals were stored in ethanol until preparation and were studied after clearance in lactic acid in open hollow-ground microscope slides covered partly with a cover slip, which allows to view the animal in different positions. Permanent slide preparations are mounted in modified Berlese-fluid. The terminology of morphological structures follows van der Hammen (1980) and Weigmann (2006).

*Austrocarabodes folicieisetus georgiensis* subsp. n.

Figs 1–5

**Type material.** Holotype ♀: Georgia: Eastern Georgia, soil of river Pantishara gorge (at the border to Azerbaijian), N 41°08’30.98”, E 46°38’24.25”; altitude 262 m. Collected by A. Bukhnikashvili, 2.vii.2003. Material in permanent slide deposited in collections of Georgia LEPL Institute of Zoology.

**Diagnosis**

Notochaster structured with clear tubercles, sculpture of prodorsum formed by irregular ridges, the one of the ventral plate by bright foveolae. Interlamellar
setae long phylliform. Sensilli bacilliform, bent upwards, distally granulated. 14 pairs of notogastral setae phylliform and dentate. All adanal and anal setae phylliform.

Description

Prodorsum. Sculpturing with fine pattern of irregular ridges. Lamellae rounded. Rostral setae strong, thick bacilliform, dentate, curved inside. Lamellar setae situated on the anterior edge of lamellae, thick, strong, barbed. Interlamellar setae the longest prodorsal setae, phylliform, with dentate edges. The sensillus bacilliform and pointed, curved upwards, distal part slightly granulated, about 90 μm long (Fig. 1, 3).

Notogaster. Cuticle covered with clear tubercles. Dorsosejugal line nearly straight. On the shoulders strongly chitinized, triangular tubercles present. With 14 pairs of long, phylliform, dentate notogastral setae, length about 60 μm (Fig. 1).


Legs. With 1 claw.

Ecology
The semi desert vegetation is dominated by the tree Pistacia mutica F. et M.

Discussion
Three species of Austrocarabodes have been recorded (Shtanchaeva 2001) from the Caucasus area: A. foliaceisetus Krivolutski, 1969, A. ensifer (Sellnick, 1931) and A. arrogans Perez-Iñigo, 1967. The new subspecies resembles most of all A. foliaceisetus, firstly described from Kirgizia (Krivolutski 1971), but there are some evident differences. (1) In the original description of A. foliaceisetus, its length is indicated as 602 μm; in the identification keys edited by Ghilarov & Krivolutski (1975) the length is given as 610 μm; both records show a slender body size (in contrast to all cited European species) with a length/width-index of 2–2.2. The new subspecies has a body length of 540 μm and a length/width-index of 1.8. (2) The sculpture of the body surface of A. foliaceisetus is formed by well developed rough tubercles.
and ridges; the Georgian subspecies has a sculpture with fine clear tubercles on the notogaster and irregular ridges on the prodorsum. (3) The sculpture of the ventral side is quite different: *A. foliaceisetus* has well developed net-pattern on the whole ventral region (similar to that of *A. ensifer*); on the contrary, *A. f. georgiensis* subsp. n. has weakly developed sculpture formed by big light foveolae. (4) According to the original description, the shoulder curvature of *A. foliaceisetus* is weakly developed and lacks any triangular tubercle, which is present in *A. f. georgiensis* subsp. n., as in *A. ensifer* and other species. Future findings will allow to assess the variability of the differentiating characters. For the present, we avoid to declare it a new species. We think it more probable that the citations from the Caucasus region (Shtanchaeva 2001) concern the new subspecies than the Kirgizian nominal subspecies.

With a body length of 495–565 μm and a length/width-index of 1.8, *A. ensifer* is similar in size and proportions to *A. f. georgiensis* subsp. n. The sculpture of the prodorsum is formed by roundish foveolae. The sensilli are with 50–55 μm length shorter and have a distinctly thickened head (Fig. 7). According to Ghilarov & Krivolutski (1975), *A. ensifer* has rounded shoulders and no tubercles, but Perez-Itígo (1971, 1997) illustrated chitinized triangular tubercles. This character is also shown by recent findings of *A. ensifer* in Portugal by one of the authors (G. W.), which are in concordance with the redepiction of Mahunka (1986) from Greece, where the type locality is situated. Strong differential characters of *A. ensifer* are the thin anal setae and adanal setae ad₃, whilst the same are phylliform in both subspecies of *A. foliaceisetus*. The ventral plate has a net-like structure. For reasons of comparison we present figures of *A. ensifer* from South Portugal (Figs 6–9). *A. ensifer* is distributed in Europe from the Iberian region through the Mediterranean area to the Caucasus region; the references in Shtanchaeva (2001)

Figs 6–9. *Austrocarabodes ensifer*. – 6, Dorsal aspect; 7, sensillus; 8, notogastral seta la; 9, ventral aspect of anal region. Scales: at 6: 100 μm; at 8: 100 μm, for 7–9.
regarding *A. ensifer* might be based on material of *A. f. georgiensis* subsp. n., indeed. But the material was not available for us.

The species *A. arrogans*, originally described from Spain, is 500–550 μm in length and broader than *A. f. georgiensis* subsp. n. (length/width-index of 1.6, measured behind shoulders), it has distinctly protruding shoulder curvatures in contrast to *A. ensifer* and *A. foliaceisetus*; all anal setae are leaf-like, too, but the anal setae are fine. The sensillus of *A. arrogans* is setiform and about 90–95 μm long (cf. Pérez-Íñigo 1971, 1997), as in *A. f. georgiensis* subsp. n. From Spain also *A. intermedius* Ruiz et al., 1989, is known, which is very large (540–660 μm length) and slightly broader than *A. f. georgiensis* subsp. n. (length/width-index 1.7), it has fine ad3 and an setae, as *A. ensifer*; the sensillus is unique: setiform with fine setulae in the distal part (cf. Pérez-Íñigo 1997).

**Carabodes cf. granulatus**

Banks

Figs 10–14

*Carabodes granulatus* Banks, 1895: 129.

*Carabodes omo* Jacot, 1937: 241. Type data (synonymised by Norton 1978)

*Carabodes granulatus*; Norton 1978: 614 (redescription)

**Diagnosis**

Anterior part of prodorsum widely foveolate, posterior part with larger foveolae and chitinized longitudinal ridges; dorsosejugal groove narrow. Interlamellar and notogastral setae are phylliform and barbed; rostral and lamellar setae setiform to spiniform; head of sensilli finger-like divided. Sculpture of notogaster and ventral plate with rosette-like foveolae. Adanal setae ad1, ad2 phylliform, ad3 fine and short.

**Description**


Prodorsum. Sculpture in the anterior part of prodorsum formed by wide-set arranged foveolae and in posterior part by larger foveolae and irregular longitudinal ridges. Lamellae broad. Rostral setae nearly smooth, curved inside; lamellar setae thick setiform curved and barbed. Interlamellar setae situated near to the lamellae, phylliform, barbed, about 30 μm long. Sensilli about 40 μm long, with a short stalk and a distally finger-shaped head. Prodorsum with narrow dorsosejugal groove (Fig. 10).

Notogaster. Sculpture formed by bright rosette-like foveolae surrounded by dark cuticula surface, with fine granula (Fig. 13). With 10 pairs of phylliform, barbed notogastral setae, length 20–30 μm (Fig. 12).

Ventral side. Sculpture with rosette-like foveolae. Epimal formula 3–1–2–3, all setae are smooth, pointed. Genital-anal formula 4g–1ag–2a–3ad. Genital setae short, about 5 μm, smooth, thin; ag setae 7 μm, smooth, thin. ad1, ad2 phylliform, barbed about 40 μm. ad3 thin and smooth (Fig. 14).

Legs. With 1 claw.


**Discussion**

The species is widely distributed in Northern America, but has not yet been found in the Palaearctic region. Its typical habitat is forest litter, rotten wood and soil, preferably with lichens and moss (Reeves 1988). The Georgian species shows evident similarities with *C. granulatus* in shape of sensilli, interlamellar and notogastral setae, sculpture of notogaster and shape of anal setae, as far as the indications of the American authors are given. The identification key of Reeves & Behan-Pelletier (1998) of the North American species leads to *C. granulatus*, a similar European species is not known to us.

Nevertheless, there are some differences: (1) the lamellar setae of *C. granulatus* in the SEM picture in Reeves & Behan-Pelletier (1998) looks as thin as the rostral setae; yet, Jacot (1937) indicates for *C. omo* a body length of 430 μm and “rostral and lamellar bristles stout, spikelike, faintly burred”, which seems to fit to the setae in our Fig. 10. (2) The lengths of the interlamellar and notogastral setae of *C. granulatus* (Fig. 41 in Reeves & Behan-Pelletier 1998) seem to be longer than in the Georgian specimen; still, the Fig. 11 in Norton (1978) gives the same size range (20–30μm) for the interlamellar and notogastral setae. (3) Reeves & Behan-Pelletier (1998) indicate unequal adanal setae for *C. granulatus* (without further details); Jacot (1937) declares all ventral setae as “short, except ad2 and ad3, the latter being half length of notogastral bristles, and weakly clavate-fimbriate”. It seems to us that the numbering of an setae by Jacot is the opposite of the one given in the contemporary literature, and he may have described the setation as in our Fig. 14. Yet, the Georgian speciimen has longer adanal setae than notogastral setae; Jacot describes the opposite characteristic. There is no certainty of the specific identity with *C. granulatus*, but the likelyhood is high.
One of the diagnostic characters of the species are the phylliform interlamellar and notogastral setae. *C. bellus* Aoki, 1959, *C. chirstlus* Mahunka, 1987, and *C. foliatus* Morell, 1990, have similar setae. Differences are as follows.

With 550–660 μm, *C. bellus* is much longer than *C. granulatus*. Posterior part of prodorsum strongly chitinized, notogastral sculpture is made with tubercles (Aoki 1959).

With 500–566 μm, *C. chirstlus* is also longer; with long, fusiform, bent sensillus, large dorsosejugal groove at prodorsum, and notogastral sculpture with polygonal pattern and tubercles (Mahunka 1987).

*Carabodes foliatus* differs in non phylliform notogastral setae of the p-row, a different form of sensillus and special apophyses in the dorsosejugal region (cf. Perez-Iñigo 1997).

**Carabodes djaparidzae** sp. n.

*Fig. 15-18*

**Type material.** Holotype ♀, Georgia: Gombori Range, Shuamta; N 42°04′42.17″, E 45°32′38.58″; collected by T. Arabuli, 22.iv.2002. Paratypes: 2♂, same data as Holotype; 2♂, Georgia, Great Caucasus Range, Omalo Plateau; N 42°15′45.19″, E 45°13′01.11″, altitude 1765 m; collected by E. Kvavadze, 7.viii.2004. Type material stored in glycerine, deposited in collections of Georgia LEPL Institute of Zoology.

**Diagnosis**

Notogaster with “flower-shaped” pattern formed by bright foveolae surrounded by chitinized tubercles. Interlamellar setae long, curved inside. Sensillus head distally finger-shaped. 10 pairs of notogastral setae. Setae c₂ long, strong, erect; other notogastral setae ad₁ and ad₂ phylliform, distally widened and barbed.

**Description**

**General characters.** Colour reddish-brown. Body length 510 μm, width 260 μm.

**Prodorsum.** Sculpturing of prodorsum is formed with bright foveolae and irregular longitudinal ridges. The dorsosejugal groove is moderately broad. Lamellae
rounded. Rostral and lamellar setae are curved inside, slightly granulated. Interlamellar setae are 90 µm long, strong, setiform, smooth, slightly curved inside and positioned on the lamellae. The sensilli are directed laterally, head distally finger-shaped (Fig. 15).

**Notogaster.** With “flower-shaped” pattern formed by bright foveolae surrounded by chitinized pavement-like tubercles between which the bright foveolae seem interconnected by bright lines (Fig. 16). With 10 pair of notogastral setae; c₂ setae are about 85 µm long, strong, directed forward. Other setae are 38–50 µm long, phylliform, distally widened and barbed, especially at the distal edge (Fig. 15, 17).

**Ventral side.** Epimeral formula 3–1–3–3. Genital-anal formula 4g–1ag–2an–3ad; ad₁ and ad₂ are distally widened and barbed, ad₃ and an setae are smooth setiform (Fig. 18).

**Legs.** With 1 claw.

**Ecology**
Shuamta: in soil of *Carpinus* forest; Omalo Plateau: moss in *Populus tremula-Pinus* forest; understory with different grasses.

**Etymology**
The name *Carabodes djaparidzae* sp. n. is dedicated to the first oribatidologist of Georgia, Dr. N. I. Djaparidze.

**Discussion**
Based on the descriptions of two new species, Kuliev (1977) created the new genus *Flexa* and designated *Carabodes dubius* Kuliev, 1968 as type species. Mahunka (1987) considered the differentiating characters of minor taxonomic value with high variability (shape of shoulder and of femora III and IV; orientation of notogastral setae c₂), and he sank *Flexa* again as a junior synonym of the genus *Carabodes*. We agree with the statement of Mahunka and regard *Flexa* as a junior synonym of *Carabodes*.
sp. n. belongs to the species group *Flexa* Kuliev, 1968 semeistvo Carabodidae.


The *notogastral setae* of *C. dubius* are fusiform and barbed all around (cf. Shtanchaeva 2004) with minor length about 25–30 μm. This diagnostic character is evaluated together with recent findings in Georgia (Surami Range, mixed forest soil; leg. M. Murvanidze) and is illustrated in Fig. 19, which is in conformity with the original description and the redescriptions of Shtanchaeva (2004). The notogastral setae in *C. djaparidzae* sp. n. are quite different: flattened leaf-like, distally widened and sparsely barbed (Fig. 17). The redescription of “*C. dubius*” by Mahunka (1987) shows notogastral setae as being typical for *C. djaparidzae* sp. n.; thus, we suppose that his redescription does not regard *C. dubius*. *C. scopulae* has distally widened notogastral setae, similar to those of *C. djaparidzae* sp. n., but the sculpturing of the prodorsum and notogaster are quite different. The posterior part of prodorsum of *C. scopulae* is sculptured with fine longitudinal ridges. The anterior border of the notogaster is rounded forwards and makes the dorsosejugal groove very narrow. The notogastral pattern is characterized by bowed tubercles, which form rosette-like structures isolated from each other (cf. Shtanchaeva 2004).

*C. bidens* differs in bacilliform notogastral setae, slightly widened distally, if at all. The sculpture of the posterior part of the prodorsum is formed by several longitudinal ridges. The notogastral setae c2 of *C. bidens* are distinctly longer (120 μm) than the ones of *C. djaparidzae* sp. n. (85 μm) (cf. Djaparidze 1990).

Sculpture of prodorsum of *C. horreo* is formed by strongly chitinized longitudinal ridges at the posterior part and transversal ridges on the anterior part. The sculpture of the notogaster is formed by bright foveolae, diffuse and indistinct rosette-like pattern. The notogastral setae are thick, bacilliform and short (28–35 μm) (Djaparidze 1990).

The sculpturing of prodorsum and notogaster in *C. tarbae* is similar to that in *C. djaparidzae* sp. n. The notogastral setae of *C. tarbae* are variable in shape: from smooth and pointed in the centrodorsal region to slightly widened bacilliform and barbed in the posterior-marginal region (Shtanchaeva 2004). All listed species were found in the mountains of the Caucasus. An additional species of the “*Flexa*-type” is *C. intermedius* Willmann, 1951, which occurs in alpine meadows of Switzerland (Schweizer 1956), and in the Italian and Austrian Alps. The notogastral ornamentation is similar to that of *C. djaparidzae* sp. n. and *C. tarbae*, as redescribed by Weigmann (2006). The notogastral setae are about 50 μm in length and are setiform to bacilliform, at most slightly widened, sparsely barbed. The anal setae ad1 and ad2 are strong setiform, ad3 and the anal setae are fine (cf. redescriptions of Bernini & Baratti 1991; Weigmann 2006). The redescription of “*C. intermedius*” from the Caucasus region of Georgia in Murvanidze & Arabuli (2003) refers to *C. djaparidzae* sp. n.

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### References


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