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The first records of two cryptic species of the genus *Cardiocondyla* Emery, 1869 (Hymenoptera: Formicidae) in Russia

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Abstract. Two ants, *Cardiocondyla brachyceps* Seifert, 2003 and *C. persiana* Seifert, 2003, are recorded from Russia for the first time. These species were found in Krasnodar Region, in Novorossiysk and Sochi, respectively. The closest known locality for both species is western Georgia. The localities in Krasnodar Region are the westernmost for these species known so far. Both species are similar to other representatives of the *C. elegans* group and can be confidently identified using both the microsculpture of the head surface and morphometric characteristics.

Key words: cryptic species, ants, *Cardiocondyla*, morphometry, new records.

Первые находки двух криптических видов рода *Cardiocondyla* Emery, 1869 (Hymenoptera: Formicidae) в России

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Резюме. Представлены сведения о первых находках в России муравьев *Cardiocondyla brachyceps* Seifert, 2003 и *C. persiana* Seifert, 2003. Виды найдены на территории Краснодарского края, в Новороссийске и Сочи соответственно. Ближайшим известным местонахождением обоих видов является Западная Грузия. Местобитания в Краснодарском крае – самые западные из известных для этих видов на данный момент. Оба вида сходны с другими представителями группы видов *C. elegans* и могут быть надежно идентифицированы только по морфометрическим характеристикам в совокупности с микроскульптурой поверхности головы.

Ключевые слова: криптические виды, муравьи, *Cardiocondyla*, морфометрия, новые указания.

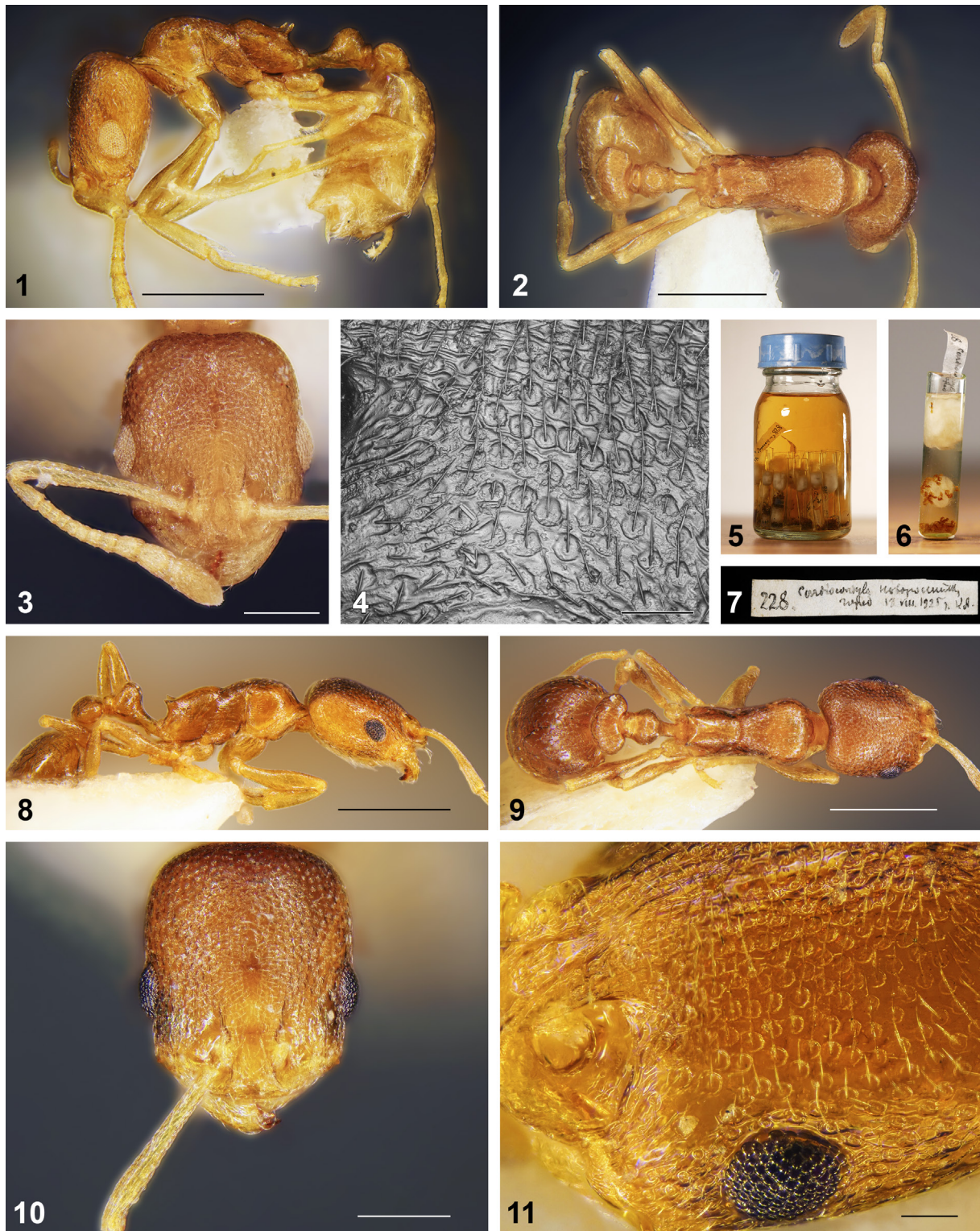
Introduction

The genus *Cardiocondyla* Emery, 1869 is one of the poorly studied ant genera in Eastern Europe. The paper of Arnoldi [1926] on *Cardiocondyla stambuloffii* Forel, 1892 represented for a long time the only research referring to this genus in Russia. Some information about the fauna of the genus was provided by Radchenko [1996]. The last revision of the Palaearctic species of the genus was conducted by Seifert [2023a]. Applying the synonymies given by Seifert to the checklist provided by Dubovikoff and Yusupov [2017] and using the data provided by Seifert [2023a], only four autochthonous species are known to occur on the territory of the Russian Federation: *C. ulianini* Emery 1889, *C. sahlbergi* Forel 1913, *C. stambuloffii* and *C. koshewnikovi* Ruzsky 1902. A lot of *Cardiocondyla* samples collected by K.V. Arnoldi have been preserved

until today in the collections of the Zoological Institute of the Russian Academy of Sciences (ZISP, St Petersburg, Russia) and the Zoological Museum of Moscow State University (ZMMU, Moscow, Russia). But a large part of the material was not identified even by the collector himself. A detailed analysis of the material revealed new records of two species of the genus for the fauna of Russia, *C. brachyceps* Seifert, 2003 and *C. persiana* Seifert, 2003, is given below.

Material and methods

Most of the investigated specimens are deposited in the collection of the Zoological Institute of the Russian Academy of Sciences. Many test tubes with labels were stored in a common glass jar filled with ethanol (Figs 5, 6). About half of the test tubes were marked



Figs 1–11. *Cardiocondyla* samples and label.

1–4 – *C. brachyceps*: 1 – lateral view, 2 – dorsal view, 3 – head, frontal view, 4 – microsculpture of the head surface between the inner eye margin and the paramedian vertex; 5–7 – *Cardiocondyla* samples, collected by K.V. Arnoldi (ZISP): 5 – a glass jar with the test tubes filled with ethanol, 6 – test tube with the *Cardiocondyla* specimens, 7 – label of the *C. brachyceps* sample; 8–11 – *C. persiana*: 8 – lateral view, 9 – dorsal view, 10 – head, frontal view, 11 – microsculpture of the head surface between the inner eye margin and the paramedian vertex. Scale bars: 1–2, 8–9 – 0.5 mm, 3, 10 – 0.2 mm, 4, 11 – 0.05 mm.

Рис. 1–11. Образцы *Cardiocondyla* и этикетка.

1–4 – *C. brachyceps*: 1 – латерально, 2 – дорсально, 3 – голова, фронтально, 4 – микроскульптура поверхности головы между усиковой ямкой и верхним краем глаза; 5–7 – образцы *Cardiocondyla*, собранные К.В. Арнольди (ZISP): 5 – стеклянная банка с пробирками, заполненными этанолом, 6 – пробирка с экземплярами *Cardiocondyla*, 7 – этикетка пробы с *C. brachyceps*; 8–11 – *C. persiana*: 8 – латерально, 9 – дорсально, 10 – голова, фронтально, 11 – микроскульптура поверхности головы между усиковой ямкой и верхним краем глаза. Масштабные линейки: 1–2, 8–9 – 0.5 мм, 3, 10 – 0.2 мм, 4, 11 – 0.05 мм.

with only four-digit numbers, which made their location impossible to determine as they are undocumented in any way. Fortunately, the sample which turned out to be *C. brachyceps* has a geographic label (Fig. 7). The single specimen of *C. persiana* was found in the collection of the Zoological Museum of Moscow State University. Material on these two species from other regions and comparative material was previously examined and published by Seifert [2023a].

The photos were taken via a Motic BA210 microscope in reflected light using a Panasonic Lumix G7 digital camera and via a laser microscope Keyence VK-9700. The final images were processed with Adobe Photoshop CS5. Morphological terms and morphometric analysis were carried out according to Seifert [2023b]. The morphometric measurements of four *C. brachyceps* workers were taken by B. Seifert using a Leica M165C high-performance stereomicroscope equipped with a 2.0× planapochromatic objective (resolution 1050 lines/mm). The single specimen of *C. persiana* from Sochi was measured by D.M. Shevchenko using a Motic BA210 microscope with 10× plan semi-apochromatic objective. These data are less accurate due to lower resolution and magnification of the microscope.

Definition of numeric characters:

CL – maximum cephalic length in median line; the head must be carefully tilted to the position yielding the true maximum; excavations of hind vertex and/or clypeus reduce CL.

CW – maximum cephalic width; the maximum is usually found across and including the eyes, exceptionally posterior of the eyes.

CS – cephalic size; the arithmetic mean of CL and CW, used as a less variable indicator of body size.

dFOV – mean inner diameter of foveolae or of meshes of a reticulum on vertex at about half way between the median line of head and the inner eye margin. These structures usually have the base of a pubescence hairs in their center. At least seven measurements at magnifications of 360× are averaged.

EYE – eye-size: the arithmetic mean of the large (EL) and small diameter (EW).

FRS – distance of the frontal carinae immediately caudal of the posterior intersection points between frontal carinae and the lamellae dorsal of the torulus. If these dorsal lamellae do not laterally surpass the frontal carinae, the deepest point of scape corner pits may be taken as reference line. These pits take up the inner corner of scape

Table 1. Morphometric data of *Cardiocondyla* spp. workers in the sequence arithmetic mean ± standard deviation (minimum, maximum) according to the data given by Seifert [2023a] and supplemented by the two samples provided in this paper.

Таблица 1. Морфометрические данные рабочих особей *Cardiocondyla* spp. в последовательности среднее арифметическое ± стандартное отклонение (минимум, максимум) в соответствии с данными, приведенными Зайфертом [Seifert, 2023a] и дополненными двумя выборками, представленными в этой статье.

	<i>C. sahlbergi</i> (n = 76)	<i>C. persiana</i> Sochi / Сочи (n = 1)	<i>C. persiana</i> (n = 26)	<i>C. brachyceps</i> (n = 20)	<i>C. brachyceps</i> Novorossiysk / Новороссийск (n = 4)
CS, μm	522 ± 20 (468, 564)	553	536 ± 20 (495, 566)	561 ± 22 (498, 587)	570 ± 15 (552, 587)
CL/CW	1.176 ± 0.019 (1.11, 1.254)	1.15	1.165 ± 0.026 (1.123, 1.216)	1.129 ± 0.019 (1.093, 1.164)	1.113 ± 0.014 (1.1, 1.125)
SL/CS	0.8 ± 0.013 (0.764, 0.829)	0.792	0.794 ± 0.017 (0.764, 0.827)	0.842 ± 0.022 (0.812, 0.877)	0.859 ± 0.008 (0.854, 0.871)
PoOc/CL	0.438 ± 0.008 (0.414, 0.453)	0.47	0.441 ± 0.008 (0.429, 0.458)	0.379 ± 0.008 (0.367, 0.396)	0.378 ± 0.004 (0.374, 0.383)
EYE	0.231 ± 0.007 (0.215, 0.244)	0.21	0.233 ± 0.007 (0.224, 0.246)	0.252 ± 0.006 (0.244, 0.268)	0.26 ± 0.006 (0.253, 0.268)
dFOV	17.4 ± 0.82 (15, 19)	18.6	19.4 ± 0.96 (17.8, 21)	19.4 ± 0.85 (18.0, 21)	19.5 ± 0.45 (18.9, 19)
FRS/CS	0.256 ± 0.009 (0.236, 0.275)	0.261	0.254 ± 0.009 (0.235, 0.268)	0.258 ± 0.011 (0.235, 0.273)	0.255 ± 0.011 (0.239, 0.264)
MGr/CS, %	3.73 ± 0.64 (2.3, 6.6)	4.87	4.4 ± 0.99 (2.4, 6.6)	4.4 ± 0.99 (2.4, 6.6)	4.58 ± 0.64 (4, 5.4)
SPBA/CS	0.278 ± 0.013 (0.253, 0.322)	0.25	0.27 ± 0.015 (0.24, 0.294)	0.236 ± 0.016 (0.214, 0.282)	0.243 ± 0.012 (0.23, 0.254)
PEW/CS	0.33 ± 0.021 (0.292, 0.401)	0.332	0.316 ± 0.025 (0.278, 0.355)	0.302 ± 0.015 (0.265, 0.347)	0.315 ± 0.022 (0.299, 0.347)
PPW/CS	0.565 ± 0.024 (0.509, 0.654)	0.554	0.543 ± 0.033 (0.478, 0.593)	0.532 ± 0.028 (0.448, 0.573)	0.548 ± 0.02 (0.528, 0.573)
PEH/CS	0.351 ± 0.013 (0.323, 0.388)	0.36	0.347 ± 0.019 (0.316, 0.382)	0.301 ± 0.014 (0.269, 0.327)	0.303 ± 0.015 (0.285, 0.32)
PPH/CS	0.305 ± 0.011 (0.281, 0.331)	0.297	0.297 ± 0.014 (0.278, 0.323)	0.263 ± 0.015 (0.232, 0.291)	0.264 ± 0.012 (0.255, 0.281)
PLG/CS, %	6.47 ± 0.54 (5.18, 8.06)	6.52	6.77 ± 0.39 (5.61, 7.38)	8.15 ± 0.68 (6.88, 9.08)	8.81 ± 0.37 (8.29, 9.08)

base when the scape is fully switched caudad and produce a dark triangular shadow in the lateral frontal lobes immediately posterior of the dorsal lamellae of scape joint capsule.

MGr – depth of metanotal groove or depression, measured from the tangent connecting the dorsalmost points of promesonotum and propodeum.

ML – mesosoma length in the alates; measured in lateral view from the caudalmost portion of propodeum to the frontalmost point of the anterior pronotal slope (i.e. not to the frontalmost point of the whole pronotum that is usually concealed by the occiput).

PeW – maximum width of petiole.

PeH – maximum height of petiole.

PLG – mean length of pubescence hairs on dorsum of first gaster tergite as arithmetic mean of at least seven measurements taken at magnifications of 360×.

PpH – maximum postpetiole height; the lateral suture of dorsal and ventral sclerites is the reference line perpendicular to which the maximum height of postpetiole is measured.

PpW – maximum width of postpetiole.

PoOc – postocular distance. Use a cross-scaled ocular micrometer and adjust the head to the measuring position of CL. Caudal measuring point: median occipital margin; frontal measuring point: median head at level of posterior eye margin. Note that many heads are asymmetric; therefore, average the left and right postocular distance.

SL – maximum straight line length of scape excluding the articular condyle given as the arithmetic mean of both scapes.

SP – maximum length of propodeal spines; measured in dorsofrontal view along the long axis of the spine, from spine tip to a line, orthogonal to the long axis that touches the bottom of the interspinal meniscus.

SPBA – the smallest distance of the lateral margins of the spines at their base. This should be measured in dorsofrontal view, since the wider parts of the ventral propodeum do not disturb the measurement in this position. If the lateral margins of spines diverge continuously from the tip to the base, the smallest distance at base is not defined. In this case SPBA is measured at the level of the bottom of the interspinal meniscus.

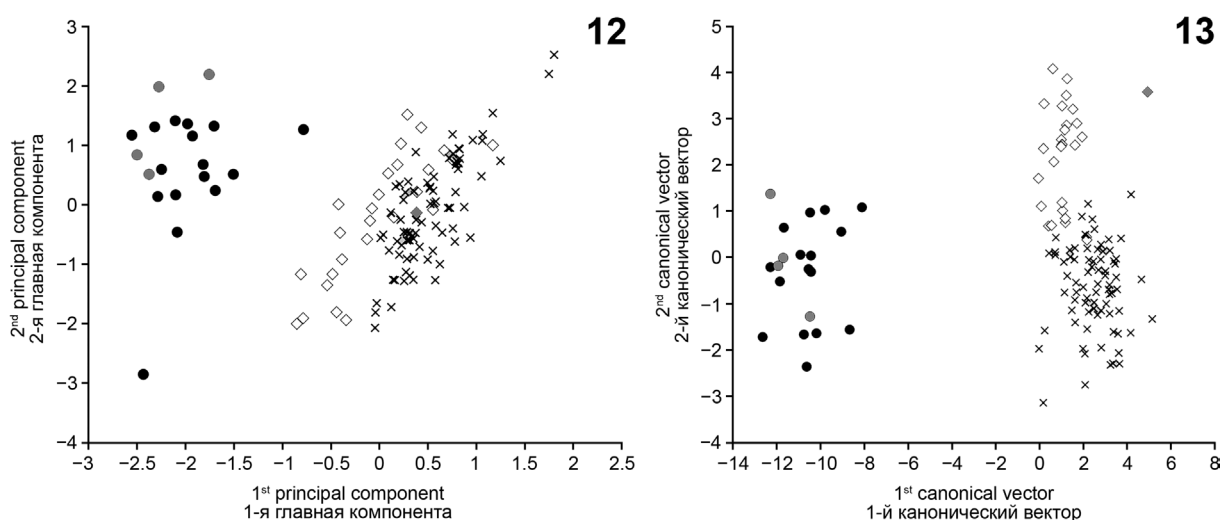
Cardiocondyla brachyiceps Seifert, 2003

(Figs 1–4)

Material. 35 workers (ZISP), “228. *Cardiocondyla* Новороссийск, город 12 VIII.1925 г., КА.” (Russia, Krasnodar Region, Novorossiysk, city, K.V. Arnoldi).

Notes. Among the species groups defined by Seifert [2023b], *C. brachyiceps* is a member of the *C. elegans* species group and is well separable from the two *C. ulianini* species group members known for the fauna of Russia (*C. sahlbergi* and *C. ulianini*) by a much smaller postocular index PoOc/CL and a larger eye size index EYE/CS (Table 1). Furthermore, *C. brachyiceps* differs from the former two species by the microsculpture of the head surface between the inner eye margin and the paramedian vertex, which is rougher, with coarse wrinkles (Fig. 4). A principal component analysis of 14 characters given in Table 1 allocated the four measured specimens from Novorossiysk clearly to *C. brachyiceps* (Fig. 12).

Distribution. The range of the species covers the territory from Eastern Afghanistan (69.5°E) westwards over Iran to southern Georgia and northeast Turkey (41.7°E) [Seifert, 2023a] (Fig. 14). The southern and northern boundaries of the range are unclear. At present, the city of Novorossiysk is the westernmost locality of this species. The closest locality to Novorossiysk is Adjara (41°48'17.4"N /



Figs 12–13. Principal component analysis of 14 morphometric characters given in Table 1 (12) and linear discriminant analysis using the indexes CS, PoOc/CL, PeH/CS, PLG/CS, MGr/CS and dFov (13). Black circles – *C. brachyiceps*, material is given in Seifert [2023a]; gray circles – *C. brachyiceps* (Novorossiysk); white rhombs – *C. persiana*, material is given in Seifert [2023a]; black crosses – *C. sahlbergi*, material is given in Seifert [2023a]; gray rhomb – *C. persiana* (Sochi).

Рис. 12–13. Анализ главных компонент 14 морфометрических характеристик, приведенных в таблице 1 (12), и линейный дискриминантный анализ, использующий индексы CS, PoOc/CL, PeH/CS, PLG/CS, MGr/CS and dFov (13). Черные круги – *C. brachyiceps*, материал приведен в работе Зайферта [Seifert, 2023a]; серые круги – *C. brachyiceps* (Новороссийск); белые ромбы – *C. persiana*, материал приведен в работе Зайферта [Seifert, 2023a]; черные крестики – *C. sahlbergi*, материал приведен в работе Зайферта [Seifert, 2023a]; серый ромб – *C. persiana* (Сочи).

41°47'03.1"E), where nests of the species were found on the sandy bank of the Kinkishi River, in a community of thorny shrubs.

Cardiocondyla persiana Seifert, 2003
(Figs 8–11)

Material. 1 worker (ZMMU), "5240 Sotschi 4.8.31 V. Lutschnik" (Russia, Krasnodar Region, Sochi, 4.08.1931).

Notes. The PCA could not decide if the specimen from Sochi belonged to *C. sahlbergi* or *C. persiana*. A sufficiently clear determination of this problematic specimen was possible by a wild-card run in a character-reduced linear discriminant analysis using the characters CS, PoOc/CL, PeH/CS, PLG/CS, MpGr/CS and dFov with $p = 0.9666$ (Fig. 13). The classification as *C. persiana* along the 2nd canonical vector is clear. The detached placement along the 1st canonical vector is most likely due to the low measuring accuracy. The determination of the Sochi specimen as *C. persiana* is also supported by the microsculpture of the vertex which is much coarser than in *C. sahlbergi* (Fig. 11).

Distribution. The range of the species covers the territory from Central Iran (54.0°E) westwards to Western Georgia (41.8°E) [Seifert, 2023a] (Fig. 14). The most southern and northern sites are in Iran at 29.2°N and in Georgia at 41.8°N. Sochi is the most western locality known for the species so far – it is situated 255 km northwest of Adjara in Georgia where the species inhabits the same locality as the previous one.

The bionomics of both species are still poorly known. There is no doubt that both species are native to Krasnodar Region, as they are widely distributed along the southeastern coast of the Black Sea.

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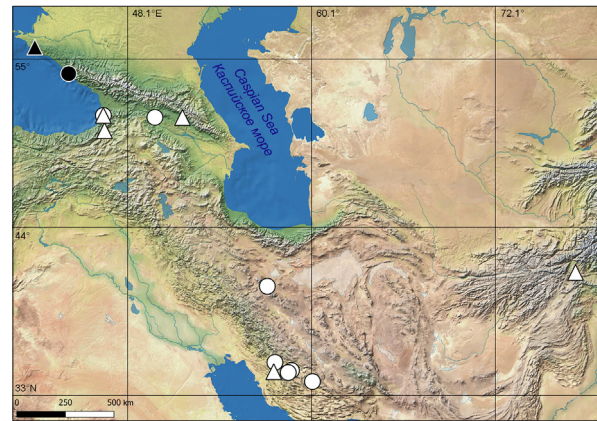


Fig. 14. A distribution map of two *Cardiocondyla* species. White triangles indicate *C. brachyceps* localities, white circles – *C. persiana* localities, black triangle and circle – new locality of species respectively.

Рис. 14. Карта распространения двух видов *Cardiocondyla*. Белые треугольники обозначают местонахождения *C. brachyceps*, белые круги – местонахождения *C. persiana*, черные треугольник и круг – новые местонахождения упомянутых видов соответственно.

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