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Morphological variability, bionomics and trophic associations of the rare Cypriot endemic *Odocnemis intrusicollis* (Seidlitz, 1895) (Coleoptera: Tenebrionidae)

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Abstract. A single species of the genus *Odocnemis* Allard, 1876 occurs in Cyprus and it is considered endemic to the island: *O. intrusicollis* (Seidlitz, 1895). The species was known only by the original description of one female (holotype) from the type locality "Cyprus". We found two populations of this darkling beetle across the Troodos mountain range, at higher and lower altitudes. The two populations differ in the structures of the prothorax and have slightly different male genitalia. Additionally, the two populations are isolated geographically, have different trophic associations and inhabit different types of forest. These differences may suggest early stages of differentiation into separate taxa. *Odocnemis intrusicollis* can be included in the separate *intrusicollis* species-group, similar to some groups from south Anatolia.

Key words: tenebrionid beetles, Helopini, lichen-feeding beetles, Cyprus.

Морфологическая изменчивость, экология и трофические связи редкого кипрского эндемика *Odocnemis intrusicollis* (Seidlitz, 1895) (Coleoptera: Tenebrionidae)

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Резюме. Единственный вид рода *Odocnemis* Allard, 1876 обитает на Кипре и является эндемиком острова: *O. intrusicollis* (Seidlitz, 1895). Этот вид был известен только по первоописанию, основанному на одной самке из типового местонахождения «Cyprus». Мы обнаружили две популяции этого жука-чернотелки на хребте Троодос: высокогорную и низкогорную. Эти популяции отличаются строением проторакса и обладают незначительными отличиями в структурах гениталий самца. Кроме того, эти две популяции изолированы географически, имеют различные трофические связи и населяют леса разных типов. Эти различия могут свидетельствовать о ранних стадиях дифференциации отдельных таксонов. *Odocnemis intrusicollis* может быть включен в отдельную группу видов *O. intrusicollis*, похожую на некоторые группы из Южной Анатолии.

Ключевые слова: жуки-чернотелки, Helopini, лихенофаги, Кипр.

Introduction

Species of the genus *Odocnemis* Allard, 1876 are widespread in the Mediterranean Region, from Eastern Europe to the Caucasus, Iran and Kazakhstan [Nabozhenko, 2020]. The Near East *Odocnemis* are the most studied after several revisions and some subsequent descriptions [Nabozhenko, Keskin, 2013, 2016; Nabozhenko, 2019a; Nabozhenko, Háva, 2020; Nabozhenko et al., 2021]. Nevertheless, the Cypriot fauna of *Odocnemis* has not been studied and records of this genus from the island are scarce and doubtful [Nabozhenko, Háva, 2020; Nabozhenko et al., 2020]. In the entire history of research in Cyprus, only two specimens of two species, *Odocnemis intrusicollis* (Seidlitz, 1895) and *O. crenatostriatus* (Allard, 1877), were recorded at the end of the 19th [Seidlitz, 1895] and in the middle of the 20th century [Freude, 1952]. Since then, no further information about this genus in Cyprus has been published.

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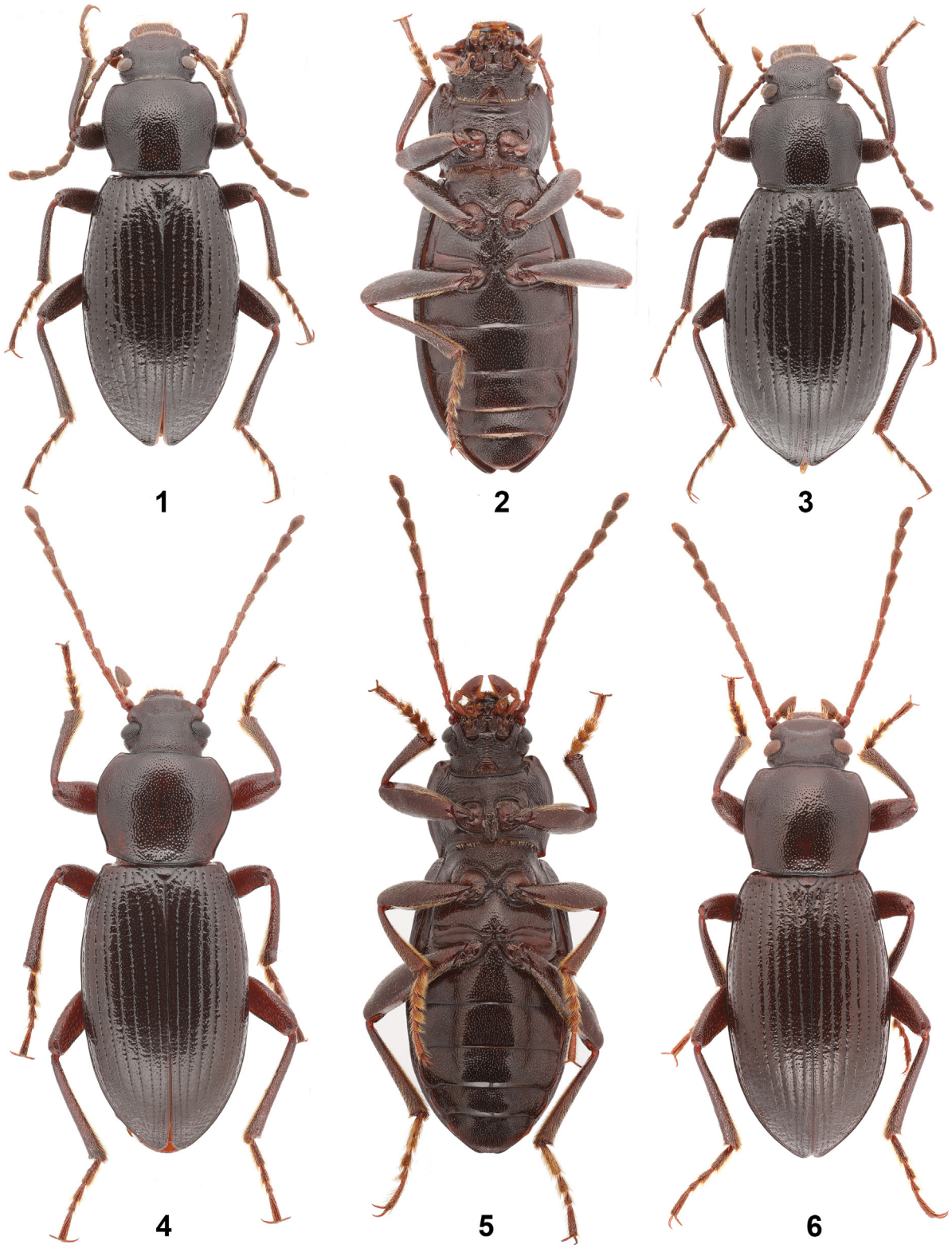
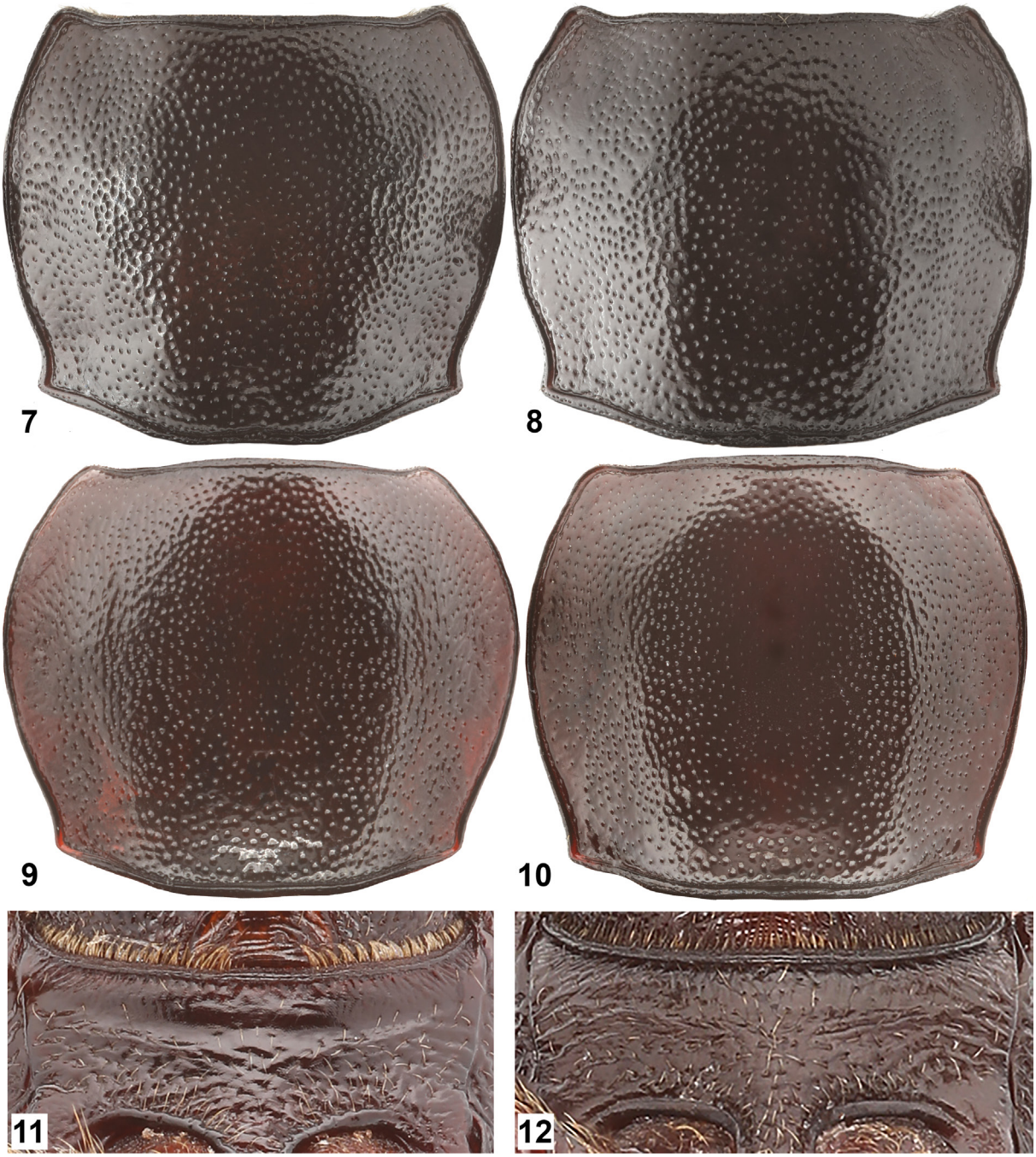


Figs 1–6. *Odocnemis intrusicollis*, habitus.

1, 2, 4, 5 – male: 1, 4 – dorsally, 2, 5 – ventrally; 3, 6 – female, dorsally; 1–3 – high-altitude population from Chionistra Mt.; 4–6 – lower-altitude population from Pano Panagia.

Рис. 1–6. *Odocnemis intrusicollis*, габитус.

1–2, 4–5 – самец: 1, 4 – дорсально, 2, 5 – вентрально; 3, 6 – самка, дорсально; 1–3 – высокогорная популяция с горы Хионистра; 4–6 – низкогорная популяция из Пано Панагии.



Figs 7–12. *Odocnemis intrusicollis*, details of structure.

7, 9–10 – male pronotum; 8 – female pronotum; 11–12 – prosternum; 7–8, 11 – high-altitude population from Chionistra Mt.; 9–10, 12 – lower-altitude population from Pano Panagia.

Рис. 7–12. *Odocnemis intrusicollis*, детали строения.

7, 9–10 – переднеспинка самца; 8 – переднеспинка самки; 11–12 – стернит переднегруди; 7–8, 11 – высокогорная популяция с горы Хионистра; 9–10, 12 – низкогорная популяция из Пано Панагии.

After studying the private collection of Christodoulos Makris and conducting extensive fieldwork on the Troodos mountain range in May 2021, we found two different isolated populations of *Odocnemis intrusicollis* in Cyprus. Below we redescribe this species with data on morphological variability and provide some first data on bionomics and trophic associations of this poorly known species.

Material and methods

The following institutions and collections are used for deposition of the collected material:

MNHN – Muséum national d'Histoire naturelle (Paris, France);

PCCM – private collection of Ch. Makris (Lemesós, Cyprus);

UCY – University of Cyprus (Nicosia, Cyprus);

ZIN – Zoological Institute of the Russian Academy of Sciences (St Petersburg, Russia).

Photographs of beetles were taken with Canon EOS 5D Mark IV Body, lens Canon MPE65MM F2.8 Macro, flush bulb Canon Macro Twin Lite MT-26X-RT, while stacking was made using Stack-shot 3X with enlarged macro rails s/n 3734; the photosystem is installed on a reproduction machine Kaiser Copy Stand RS 1. Images were stacked in Helicon Focus 7.7.4 Pro.

Laboratory processing of the collected lichens was carried out by the traditional morphological and anatomical methods using light microscopes Carl Zeiss Primo Star, and Zeiss STEMI-2000 CS stereomicroscopes equipped with camera AxioCam ICc3. A standard set of reagents (KOH (K), 10% solution, J/KJ (J) – 1 mg J2 in 100 ml

Figs 13–20. *Odocnemis intrusicollis*, male genitalia and terminalia.

13–14 – male inner sternite VIII; 15–16 – spiculum gastrale; 17–18 – aedeagus ventrally; 19–20 – aedeagus laterally; 13, 15, 17, 19 – high-altitude population from Chionistra Mt.; 14, 16, 18, 20 – lower-altitude population from Pano Panagia.

Рис. 13–20. *Odocnemis intrusicollis*, гениталии и терминалии самца.

13–14 – VIII внутренний стернит самца; 15–16 – гастральная спикула; 17–18 – эдеагус вентрально; 19–20 – эдеагус латерально; 13, 15, 17, 19 – высокогорная популяция с горы Хионистра; 14, 16, 18, 20 – низкогорная популяция из Пано Панагии.

10% solution KJ, P) was used for lichen determination [The lichens..., 2009; Andreev et al., 2014]. The HPTLC method was used to identify chemically complex (in terms of lichen substance content) lichen species. The HPTLC was performed according to the standard procedure [Culberson, Ammann, 1979; Orange et al., 2001; Protocols..., 2002], using solvent systems A and B.

Temperature and humidity were registered using recorders TR-2V. The data were summarized using the TR Complex v.1.12 and processed in Microsoft Excel 2016. Trophic relationships of imagoes were observed in nature at night and in field entomological cages during the course of several days.

Acronyms of measurements: Y – ratio of the head width at eyes to the distance between eyes; PH_w – ratio of the maximal pronotal width to the maximal head width; P_wP_l – ratio of the pronotal width at widest level to the length at middle; E_lE_w – ratio of the elytral length (from apices to the base of the scutellar shield) to the maximal width; EH_w – ratio of the elytral maximal width to the head maximal width; EP_w – ratio of the elytral maximal width to the pronotal maximal width; EP_l – ratio of the elytral length (from apices to the base of the scutellar shield) to the pronotal length at the middle.

Odocnemis intrusicollis (Seidlitz, 1895)
(Figs 1–20)

Helops var. *nigropiceus*? Küst.: Baudi di Selve, 1877: 103.

Helops (*Stenomax*) *intrusicollis* Seidlitz, 1895: 733, 753; Gebien, 1911: 545 (in catalogue).

Cylindronotus (*Omaleis*) *intrusicollis*: Gebien, 1943: 429 (808) (in catalogue).

Odocnemis (*Odocnemis*) *intrusicollis*: Nabozhenko, 2008: 37; Nabozhenko, Löbl, 2008: 244; Nabozhenko et al., 2020: 416 (in check-list); Nabozhenko, Háva, 2020: 329; Nabozhenko, 2020: 321.

Material. High-altitude population from Chionistra Mt.: 1♀ (PCCM), Cyprus, Lemesós District, Troodos, 1750 m, 14.11.2009 (Ch. Makris); 2♂, 1♀ (ZIN), 4♂, 1♀ (UCY), Cyprus, Lemesós District, Chionistra Mt., near Troodos village, 34°55′03.2″N / 32°53′11.9″E, 1740 m, 17.05.2021 (A. Papadopoulou, M.V. Nabozhenko, I.A. Chigray, D.G. Kasatkin, K. Ntatsopoulos, L. Jelinscaia Lagou); 3♀ (ZIN), Cyprus, Chionistra Mt., between Troodos and Amiantos, 34°54′16″N / 32°54′27″E, 1700 m, 18.05.2021 (M.V. Nabozhenko, I.A. Chigray).

Lower-altitude population from NW part of the Troodos mountaine range: 2♂ (PCCM), Cyprus, Paphos District, near Pano Panagia, 34°54′30.4″N / 32°38′59.9″E, 800 m, 3.03.2002, under bark of Pinus brutia (Ch. Makris); 1♂, 1♀ (UCY), the same place, 12.05.2021 (M.V. Nabozhenko, I.A. Chigray).

Redescription. Body slender, shiny, glabrous dorsally and pubescent ventrally, brown, legs and antennae red-brown. Measurements: Y = 1.73; PH_w = 1.43–1.53; P_wP_l = 1.13–1.16; E_lE_w = 1.64–1.71; EH_w = 1.84–1.86; EP_w = 1.21–1.28; EP_l = 2.42–2.5.

Head widest at level of eyes. Eyes large, convex. Anterior margin of epistoma weakly rounded. Outer margin of genae angulate at base and weakly rounded from base to epistoma. Puncturation of head coarse, moderately dense (puncture diameter slightly longer than interpuncture distance). Epistoma depressed and separated from frons. Ventral side of head pubescence with yellow long setae; surface between gula and prementum with coarse transverse wrinkles. Apical maxillary palpomeres strongly widened, securiform. Prementum and mentum with very long erected setae. Antennae long, with 3 antennomeres extending beyond base of pronotum when directed backward.

Prothorax. Pronotum from weakly to strongly transverse, cordate, widest slightly before middle at anterior third; lateral margins from weakly to strongly rounded, weakly and emarginated near base. Anterior margin widely rounded, slightly emarginated near angles; base widely rounded, but straight at middle. Anterior angles not protruding, turned down, straight (lateral view); posterior angles obtuse. All margins distinctly beaded; lateral margins with deep very narrow groove along bead. Disc of pronotum moderately evenly convex, only with very weak transverse impression at middle near base; puncturation of disc moderately coarse and sparse (puncture diameter near 2 times shorter than interpuncture space at middle of disc and 3–4 times shorter on lateral sides). Prosternal process strongly protruded, angulate, with straight upper contour in lateral view, densely pubescent.

Pterothorax. Scutellar shield almost smooth, only with several punctures at base. Elytra elongate, widest at middle. Striae impressed, strial punctures slightly elongate, connected by interrupted furrows; puncture sometimes separated in striae 1 and 2. Interstriae slightly convex in middle and at apex, with short transverse wrinkles at apex, without clear tubercles, comparatively coarsely and sparsely punctured. Epipleura almost reaching sutural angles, where they transform to rounded roller; inner carina of epipleura not reaching sutural angles; elytral dorsal carina (inflexed lateral margin of elytra) almost reaching apex of first interstria; apical part of interstria 8 not more convex than other ones and not connected with elytral margin. Mesoventrite with very dense and coarse puncturation, while mesepimera and mesepisterna with the same but sparse punctures. Metaventrite evenly, finely and sparsely punctured (puncture diameter near 3 times shorter than interpuncture space).

Legs. Trochanters with long, dense, recumbent hairs. Half to 2/3 of inner (flexed) femoral side densely pubescent with yellow, recumbent hairs, while apical part smooth and shiny. Tibiae without teeth or tubercles, with dense suberect pubescens on inner side; pro- and metatibiae straight, mesotibiae slightly bent. Tarsi not widened, with very dense yellow pubescence (especially mesotarsi) on sole.

Abdomen. Puncturation of abdominal ventrites the same as on metaventrite but slightly denser. Apical margin of abdominal ventrite 5 not beaded. Male genitalia: inner abdominal sternite VIII with slightly truncated apices between deep middle emargination, surface of the sternite densely covered by long hairs; spiculum gastrale with very large blades (third of spiculum length); apical piece of aedeagus very narrow and elongate at apical quarter; ventral apophyses of apical piece connected at apex.

Female. Body more robust, antennae shorter.

Variability. Both populations of *O. intrusicollis* are very similar but some differences were observed in structures of the prothorax, the aedeagus and the spiculum gastrale (Table 1).

Distribution. Cyprus (Troodos mountain range, ? Famagusta).

Taxonomic notes. Freude [1952] listed one female of "*Cylindronotus* (*Omaleis*) *crenatostriatus* Alld." (now *Odocnemis crenatostriatus* (Allard, 1877)) for Famagusta, but this species was described from Trabzon (Turkey) and Patras (Greece) according to the original description [Allard, 1877]. We do not know of any taxon of *Odocnemis* that is common in both Greece and Turkey even in adjacent regions. In addition, *Odocnemis* species are absent in Trabzon Province of Turkey [Nabozhenko, Keskin, 2016]. Thus, *O. crenatostriatus* is a collective taxon, with syntypes probably belonging to different genera and it cannot be distributed in Cyprus. We also studied a single syntype of *Stenomax crenatostriatus* from the collection of MNHN with the labels "Cephalonia", "*crenatostriatus*" (by Allard's hand), "Ex Musæ E·Allard 1899" and "SYNTYPE" but

Table 1. Differences between two populations of *Odocnemis intrusicollis*.
Таблица 1. Различия между двумя популяциями *Odocnemis intrusicollis*.

High-altitude population from Chionistra (Figs 1–3, 7, 8, 11, 13, 15, 17, 19, 21) / Высокогорная популяция с горы Хионистра (рис. 1–3, 7, 8, 11, 13, 15, 17, 19, 21)	Lower-altitude population from the northwest part of Troodos mountain range (Figs 4–6, 9, 10, 12, 14, 16, 18, 20, 21) / Низкогорная популяция с северо-западной части гор Троодос (рис. 4–6, 9, 10, 12, 14, 16, 18, 20, 21)
Lateral margins of pronotum with deep emargination near base (Figs 7, 8) / Боковые стороны переднеспинки глубоко выемчатые у основания (рис. 7, 8)	Lateral margins of pronotum with weak short emargination near base (Figs 9, 10) / Боковые края переднеспинки со слабой короткой выемкой у основания (рис. 9, 10)
Pronotum wider at level of posterior angles than at level of emargination (Figs 7, 8) / Переднеспинка шире на уровне задних углов, чем на уровне выемки перед самими углами (рис. 7, 8)	Pronotum wider at level of emargination, than at level of posterior angles (Figs 9, 10) / Переднеспинка шире на уровне выемки перед задними углами, чем на уровне самих углов (рис. 9, 10)
Anterior angles of pronotum weakly protruding forward (Figs 7, 8) / Передние углы переднеспинки слабо выступающие вперед (рис. 7, 8)	Anterior angles of pronotum not protruding, turned down (Figs 9, 10) / Передние углы переднеспинки не выступающие, повернуты вниз (рис. 9, 10)
Pronotum with straight or weakly acute projected posterior angles (Figs 7, 8) / Переднеспинка с прямыми или слабо острыми выступающими задними углами (рис. 7, 8)	Pronotum with obtuse, not projected posterior angles (Figs 9, 10) / Переднеспинка с тупыми, не выступающими задними углами (Figs 9, 10)
Anterior third of prosternum transversely impressed, smooth, without puncturation and not pubescent (Fig. 11) / Передняя треть стернита переднегруди поперечно вдавлена, гладкая, без пунктировки и опушения (рис. 11)	Anterior third of prosternum not transversely impressed, punctured and pubescent as other surface (Fig. 12) / Передняя треть стернита переднегруди не вдавлена, пунктирована и опушена, как остальная поверхность (рис. 12)
Apical piece of aedeagus evenly narrowed from base to not separated apex (Fig. 17) / Апикальная часть эдеагуса равномерно сужается от основания к неотделенной вершине (рис. 17)	Aedeagus with separated very long and narrow apical quarter of apical piece (Fig. 18) / Эдеагус с отделенной очень длинной и узкой вершинной четвертью апикальной части (рис. 18)
Spiculum gastrale with connected rods, which are not form the common stem (Fig. 15) / Гастральная спикула с соединенными стержнями, не образующими общий ствол (рис. 15)	Spiculum gastrale with common stem (Fig. 16) / Гастральная спикула со стержнями, образующими общий ствол (рис. 16)

we are not sure that this specimen belongs to the type series, because the type locality and structures of elytra don't correspond to the original description. *Odocnemis intrusicollis* has transversely wrinkled elytral striae and interstriae, especially at the apex, which was probably a reason for Freude's misidentification.

A position of *O. intrusicollis* within Middle East species of *Odocnemis*. Nabozhenko and Keskin [2016] distinguished 10 species-groups within *Odocnemis* from the Middle East and the Balkan. *Odocnemis intrusicollis* probably forms an additional separate *O. intrusicollis* species-group, which differs in the following combination of characters: elytra without tubercles or granules, male tibiae without teeth or granules; epipleura almost reaching sutural angles, where they transformed to rounded roller; inner carina of epipleura not reaching sutural angles; elytral dorsal carina (inflexed lateral margin of elytra) almost reaching apex of the first interstria; half to 2/3 of inner (flexed) femoral side densely pubescent with yellow recumbent hairs, while apical part smooth and shiny; basal piece of the aedeagus short, slightly longer than apical one; apical piece of the aedeagus strongly narrowed to the apex (unique character within *Odocnemis*).

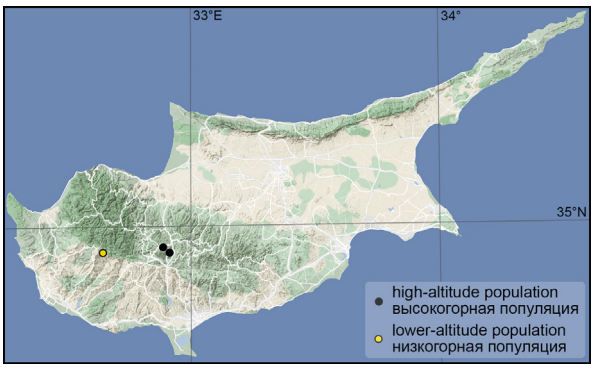
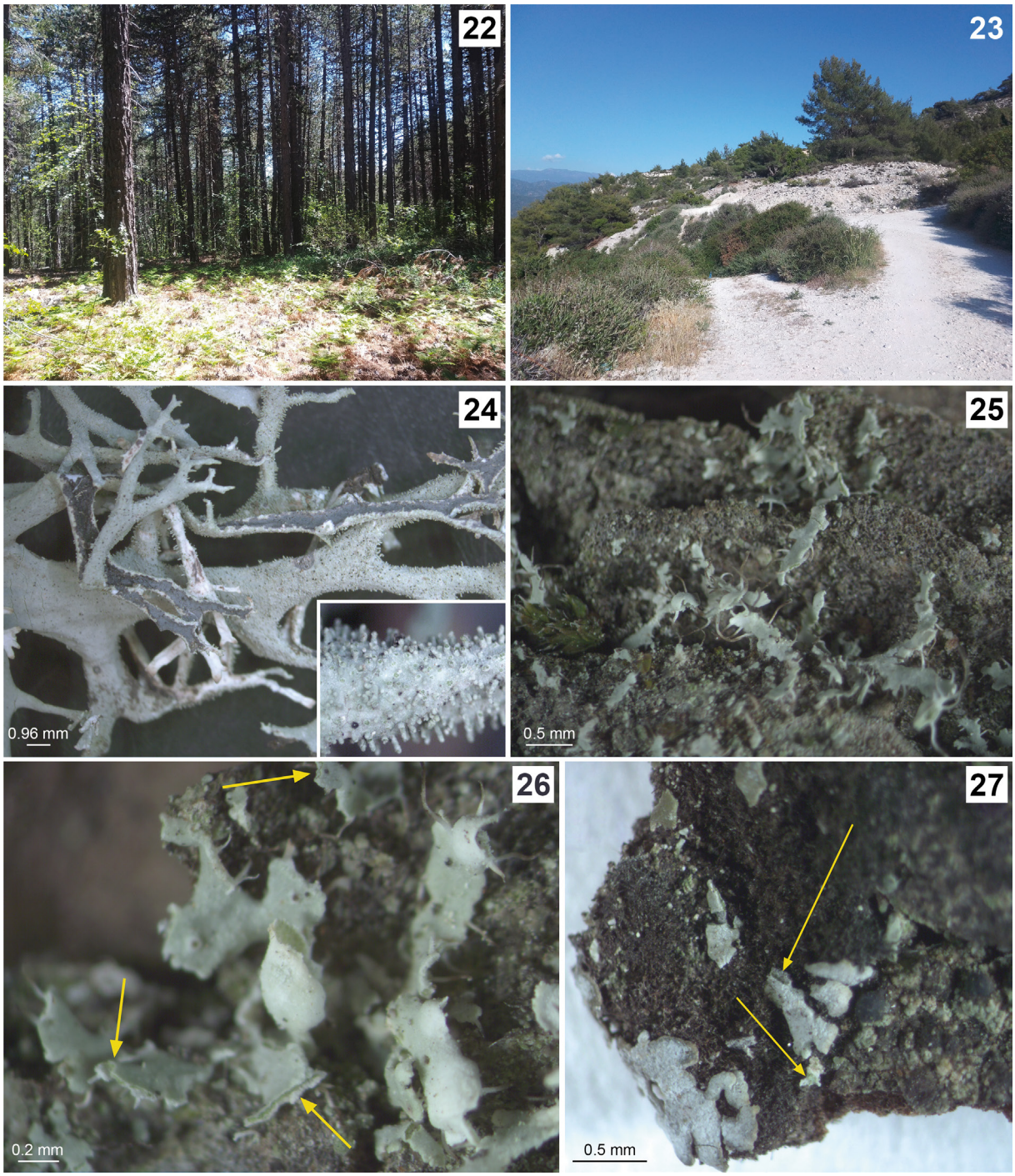


Fig. 21. Map of distribution of *Odocnemis intrusicollis*.
Рис. 21. Карта распространения *Odocnemis intrusicollis*.

The most interesting character is the reduction of teeth or granules on male tibiae which is compensated by strong development of hair brushes on tarsi and the pubescent ventrum. These structures probably serve to fixation on a female during copulation, while in the rest of *Odocnemis* from the eastern part of the range, this function is performed by the armament of tibiae [Nabozhenko, Keskin, 2016]. The reduction of elytral tubercles with coeloconic sensilla is usual occurrence among *Odocnemis* (the *O. aegaeica* species-group, *O. aurichalcea* (Adams, 1817), etc.). The structure of the epipleura of a Cypriot



Figs 22–27. Habitats and host lichens of *Odocnemis intrusicollis*.

22 – Pinus nigra forest; 23 – the northwest foothills of Troodos mountain range, Pano Panagia, Pinus brutia grove; 24 – Pseudevernia furfuracea, host lichen (inset: thallus with damaged isidia); 25 – Physcia adscendens, host lichen; 26 – the same, thallus damaged by beetles; 27 – Physconia distorta, host lichen with thallus damaged by beetles; 22, 24 – high-altitude population from Chionistra Mt.; 23, 25–27 – lower-altitude population from Pano Panagia. Arrows show damages.

Рис. 21–26. Местообитания и кормовые лишайники *Odocnemis intrusicollis*.

22 – лес черной сосны Pinus nigra; 23 – холмы в северо-западной части хребта Троодос, Пано Панагия, роща Pinus brutia; 24 – Pseudevernia furfuracea, кормовой лишайник (на вставке таллом с поврежденными изидиями); 25 – Physcia adscendens, кормовой лишайник; 26 – то же, таллом, поврежденный жуками; 27 – Physconia distorta, кормовой лишайник с талломом, поврежденным жуками; 22, 24 – высокогорная популяция с горы Хионистра; 23, 25–27 – низкогорная популяция из Пано Панагии. Стрелками показаны повреждения.

species is the same as in the *O. inornata* species-group; pubescence of inner side of femora is characteristic also for the *O. anatolica* species-group. Thus, we cannot determine with certainty the relationships with a specific group, but morphologically the *O. intrusicollis* species-group is close to the three mentioned South-West Anatolian species groups.

Bionomics. The high-altitude population inhabits mountain forests of Pinus nigra J.F. Arnold, 1785 on Chionistra Mt. (Troodos mountain range) at 1700–1800 m (Fig. 22); the species probably develops in two generations (as many representatives of the subtribe Cylindrinotina [Nabozhenko 2019b]): autumn (adult beetles hatch in autumn and imagoes overwinter) and spring (beetles overwinter in the stage of larvae and pupae, and hatch in spring). Imagoes of the autumn generation occur at least in November (according to the label), and adults of the spring generation were collected until the second half of May, but are undoubtedly active in the earlier spring period. The species is active (middle of May) from 20:35 to 21:45 at humidity levels of 60–83% and temperature of 16–18 °C. Only one species of host lichen Pseudevernia furfuracea (L.) Zopf (Parmeliaceae) (Fig. 24) was registered for this population. It should be noted that *O. intrusicollis* lives together with another species of the Helopini tribe, *Helops glabriventris* Reitter, 1885. At the same time, the first species feeds on isidia, and the second one gnaws through the upper cortex of the thallus and feed on the algal layer. We also do not exclude that *O. intrusicollis* may also feed on the algal layer after damage to the thallus by *H. glabriventris*. As far as we know, this is the first recorded trophic association of beetles of the subtribe Cylindrinotina with corticolous fruticose lichens from the family Parmeliaceae. All previously recorded host lichens for dendrophylous species of this subtribe belonged to the families Physciaceae, Teloschistaceae, and rarely Cladoniaceae [Nabozhenko et al., 2016, 2017, 2021, 2022].

The lower-altitude population was found in a small grove of Pinus brutia Tenore, 1811 on limestone terraces in the foothills of Troodos mountain range (Fig. 23). This grove is located in a kind of semicircus, in which moisture accumulates. The area around is transformed to vineyards and is a subject to pesticide load, so the only known lower-altitude population of this species appears to be at risk. We registered two species of host lichens from the family Physciaceae (corticolous foliose): Physcia adscendens H. Olivier (Figs 25, 26) and Physconia distorta (With.) J.R. Laundon (Fig. 27). According to our collecting data, the adult beetles occur from March to middle of May and they are active (in mid-May) from 20:40 to 21:20 at humidity levels of 70-86% and temperature of 16 °C.

Conclusion

The geographic isolation and the distinct habitat and trophic associations between the two populations of *O. intrusicollis* may have contributed to their morphological divergence. The observed morphological differences were consistently found in the sampled individuals, but we do not consider them as sufficient evidence for the description of a new taxon. The ecological and morphological divergence between those isolated populations shows how differentiation of taxa can occur at the early stages of the speciation process. Some preliminary mitochondrial DNA data (Ntatsopoulos, unpublished data) demonstrate relatively low levels of genetic divergence between the two populations (0.3–1.5%, depending on the gene fragment), which are considered within the intraspecific range. To establish further the status of these populations/taxa within an integrative taxonomic framework, more extensive sampling is required, at least for the lower-altitude population, and a wider range of genetic markers should be sequenced (including several unlinked nuclear genes) for DNA-based species delimitation.

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