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Promethis undulatus sp. n. – the first fossil darkling beetle (Coleoptera: Tenebrionidae: Stenochiinae: Cnodalonini) from the late Miocene of Japan

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Abstract. A well preserved print of darkling beetle, belonging to the genus *Promethis* Pascoe, 1869 (Stenochiinae: Cnodalonini) has been collected in late Miocene Isarizawa Formation (Messinian, 7.246–5.333 Ma), at the shore of Toyosawa reservoir in Minamitoyosawa National Forest, Hanamaki city, Iwate Prefecture, Japan. The extant species of this genus are widely distributed in subtropic and tropic forests of the East Hemisphere. This is the first record of Tenebrionidae from the late Miocene and the first fossil representative of this genus. We listed the combination of characters which allow to include the new described species *P. undulatus* **sp. n.** to the family Tenebrionidae and the genus *Promethis*. The new species is characterized among *Promethis* by the unique large round depression with the wedge-shaped elevation on abdominal ventrite 5 and also by the undulate lateral margins of pronotum, which are also presented in several species from China, Philippines, Andaman and Nicobar Islands.

Key words: Tenebrionidae, Stenochiinae, *Promethis*, new species, fossil, Late Miocene, Japan.

Promethis undulatus sp. n. – первый ископаемый жук-чернотелка (Coleoptera: Tenebrionidae: Stenochiinae: Cnodalonini) из позднего миоцена Японии

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Резюме. Хорошо сохранившийся отпечаток жука-чернотелки, относящегося к роду *Promethis* Pascoe, 1869 (Stenochiinae: Cnodalonini), был обнаружен в верхнемиоценовой свите Исаризава (Мессинский ярус, 7.246–5.333 млн. л. н.) на берегу плотины водохранилища Тоёсава в национальном лесу Минамитоёсава (Ханамаки, префектура Ивате) в Японии. Современные виды этого рода широко распространены в субтропических и тропических лесах Восточного Полушария. Это первая находка тенебрионид из позднего миоцена и первый ископаемый представитель этого рода. Мы перечислили комбинацию признаков, позволяющих отнести новый вид *P. undulatus* **sp. n.** к семейству Tenebrionidae и роду *Promethis*. Новый вид характеризуется уникальным среди *Promethis* крупным круглым вдавлением с клиновидным возвышением на абдоминальном вентрите 5 и волнистыми боковыми краями переднеспинки, которые также представлены у некоторых видов из Китая, Филлипин, Андаманских и Никобарских островов.

Ключевые слова: Tenebrionidae, Stenochiinae, *Promethis*, новый ископаемый вид, поздний миоцен, Япония.

Introduction

The family Tenebrionidae is presented in the fossil record by 131 species from 85 genera [Kirejtshuk, Ponomarenko, 2018; Nabozhenko, 2019; Novák, Háva, 2019; Bao, Antunes-Carvalho, 2020; Nabozhenko, Kirejtshuk, 2020; Alexeev et al., 2020; Tihelka et al., 2020; Nabozhenko et al., 2020, 2021; Nabozhenko, Bukejs, 2021 etc.]. The oldest darkling beetles are known from the Upper Jurassic and Lower Cretaceous deposits [Batelka et al., 2018], and the highest number of taxa were found in the Eocene Baltic Amber (Paleogene) and early Miocene Dominican amber (Neogene) [Kirejtshuk, Ponomarenko, 2018; Nabozhenko, 2019]. Miocene darkling beetles, in addition to Dominican amber, are represented in Lower Miocene deposits of Germany (Rott), Switzerland (Molasse), China (Shanwang) and Greece (Kumi), in the Early Miocene Mexican amber (Chiapas), in the Middle Miocene deposits of Germany (Salzhausen and Oeningen) [Nabozhenko, 2019].

A well preserved print of darkling beetle, belonging to the genus *Promethis* Pascoe, 1869 has been collected in the late Miocene Isarizawa Formation (Messinian, 7.246–5.333 Ma) near Toyosawa dam, Hanamaki city, Iwate Prefecture of Japan. This is the first record of Tenebrionidae from the late Miocene of Japan and the first fossil representative of this genus. *Promethis* is one of the highly diverse arboreal genus (near 150 species) of the subfamily Stenochiinae, distributed in the eastern part of the Palaearctic, the Afro-Tropical, Indo-Malayan, Australian and Pacific regions [Bouchard et al., 2021]. The genus was revised by Kaszab [1988], and later some publications gave further additions to it [Ren, Yang, 2004; Masumoto et al., 2005; Ren, Bai, 2005; Ren, Hua, 2006; Ba,

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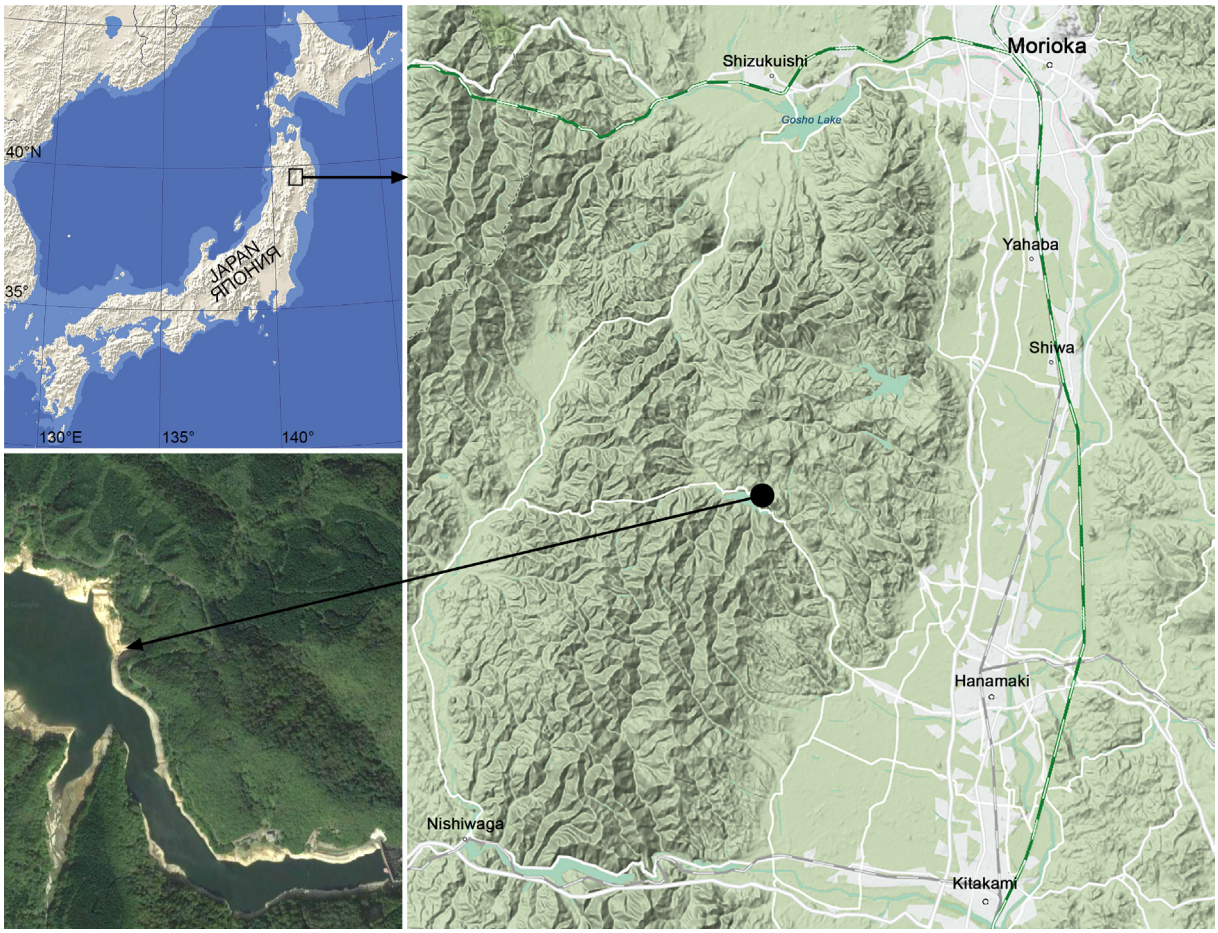


Fig. 1. The type locality of *Promethis undulatus* **sp. n.**
Рис. 1. Типовое местонахождение *Promethis undulatus* **sp. n.**

Ren, 2009; Grimm, 2011, 2013, 2016a, b, 2017]. The fauna of Japan contains 12 extant species and one subspecies of *Promethis*, seven of which are known from Nansei Islands and five ones from main islands [Akita, Masumoto, 2016].

Material and methods

The print was discovered by a local elementary school student in October 1982 from the northern shore of Toyosawa reservoir (39°29′10.51″N / 140°57′56.02″E) in Minamitoyosawa National Forest, Hanamaki city, Iwate Prefecture, Japan (Fig. 1). The holotype is deposited in Iwate Prefectural Museum (Morioka city, Iwate, Japan). The sample was photographed with direct and side lighting. Photographs were taken using an Olympus Stylus TG-2 'Tough' digital camera.

Geological setting and locality

There are some opinions on the age and stratigraphy of Miocene formations in western area of Morioka city to Hanamaki city of Iwate Prefecture. Hayakawa et al. [1954] distinguished Miocene Yuguchi Formation. Murai [1962a] divided this formation to Yabitsu and Osuke Upper Miocene formations, Tada [1973] included Yabutsu Formation to Osuke Formation. Okami et al. [1990] proposed the new stratigraphic division in the Eastern Marginal part of Backbone Range (western area of Morioka city to Hanamaki city, Iwate Prefecture) based on large material: Lower Miocene – Mizuwake and Azumaneyama Formations; Middle Miocene – Yuzawamori and Iioka Formations; Upper Miocene – Isarizawa (including former Yabutsu) Formation. Okami with co-authors [1990] also presented the schematic geological map of Neogene deposits of the locality and described Isarizawa sediments as acidic pyroclastics formed by the diagenesis.

We didn't find this locality in the lists of localities of fossil insects [Fujiyama, 1983; Ponomarenko, Kirejtshuk, 2009], therefore, we assume that this is the first documented record of a fossil insect from Isarizawa Formation. Murai [1962b] listed the following plant fossils from the upper layers of Isarizawa Formation: Cryptomeria japonica (Thunb. ex L. f.) D. Don (1839), Populus balsamifera L., 1753, Fagus protojaponica K. Suzuki, 1959 (extinct), Pterocarya assymetrosa Konno, 1931 (extinct). Okami et al. [1990] identified several marine fossils from this locality: *Lima* sp. (Mollusca: Bivalvia), *Lucinoma acutilineatum* (Conrad, 1849) (Mollusca: Bivalvia; extinct), *Fissidentalium yokoyamai* (Makiyama, 1931) (Mollusca: Bivalvia), *Coptothyris* sp. (Braichiopoda: Rhynchonellata).

Figs 2–3. *Promethis undulatus* **sp. n.**, general view of the holotype.
2 – photograph with direct lighting; 3 – photograph with side lighting.
Рис. 2–3. *Promethis undulatus* **sp. n.**, общий вид, голотип.
2 – фотография при прямом освещении; 3 – фотография при боковом освещении.

Systematic Paleontology

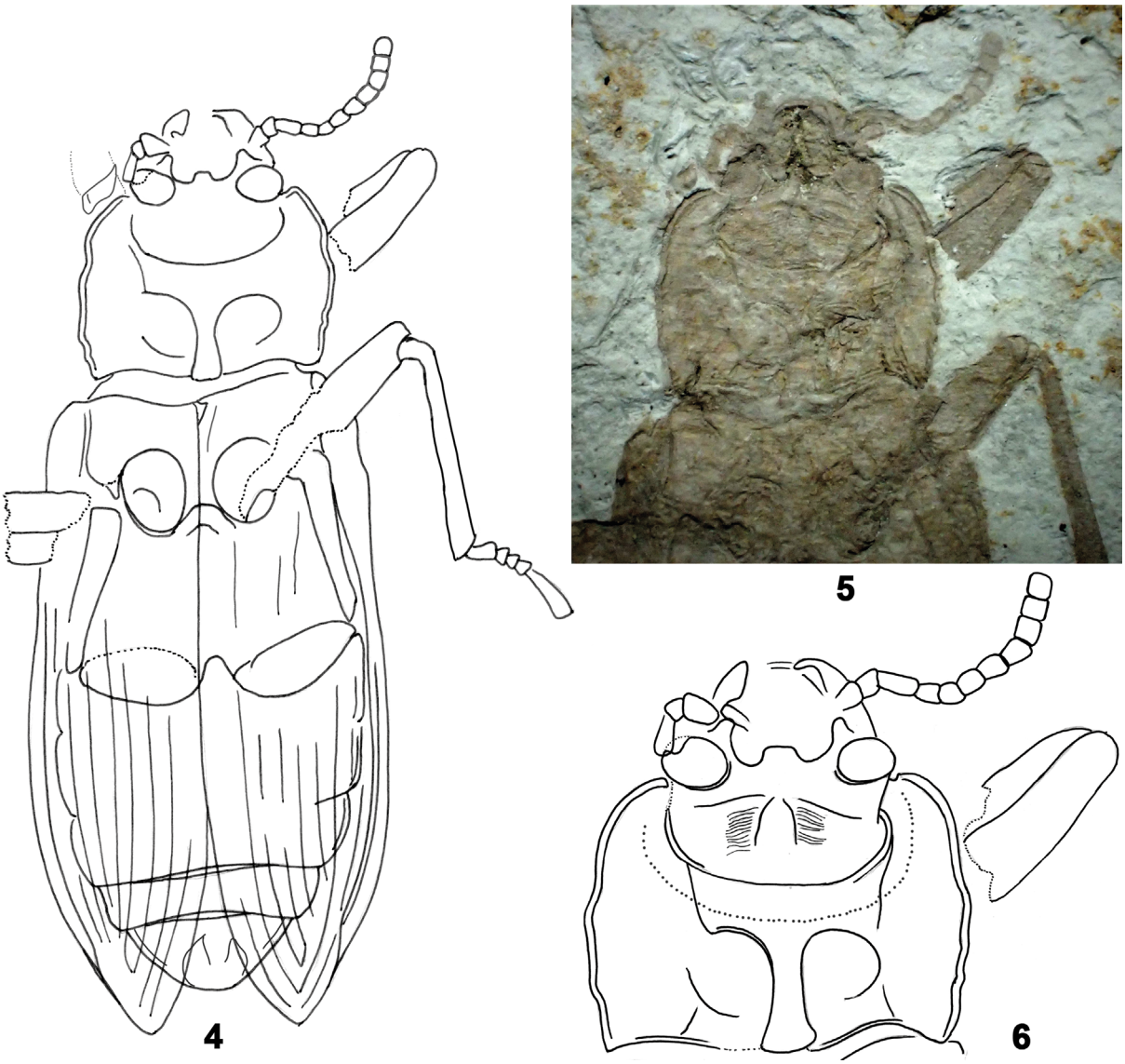
Order Coleoptera
Family Tenebrionidae Latreille, 1802
Subfamily Stenochiinae W. Kirby, 1837
Tribe Cnodalonini Oken, 1843
Genus *Promethis* Pascoe, 1869

Taxonomic position. The fossil beetle belongs to the family Tenebrionidae and the genus *Promethis* based on the following combination of characters: base of antennomere 1 concealed under genae; antennae with 11 antennomeres, with third one longer than other and antennomeres 9–10 subquadrate (typical character for *Promethis*); trochanters heteromeroid; present scutellary striola; mesocoxal cavities partly closed by mes- and metepimera and trochantine; tenebrionoid hinging of abdomen with visible intersegmental membranes between 3–5 ventrites (defensive glands present); body large, length 24 mm (typical for many *Promethis*). Large darkling beetles are presented also by other genera of Cnodalonini in the Indo-Malayan region, such as the *Camaria* genus-group, revised by Masumoto [1993a, b]. The fossil darkling beetle under description cannot be related to these genera, because it characterized by short antennae and shorter metatarsi, pronotum weakly narrower than elytral base.

Promethis undulatus **sp. n.**
(Figs 2–6)

Japanese name: “Iwateyumiashigomimushidamashi” イワテユミアシゴミムシダマシ.

Material. Holotype (male?), No IPMM33846: The print of beetle has only one complete right middle leg, and also remains of the right fore, right hind and left middle legs. The right antennae complete, while the left one has only three basal antennomeres observable. The pronotum bears semicircular depression at anterior third, but perhaps this is the result of fossilization, and not a structural feature. Weakly modified on inner side mesotibia and round depression on abdominal ventrite 5 may indicate that the specimen is probably a male.



Figs 4–6. *Promethis undulatus* **sp. n.**, reconstruction and details of structure.
4 – general view, reconstruction; 5 – head and prothorax, image with better resolution; 6 – the same, reconstruction.
Рис. 4–6. *Promethis undulatus* **sp. n.**, реконструкция и детали строения.
4 – общий вид, реконструкция; 5 – голова и проторакс, изображение в лучшем разрешении; 6 – то же, реконструкция.

Description. Body length 24 mm, maximal width 7.5 mm. Body elongate, slender. Eyes moderate in size. Head widest at eye level. Head approximately twice as wide as distance between eyes. Mouthparts open, cardo and stipes not concealed by mentum. Apical maxillary palpomere weakly securiform. Gula narrow, with rounded lateral margins; head at sides of gula with fine transverse wrinkles. Antennae 11-segmented; antennomere 3 longest; antennomeres 4–8 weakly elongate; antennomeres 9–11 subquadrate, apical antennomere rounded at apex.

Pronotum transverse (about 1.4 times as wide as long), wider at base than at apex, widest at middle, 1.42 times as wide as head, coarsely bordered in lateral margins and base. Lateral margins of pronotum undulate, sinuate before middle, behind middle and near base, rounded in anterior third and strongly narrowed near anterior margin. Anterior margin widely emarginate. Base widely bisinuate and rounded in middle. Anterior angles obtuse; posterior angles acute. Procoxal cavities rounded. Prosternal process narrowed at middle and dilated to apex.

Elytra strongly elongate (approximately 1.75 times as long as wide), widest slightly behind middle, approximately 1.4 times as wide as and 3.2 times as long as pronotum, 2.3 times as wide as head, with 10 deep striae, connected in rows and striole, interstriae convex. Lateral margins of elytra slightly and widely emarginated at anterior half, with apices narrowly rounded. Epipleura sharply narrowed at the level of middle of abdominal ventrite 5. Metaventrite elongate, trapezoidal, 1.7 times as long as wide.

Abdominal ventrites beaded laterally; ventrite 5 beaded at least laterally, evenly rounded at apex, not triangular, surface with large round depression and with wedge-shaped elevation in anterior part.

Legs long. Profemora weakly bent, basal part of protibiae straight. Mesofemora straight. Mesotibiae straight, weakly widened from base to apex, with weak sinuation on inner side at basal third. Mesotarsomere 1 longer than 2nd and 3rd mesotarsomeres combined, but 0.53 times as long as mesotarsomere 5.

Comparative diagnosis. Representatives of the genus *Promethis* are usually distinguished by males, which have diagnostic characters in their sexual dimorphism [Kaszab, 1988]. The holotype examined has no sexual comparative diagnostic characters, such as male protibiae, aedeagus, etc. The new species is characterized by the large round depression with the wedge-shaped elevation on abdominal ventrite 5 (unique feature among *Promethis*). Three species, *P. mindanaoensis* Kaszab, 1988 (Philippines), *P. sulcatipennis* Kaszab, 1988 (Andaman and Nicobar Islands) and *P. angulicollis* Kaszab, 1988 (China: Yunnan), have also undulate lateral margins of the pronotum. *Promethis undulatus* **sp. n.** differs from *P. mindanaoensis* and *P. sulcatipennis* in having the more slender and elongate elytra without very large and deep strial punctures in rows; the pronotum less transverse, with not so strongly undulate lateral margins. The new species is externally similar to *P. angulicollis*, which has similar elytral striae, the slender body and moderately undulated lateral margins of the pronotum, but *P. undulatus* **sp. n.** differs from the latter in having the pronotum widest at middle and much shorter antennae with subquadrate apical antennomeres.

Etymology. Latin "undulatus" (means "wavy") referring to wavy lateral margins of the pronotum in the new species.

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