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Two new species of *Nothochodaeus* Nikolajev, 2005
from Palawan Island, Philippines
(Coleoptera: Scarabaeoidea: Ochodaeidae)

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Two new species of *Nothochodaeus* Nikolajev, 2005 from Palawan Island, Philippines (Coleoptera: Scarabaeoidea: Ochodaeidae)

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Abstract. *Nothochodaeus minotaurus* Huchet, **new species**, and *N. huxleyi* Huchet, **new species** (Coleoptera: Scarabaeoidea: Ochodaeidae), from Palawan Island, Philippines, are described and illustrated.

Key words. Taxonomy, beetle, scarab, Ochodaeinae.

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Introduction

Following my study of the Ochodaeidae of the Philippine archipelago (Huchet 2014a, 2014b, 2017, 2018, 2019), I describe here two new species of the genus *Nothochodaeus* Nikolajev, respectively *N. minotaurus* Huchet, **new species**, and *N. huxleyi* Huchet, **new species**, bringing to four species, all endemic, the representatives of this genus in the archipelago. Both species described here are illustrated and compared with their closest relatives.

These new species originate from the island of Palawan. This discovery is interesting in several respects since it is the first mention of the family Ochodaeidae on this island. Morphologically, these new species present no obvious affinities with the other relatives inhabiting the archipelago. In all likelihood, the morphological originality of these taxa is due to the fact that the biogeographical history of Palawan and surrounding smaller islands is very distinct from that of the other islands of the Philippines. Palaeogeographical reconstructions have evidenced that, unlike the other islands of the archipelago, Palawan was contiguous with Borneo when sea level dropped repeatedly during the Pleistocene (Heaney 1985; Robles et al. 2015). Accordingly, due to its geological and biogeographical history, Palawan has been considered to be a portion of the Sunda Shelf and present more biotic affinities with Borneo than with all the other islands of the archipelago (Everett 1889; Dickerson 1928; Heaney 1985, 1986; Esselstyn et al. 2004). Heaney (1985) argued that the high endemism demonstrated by the mammal fauna of Palawan Island implies a long separation from their conspecifics in Borneo. According to Robles et al. (2015), a land bridge existed between Borneo and Palawan during the Middle Pleistocene, perhaps ca. 440 Ka or earlier at ca. 630 Ka.

Materials and Methods

The specimens described in this study were compared with other Filipino, Indonesian and Malaysian species deposited in the Muséum national d'Histoire naturelle, Paris, France (MNHN), and in author's private collection (CJBH).

Genitalia treatment. After removal of the entire abdomen to avoid any damage of the genital parts and other useful features, both male and female genital apparatus was treated with 10% potassium hydroxide solution (KOH) to destroy and remove the unneeded soft tissues. The cleaned genital parts were then placed in 10% acetic acid to neutralize the effects of the KOH, rinsed with ethanol, and stored in a small glycerol vial pinned under the specimen. In order to accurately observe both genital segments (ectodermic and internal female genitalia) the dissected parts were placed in a polyvinyl solution of lactophenol with chlorazol black E as a stain, following the method described by Carayon (1969). Finally, the abdomen was returned to its original position and maintained

in anatomical position using a small drop of hydrosoluble glue. Terminology of female genitalia follows Dupuis (2005).

Illustrations. Digital images of the habitus and genital parts were taken at the Entomology Department (MNHN, Paris) with a Canon EOS 6D digital camera (zoom MP-E 65 mm) mounted on a Kaiser RTx column. The z-stepper was controlled through the focus stacking software Helicon Remote 3.8.6w and images were processed using Helicon focus 7. The digital images were finally imported into Adobe Photoshop CC 2019 for post-processing, labeling and plate composition. To temporally stabilize both male and female genitalia for photography, these were placed in a slide concavity containing a drop of K-Y*1 gel as described by Bameul (2001).

Taxonomic Treatment

Ochodaeidae Streubel 1846: 960

Ochodaeinae Streubel 1846: 960

Nothochodaeini Nikolajev 2015: 25

Genus *Nothochodaeus* Nikolajev, 2005: 219 [= *Notochodaeus* Nikolajev, 2005]

Nothochodaeus minotaurus Huchet, new species (Fig. 1–4, 20)

Type material. Holotype female (CJBH), labeled: a) rectangular, white paper, printed : “PHILIPPINES, Palawan / El Nido, VI. 2012 / Flight interception trap / V. Gutierrez Lgt”; b) rectangular, framed, white paper: “Coll. J.-B. Huchet”; c) rectangular, red paper: “TYPE”; d) red paper: “*Nothochodaeus / minotaurus* n. sp. / HOLOTYPE / J.-B. Huchet det. 2021”. Genitalia stored in a small glycerol vial, pinned under the specimen. To ensure the perennality of this material, the holotype is intended to be deposited at the Muséum national d’Histoire naturelle, Paris.

One female paratype (CJBH) labeled: a) “PHILIPPINES, Palawan / Roxas, VI. 2012 / Flight interception trap / V. Gutierrez Lgt”. One female paratype (CJBH) labeled: a) “PHILIPPINES, Palawan / Roxas, XII. 2013 / Flight interception trap / V. Gutierrez Lgt”. Genitalia stored in a small glycerol vial, pinned under the specimens.

Diagnosis. Body medium-sized, robust, convex, densely pubescent, unicolored, uniformly chestnut-brown; surface nitid; the head quadrituberculate with a distinct acute tubercle on each side of the clypeal carina, and two other flattened tubercles, barely perceptible, on the vertex. The stridulatory peg is present.

Description. Holotype female (Fig. 1–4). **Length:** 8.4 mm (from the apex of the mandibles to the apical part of the tergite VIII). **Width:** 4.3 mm (greater width of the pronotum). **Head:** Strongly transverse, sub-hexagonal, flattened dorso-ventrally. Surface shiny, long pubescent, the setae obliquely directed backwards; surface microreticulate covered with medium setiferous granules separated by approximately twice their diameter. Labrum transverse, dorsally convex, strongly emarginate and transversely split into two superimposed laminae in the middle front; dorsal surface with large setose punctures, the anterior edge pubescent. Eyes very large, globose, strongly produced laterad, lacking ventral projection of canthus. Anterior clypeal membrane transverse, trapezoidal, in thin hyaline tegumentary plate overhanging the labrum. Clypeus subtrapezoidal, slightly obliquely declivous forwards, the front margin distinctly beaded and pubescent on edge; clypeus separated from frons by a weakly curved carina ended by a distinct acute tubercle on both sides (Fig. 3); the area behind the carina shallowly concave. Vertex bituberculate, the tubercles flattened, obsolete (Fig. 1). Mandibles subequal, falciform, broadly scooped dorsally. Mentum subquadrangular, slightly transverse, the base sublinear, the sides slightly convex, weakly depressed; the disc densely pubescent; a median longitudinal groove extending nearly from the base to the insertion of the palps forward. Labium with 3-segmented palpi: basal palpomere very reduced, slightly curved; median palpomere strongly developed, securiform, 3–4× longer than the basal palpomere; distal palpomere elongate, fusiform, inserted at the inferodistal third of the median palpomere. Maxillae with 4-segmented



Figures 1–2. *Nothochodaeus minotaurus* Huchet, new species, female holotype. 1) habitus, dorsal view. 2) habitus, latero-dorsal view (Photos J.-B. Huchet, MNHN).

palpi; lacinia and galea well sclerotized, distinctly separated. Galea well developed, subtriangular, the inner margin with ten long thick curved setae and three thinner apical setae, the latero-external edge glabrous. Galea subdivided into galea (distal part) and subgalea (proximal part) (respectively “proxagalea” and “distagalea” according to Nel and Scholtz (1990)). Lacinia in the shape of a thin longitudinal plate, apically acuminate as an elongated curved spur, its inner edge densely pubescent. Antenna 10-segmented, fawn-colored, the scape densely pubescent, the outer antennomere club segment distinctly brightened and pubescent at the upper edge. **Pronotum:** Transverse, convex, the lateral edges and base fringed with long setae, the outline entirely margined, the margin distinctly widening in the middle of the base forming a transverse bulge in a portion extending on both sides up to the level of the humeral callus. Anterior margin slightly convex behind the head, with a thin hyaline membrane in front. Front angles obtuse, the posterior ones regularly rounded. A short, barely impressed, median longitudinal furrow at base. Pronotal surface with double punctation consisting of long setiferous medium foveolate punctures mixed with small setose punctures, the setae obliquely directed anteriorly; surface shiny with two darkened foveae in the middle of each side. Scutellum sublinguiform, weakly depressed in front, the surface slightly concave with few scattered setose medium punctures. **Elytra:** Transverse, densely pubescent, their color similar to that of the pronotum. Surface with well impressed striae, consisting of sunken large points separated by about 1× their diameter; each puncture, rather deep, round, with a very short non-erect bristle along the internal anterior edge; interstriae weakly convex, with strong and tight punctation consisting of small setose granules, the setae oriented backward; juxta-sutural interstriae darkened, noticeably depressed. Humeral callus well developed. **Abdomen:** Strongly convex with six visible ventrites (III–VIII). The ventrites convex, shiny, with a transverse row of large darkened granules along their anterior edge; the granules setose, quite close in the median part of the ventrites (separated by $\pm 2\times$ their diameter), more spaced on the sides (separated by $\pm 3\text{--}4\times$ their diameter). Tergite VIII (pygidium) convex, the surface with large setose punctures not uniformly distributed, the setae denser in the apical part. Metasternal process subplanar with a thin, barely visible median darkened groove in the anterior half; mesocoxae widely separated. Stridulatory apparatus (sternite VI) present. **Legs:** Protibia tridentate externally, the basal tooth spinose, acute, very reduced. Femurs without accessory teeth, their surface with two parallel rows of setose punctures. First metatarsomere of equal length than tarsomeres 2–5 combined. **Genitalia:** Female terminalia rather weakly chitinized. Gonopode IX dimeric (one subcoxite and one coxite on each side), the terminal stylus IX lacking (Fig. 4). Subcoxite IX barely sclerotized, roughly triangular, with two long setae at the apical end of the ventral edge; coxite IX elongated, digitiform, bearing about twenty long setae.

Sexual dimorphism. Unknown.

Etymology. In reference to the *Minotaur*, a twin-horned mythological creature.

Distribution. North Palawan (El Nido, Roxas) (Fig. 20).

Remarks. From the presence of two distinct tubercles on the vertex and the outer 3rd protibial tooth located near the base, *N. minotaurus* Huchet, new species appears to be morphologically closest to *Nothochodaeus maruyamai* Ochi, Kon and Masumoto, 2013 from the Malay Peninsula but also to *N. hirtus*, from Java. It differs from *N. maruyamai* by the presence of two acute tubercles on each side of a distinctly raised clypeal carina (the clypeal carina is very thin, slightly raised, and weakly tuberculate on either side in *N. maruyamai*). Additionally, the pronotal punctation of *N. minotaurus* Huchet, new species, is denser than that of *N. maruyamai*, and the setose punctures distinctly larger. *N. minotaurus* Huchet, new species is distinguished from *N. hirtus* by its smaller size, the conformation of the clypeal carina (very high and without tubercles in *N. hirtus*). Finally, the pronotal punctation of *N. hirtus* is very distinct (very dense, consisting of small, tightly packed but non-contiguous setose granules).

In addition to similar coloration patterns, these three species share the presence of a pair of weakly raised tubercles on the vertex. Interestingly, other species belonging to the geographically distant genus *Parochodaeus* Nikolajev, 1995 present similar tubercles, as notably the neotropical species *P. bituberculatus* (Erichson, 1847), inhabiting Peru and Chile, but also *P. pudu* Paulsen and Ocampo, 2012, from Argentina (in this last species, the tubercles are nevertheless very prominent).

Dupuis (2005), based on a detailed study of three female representatives of the family (*Ochodaeus gigas* Marseul, 1913, *O. miliaris* Klug, 1832 and *O. pocadioides* Motschulsky, 1859 (this last species now included in the genus *Parochodaeus* Nikolajev, 1995 (Huchet 2016)) evidenced the presence of a trimeric gonopod IX (subcoxite/

coxite/stylus) within these taxa. A similar conformation has recently been demonstrated in the South African species *O. congoensis* Benderitter, 1913, *O. adsequa* Kolbe, 1907 as well as in the genus *Afrochodaeus* Huchet, 2020 (Huchet 2020). Although belonging to three distinct genera, all these species belong to the tribe Ochodaeini Streubel, 1846. Interestingly, unlike representatives of the Ochodaeini, the gonopod IX of Nothochodaeini Nikolajev, 2015 (ie. *Nothochodaeus* Nikolajev, 2005 and *Ceratochodaeus* Huchet, 2017) is dimeric and lacks a terminal stylus (Fig. 4). An exhaustive study of the female terminalia at suprageneric level would obviously be relevant to

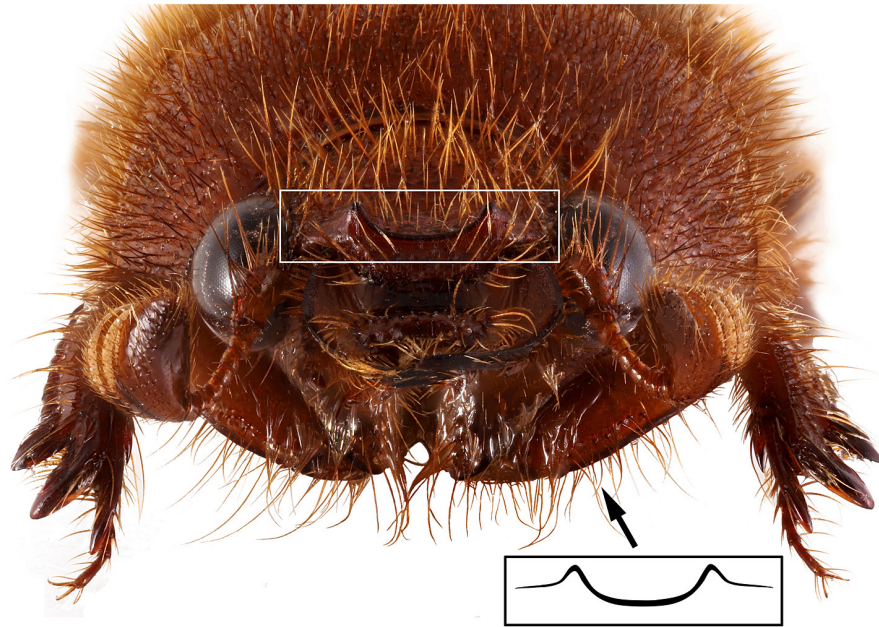
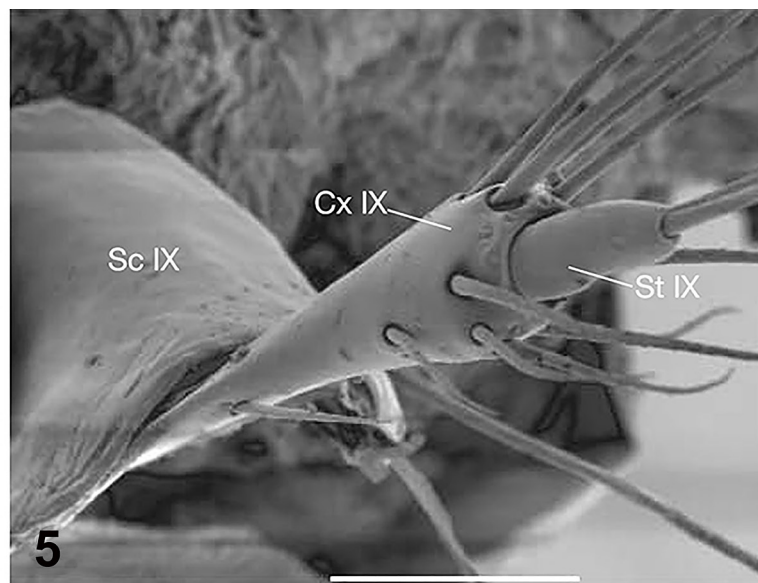
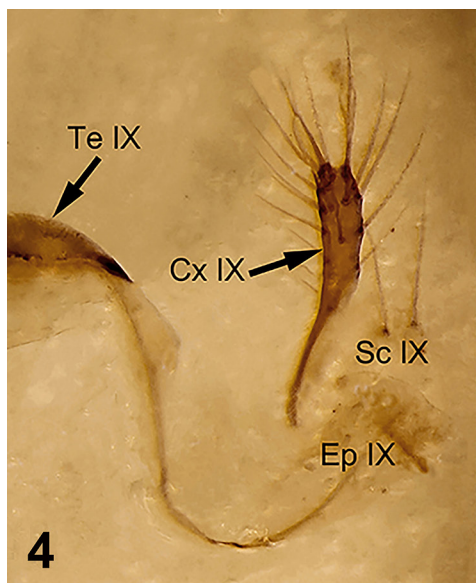


Figure 3. *Nothochodaeus minotaurus* Huchet, new species, head, frontal view (paratype), inset illustrating the two acute clypeal tubercles (Photo J.-B. Huchet, MNHN).



Figures 4–5. Ochodaeidae, female terminalia. 4) *Nothochodaeus minotaurus* Huchet, new species (holotype), right part. 5) *Ochodaeus miliaris* Klug, 1832, with stylus IX present (after Dupuis, 2005) (Cx: coxite; Ep: epipleurite; Sc: subcoxite; Te: tergite). (Fig. 5: photo courtesy of F. Dupuis; scale = 100 μ m).

reach a definitive conclusion. Although rarely described and used, the morphology of female genitalia is revealed to be of great value within the systematics of the Ochodaecidae as evidenced by Ortuño (2007). Along with male genitalia, we are convinced that female terminalia bear relevant features that may be useful both in the specific identification of the taxa and to clarify the phylogenetic relationships between the different genera.

Nothochodaeus huxleyi Huchet, new species (Fig. 6–11, 13, 16, 18, 20)

Type material. Holotype male (CJBH), labeled: a) rectangular, white paper, printed: “PHILIPPINES, Palawan / Roxas, V. 2016 / Flight interception trap / S. J. Soriano lgt”; b) rectangular, white paper, printed: “Coll. J.-B. Huchet”; c) rectangular, red paper: “TYPE”; d) rectangular, red paper, printed: “*Nothochodaeus huxleyi* n. sp. / HOLOTYPE / J.-B. Huchet det. 2021”. Genitalia stored in a small glycerol vial, pinned under the specimen. Note: currently in the author collection, this specimen is intended to be deposited at the Muséum National d’Histoire naturelle, Paris.

One female allotype (CJBH) labeled: a) “PHILIPPINES, Palawan / Roxas, VI. 2016 / Flight interception trap / S. J. Soriano lgt” b) rectangular, white paper, printed: “Coll. J.-B. Huchet”; c) rectangular, red paper, printed: “*Nothochodaeus huxleyi* n. sp. / PARATYPE / J.-B. Huchet det. 2021”. One female paratype (CJBH) labeled: a) “PHILIPPINES, Palawan / Roxas, Tinitian / IX. 2021 / local collector” b) rectangular, white paper, printed: “Coll. J.-B. Huchet”; c) rectangular, red paper, printed: “*Nothochodaeus huxleyi* n. sp. / PARATYPE / J.-B. Huchet det. 2021”. One female paratype (CJBH) labeled: a) “PHILIPPINES, Northern Palawan / Roxas, Mt. Magara / 21-VIII.2021, light trap / local collector”. b) rectangular, white paper, printed: “Coll. J.-B. Huchet”; c) rectangular, red paper, printed: “*Nothochodaeus huxleyi* n. sp. / PARATYPE / J.-B. Huchet det. 2021”.

Diagnosis. This species has the body robust, strongly convex, densely pubescent, the head with a strongly pro-curved “U” shaped raised carina distinctly tuberculate at both ends. Overall color orange with localized dark patterns on pronotum and elytra. The underside and legs are pale yellow; the antennae orange-yellow except the club, dark-brown. The stridulatory peg is present.

Description. Holotype male (Fig. 6–8, 11, 13, 16). **Length:** 11 mm (from the apex of the mandibles to the apical part of the tergite VIII). **Width:** 5.9 mm (greater width of the pronotum). **Head:** Head transverse, sub-hexagonal, entirely orange except for the frontoclypeal carina which is darkened. Frontoclypeal carina strongly raised, in inverted “U” shape, ended on both sides by a small, well individualized tubercle (Fig. 6, 16). Clypeus trapezoidal in outline, strongly obliquely sloping forward, the anterior margin finely denticulate, the interval between these small denticles with a small yellow-orange bristle directed forward. Posterior declivity of clypeus relatively abrupt behind the carina, flanked on both sides by the clypeofrontal suture, slightly impressed and extending laterally



Figure 6. *Nothochodaeus huxleyi* Huchet, new species, male holotype, head in frontal view showing the U-shaped frontoclypeal carina (Photo J.-B. Huchet, MNHN).



Figures 7-8. *Nothochodaeus huxleyi* Huchet, new species, male holotype. **7)** Habitus, dorsal view. **8)** Habitus, latero-dorsal view (Photos J.-B. Huchet, MNHN).

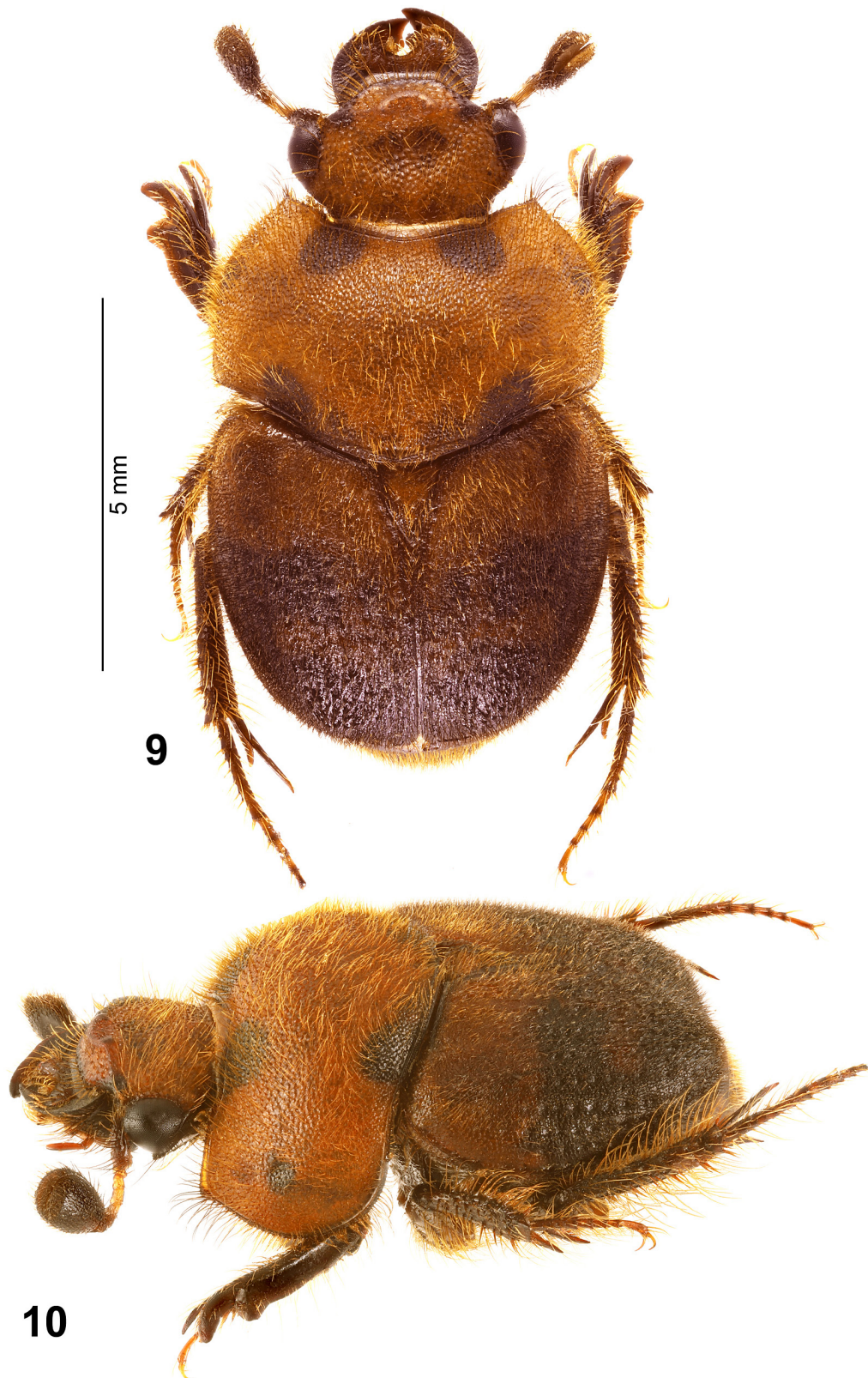
up to the level of the anteromedial angle of the eye. Head surface shiny, covered with tight but not contiguous medium setiferous granules; a median longitudinal area, smooth, from the base to the middle of the head in front. Labrum transverse, dorsally convex, hyaline, long pubescent, strongly emarginate in the middle front, with a distinct raised transverse ridge in the middle. Eyes moderate in size, globose, strongly produced laterad with spaced long setae along their inner edge. Mandibles subequal, falciform, slightly concave dorsally, the surface matt, distinctly wrinkled on a microreticulate background. Mentum oblong, subquadrangular, weakly depressed in front. Antenna 10-segmented, the scape and funicle yellow-orange, pubescent, the club shiny, dark-brown except for narrow whitish apical part. **Pronotum:** Transverse, strongly convex, entirely margined, distinctly emarginate behind the head with a thin hyaline membrane in front, the lateral edges and base fringed with setae. Front angles prominent, projecting forward, the posterior ones obtusely rounded. Pronotal surface with a very dense punctation, consisting of small, tightly packed, medium-sized setiferous rounded granules with yellow-orange setae erect upwards. The setae located laterally at the front angles distinctly longer, black, curved upwards. A short median longitudinal furrow at basal third, extending forward to the anterior margin as a thin, darkened line. Pronotum uniformly orange with two black paramedian spots along the front margin, two other spots more broadly spaced along the base, and a distinct darkened fovea in the middle of each side. **Elytra:** Transverse, dull, densely pubescent, their color coarsely similar to that of the pronotum. Striae well-marked, relatively shallow, consisting of aligned sunken medium points separated by about 1–1.5× their diameter. Intervals almost flat, punctation strong and tight consisting of small setose granules on a microreticulate background, the minute setae erected, distinctly darkened. Humeral callus well developed. Elytral color patterns as follow: a thin transverse dark band on the fourth interstria along the front margin, a round black spot located on the humeral callus and a transverse median dark band interrupted in the middle, merging laterally with the next band located in the apical third of the elytra. Scutellum elongate, triangular in outline, the lateral edges darkened, the disc slightly depressed longitudinally in the middle. **Abdomen:** Strongly convex with six visible ventrites (III–VIII). Surface smooth, shiny, microreticulate; ventrites with minute setigerous tubercles along their front margin, the disc with medium setae roughly aligned. Tergite VIII (pygidium) brownish-black, pubescent, the punctation consisting of small close setose granules embedded on a microreticulate background; a lightened transverse band along the upper edge. Tergite VII (propygidium), entirely orange with trapezoidal interlocking mechanism. Stridulatory apparatus (sternite VI) present. **Legs:** Protibia quadridentate externally, the median tooth (third) barely visible, the basal tooth very reduced, spinose, pointed; inner apical angle of protibia with a short, acute pollex directed anteriorly (Fig. 18). Femur without accessory teeth, their surface with two parallel rows of setose punctures. **Genitalia:** Aedeagus with phallobase dorsoventrally curved, acuminate apically; parameres short, symmetrical, distinctly divergent at apex, the apical lobe ovoid. Endophallus well developed, unarmed (lacking endophallites) (Fig. 11).

Sexual dimorphism. The female paratypes show little variation from the male, and negligible sexual dimorphism. The area located behind by the clypeofrontal carina is flat-topped within the female, somewhat reminiscent of the clypeal horn of males of the genus *Ceratochodaeus* Huchet, 2017 (this area is obliquely truncated backwards within the male). Finally, overall body coloring of the female may appear distinctly darker than in males (notably the underside, entirely dark orange-brown within the female allotype whereas it is entirely pale yellow in male holotype, except for the abdomen, partly darkened). Similar color variation patterns between both sexes have been reported for the close species *N. borneensis* (Ochi et al. 2013).

Etymology. Dedicated to the late English biologist Thomas Henry Huxley (1825–1895) who modified the famous Wallace's Line, including Palawan as a component of the Asian biogeographic realm and separating this island from the oceanic Philippines.

Distribution. North Palawan (El Nido, Roxas) (Fig. 20).

Remarks. *N. huxleyi* Huchet, new species, presents close affinities with *N. borneensis* Ochi, Kon and Masumoto, 2013 from Borneo, but also with *N. xanthomelas* (Wiedemann, 1823), inhabiting Java and Sumatra, pointing to a common biogeographical history between these two regions. Other geographically more distant species also appear to be morphologically closely related to these taxa. These include *N. grandiceps* (Fairmaire, 1897) from continental China, *N. sakaii sakaii* (Ochi, Masumoto and Li, 2006) from Taiwan, and *N. sakaii khaoyaiensis* Masumoto and Ochi, 2015 inhabiting Thailand. We propose here to group all these morphologically related species into a distinct species complex designated as “*N. xanthomelas* species complex”.



Figures 9–10. *Nothochodaeus huxleyi* Huchet, new species, female allotype. **9)** Habitus, dorsal view. **10)** Habitus, latero-dorsal view (Photos J.-B. Huchet, MNHN).

N. huxleyi Huchet, new species can be separated from *N. borneensis* by the conformation of the clypeus, distinctly more abruptly sloping forward, the clypeofrontal carina more strongly arched in male (Fig. 16–17), the pronotal and elytral patterns of coloration, and the scutellum uniformly orange (always black or darkened within *N. borneensis* as indicated by Ochi et al. (2013)) (Fig. 14–15). Protibiae broader in both sexes, 1st tooth longer and more strongly curved outward, 2nd very large (distinctly shorter and less developed within *N. borneensis*) (Fig. 18–19). Finally, these two species can be separated by the conformation of male genitalia (Fig. 11–12).



Figures 11–13. *Nothochodaes* sp., male genitalia. 11) *N. huxleyi* Huchet, new species, aedeagus in latero-dorsal view. 12) *N. borneensis* Ochi, Kon and Masumoto, 2013, aedeagus in latero-dorsal view (insets illustrating a close-up of left paramere). 13) *N. huxleyi* Huchet, new species, genital segment (urite IX) (Photos J.-B. Huchet, MNHN).



Figures 14–15. *Nothochodaes borneensis* Ochi, Kon and Masumoto, 2013. 14) Male, dorsal view (coll. MNHN). 15) Female, dorsal view (coll. MNHN) (Photos J.-B. Huchet, MNHN).



Figures 16–19. *Nothochodaeus* sp., clypeofrontal carina and protibia, comparizon. **16)** *N. huxleyi* Huchet, n. sp., holotype male, clypeofrontal carina, frontal view. **17)** *N. borneensis*, male, clypeofrontal carina, frontal view. **18)** *N. huxleyi* Huchet, n. sp., holotype male, right protibia, dorsal view. **19)** *N. borneensis*, male, right protibia, dorsal view.

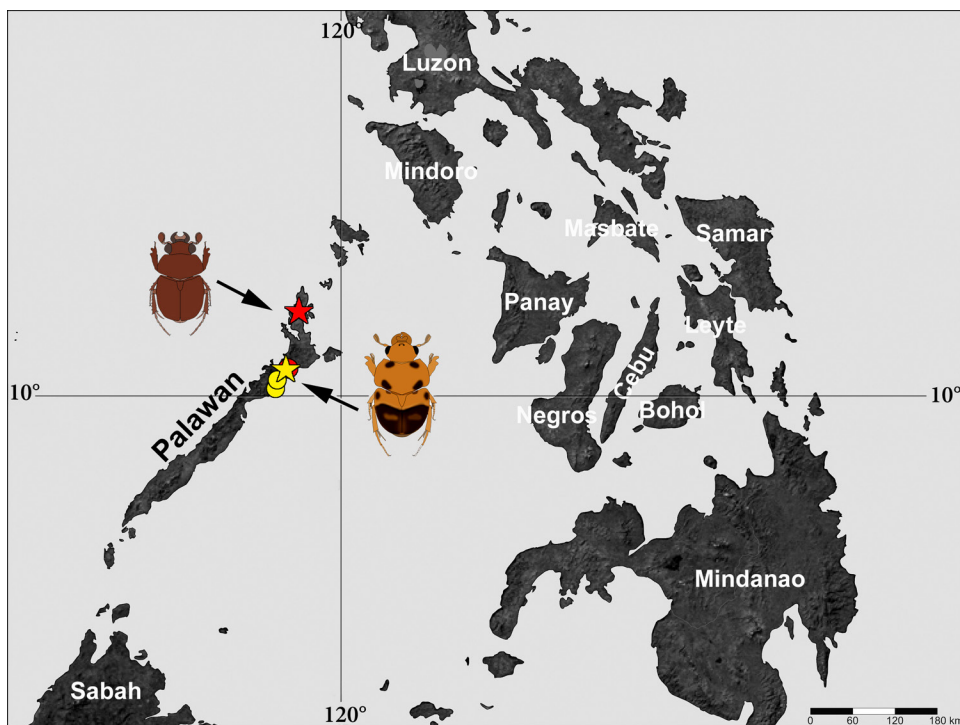


Figure 20. Distribution map of *Nothochodaeus minotaurus* Huchet, new species (red dots), and *N. huxleyi* Huchet, new species (yellow dots) on Palawan Island (the type locality indicated with a star).

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