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Two new species of *Paranomala* (Coleoptera: Melolonthidae: Rutelinae: Anomalini) from Mexico and Costa Rica with remarkable modifications on the pronotum

Dos especies nuevas de *Paranomala* (Coleoptera: Melolonthidae: Rutelinae: Anomalini) de México y Costa Rica con modificaciones notables en el pronoto

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Abstract. Two new species of the genus *Paranomala* Casey that exhibit notable and unusual pronotal surface configurations are described. Distinctive characters of these species are discussed and illustrated and comments on their resemblance and kinship with other *Paranomala* species that also exhibit an irregular pronotal surface are included.

Key words: Coleoptera, scarab beetles, pronotal shape, morphology, new species.

Resumen. Se describen 2 especies nuevas del género *Paranomala* que presentan notables e inusuales configuraciones de la superficie del pronoto. Se discuten e ilustran los caracteres distintivos de estas especies y se comentan las similitudes y afinidades con otras especies de *Paranomala* que también presentan una superficie pronotal irregular.

Palabras clave: Coleoptera, escarabajos, forma pronotal, morfología, nuevas especies.

Introduction

The New World genus *Paranomala* comprises nearly 200 species (Machatschke, 1972) widely distributed from southern Canada to northern Argentina, reaching its greatest diversity in Mexico and Central America (Bates, 1888; Blackwelder, 1944; Jameson et al., 2003; Morón et al., 1997). Although recently some research has been done on New World Anomalini (Morón and Nogueira, 1998, 2002; Jameson et al., 2003; Micó et al., 2003; Paucar-Cabrera, 2003; Ramírez-Ponce and Morón, 2009; Ramírez-Ponce, 2010), the genus *Paranomala* remains problematic and in serious need of taxonomic and phylogenetic study (Jameson et al., 2003). Since the great nineteenth century works on American beetle fauna, the species level studies of this genus have been scant in contrast to other Melolonthidae genera in which the study of regional faunas and comparative morphology of genitals led to the discovery of many new species. One of the most crucial aspects that complicates the taxonomic study of this genus is the prevalence of many uniform morphological

characters within the described subgenera and species groups as well as the lack of comparative studies of the genitalia (Ramírez-Ponce and Morón, 2009).

The objective of the present work is to describe 2 new *Paranomala* species that are distinctive among the described Anomalini species because of their prominent pronotal bulges.

Materials and methods

We place both species in *Paranomala* because they exhibit, according to the definition of the genus by Ramírez-Ponce and Morón (2009), the following diagnostic combination of characters: mesometasternal process absent, sexual dimorphism slight, pronotal shape subtrapezoidal or subhexagonal, frontoclypeal suture complete, mesepimera covered by elytral humerus, and last sternite with beaded apical margin. As these species do not resemble any other we are familiar with, a detailed revision of the original descriptions of valid species of *Paranomala* distributed within the geographical areas where these were collected was made in order to find evidence of the existence of these strange pronotal forms (sensu Machatschke, 1974; Morón et al., 1997).

Dissection of type specimens was made using forceps and entomological hooks for the extraction of genitalia and/or mouthparts. These were glued on cards and associated with their respective exemplars. The taxonomic characters, terms, and criteria used are those proposed by Ramírez-Ponce and Morón (2009) and Ramírez-Ponce (2010). The observations and measurements were made using an Olympus SZH10 (8-50×) microscope with an ocular micrometer. Photographs were taken with a multifocal Leica Z16AP0A microscope and a Leica camera DFC 490 using the Leica Application Suites software in the Laboratory of Biodiversity II, Institute of Biology, UNAM, Mexico.

Specimens are deposited in the Colección Nacional de Insectos (CNI; UNAM, México City) and Instituto Nacional de la Biodiversidad (INBIO, Costa Rica), and in the personal collections of Miguel Ángel Morón (MXAL; Xalapa, Veracruz, Mexico), Andrés Ramírez Ponce (ARMX; México City), Alberto Bitar (CABS; México City), and Daniel Curoe (DJCC; México City).

Description

Paranomala corcovada Ramírez-Ponce, Bitar and Curoe, sp. nov.

(Figs. 1-5)

Holotype. Male. Total body length 8.15 mm. Maximum humeral width 3.42 mm. Length to width ratio 1:0.41 (Figs. 1a, 1b).

Coloration: head: posterior part of frons and clypeal free margins dark reddish-brown, surface otherwise yellowish-ochre; antennae light yellow. Pronotum: posterior and lateral margins edged with yellowish-ochre; disc and a large lateral spot on each side dark reddish-brown. Scutellum: dark reddish-brown. Elytra: disc light yellowish-ochre; margins dark reddish-brown. Pygidium: base and disc dark reddish-brown; surface otherwise yellowish-ochre. Sternum and abdomen: light yellowish ochre. Legs: mostly yellowish-ochre; protibial teeth dark reddish-brown (Figs. 1a, 2, 3).

Head: pronotum (at middle) head width ratio 1: 0.65. Clypeus subrectangular, anterior angles broadly rounded; anterior margin weakly rounded; free margins reflexed; disc surface weakly tumid, densely and deeply punctuate. Frontoclypeal suture complete, weakly sinuate. Frons surface flat; punctuation uniformly dense; punctures deeper than on clypeus; interocular width equals 2.85 ocular diameters. Eyes prominent; portion of eye anterior to canthus visible in dorsal view. Antenna with club straight, elongate, longer than scape, pedicel and funicle combined (Fig. 1a). Mouthparts well developed; labium longer than wide. Prementum with apical margin strongly

bilobed; surface glabrous, deeply concave. Mentum surface impunctate, with 6 long, thick setae on lateral and basal margins. Labrum with apical margin widely emarginate, fringed with long, thick setae. Epipharynx subtriangular with a strongly curved projection on each side. Maxilla with lacinia well developed, armed with 6 long, acute teeth; terminal palpus thick, about 1.5× longer than basal segments combined. Mandibles with external border curved; surface moderately setose; scissorial area wide, bidentate, preceded by preapical constriction.

Pronotum. Shape subhexagonal. Length to width ratio 1:1.5; pronotal elytral length ratio 1:3.2. Width of base slightly narrower than at middle and distinctly wider than anterior margin. Anterior margin entirely lined by membranous border; posterior margin weakly sinuate. Lateral margins angulate with 4 long, curved setae on each side. Anterior angles acute and pronounced; posterior angles obtuse, rounded. Disc surface strongly irregular with deep, narrow furrow on midline and wide, transversely sinuate groove separating 2 large, transversely elongate bulges on each side. Punctuation uniformly dense; punctures large, deep.

Scutellum. Slightly wider than long (length to width ratio 1:1.25); shape subparabolic; punctuation as on pronotum.

Elytra. Shape slender, length to width ratio 3.14:1), with 12 weak, mostly irregularly punctuate striae; punctures deep, moderate in size, separated by 1-3 diameters. Sutural margin slightly raised on apical 2/3; stria I confusedly punctuate on basal 2/3; stria IV irregularly punctuate, striae X and XI extending from humeral umbone and not reaching apical callus. Lateral margin beaded and fringed with long setae to apical curve. Humeral umbone prominent; apical umbone discrete.

Sternum. Mesosternum with narrow intercoxal space; mesosternal process not projected; mesometasternal suture strongly carinate. Metasternal surface sparsely, setigerously punctuate; punctures shallow, small; setae long, fine, yellowish.

Abdomen. Punctuation on sternites moderately dense; punctures shallow, minute; sternites I-V with submarginal row of small punctures bearing long, yellowish setae. Metanotum slender, length to width ratio 3.67:1. Last sternite with broad, beaded emargination. Pygidium broadly convex in lateral view, with a broad, transverse groove along basal margin; surface densely punctuate; punctures large, shallow; apex with scattered, long setae.

Legs. Protibia tridentate; apical tooth oblique, strongly curved, acute; medial tooth smaller; basal tooth weak. Length of protarsomeres I-IV combined greater than V; protarsomere I slightly longer than II; protarsomere V with prominent denticle situated basoventrally and slightly on internal side. Protibial spur straight, almost reaching apex

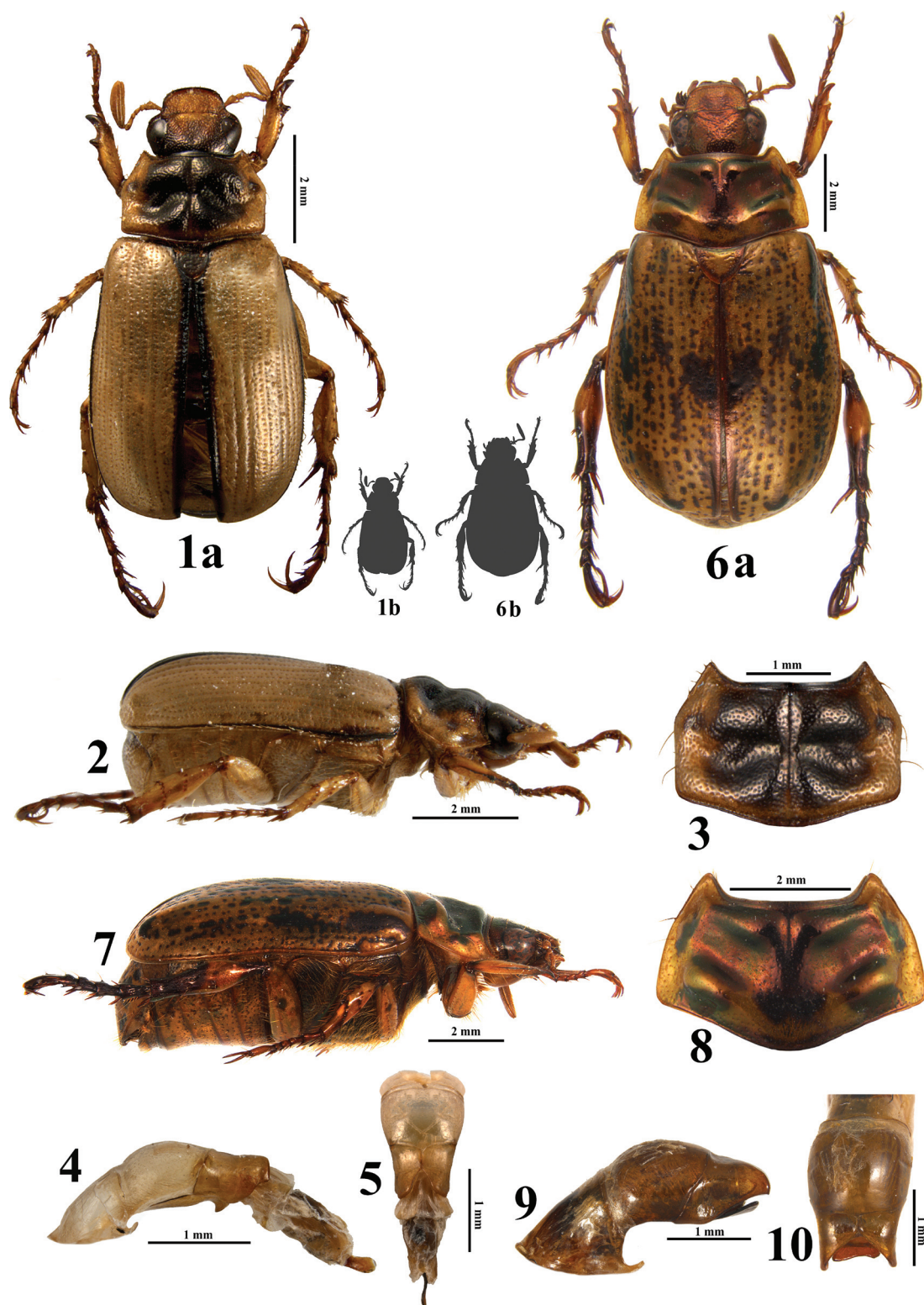


Figure 1-10. Habitus and diagnostic characters of the new species. 1-5) *Paranomala corcovada*; 1a) dorsal habitus, 1b) body size comparison, 2) lateral view, 3) pronotum, 4-5) male genitalia. 6-10) *Paranomala inbio*; 6a) dorsal habitus, 6b) body size comparison, 7) lateral view, 8) pronotum, 9-10) male genitalia.

of internal protibial margin. Meso- and metatibia each with 2 transverse carinae; basal carinae discontinuous, apical carinae continuous. Mesotibial apex with 9 spinules; metatibial apex with 15. Metatibia moderately widened mesial and apically. External metatibial spur acute, slightly curved, length about 0.5x metatarsomere I; internal metatibial spur apically blunt, weakly curved, slightly longer than metatarsomere I. Metatarsal length 1.25x metatibia; metatarsomere I shorter than II, equal to III and longer than IV. Inner protarsal claw widely, deeply cleft; outer ramus shorter than inner. Mesotarsal outer claw narrowly cleft; outer ramus longer than inner. Metatarsal claws simple.

Genitalia. Phallobase: tectum: parameres length ratio 1.0:0.88:0.78. Tegmen with phallobase and tectum fused. Ventral plate separated from tectum and parameres; apex cariniform and recurved ventrally. Parameres short, in dorsal view separated from tectum and in contact to middle, then widely divergent, in lateral view surface uniformly cylindrical and distally sharply. Internal sack of aedeagus with wide, membranous and sclerotized areas and a long, laterally compressed, spatulate and sclerotized terminal structure (Figs 4, 5). *Spiculum gastrale* T-shaped; basal sclerite straight; lateral sclerites longer than basal; associated plates short, wide, free margin rounded; surface and free margin setigerous; setae long, some longer than plates.

Paratypes (5 females, MXAL, ARMX, CABS, DJCC). As the holotype except: Length 8.0-9.2 mm; elytral width 3.2-3.63 mm. Frons, clypeus and protibiae uniformly dark reddish-brown; eyes larger; antennal club shorter than scape, pedicel and funicle combined; scutellum longer; elytral apical calla dark reddish-brown; last sternite without emargination; protibia broader and with apical tooth less curved; metatibia thicker and apically more strongly flared; metatarsus thicker; metatibial spurs curved; length of external spur longer 0.5x internal spur; internal spur distinctly longer than metatarsomere I; inner protarsal claw with outer ramus longer than inner; genital plates large, subtriangular; free margins fringed with moderately long setae.

Taxonomic summary

Type material. (1 ♂, 5 ♀♀; CNIN, MXAL, ARMX, CABS, DJCC). Holotype. Male (CNIN) labeled: a) "México, Chiapas / Bellavista, Bellavista / 5-11/VII/2010. / O. Velázquez, A. Bitar" (typed); b) "15°34'60" N, 92°14'47" O, 1 500 m, Bosq. Mixto-SBC" (typed); c) "HOLOTYPE ♂ / *Paranomala corcovada* Ramírez-Ponce, Bitar and Curoe, sp. nov." (red label, typed). Paratypes. (1 ♀ MAXL; 1 ♀ ARMX; 2 ♀ CABS; 1 ♀ DJCC). Same data as holotype except: c) "PARATYPE ♀ / *Paranomala corcovada* Ramírez-Ponce, Bitar and Curoe, sp. nov." (yellow label, typed).

Diagnosis. *Paranomala corcovada* is distinguished from other members of the genus by the following combination of characters: head with frontoclypeal suture sinuate; eyes prominent; antennal club long (as long as scape, pedicel, and funicle combined); mouthparts well developed; protibiae tridentate; pronotal shape subhexagonal, with deep longitudinal furrow on midline and a pair of noticeable bulges on each side; parameres short, lateral surface uniformly cylindrical; internal sack with prominent, sclerotized structure; ventral plate apically recurved. Female genital plates subtriangular.

Type locality. Town of Bella Vista, municipality of Bella Vista, located in the Sierra Madre de Chiapas, state of Chiapas, Mexico (15° 34' 60"N, 92° 14' 47" W).

Distribution, habits and biology. This species is known only from the type locality at the base of the inland slope of the Sierra Madre de Chiapas (about 40 km from the border with Guatemala) at an elevation of 1,500 m. The topography in this area makes it difficult to ascribe an ecosystem type (based on García, 1996) but may be part of the moderately hot-humid region (ACm; García, 1998). The type locality is within the northern limits of the "Pico el Loro Paxtal" state reserve and the Priority Mexican Terrestrial Region "El Mozotal" (RTP-134). This area is conserved because it serves as a biological corridor between the natural protected areas of "Tacaná-Boquerón" (RTP-135) and "El Triunfo-La Encrucijada-Palo Blanco" (RTP-133) (Arriaga et al., 2000). The type series was collected at public lights between 21-23:00 hours in the first days of April 2010, in synchrony with the first rains of the year. Nothing is known about its life cycle or feeding habits.

Etymology. Specific epithet *corcovada*, from latin "*cucurvus*", reduplication of "*curvus*", for describing an abnormal curvature of the spine or chest or a curvature or bulk that alters the normal outer shape (RAE, 2014).

Paranomala inbio Ramírez-Ponce, Bitar and Curoe, sp. nov.

(Figs. 6-10)

Holotype. Male. Length 11.4 mm. Maximum elytral width 5.12 mm. Length to width ratio 1:0.45 (Fig. 6a,b).

Color. Head: coppery with intense metallic reflections. Pronotum: basal and lateral margins edged mostly with yellowish-ochre; each side with a large lateral and basolateral piceous spot; entire surface suffused by overlying, intense, coppery reflections. Scutellum: disc yellow-ochre, margins coppery. Elytra: ground color yellow-ochre, with piceous punctures, umbones and each with 4 large piceous blotches across middle; sutural margin coppery. Pygidium: ground color yellow-ochre, with scattered, small piceous blotches. Legs: femora and tibia basally and apically piceous,

medially yellow-ochre; metatibia's piceous apical portion also suffused by coppery reflections; pro- and mesotarsi ochre; metatarsi piceous with coppery reflections.

Head. Pronotum (at middle) head width ratio 1.0:0.59. Clypeus subtrapezoidal; anterior angles broadly rounded; lateral margins straight; anterior margin straight and reflexed; disc surface weakly tumid and contiguously punctuate; punctures wide, shallow. Frontoclypeal suture complete, sinuate. Frons surface irregularly punctuate; punctures moderate in size, separated by 1-4 diameters; interocular distance equals 3.3 eye diameters. Eyes prominent; portion of eye anterior to canthus visible in dorsal view (Fig. 6a). Antennae with club straight, elongate, longer than scape, pedicel and funicle combined (Fig. 6a). Mouthparts well developed; labrum longer than wide. Prementum glabrous; surface basally weakly concave, sparsely punctuate; punctures large, deep; apical margin bilobed. Mentum surface nearly impunctate with 4 long, thick setae on disc. Maxilla and lacinia well developed, armed with 6 large teeth; apical palpus long and thick, smaller than 1.5× longer than 2 basal segments combined. Mandibles with external border rounded; surface glabrous, scissorial area wide, bidentate, preceded by preapical constriction.

Pronotum. Shape subtrapezoidal. Length to width ratio 1:1.70; pronotal elytral length ratio 1:3.0. Widest at base. Anterior margin almost entirely lined by membranous border, projected backward at middle; basal margin subangulate. Lateral borders rounded, with 2 long setae on each side. Anterior angles rounded; posterior angles obtuse and rounded. Surface strongly irregular; disc with 2 oblique, elongate bulges on each side separated by wide, oblique depression; anterior third of midline deeply, narrowly furrowed. Punctuation uniformly and sparse punctuate, punctures shallow, minute (Figs. 6a, 8).

Scutellum. Subtriangular; wider than long (length to width ratio 1:1.52); punctuation as on pronotum (Fig 6a).

Elytra. Wider in posterior half; maximum length to width ratio 2.9:1.0. In lateral view sutural margin slightly raised on apical third. Disc with 9 striae indicated by irregularly spaced dark punctures separated by 1-3 diameters; punctures moderate in size, deep. Lateral margin glabrous and beaded to level of apical umbone. Humeral and apical umbones prominent.

Sternum. Mesosternum with wide intercoxal space; mesosternal process tuberculiform; mesometasternal suture carinate; metasternal surface densely punctuate; punctures large, bearing long, fine yellowish setae.

Abdomen. Punctuation on sternites sparse; punctures mostly small, shallow; sternites I-V with submarginal row of scattered small punctures bearing long setae. Apical margin of last sternite moderately emarginated, thickly beaded and fringed by about 5 short setae. Pygidium (lateral

view) broadly convex; surface irregularly punctuate; most punctures separated by 1-4 diameters, some coalesced; punctures large, deep; apical surface with a few scattered setae, margin at apex fringed with a few long setae.

Legs. Protibiae tridentate; apical tooth oblique, strongly curved, acute; medial tooth strong; basal tooth small. Length of protarsomeres I-IV combined greater than protarsomere V; protarsomere I slightly longer than II; protarsomere V with subtriangular denticle situated basoventrally and slightly on internal side. Protibial spur straight, reaching the internal protibial apex. Meso- and metatibia each with 2 discontinuous, transverse carinae. Mesotibial apex with 9-10 spinules, metatibial apex with 11. Metatibia strongly thickened medially and strongly flared apically; external metatibial spur acute, slightly curved; length equals 0.5× metatarsomere I; internal metatibial spur straight, apically rounded, somewhat larger than metatarsomere I. Metatarsus moderately long, length about 1.15× metatibia. Metatarsomeres I to IV each longer than following one. Inner protarsal claw deeply, widely cleft; outer ramus shorter than inner. Mesotarsal outer claw narrowly cleft, with outer ramus slightly shorter than inner; metatarsal claws simple.

Genitalia. Phallobase tectum parameres length ratio 1.00:0.92:0.68. Tegmen with phallobase and tectum separated by a suture. Ventral plate separated from tectum and parameres; apical margin asymmetrically bilobed; left lobe more produced. Parameres short; in dorsal view separated from tectum and in contact to basal fifth, then widely divergent; in lateral view subquadrate angle; each side with deep oval excavation. *Spiculum gastralle* "T" shaped; basal sclerite straight, shorter than laterals; associated plates large, free margins slender and rounded, this with long setae, all longer than plates.

Paratype (1 female, DJCC). It differs from the holotype in the following respects: length 13.0 mm; maximum elytral width 5.23 mm. Head coloration with greenish and coppery reflections, instead of coppery only; elytral apical umbone piceous; pronotal disc almost entirely coppery with yellowish-ochre coloration restricted to lateral margins. Eyes larger. Antennal club slightly shorter; length less than scape, pedicel and funicle combined. Prementum with moderately dense, short setae. Mentum with 4 long setae on each side. Pygidium with a wide depression near each basal angle. Last abdominal sternite with apical margin straight instead of emarginate. Protibia broader; teeth apices rounded; apical tooth less curved; inner protarsal claw with outer ramus longer than the inner. Metatibiae and metatarsus broader, the first noticeable broaden apically; metatibial spurs thicker, curved, apically blunt; external spur slightly longer than 0.5 the internal; internal

spur distinctly longer than metatarsomere I. Female genital plates large, subtriangular; free margins with moderately long setae.

Taxonomic summary

Type material. (1 ♂, 1 ♀; INBIO, DJCC). Holotype. Male (INBIO) labeled: a) "COSTA RICA: S. J. / 9 Rd km s of DIVISIÓN / 18-v-91 / D. Curoe col." (typed); b) "MERCURY LIGHT"; c) "HOLOTYPE ♂ / *Paranomala inbio* Ramírez-Ponce, Bitar and Curoe, sp. nov." (red label, typed). Paratype. (1 ♀, DJCC). Same data as holotype except: c) "PARATYPE ♀ / *Paranomala inbio* Ramírez-Ponce, Bitar and Curoe, sp. nov." (yellow label, typed).

Diagnosis. *Paranomala inbio* is distinguished from other species of the genus by the following combination of characters: head with frontoclypeal suture sinuate; eyes prominent; antennal club long (as long as scapus, pedicellus, and funiculus combined); mouthparts well developed; protibiae tridentate; pronotal shape subtrapezoidal, with deep furrow on anterior third and 2 large, oblique, elongate bulges on each side; parameres short; laterobasal surface excavated; apical margin of ventral plate asymmetrically bilobed with right lobe more produced. Female genital plates elongate, subelliptical.

Type locality. The 2 specimens were collected in premontane rain forest (bp-P) (Holdridge et al., 1971) on the Cerro de la Muerte, in the Talamanca Sierra.

Distribution, habits and biology. This area is an important forest reserve with very moist and well-preserved forests. It is also the area with the highest altitude in the country because some peaks such as Cerro de la Muerte exceed the 3 000 m (Solano and Villalobos, 2001). Nothing is known about its life cycle or feeding habits. Both specimens were attracted to lights.

Etymology. We are pleased to name this strange species after Costa Rica's pioneering Instituto Nacional de Biodiversidad.

Discussion

Among the New World species of the tribe Anomalini, there is great variation in certain characters, but in nearly all species the surface of the pronotum is evenly convex. One notable exception is the genus *Anomalorhina* Jameson, which can be easily recognized by the presence of the median depression on the pronotum (Jameson et al., 2003). Within the genus *Paranomala*, 2 cases are striking. In the classic *Biologia Centrali-Americana*, the description of *P. compressicollis* Bates, a species from Guatemala, is noteworthy and mentions "a strange apparent deformity of the thorax" (Bates, 1888). In recent literature, *P. terroni* Morón and Nogueira, a species from Mexico, is distinguished by the "surface of the pronotum irregular,

with parts closest to all edges partially excavated" (Morón and Nogueira, 1998). In *P. corcovada*, however, the pronotum's subhexagonal shape and irregular surface, and the configuration of the internal sack of the aedeagus, with a long, spoon-like structure, are unique. Whereas in *P. inbio*, the pronotum's irregular surface with coppery reflections and the asymmetric shape of the ventral plates of the aedeagus are diagnostic.

These species exhibit a set of morphological characters that link them with Machatschke's (1972) *innuba* and *gemella* species groups, which are typified by a central and lateral spots on the pronotum, the dark coloration of the irregular punctures of the scutellum, and elytra and of parts of the pygidium, sternum, abdomen, and tarsi. In *P. corcovada*, the shape of the scutellum, the length of the antennal club, the length of metatarsomeres I and II, the shape and size of the parameres and the carinate, apically recurved ventral plate are shared with the *innuba* species group. In *P. inbio*, the body size, the trapezoidal form of the pronotum and the form and coloration of the meso- and metatibiae are characters that are shared with *P. terroni*, a species that must belong to the *gemella* species group. *Paranomala corcovada* is distinguished from *P. terroni* by the body length between 8.0 and 9.2 mm (11.5 to 14.0 mm in *P. terroni*), pronotum sub-hexagonal, glabrous and strongly irregular by deep furrow and large bulges (subtrapezoidal, setose and without furrow nor large bulges in *P. terroni*), meso and metatibiae slightly obscured on base and apex (wide and markedly obscured in *P. terroni*), sternum and abdomen yellowish (dark brown in *P. terroni*). *P. inbio* is distinguished from *P. terroni* by pronotum glabrous and with 2 oblique bulges on each side and a wide depression (setose and without bulges nor depression in *P. terroni*), elytra with piceous punctures (punctures yellowish as the surface in *P. terroni*), and ventral plate of male genitalia asymmetric (symmetric in *P. terroni*).

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