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Anurocampa (Lepidoptera: Notodontidae): two new species, systematics and immature stages

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Abstract

Notodontidae (Lepidoptera, Noctuoidea) comprise over 4,000 described species distributed worldwide, among which nearly half are restricted to the Neotropics. Morphology of adults and immatures of Notodontidae have been broadly investigated and many larval, pupal, and adult characters were found to be synapomorphies of subfamilies and tribes. Despite this, the current classification of Notodontidae remains unsettled as most recent classification systems are contradictory due to reliance on incomplete global sampling and, many taxa, especially in the Neotropics, are still informally classified as *incertae sedis*. *Anurocampa* Herrich-Shäffer was recently treated as an *incertae sedis* genus, and immature and adult characters may provide further evidence for its systematic position among the Notodontidae. With this goal in mind, the present study describes the immature stages of *Anurocampa mingens* Herrich-Shäffer from Brazil and describes two new species in the genus from Costa Rica based on morphology and mitochondrial DNA: *Anurocampa markhastingsi* Chacón and St Laurent **sp. nov.** and *Anurocampa abelardochaconi* Chacón and St Laurent **sp. nov.** and discusses the systematic position of *Anurocampa*.

Key words: insect-plant interactions, life cycle, Melastomataceae, Noctuoidea, prominent moths, taxonomy

Introduction

The "prominent" moths (Lepidoptera, Notodontidae) comprise over 4,000 described species distributed worldwide, among which nearly half are restricted to the Neotropics (Becker 2014; Schintlmeister 2013; Van Nieukerken *et al.* 2011). The family belongs to the Noctuoidea, the most speciose superfamily of Lepidoptera (Becker 2014; Schintlmeister 2013; Van Nieukerken *et al.* 2011) and also includes species of economic relevance in South America (Kowalczuck *et al.* 2012; Santos *et al.* 2021). However, the current classification of Notodontidae remains unsettled, primarily due to incomplete global sampling in various systematic studies (Becker 2014; Kobayashi & Nonaka 2016; Miller 1991, 1992; Regier *et al.* 2017; Schintlmeister 2008). Many taxa genera, especially in the Neotropics, are still informally classified as *incertae sedis*. Therefore, studies on notodontid relationships are being cited as "the most important future tasks for noctuoid systematics" (Regier *et al.* 2017).

Anurocampa Herrich-Shäffer, [1854] has been treated as one such *incertae sedis* notodontid genus (Becker 2014, but see Prada-Lara *et al*., 2023). The genus was described to accommodate a single species *Anurocampa*

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mingens Herrich-Schäffer, [1854], described from Rio de Janeiro, Brazil. After that, *A. orousseti* Thiaucourt, 1985, was described from a single male collected in French Guiana, thus concluding all formal taxonomic acts related to the genus (an additional species described by Schaus (1920), originally assigned to *Anurocampa*, has since been recombined with *Eustema* Schaus, 1901 in Schintlmeister (2013)). Prada-Lara *et al.* (2023) recently listed all Notodontidae from Colombia and assigned one species of *Anurocampa* to Heterocampinae based on ongoing phylogenomic work.

Anurocampa mingens, a notably large species of notodontid, has not been included in any published phylogenetic or formal, modern classification systems of Notodontidae (Kobayashi & Nonaka 2016; Regier *et al*. 2017). Besides being relatively common in southern Brazil (Zenker *et al.* 2012), neither the adult nor the immature stages have been described in the literature in detail. However, the Melastomataceae host plants are known, and in Costa Rica, an undescribed *Anurocampa* has been reared (Janzen & Hallwachs 2009; Silva *et al.* 1968).

Immatures of Notodontidae have been broadly investigated in the last decades (Dolinskaya 2013, 2014; Miller 1991, 1992), and many characters found in larvae and pupae were found to be synapomorphies of subfamilies and tribes (Miller 1991, 1992; Miller *et al.* 2018, 2021). As these aforementioned efforts have mostly concentrated on the Nearctic and Palearctic fauna, the aid of immature and adult characters may provide further evidence for the systematic position of *Anurocampa* among Notodontidae. Aiming to improve the knowledge about this genus, the present study describes immature stages of *A. mingens*, describes two new species from Costa Rica (with larval images for one of them), illustrates and presents diagnoses for all species, and discusses the systematic position of the genus considering morphological systems of classification available in the literature.

Material and Methods

Immature rearing

A female of *Anurocampa mingens* was collected at the Parque Estadual do Cerrado, Jaguariaíva, Paraná, Southern Brazil (24°10'18.0"S 49°39'59.5"W) on 01–03 October 2021, using a reflective sheet setup adjacent to a light. The female was placed in a plastic container for her to oviposit. After hatching from the eggs, Melastomataceae A.Juss. was offered to the larvae as a hostplant, following Silva *et al*. (1968) and Janzen & Hallwachs (2009). We offered *Pleroma* aff. *fothergillii*, *Pleroma granulosum* (Desr.) D. Don, and *Pleroma heteromallum* (D.Don) D.Don to the larvae, but they ate only *P. granulosum*. A voucher exsiccate of *P. granulosum* is deposited at UPCB — Herbário do Departamento de Botânica da UFPR, Paraná, Brazil, under catalogue number: UPCB 105222 and Barcode: UPCB0055441, available at: http://upcb.jbrj.gov.br/v2/consulta.php. Whenever necessary, branches were replaced to maintain fresh, abundant, and high-quality leaves. Immediately after each molt, dry head capsules were retained and stored in glass vials. Specimens from the first, second, and third immature stages (instars) were killed through immersion in boiling water, fixed in 10% Kahle–Dietrich solution for 72 h, and subsequently preserved in 70% ethanol. The biological material is deposited in the Immature Collection of Lepidoptera at the Entomological Collection "Pe. Jesus Santiago Moure, Universidade Federal do Paraná" (DZUP) under voucher number DZUPIL 0163. The imago, male is deposited in DZUP under voucher number DZ 53.048.

Immature morphology

Images of the egg, first and second instars, and pupa were taken using an optical stereomicroscope adapted with focus stacking (Leica Application Suite version 4.12.0, build 86), and later instars were photographed with a Sony DSC-HX100V digital camera. We used ImageJ software (Schneider *et al.* 2012) to measure the length of eggs, head capsules, larvae, and pupae. Measurements of larval body size were taken between 2–4 days before molting. The larval terminology followed Peterson (1962) and Stehr (1987), and for the pupae, we followed Miller (1992). We summarize our findings with available morphological systems of classification in the literature (Marquis *et al.* 2019; Miller 1991, 1992; Pinheiro *et al.* 2011) in Table 1.

TABLE 1. Summary of our findings with available morphological systems of classification in the literature, though note all valid subfamilies (e.g. Cerurinae, Spataliinae) are not listed here due to disagreements among various sources (Marquis *et al.* 2019; Pinheiro *et al.* 2011; Miller 1991, 1992). *Lobeza* Herrich-Schäffer, [1854] and *Anurocampa* were recently treated as *incertae sedis* (Becker 2014) but both belong to Heterocampinae (St Laurent *et al.* in prep.).

	Notodontidae Subfamilies									
	Thaumetopoeinae	**Pygaerinae**	**Notodontinae**	**Phalerinae**	**Dudusinae**	**Heterocampinae**	**Nystaleinae**	**Dioptinae**	***Lobeza dentilinea***	***Anurocampa mingens***
LAST LARVAL INSTAR										
Head secondary setae	present	present	absent	absent	absent	absent	absent	absent	absent	absent
Body secondary setae (hairy)	present	present	absent	present/ absent	absent	Dicranurini yes Others no	absent	absent	absent	absent
Mandibular cutting edge	smooth	smooth	smooth	smooth	smooth/ serrate (*Crinodes*)	Smooth	Smooth	Serrate in three genera	smooth	smooth
L4 setae on A3-A6			present						absent	absent
Anal proleg	not reduced	not reduced	smaller than A3-A6 prolegs	smaller than A3-A6 prolegs	stemapodiform or reduced	variable	smaller than A3-A6 prolegs		smaller than A3-A6 prolegs	smaller than A3-A6 prolegs
PUPAE										
Labial palpus sclerite	absent	absent	absent	absent		absent	present	present	absent	absente
Proximolateral angles of proboscis	not reaching eye-piece	not reaching eye-piece	not or reaching eye-piece	reaching eye-piece	reaching eye-piece	reaching eye-piece	reaching eye-piece	reaching eye-piece	reaching eye-piece	reaching eye-piece
Cremaster	present	present	absent	present		present	present	present	absent	absent
Segments A8-10 aspect	not rounded	not rounded	rounded	not rounded	not rounded	not rounded	not rounded	not rounded	rounded	rounded

......*Continued on the next page*

TABLE 1. (Continued)

	Notodontidae Subfamilies									
	Thaumetopoeinae	**Pygaerinae**	**Notodontinae**	**Phalerinae**	**Dudusinae**	**Heterocampinae**	**Nystaleinae**	**Dioptinae**	***Lobeza dentilinea***	***Anurocampa mingens***
					ADULT					
Hairy eyes		present	present/absent							absent
Ocelli	absent						present	absent	present	present
Epiphysis length	short or almost as long as tibia	almost as long as tibia	almost as long as tibia						almost as long as tibia	almost as long as tibia
Tibial spur formula	0-2-2	0-2-4		0-2-4	0-2-2/0-2-4	0-2-2/0-2-4	0-2-4	0-2-4	0-2-2	0-2-4
Tarsal claws	simple	bifid	simple	bifid	bifid	simple/bifid	bifid	bifid	simple	simple
Female frenulum bristles	more than 20	fewer than 15	2-10 or more than 20	fewer than 10	fewer than 10	2 to 10	2 or 3	fewer than 10		more than 20
Cteniophores on male fourth sternite						Often present			present	present

Adult morphology

For the description of adults, abdomens were detached, soaked in hot saturated KOH solution for approximately 3–15 min, washed in water, examined, illustrated and then stored in glycerin.

For this study, we examined specimens deposited in the Collection of Lepidoptera from the Entomological Collection Pe. Jesus Santiago Moure, Universidade Federal do Paraná (DZUP): 76 specimens of *A. mingens* from Brazil (Rio de Janeiro, São Paulo, Paraná, and Santa Catarina). For taxonomic study of new species described herein, we examined additional materials deposited in the National Museum of Natural History, Smithsonian Institution; Washington, D.C., United States of America (USNM): three specimens of *A. mingens* from Brazil (Rio de Janeiro and Santa Catarina); one specimen of *A.* cf. *orousseti* from French Guiana (Saint-Laurent du Maroni); 23 specimens of *A. markhastingsi* **sp. nov.** from Costa Rica (ACG, (Janzen & Hallwachs 2009); and 32 specimens of *A. abelardochaconi* **sp. nov.** from the Museo Nacional de Costa Rica, San Jose, Costa Rica (MNCR). In addition, photographic records available in the Dynamic Database for an Inventory of the Macrocaterpillar Fauna, and its Food Plants and Parasitoids, of Área de Conservacion Guanacaste (ACG) (Janzen & Hallwachs 2009) and iNaturalist.org are reported.

Phylogenetic methods

In order to begin to understand the evolutionary relationships of *Anurocampa* species, we have accessed publicly available cytochrome oxidase I (COI) mitochondrial barcodes from the Barcode of Life Datasystems (BOLD) online portal (Hebert *et al.* 2003; Ratnasingham & Hebert 2007). All *Anurocampa* with >650 base pairs were downloaded, though due to the high number of available *A. markhastingsi* **sp. nov.** samples, we limited the phylogenetic sampling to specimens examined by St Laurent in the USNM, which include the holotype and several paratypes of that new species. As there is morphological similarity between *Anurocampa* and *Naprepa* Walker, 1855 larvae and preliminary phylogenomic analyses by St Laurent *et al.* (in prep.) recovered these two genera as closely related, the DNA barcode of a single exemplar of *Naprepa flexifera* Schaus, 1916 (Heterocampinae) was also downloaded to root the trees. Downloaded sequences were aligned with MUSCLE in AliView v. 1.28 (Larsson 2014) and IQ-TREE 2 v. 2.1.3 was used to infer 100 independent maximum likelihood phylogenies, with the best phylogeny according to the likelihood score selected for discussion in our study. For measures of support, 1,000 Ultrafast Bootstraps (UFBoot) and 1,000 SH-aLRT support values were calculated using the -B 1000 and -alrt 1000 commands respectively (Hoang *et al.* 2018; Nguyen *et al.* 2015). The -bnni command was used to alleviate model violations of the UFBoot. Prior to running 100 independent analyses, the optimal model of nucleotide evolution was selected by ModelFinder within IQ-TREE using the -m MFP command and was found to be TIM2+F+G4.

Results

Anurocampa mingens Herrich-Schäffer, [1854] (Figs 1–8)

Diagnosis (Figs 1–3). *Anurocampa* are among the largest Notodontidae in the Americas and can be readily recognized by the large size and green, lichen-patterned forewings and yellow-tan basal areas of the otherwise dark brown hindwings. *Anurocampa mingens* is the largest member of the genus, males have a forewing length of 50–65 mm and a wingspan of 110–140 mm (n=10), while females have a forewing length of 65–75 mm and a wingspan of 145–160 mm (n=7). This species is differentiated from congeners in the respective diagnoses below but is most notable in having lighter dorsal forewing patterning compared to other members of the genus and weak differentiation between a lighter costal patch and the remainder of the forewing. The genitalia have more heavily sclerotized subapical valvae teeth than in the following two species, but the genitalia are quite similar to those of *A. abelardochaconi* **sp. nov.** described below. *Anurocampa abelardochaconi* **sp. nov.**, can be differentiated from *A. mingens* by the lack of pits on sternite VIII, a narrower, more triangular uncus, and the uniform size of the subapical valval teeth.

Immature stages (Figs 4–8)

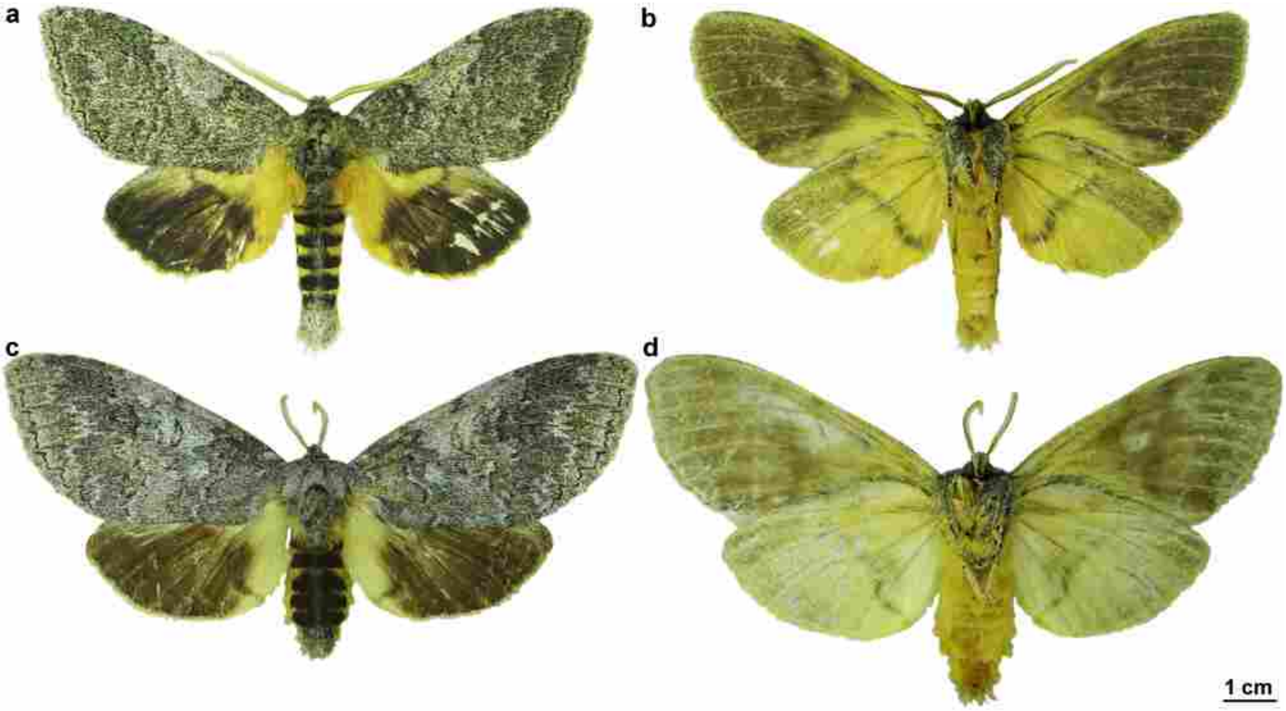

FIGURE 1. *Anurocampa mingens* (Petrópolis, Rio de Janeiro, Brazil). a) male dorsal view; b) male ventral view; c) female dorsal view; d) female ventral view.

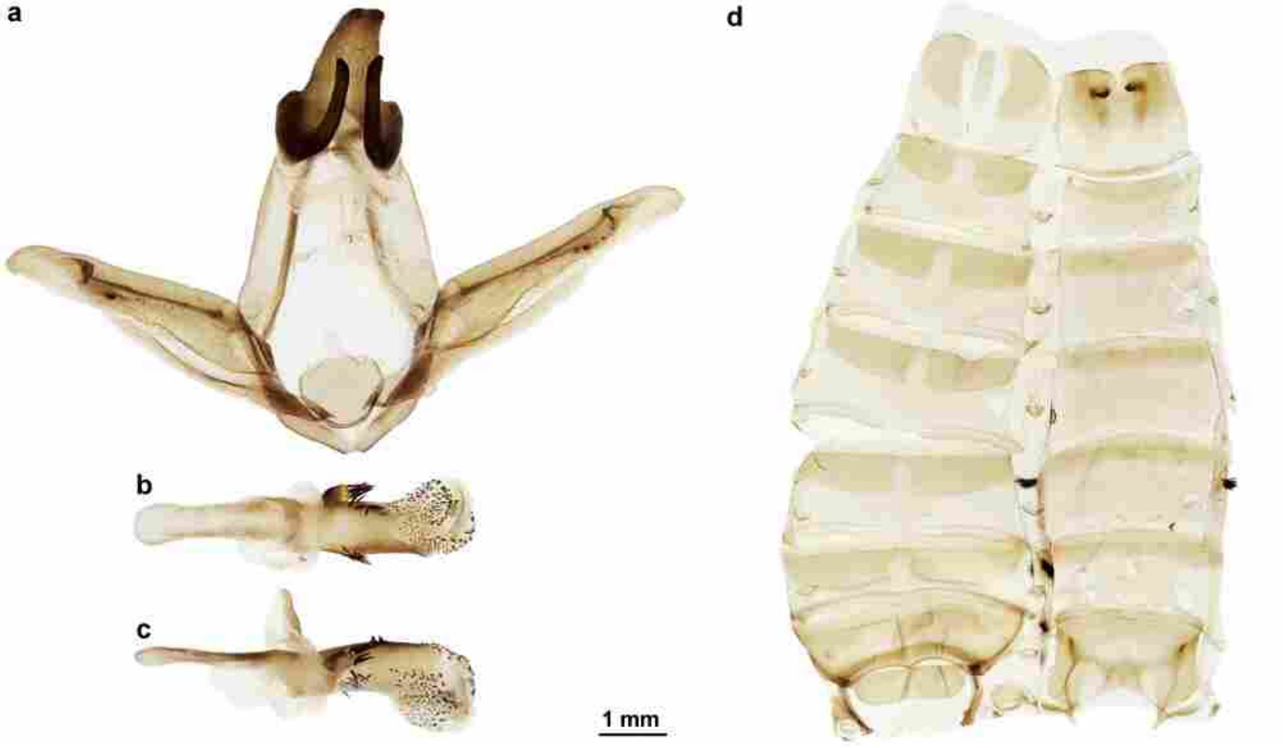

FIGURE 2. *Anurocampa mingens* (Petrópolis, Rio de Janeiro, Brazil). a) male genitalia ventral view; b) phallus dorsal view; c) phallus lateral view; d) abdominal integument (tergites left, sternites right).

Eggs (Fig. 4). Mean duration 13–16 days (n = 125). Dome-shaped, slightly flattened, 2.9–3.2 mm in diameter, 1.75–1.82 mm in height (n = 10). Chorion smooth, cream colored at oviposition becoming whiter near hatching, micropylar area light-brown at the upper pole of the egg.

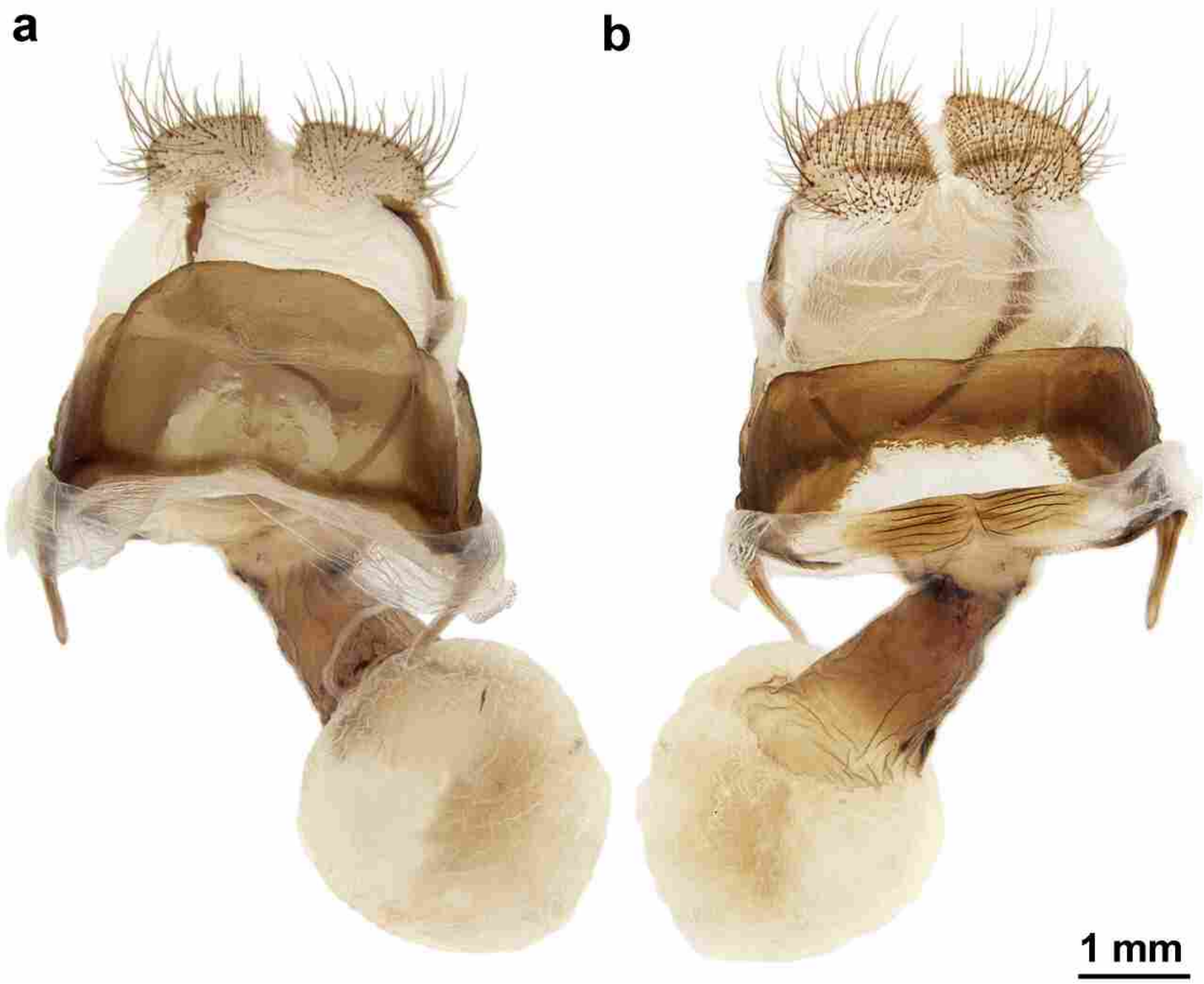

FIGURE 3. *Anurocampa mingens* (Petrópolis, Rio de Janeiro, Brazil). Female genitalia: a) dorsal view; b) ventral view.

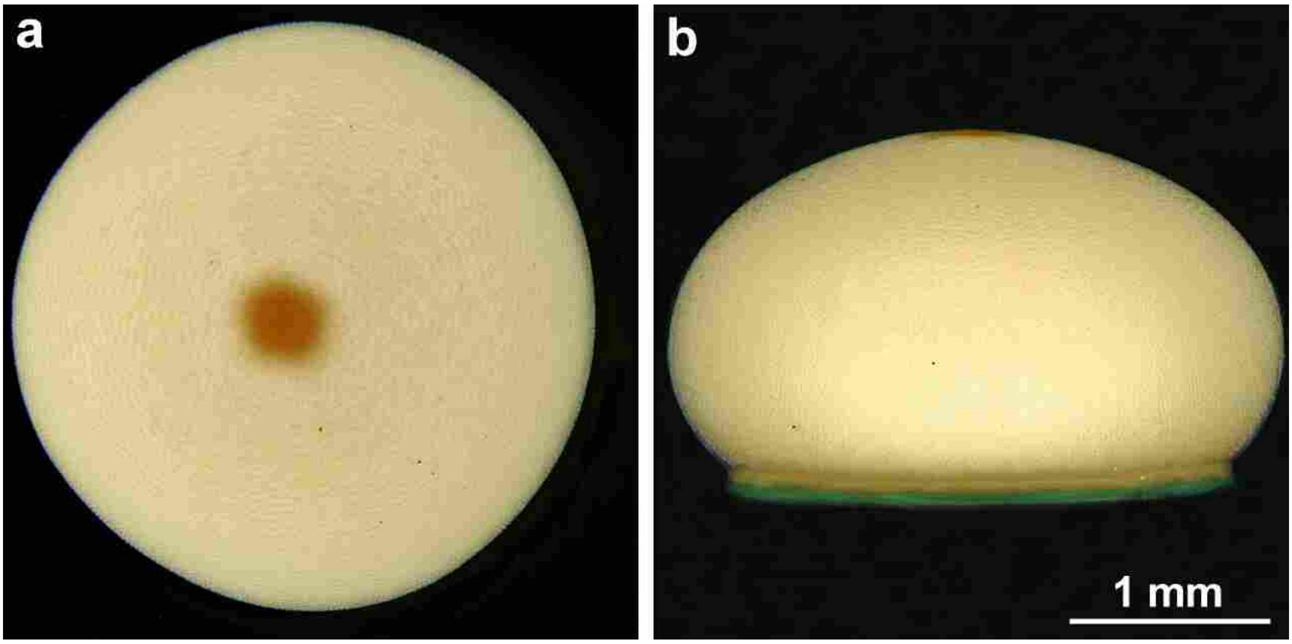

FIGURE 4. *Anurocampa mingens*. Egg: a) dorsal view; b) lateral view.

FIGURE 5. *Anurocampa mingens*. Immature stages: a) first instar, dorsal view; b) first instar, lateral view; c) second instar, dorsal view; d) second instar, lateral view; e) third instar, dorsal view; f) third instar, lateral view; g) fourth instar, dorsal view; h) fourth instar, lateral view; i) fifth instar, dorsal view; j) fifth instar, lateral view.

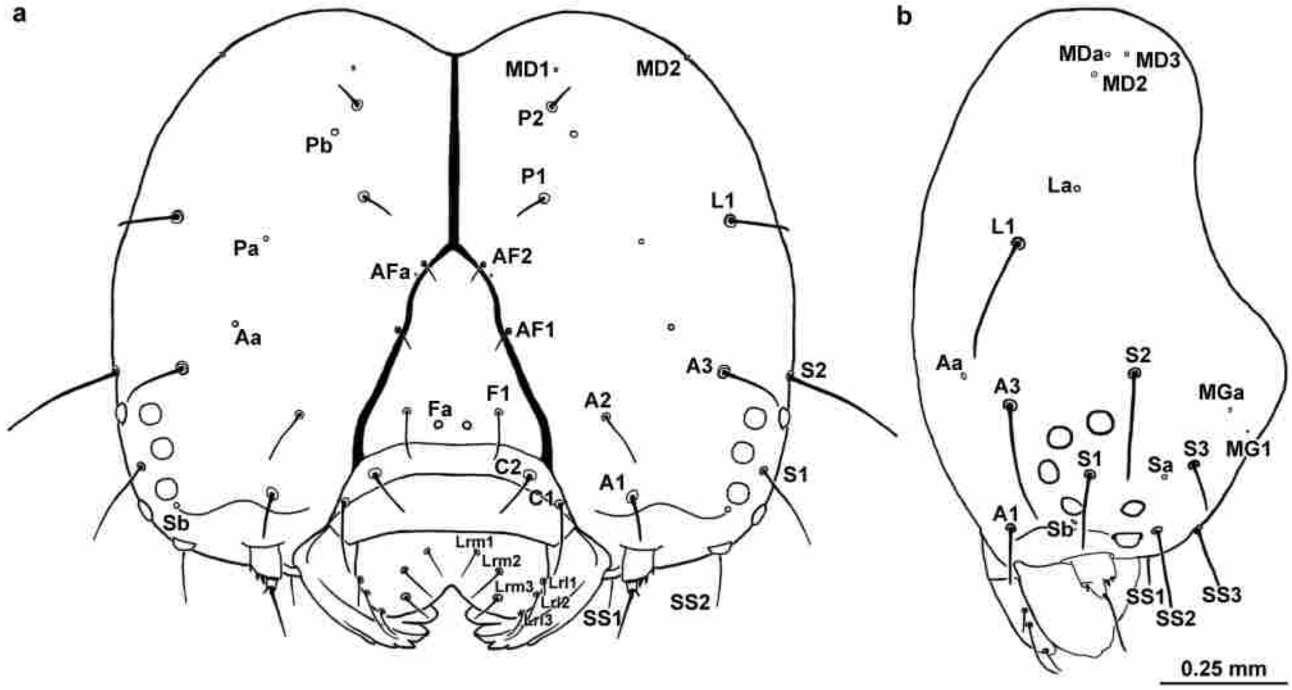

FIGURE 6. *Anurocampa mingens*. Head chaetotaxy of the first instar: a) frontal view; b) lateral view.

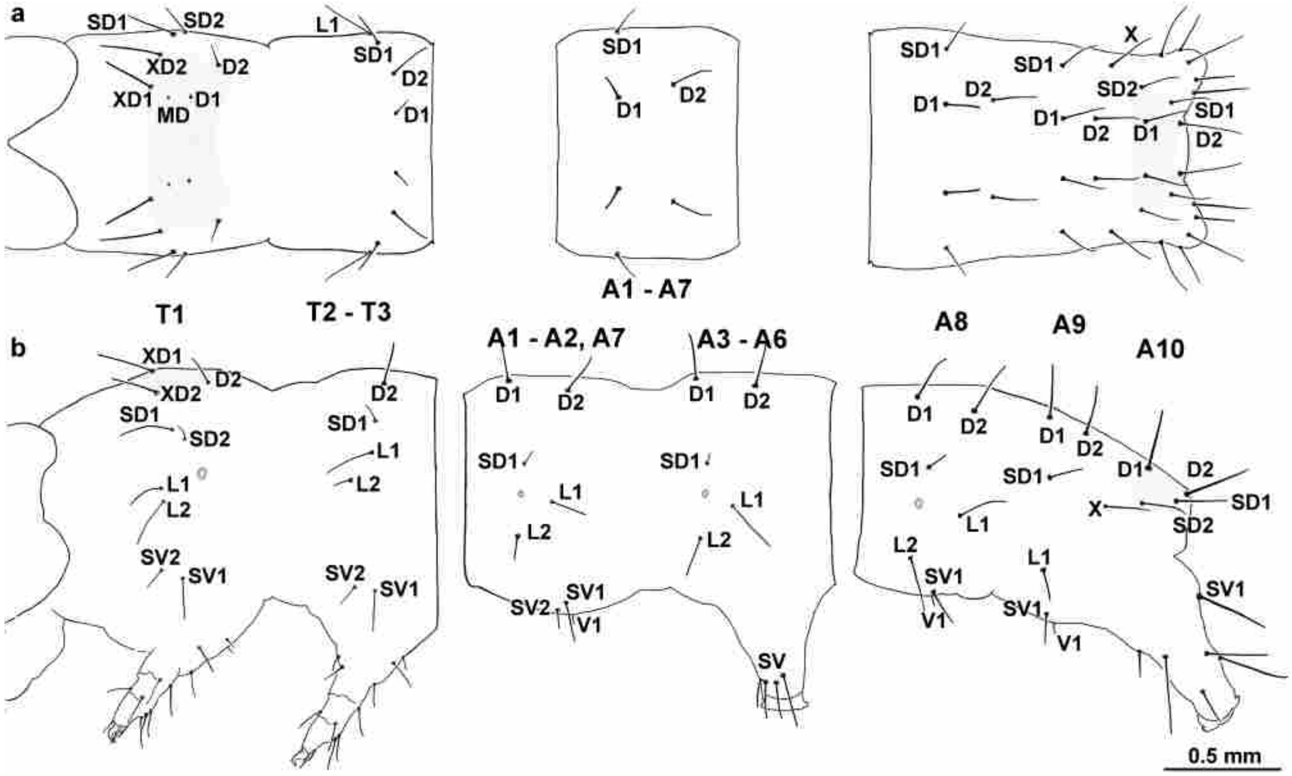

FIGURE 7. *Anurocampa mingens*. Body chaetotaxy of the first instar: a) dorsal view; b) lateral view.

First instar (Fig. 5a–b, 6–7). Mean duration 4–7 days (n = 90); head capsule width 1.2–1.3 mm (n = 10), body length 8–10 mm (n = 10). Head hypognathous, cream colored setae with the base of the antenna and the clypeus yellow, and a wide whitish stripe that extends from the base of the antenna to the dorsal region; stemmata all equal in size, stemma 5 ventral in position, near base of antennae, stemmata 1, 2, 3, 4, and 6 forming semicircle, ventral margin of labrum moderately V notched, mandibles with cutting edge bearing five teeth; head bearing only primary setae. Body slightly flattened dorsoventrally, covered by yellowish primary setae, body color light green, semitransparent, subdorsally with a broad yellow stripe, T1 with a whitish patch between XD2 and D2; A1–A3 laterally with a burgundy patch on each segment; A10 with a whitish patch between D and SD setae; spiracles elliptical, those of T1 and A8 larger; abdominal prolegs fully developed on A3–A6 and A10; anal prolegs projected backwards, slightly smaller in diameter and length than A3–A6 prolegs; crochets in uniordinal mesoseries.

Chaetotaxy. Head (Fig. 6). One pair of frontal setae (F1), between them one pair of frontal pores (Fa); two pairs of adfrontal setae (AF1, AF2), smaller than the other setae, between them, one pair of adfrontal pores (AFa) proximal to AF2; three pairs of anterior setae (A1, A2, A3), and above A3, one pore (Aa); two pairs of posterior setae (P1, P2) equidistant from the midline, and two pairs of pores (Pa, Pb); on the clypeus two pairs of setae (C1, C2); on the labrum three central (Lrm1, Lrm2, Lrm3) and three lateral (Lrl1, Lrl2, Lrl3) pairs of setae; one pair of lateral setae (L1) and one pair of pores (La); three pairs of stemmatal setae (S1, S2, S3) and two pairs of pores (Sa, Sb); three pairs of substemmatal setae (SS1, SS2, and SS3); one pair of microgenal setae (Mg1) located below the microgenal pore (Mga) three pairs of microdorsal (Md1, Md2, Md3) setae, Md1 above P2, Md2 and Md3 laterally and, one pair of pores (Mda) between Md2 and Md3.

Body (Fig. 7). T1—Pronotal shield not sclerotized; XD1 and XD2 setae located in the anterior area of pronotal shield; D1 much smaller than D2, located on the pronotal shield, D2 located outside the pronotal shield, but very close to it; one pair of proprioceptor setae MD located in anteriorly to D1; SD1 and SD2 setae located between XD2 setae and spiracle; L1 and L2 setae located ventrally to the spiracle, L2 below L1; SV1 and SV2 setae located below of the lateral setae, SV1 located posteriorly and under SV2. T2 and T3—D2 setae located laterally to D1 setae; SD1 setae located below of the D2 setae; L1 setae located below of the SD1 setae, L2 setae located below and anterior of the L1 setae; SV1 and SV2 setae show the same configuration of T1. A1, A2, and A7—D1 setae located anterior of the D2 setae; SD1 setae located above the spiracle; L1 setae located below and posteriorly of the spiracle, L2 setae located below of the spiracle; SV1 setae located below of the L1 setae, and SV2 setae below and anterior of the SV1; V1 setae smaller than subventral setae. A3–A6—D, SD and L setae show the same configuration of A1, A2, and A7; SV setae on prolegs with some secondary setae. A8— D, SD, L and V setae show the same configuration of A1, A2, and A7; only SV1 setae present. A9—D, SD and V setae show the same configuration of A1, A2, and A7; only L1 and SV1 setae present. A10—anal shield not sclerotized; D1, D2, SD1, and SD2 on anal shield; an extra seta (X) anterolaterally of the anal shield.

Second instar (Fig. 5c–d). Mean duration 10–13 days (n = 70); head capsule width 1.6–1.7 mm (n = 2); body length 12.9–13.7 mm (n = 10). Head as the first instar but more whitish and with two parallel narrow dark stripes that cross the head, from near the base of the antenna to the vertex; mandibles with cutting edge smooth. Body as the first instar but with subprimary setae "L3" from T2 to A8 segments and with one subdorsal proprioceptor setae MSD anterior of the spiracle from A1 to A8 segments; dorsally with a pink stripe on T1, T2, and A10; subdorsally with a yellow stripe between T3 and A10 and bellow this, a white stripe between T1 and A10; D setae from T3 to A7 on small whitish circular spots; SD setae on the white stripe; L, and SV setae from T1 to A7 on white circular spots.

Third instar (Fig. 5e–f). Mean duration 10–11 days (n = 2); head capsule width 2.4 mm *(*n = 1); body length 17.8–18.2 mm (n = 2). Head as in the second instar. Body as in second instar but T3 with a pronounced dorsal hump, this structure has three transverse bands: one greenish-yellow, the second white, and the third burgundy; laterally whitish with whitish circular spots better defined along the whole length of the body; subventral region of A8 with a large yellow ellipsoid patch.

Fourth instar (Fig. 5g–h). Duration 8 days (n = 1); head capsule width 3.1 mm (n = 1); body length 30.2 mm (n = 1). Head as in third instar but more whitish and without a narrow dark stripe. Body as the third instar but the white circular patches on T1 (SD, L and SV setae), T2 (L and SV setae), T3 (L2, L3 and SV setae), A1 (L2 and L3 setae), A2 (L setae), A3–A6 (L and SV setae), A7 (L2 setae), and the yellow ellipsoid patch on A8 all ringed by burgundy. Also, the burgundy spot of L3 is continuous with the burgundy transverse band that surrounds the dorsal hump of T3.

Fifth instar (Fig. 5i–j). Duration 10 days (n = 1); head capsule width 6 mm (n = 1); body length 56.3 mm (n = 1). Head as the third instar but mandibles and labrum bluish. Body as in fourth instar but colors more striking; on A9, dorsally a golden-yellow patch highlighted by two laterally burgundy stripes; subdorsally, on A1 to A7, a white stripe, and on A8 to A10 a golden-yellow stripe highlighted by two burgundy stripes; spiracles ringed by burgundy; laterally, burgundy rings surrounding setae distinctly larger, sometimes fused as in SD1-SD2, L1-L2 (on T1), SD1-L1-L2 (on T2-T3), and SV1-SV2 (on T1-T3); legs and prolegs bluish. Pre-pupa (making the cocoon until pupation) duration 16 days.

FIGURE 8. *Anurocampa mingens*: a) cocoon lateral view; b) pupa ventral view; c) pupa dorsal view; d) pupa lateral view.

Pupa (Fig. 8). Duration 27 days (n = 1); 30 mm long (n = 1); obtect and stout, body cylindrical, integument light brown, smooth, and glabrous. Head. Antenna broad basally, tapering to apex, reaching 2/3 the length of the forewing, beyond mesothoracic legs; labial palpus sclerite absent; proboscis short, reaching half-length of forewing; proximo-lateral angles of the proboscis reach the eye sclerites; anterior suture of proboscis bending toward the vertex. Thorax. Dorsally ornamented by transverse striae, ventrally smooth; prothorax trapezoidal, midline distinct, but lacking a developed crest. Mesothorax also with a well-defined midline; wings separated from scutum by depressions; posterior margin lacks quadrangular plates separated by pits; spiracular margins smooth. Metathorax almost rectangular, but with concave anterior suture. Legs. Sclerite of prothoracic femur absent; tip of metathoracic leg exposed beyond the forewing. Wings. Forewing truncated at apex, posteriorly connected in midline; hindwing narrow and short, reaching to third abdominal segment. Abdomen. Dorsally marked by a longitudinal black dashed line; A1–A4 with a dorso-lateral pair of shallow irregular depressions; anterior margin of movable segments (A5–A7) with diffuse band of small pits; A8–A10 apex broadly rounded, not tapering posteriorly; spiracles elliptical, prominent in A2 to A7, smaller on A8; margins of all spiracles not protruded; cremaster absent. Pupa formed in a silken cocoon.

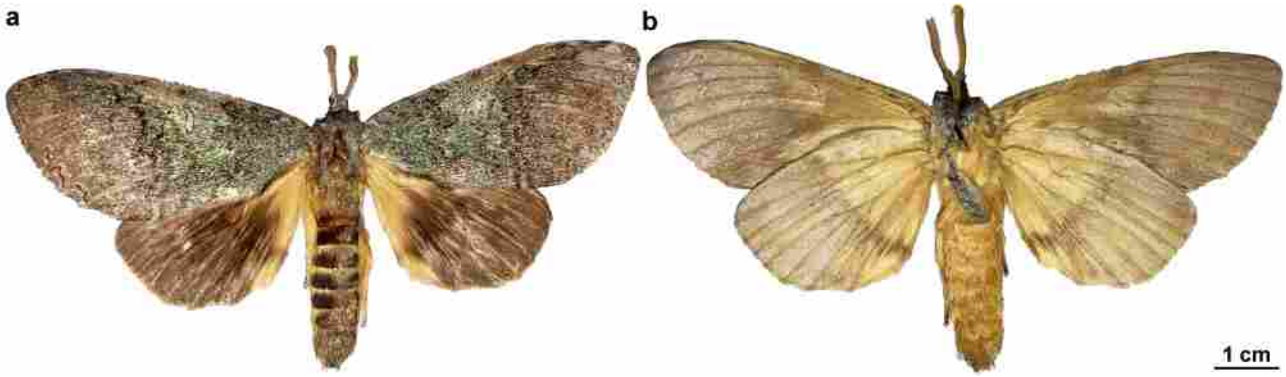

FIGURE 9. *Anurocampa* cf *orousseti* (Saint-Laurent-du-Maroni, French Guiana): a) male dorsal view; b) male ventral view.

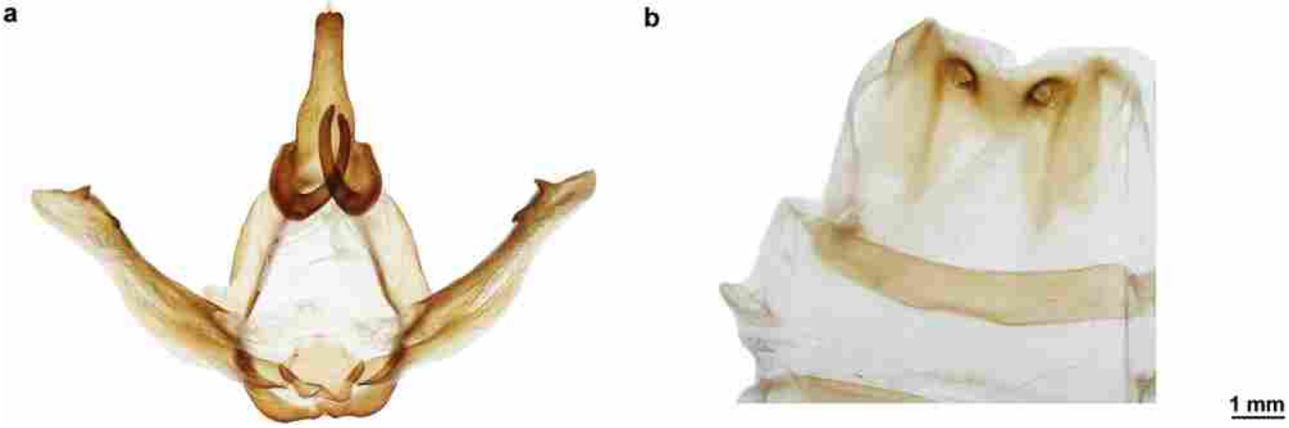

FIGURE 10. *Anurocampa* cf *orousseti* (Saint-Laurent-du-Maroni, French Guiana): a) male genitalia ventral view (phallus missing); b) eighth sternite.

Anurocampa orousseti Thiaucourt, 1985 (Figs 9–10)

Diagnosis. Very little is known about this species which was described based on a single male from French Guiana, but Amazonian populations that we are familiar with, which likely belong to a separate undescribed species, are recognizable by the very faint to nonexistent medial costal patch and well-defined double postmedial lines on the forewings. The holotype of *A. orousseti* has lighter forewing coloration than in any other examined *Anurocampa*, and has a well-defined, strongly contrasting dark apical patch of scales that are absent from all other examined material (including examined Amazonian specimens). We have been unable to locate any specimen closely matching the type, but in our examined specimen from French Guiana, the uncus is much narrower than in any other examined *Anurocampa* or from the genitalia of the type of *A. orousseti* figured in Thiaucourt (1985), though the uncus in

A. orousseti is still narrower than in the other species treated here. The VIII sternite is also distinct among both Amazonian populations, having a single narrow slit-like pit in the type of *A. orousseti* and having more widely spaced, more heavily sclerotized, and more posteriorly situated pits in the specimen we examined from French Guiana. Pending more clarity on the identity of *A. orousseti*, we do not describe any Amazonian taxa at this time.

***Anurocampa markhastingsi*, Chacón and St Laurent sp. nov. (Figs 11–17)**

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Type material. Holotype. 1 ♂ COSTA RICA: Area de Conservacion Guanacaste, Guanacaste Prov., Sector Cacao, Sendero Arenales, 10.92471, -85.46738, 1080 m, eclosed 2.V.2009 host: *Eugenia costaricensis* |Voucher 08-SRNP-35711 D. H. Janzen & W. Hallwachs DB http://janzen.sas.upenn.edu |USNMENT01771159 | HOLOTYPE *Anurocampa markhastingsi* Chacón and St Laurent. Note, this specimen was sequenced for mitochondrial COI and phylogenomics separately, its COI barcode associated with voucher 08-SRNP-35711 and phylogenomic data associated with USNMENT01771159. **Paratypes,** same forest locality as holotype, **COSTA RICA:** Area de Conservacion Guanacaste, Guanacaste Province, 18 ♂, 4 ♀, Sector Cacao, Sendero Arenales, 10.92471°, -85.46738°, eclosed 27.V.1998 (♂), 10.V.2000 (♀), 19.V.2000 (♀), 14.IV.2001 (♂), 20.IV.2001 (♂), 8.IX.2003 (♂), 24.IV.2004 (♂), 7.V.2004 (♂), 10.V.2003 (♂), 24.IV.2005 (♂), 30.IV.2009 (♂), host: *Eugenia costaricensis*, 97-SRNP-1971 (♂), 99-SRNP-1162 (♀), 00-SRNP-9851 (♂), 00-SRNP-9852 (♀), 00-SRNP-9889 (♂), 02-SRNP-23881 (♂), 03-SRNP-4226 (♂), 03-SRNP-4227 (♂), 03-SRNP-22769 (♂), 04-SRNP-35554 (♂), 08-SRNP-36489 (♂) (USNM). All paratypes were reared from wild-caught caterpillars in the same forest as the holotype, from among a total of 112 caterpillars found over 14 years. Almost all were found at night because of their differential reflection from foliage when hit by the beam of a flashlight. None were parasitized by a wasp or fly. An additional 5 ♂ paratypes are in MNCR: **COSTA RICA:** Prov. Alajuela: 1 ♂: INBIOCRI002247148 (COI Barcoded), Upala, Sector San Ramón de Dos Ríos, 1.5 Km NW Hacienda Nueva Zelandia, 620 m, 10.88326 -85.41354, 18 March 1995, Quesada, Freddy A. (MNCR). 1 ♂: INB0004294955 (COI Barcoded), Upala, Bijagua, Alto Los Brenes, 700 m, 10.71666 -85,09056, 30 August 2011, Azofeifa Zuñiga, José Antonio (MNCR). 1 ♂: INB0004336487 (COI Barcoded), Guatuso, Buenavista (San José), Punto 1: Catarata Río Buenavista, 800 m, 10.70612 -84,99288, 17 August 2012, Azofeifa Zuñiga, José Antonio (MNCR). 1 ♂: INBIOCRI002405252 (COI Barcoded), San Ramón, Ángeles, Sector Colonia Palmareña, San Ramón, 760 m, 10.23222, -84,55330, 1 September 1995, Carballo, Gerardo (MNCR). 1 ♂: INB0004249967 (COI Barcoded), San Ramón, Ángeles, Estación Biológica Villa Blanca, 1115 m, 10.20136 -84,48510, 8 August 2010, Rojas Vásquez, Robert (MNCR). All of these specimens were originally identified as *A. mingens* in the original INBIo national inventory collection (today, in the MNCR).

Etymology. *Anurocampa markhastingsi* **sp. nov.** is named in honor of Mr. Mark Hastings of Boston, Massachusetts, USA for his substantial support of the mitochondrial DNA sequencing of Costa Rica wild insects as part of the BioAlfa bioliteracy process conducted by the Guanacaste Dry Forest Conservation Fund in its support of the survival of Area de Conservacion Guanacaste, northwestern Costa Rica and growth of the DNA barcode library of Costa Rica. The name is a masculine noun in the genitive case.

Diagnosis. Externally similar to *A. mingens* and the following species *A. abelarochaconi* **sp. nov.**, but the forewings are darker green with a more contrasting and well-defined costal white patch than in either species, and furthermore in *A. mingens*, the costal patch may be almost absent and is less contrasting in *A. abelardochaconi* **sp. nov.**. *Anurocampa mingens* in particular, tends to be grayer and lighter overall on the forewing surface due to heavier presence of light gray scales overlaying the green ground color that is typical of the genus. The forewing lines and discal mark of *A. markhastingsi* **sp. nov.** are not readily discernable (but usually present) whereas these markings are quite apparent in *A. mingens*. In *A. markhastingsi* **sp. nov.** the hindwings are typically lighter, tending to be darker brown in *A. mingens* and more intermediate in *A. abelardochaconi* **sp. nov.**. Specimens of Amazonian *Anurocampa* which may be *A. orousseti* or a further undescribed species, are notable for nearly lacking the costal patch and having double postmedial lines that are readily apparent (these being absent in the other *Anurocampa* species). In Amazonian populations the postmedial region of the forewings may be contrasting brown against the more typical green basal antemedial and medial areas of the forewings. Ventrally, the forewing medial line is concave and the hindwing medial line is more curved tornally in *A. markhastingsi* **sp. nov.** than in any other *Anurocampa* species. Genitalia are rather nondescript but are similar to the preceding two species and the following one, the main distinction of *A. markhastingsi* **sp. nov.** being the weakly toothed apical region of the valvae, somewhat shorter socii, broader uncus, and broader phallus than in other species. Finally, the VIII tergite pits are present in *A. markhastingsi* **sp. nov.** (as in *A. mingens* and *A.* cf. *orousseti*) but are absent in *A. abelardochaconi* **sp. nov.**.

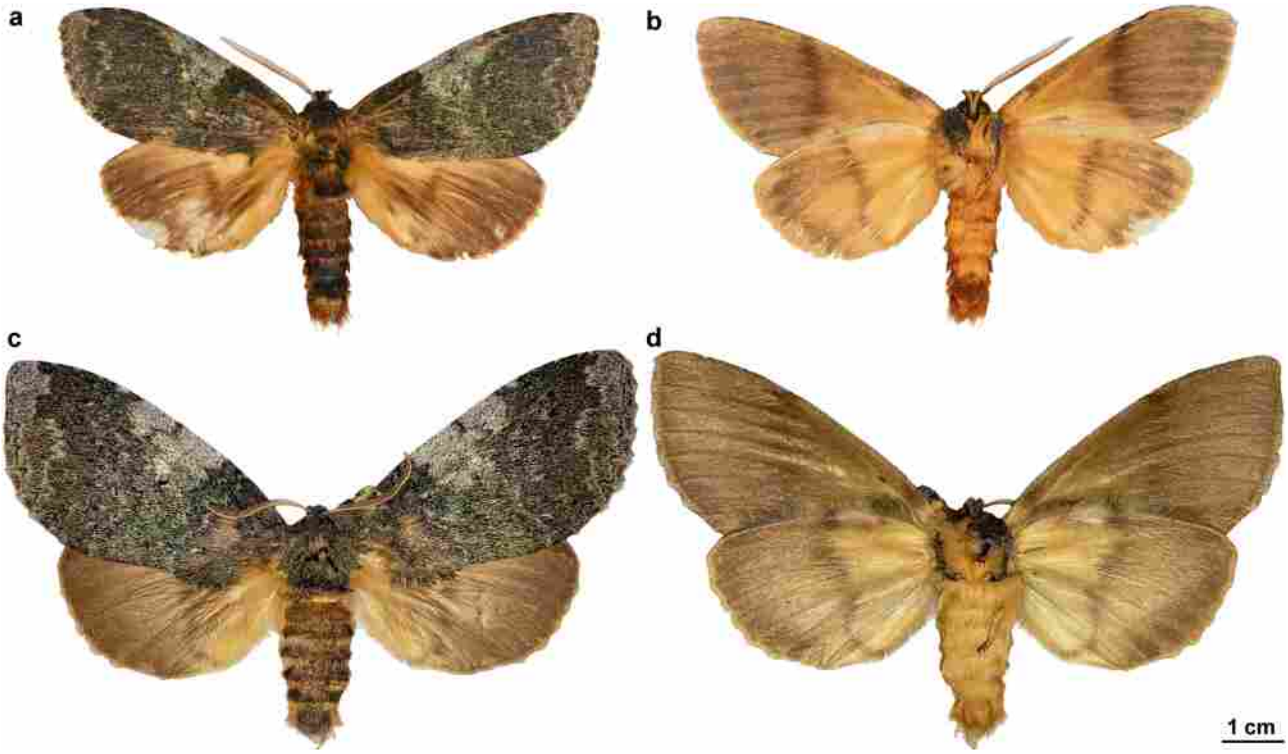

FIGURE 11. *Anurocampa markhastingsi* **sp. nov.** (Guanacaste, Costa Rica): a) male holotype dorsal view; b) male holotype ventral view; c) female paratype dorsal view; d) female paratype ventral view.

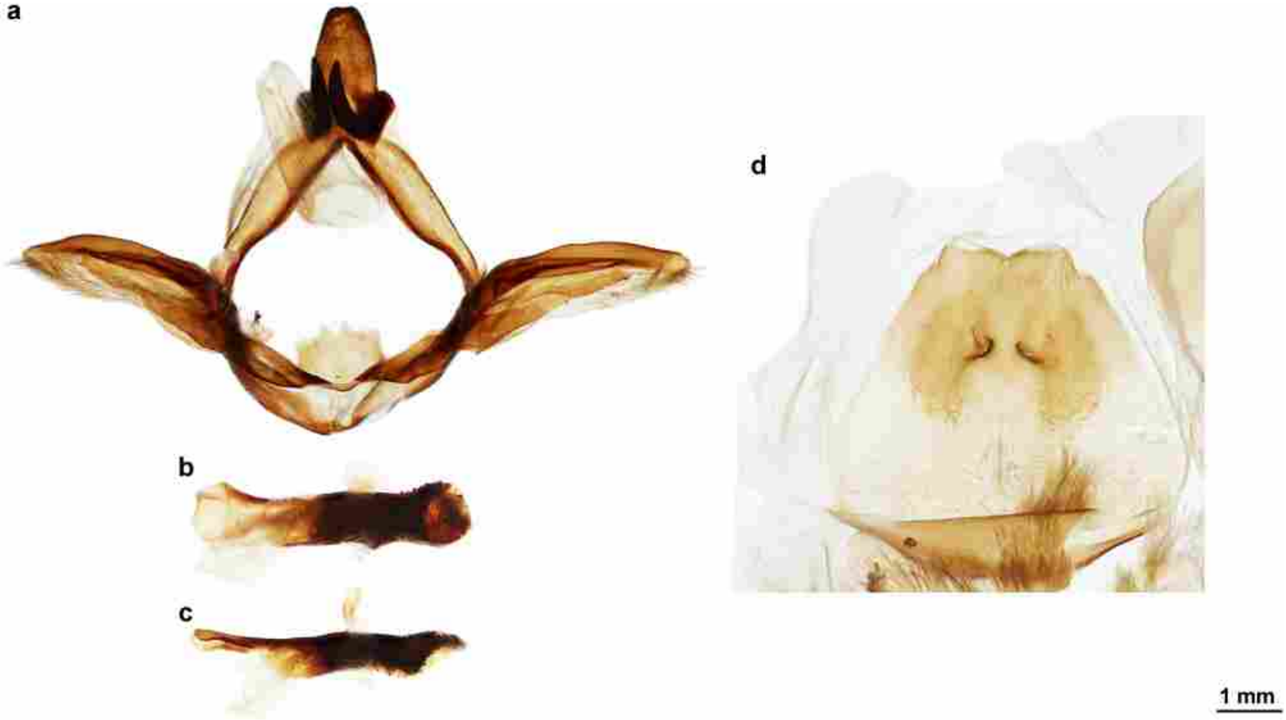

FIGURE 12. *Anurocampa markhastingsi* **sp. nov.** (Guanacaste, Costa Rica). Type: a) male genitalia ventral view; b) phallus dorsal view; c) phallus lateral view; d) eighth sternite.

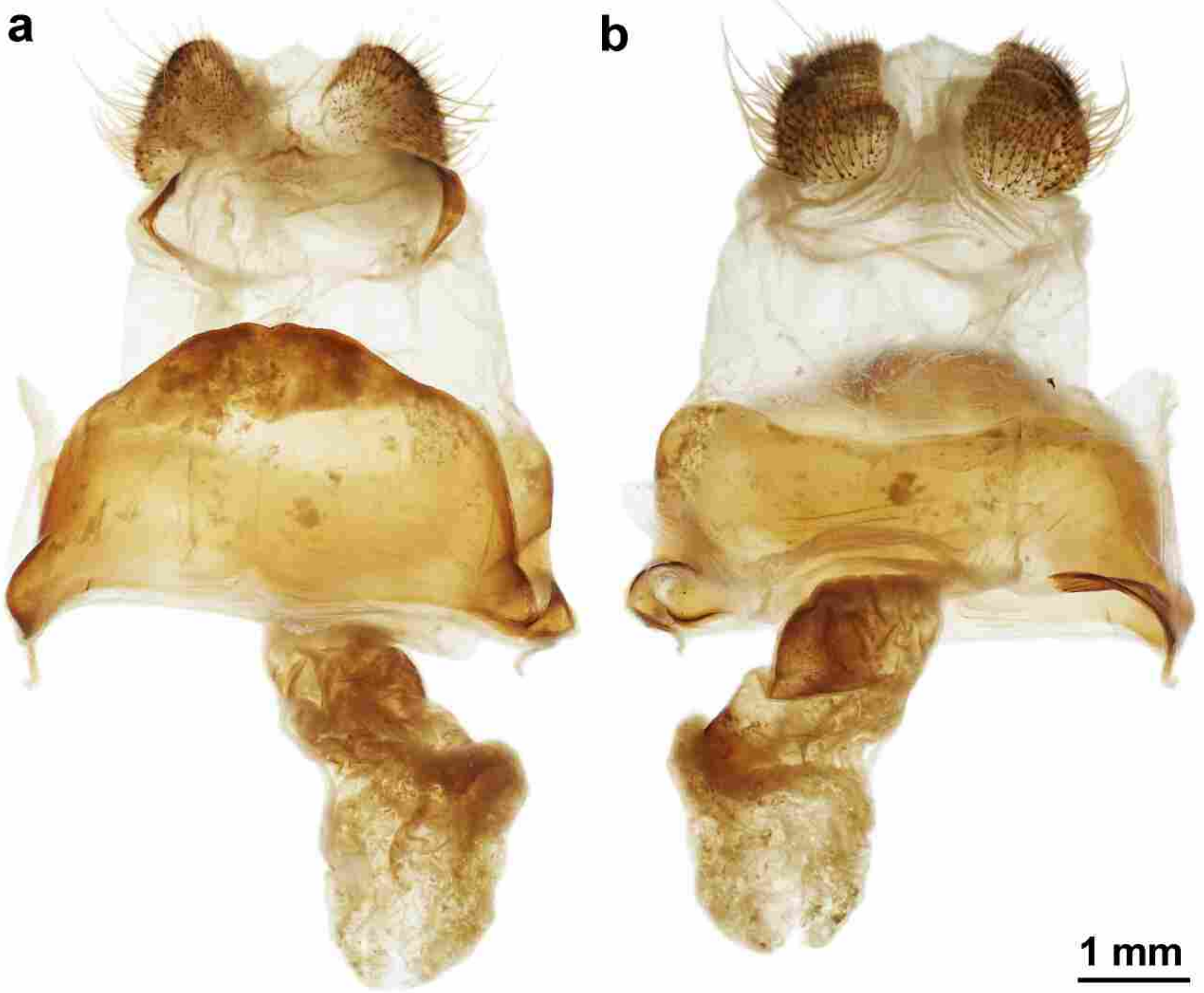

FIGURE 13. *Anurocampa markhastingsi* **sp. nov.** (Guanacaste, Costa Rica). Paraytpe, female genitalia: a) dorsal view; b) ventral view.

Description. *Adult*. Male. Head: Width less than half that of thorax, frons coloration hoary green, eyes large, naked, occupying more than 2/3 area of head; labial palpus extending beyond frons, apparently three segmented, palpi clothed in tan scales ventrally, brown scales laterally, distally and internally with hoary green scales; haustellum of moderate length (full extent not examined), antennae yellow-tan, very long extending nearly to midway of costa, bipectinate to tip with roughly uniform pectinations along length. Thorax: clothed in hoary green scales, inverted U-shaped pattern of black scales faintly present mesally. Prothoracic legs outwardly clothed in hoary green scales as for thorax, but inwardly scaled with long, fine hair-like yellow-tan scales, mesa- and metathoracic legs covered only in yellow-tan scales. Tibial spurs clothed in yellow-tan scales, in formula 0-2-4. Tarsal claws simple. Forewing length 42–47 mm, wingspan 84–96 mm (n = 9); overall ovoid, outer margin convex, apex rounded. Forewing dorsum ground color deep green with fine irroration of gray and black scales giving much of the wing hoary appearance. Overall wing pattern poorly defined due to hoary appearance, but faint wavy antemedial and postmedial lines present with latter being incomplete, submarginal region ranging from being concolorous with medial area to lighter gray. Discal spot somewhat visible as a white patch but usually appearing very faint due to its localization within a somewhat triangular white patch midway along costa that reaches to roughly halfway to inner margin, white patch overlaid by green, gray, and black scales, despite overlay of scales costal patch relatively well contrasting against wing ground color. Anal angle of forewing somewhat pronounced near thorax, with longer black erect scales. Forewing ventrum mostly unmarked, basally yellow-tan to gray-brown, distally gray-brown, these two regions of ventrum delimited by convex medial band, clear antemedial and postmedial bands absent, in some specimens ventrum more uniform yellow-tan overall. Hindwing without distinct markings, coloration brown underlaid with yellow-tan scales that are most prominent and somewhat erect basally, margin of wing with yellow-brown fringe that contrasts against overall brown coloration of hindwing. Hindwing ventrum as for hindwing dorsum but more yellow-brown than gray-brown and usually stronger medial line. Frenulum a single bristle. Abdomen: Robust, appearing banded due to yellow-tan scales at segment margins with intersegmental regions dark brown, abdomen with grayish dorsal band, ventrally yellow-tan, sclerotized cteniophores bearing many (>20) spines, distalmost spines less heavily sclerotized and longer. Eighth sternite broadest anteriorly, posteriorly truncated with pair of separate pits mesally (Figs 12d, 15d). Genitalia (Figs 12a–c, 15a–c) (n = 2) Vinculum broadly ovoid, somewhat triangular dorsally. Tegumen weakly defined. Uncus somewhat elongate but width variable, always wider than thick, heavily sclerotized and truncated or slightly indented at apex. Socii simple, fingerlike, upcurved more heavily sclerotized than uncus, reaching roughly halfway to uncus apex. Gnathos absent. Valvae narrow, bowed downward, costal region more strongly sclerotized than remainder of valvae, subapical region of valvae with weakly defined projection. Juxta ventrally projected, otherwise a simple flat structure. Phallus short, broad, somewhat flattened, distally covered in short spines ventrally, with spins continuing on to cover the thick, balloon-like vesica, phallus pointed outward laterally, coecum phallus very flat and distally broadened. When viewed from ventral or dorsal aspect, phallus broadened on either terminus.

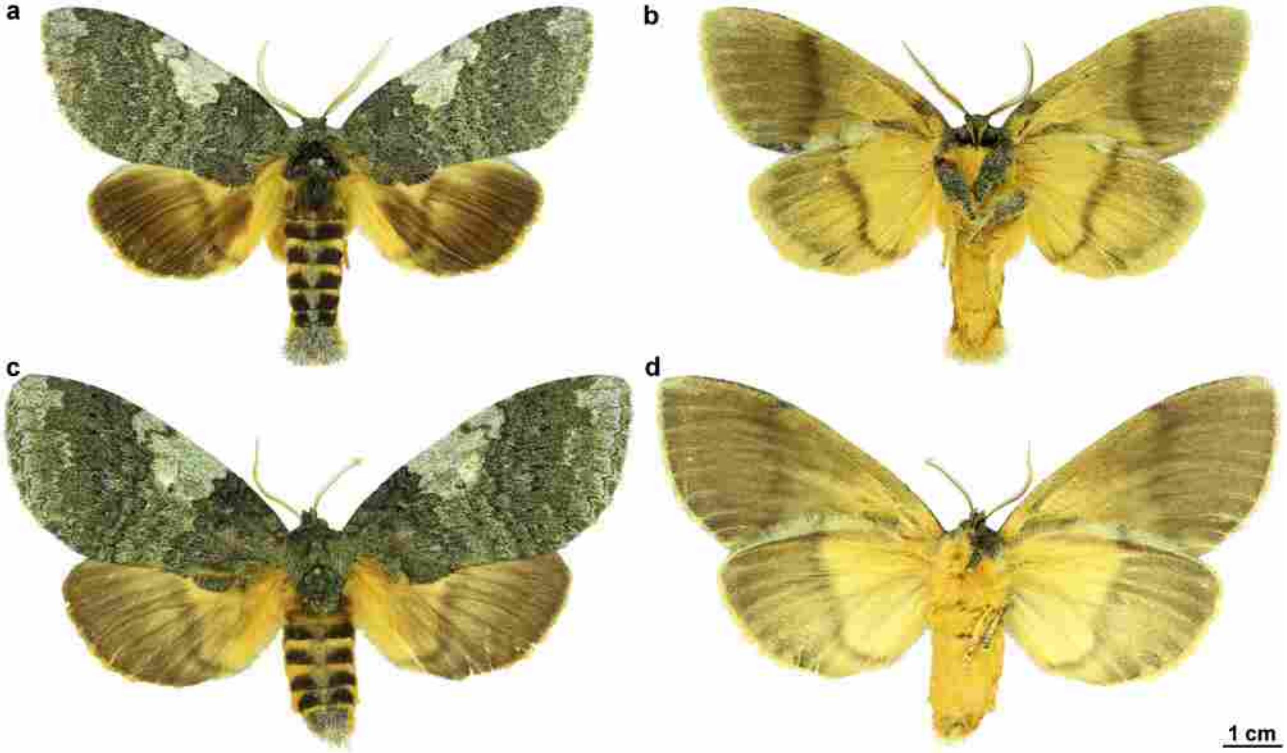

FIGURE 14. *Anurocampa markhastingsi* **sp. nov.** (Guanacaste, Costa Rica). Paratypes: a) male dorsal view; b) male ventral view; c) female dorsal view; d) female ventral view.

Female. Sexual dimorphism most notable in size difference with females being roughly 1.5 times the size of males. Head: As for male but antennae slimmer with shorter pectinations. Thorax: As for male. Forewing length 55 mm, wingspan 102–112 mm (n=2); as for male but costal white patch less contrasting and appearing stretched farther along costa. Hindwing as in male. Frenulum with numerous tightly packed bristles. Abdomen: As for male but more robust, eighth sternite and tergite simple, lacking the pits on variable sclerotization of males. Genitalia (Figs 13, 16) (n = 1) tergite VIII broadly rectangular with posterior margin outwardly project. Apophyses anteriores small, fingerlike; apophyses posteriores extremely fine, crisscrossing each other and held parallel to VIII segment margin, their length slightly less than VIII-IX/X intersegmental width. Lamella antevaginalis a weakly sclerotized plate embedded in membrane; lamella postvaginalis a more sclerotized band. Ductus broad, thickly membraned with two sclerotized bands embedded; corpus bursae very small and baglike, not greater in size than ductus; papillae anales large and broad, width almost equivalent to posterior margin of VIII, papillae anales covered in relatively short, fine setae.

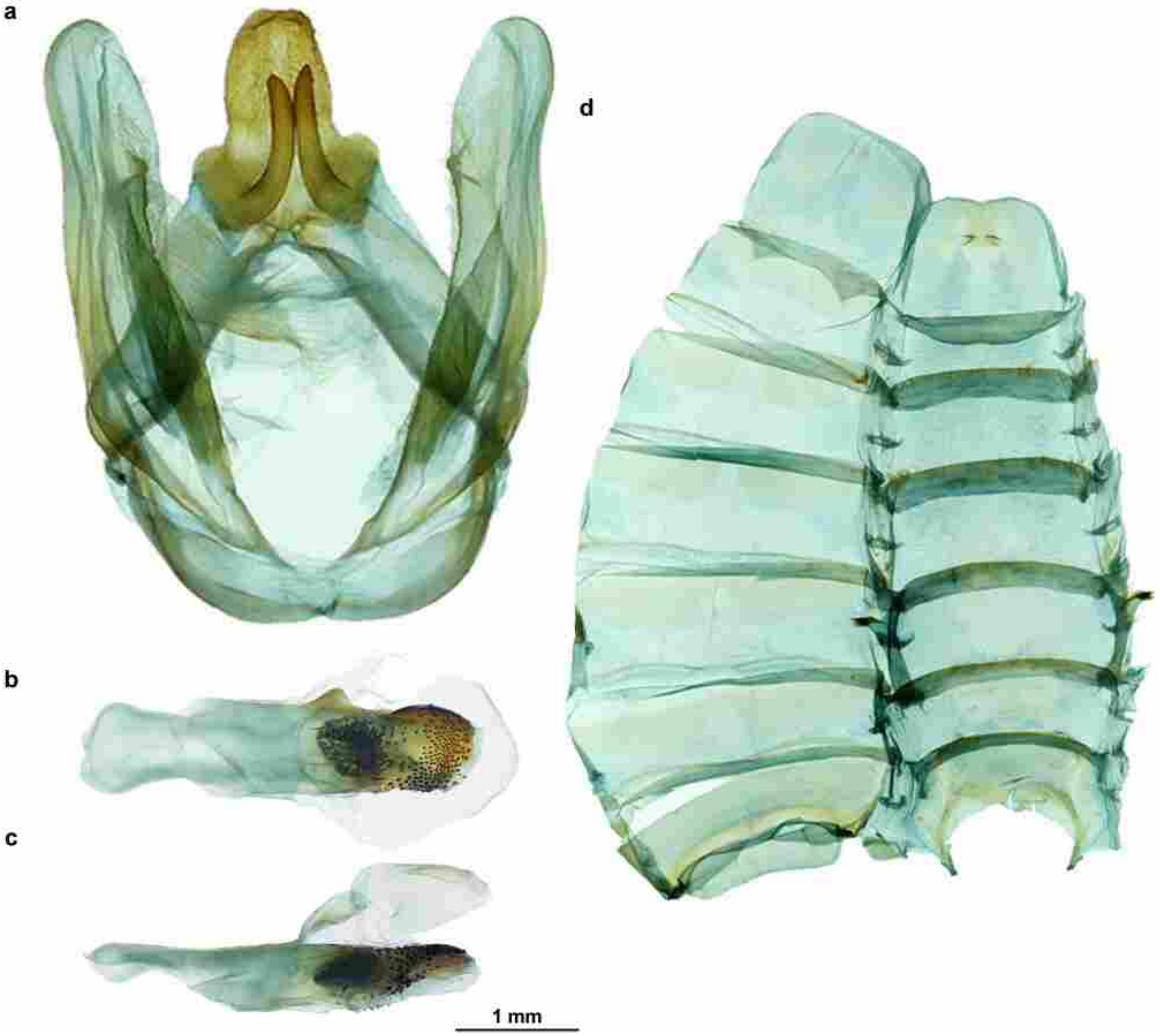

FIGURE 15. *Anurocampa markhastingsi* **sp. nov.** (Guanacaste, Costa Rica). Paratype: a) male genitalia ventral view; b) phallus ventral view; c) phallus lateral view; d) abdominal integument (tergites left, sternites right).

Life history. The gross morphology of the larva of *A. markhastingsi* **sp. nov.** is very similar to what we have described in detail for *A. mingens*. However, based on available images for late instar larvae that gave rise to our type series of *A. markhastingsi* **sp. nov.** (Fig. 17), we note the following distinct differences from *A. mingens* larvae: *A. markhastingsi* **sp. nov.** larvae lack the white spots that are present over the whole lateral body of last instar of *A. mingens* (in our unique reared individual these spots are encircled by red, but otherwise typically the red is absent in *A. mingens* larvae, nonetheless *A. markhastingsi* **sp. nov.** does not have lateral spotting); the white lateral line of *A. markhastingsi* **sp. nov.** is dorsally lined with red, this red lining absent in *A. mingens*; the dorsal-lateral longitudinal band on the squared edge of T3 is light blue in *A. markhastingsi* **sp. nov.** whereas it is white or blue and red in *A. mingens*; the lateral projected spots of A8 are either bisected red and yellow or dorsally lined with red in *A. markhastingsi* **sp. nov.** but in *A. mingens* these spots are mostly yellow encircled by red or black; finally, A9 bears a pair of red spots encircled by light blue in *A. markhastingsi* **sp. nov.**, in *A. mingens* A9 has a single yellow dorsal spot and bright yellow bands edged in red or black laterally on A8–10, these bands replacing the white lateral band over A8–10, the lateral band is continuous to A10 in *A. markhastingsi* **sp. nov.**. The last set of characters on A8–10 are the most consistent and easily observed difference between *A. markhastingsi* **sp. nov.** and *A. mingens*.

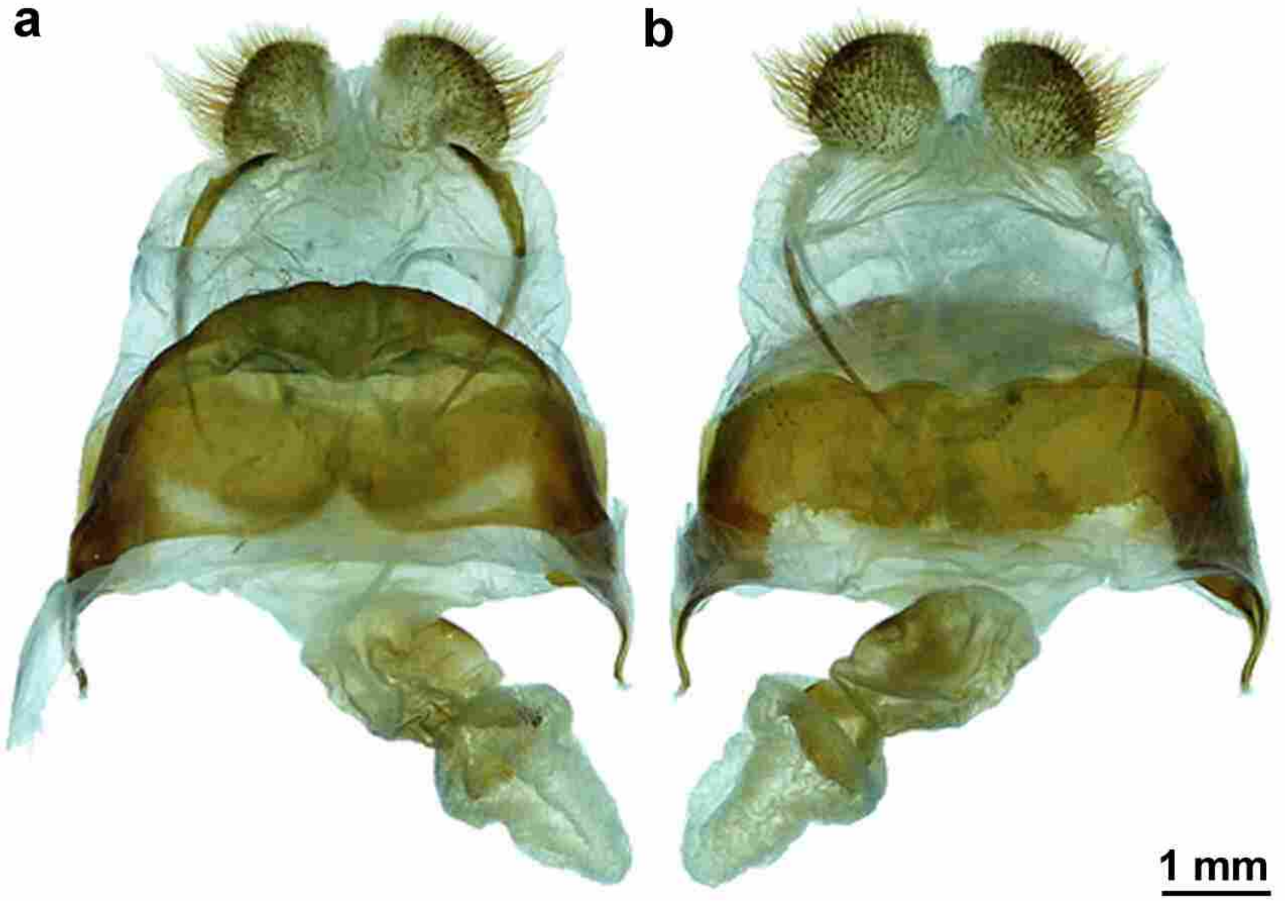

FIGURE 16. *Anurocampa markhastingsi* **sp. nov.** (Guanacaste, Costa Rica). Paratype: Female genitalia: a) dorsal view; b) ventral view.

Distribution. In Costa Rica *A. markhastingsi* **sp. nov.** has been collected in rain and cloud forest on both slopes of the Cordillera Volcánica de Guanacaste and Cordillera de Tilarán, the volcanoes to the north of the Meseta Central, but not on the uplift mountains to the south of the Meseta Central. The elevational range for the species is 620–1160 m, with nearly all from the upper edge of this range. All are from Guanacaste and Alajuela Provinces.

Remarks. This new species is principally known from Costa Rica where more than 100 wild-caught larvae were found feeding singly on *Eugenia costaricensis* O.Berg (Myrtaceae) over the course of more than a decade. Our type series is entirely restricted to these reared individuals and others that were barcoded. Adults frequently come to light traps placed in the forest where the caterpillars are found.

***Anurocampa abelardochaconi*, Chacón & St Laurent sp. nov. (Figs 18–20)**

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Type material. Holotype. 1 ♂ COSTA RICA: INBIOCRI001080279 (COI Barcoded), Prov. San José, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.14889 -83.95190, 20 February 1983, Isidro Chacón (MNCR). **Paratypes,** (Total: 25 ♂**,** 6 ♀) **COSTA RICA:** Prov. San Jose: 1 ♂: INBIOCRI001073453, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.14889 -83.95190, 1 March 1985, Abelardo Chacón & Isidro Chacón (MNCR). 6 ♂♂: INB0003007210, INB0003007216, INB0003007217 INB0003007218, INB0003007221, INB0003007212, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 August 1984, Isidro Chacón & Abelardo Chacón (MNCR). 1 ♂: INB0003011959, Vásquez de Coronado,

FIGURE 17. *Anurocampa markhastingsi* **sp. nov.**. Immature stages: a) antepenultimate instar, lateral view; b) final instar, dorsal view, detail of spots on A9; c) final instar, lateral view.

Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.14889 -83.95190, 1 March 1985, Abelardo Chacón & Isidro Chacón (MNCR). 1 ♂: INB0003007224, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 February 1985, Isidro Chacón & Abelardo Chacón (MNCR). 5 ♂♂: INB0003007214, INB0003007219, INB0003007230, INB0003007231, INB0003007233**,** Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 April 1985, Isidro Chacón & Abelardo Chacón (MNCR). 3 ♂♂: INB0003007220, INB0003007222, INB0003007227, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.14889 -83.95190, 1 May 1985, Isidro Chacón & Abelardo Chacón (MNCR). 1 ♂: INB0003007213**,** Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.14889 -83.95190, 1 January 1985, Abelardo Chacón (MNCR). 1 ♂: INBIOCRI001080284**,** Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, Sendero La Botella 700 m, 10.16517 -83.95731, 1 April1983, Hesterberg, R. L. (MNCR). 3 ♂♂: INB0003007228, INB0003007229, INB0003007232**,** Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 July 1984, Isidro Chacón (MNCR). 1 ♀: INB0003011961, Prov. San José, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 March 1985, Isidro Chacón & Abelardo Chacón (MNCR). 2 ♀♀: INB0003007239, INB0003007238, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 April 1985, Isidro Chacón & Abelardo Chacón (MNCR). 1 ♀: INB0003007240, Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio

Carrillo, Estación Carrillo, 700 m, 10.16065 -83.95645, 1 May 1985, Isidro Chacón & Abelardo Chacón (MNCR). 1 ♀: INBIOCRI001080314**,** Vásquez de Coronado, Cascajal, Área de Conservación Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Estación Carrillo, Sendero La Botella 700 m, 10.16517 -83.95731, 1 April 1983, Hesterberg, R. L. (MNCR). Prov. Limón: 1 ♂: INB0003031644 Pococí, Guápiles, Área de Conservación Cordillera Volcánica Central, Pococí, Reserva Forestal, Quebrada Molinete, 500 m, 10,17869 -83,92266 28 August 1986, Isidro Chacón (MNCR). Prov. Heredia: 2 ♂♂: INBIOCRI000210289, INBIOCRI000210311**,** Sarapiquí, La Virgen, Estación El Ceibo 400 m, 10.32804 -84.08042, 1 April 1990, Carlos Chávez (MNCR). 1 ♀: INBIOCRI000210767. Sarapiquí, La Virgen, Estación El Ceibo 400 m, 10.32804 -84.08042, 1 April 1990, Carlos Chávez (MNCR). All of these specimens were collected in light traps, and none of their localities overlap with the localities of *A. markhastingsi* **sp. nov.**.

Etymology. *Anurocampa abelardochaconi* **sp. nov.** is named in honor of Sr. Abelardo Chacon (RIP) of San Jose, Costa Rica, in recognition of his pioneering participation in the field collections for the national biodiversity insect inventory of Área de Conservación Guanacaste and for the Instituto Nacional de Biodiversity (INBio) in Santo Domingo de Heredia. The name is a masculine noun in the genitive case.

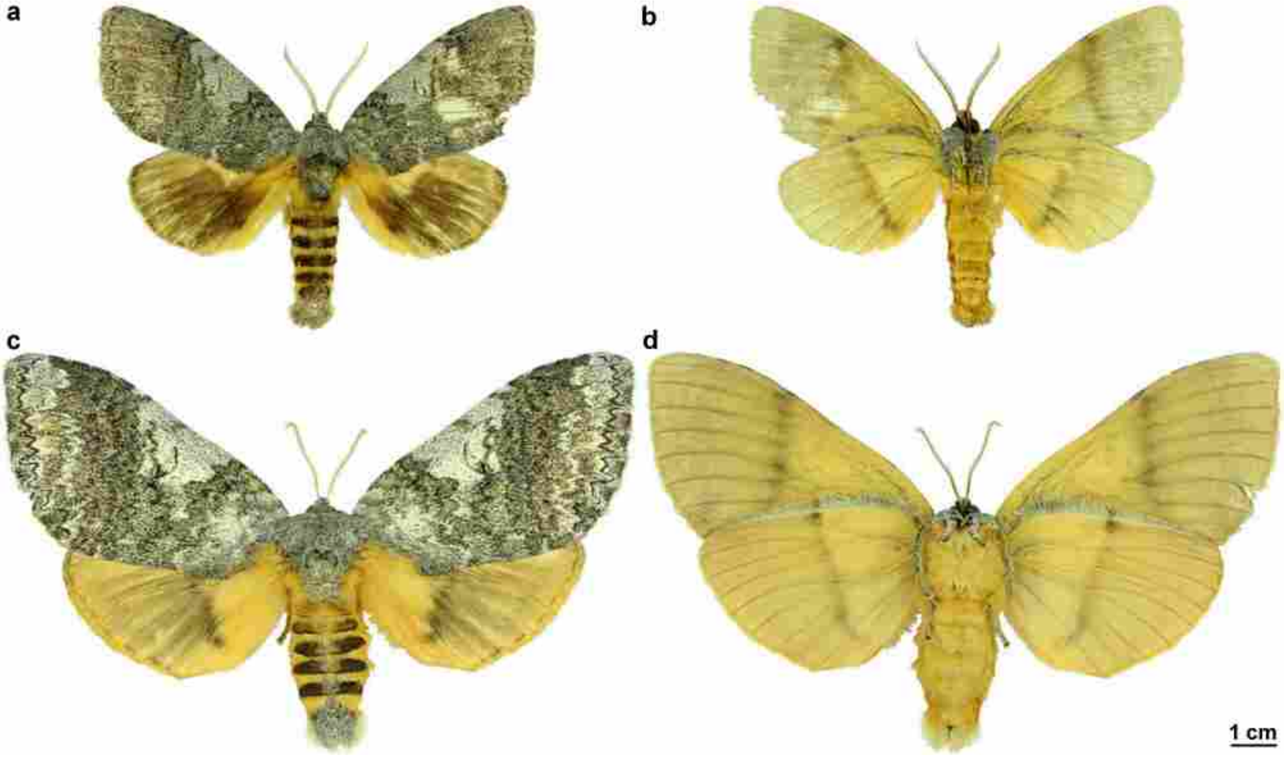

FIGURE 18. *Anurocampa abelardochaconi* **sp. nov.** (San José, Costa Rica): a) male holotype dorsal view; b) male holotype ventral view; c) female paratype dorsal view; d) female paratype ventral view.

Diagnosis. Externally mostly similar to *A. mingens* due to the somewhat lighter coloration overall than in *A.* cf. *orousseti* and *A. markhastingsi* **sp. nov.** as well as by the presence of a dark submarginal line and more well-defined discal spot (females *A. markhastingsi* **sp. nov.** may have a less well-defined submarginal line). While it may be possible to differentiate *A. abelardochaconi* **sp. nov.** and *A. markhastingsi* **sp. nov.** in the field in Costa Rica due to the aforementioned characters, we recommend examination of the terminalia to be certain of identification since the two species are very similar. The most immediately apparent morphological feature is the absence of a pair of VIII tergite pits in male *A. abelardochaconi* **sp. nov.** (present in all other examined *Anurocampa* species), and these should be discernable by brushing scales from the terminal abdominal segments so as not to require a full genitalia dissection. If genitalia are examined, the narrow, triangular uncus and a well-developed subapical pair of spines on the valvae combined with a narrow phallus all help to differentiate this new species from *A. markhastingsi* **sp. nov.**. *Anurocampa markhastingsi* **sp. nov.** and *A. abelardochaconi* **sp. nov.** have conspicuously different DNA barcodes (BIN BOLD:AAB4585 vs. BIN BOLD:AAT9497).

Description. *Adult*. Male. Head: As for previous species. Thorax: As for previous species except: Forewing length 48–49 mm, wingspan 94–99 mm (n = 2); forewing dorsum ground color light to deep green with fine irroration of gray and black scales giving much of the wing hoary appearance. Overall wing pattern poorly defined due to hoary appearance, but faint wavy antemedial and postmedial lines present and most complete costally, submarginal region lighter gray than medial or antemedial region with a dark brown zigzagging submarginal line. Discal spot present, crescent shaped, lighter patch present midway along costa that reaches to roughly halfway to inner margin, white patch overlaid by green, gray, and black scales, overall patch not strongly contrasting against medial area of wing. Forewing ventrum mostly unmarked, medial band very faint. Hindwing without distinct markings, coloration dark brown underlaid with yellow-tan. Hindwing ventrum as for hindwing dorsum but more yellow-brown than gray-brown and usually stronger, straighter medial line. Abdomen: Very similar to previous species, but VIII sternite lacking mesal pits (Fig. 19d). Genitalia (Fig. 19a–c) (n = 2) Vinculum broadly ovoid, somewhat triangular dorsally. Tegumen weakly defined. Uncus somewhat elongate, forming an isosceles triangle. Socii simple, fingerlike, upcurved more heavily sclerotized than uncus, barely reaching roughly halfway to uncus apex. Gnathos absent. Valvae narrow, costal region slightly more strongly sclerotized than remainder of valvae, subapical region of valvae with strongly sclerotized pair of teeth. Juxta a simple flat structure. Phallus short, broadest distally, somewhat flattened, distally covered in short spines ventrally, with spines continuing on to cover the thick, balloon-like vesica, coecum phallus constricted giving phallus overall much narrower appearance than in previous species. When viewed from ventral or dorsal aspect, phallus broadened on either terminus.

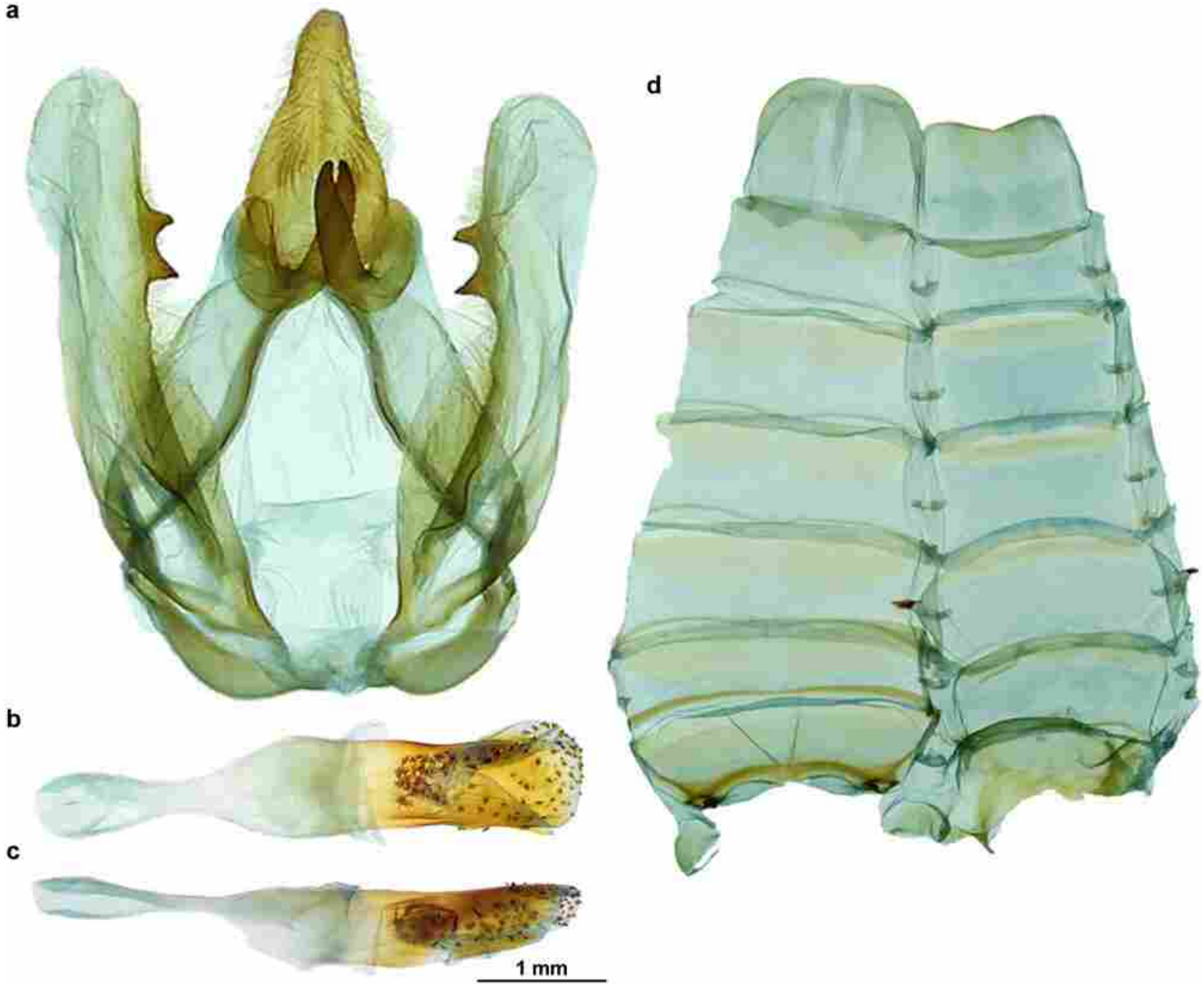

FIGURE 19. *Anurocampa abelardochaconi* **sp. nov.** (San José, Costa Rica): a) male genitalia ventral view; b) phallus ventral view; c) phallus lateral view; d) abdominal integument (tergites left, sternites right).

Female. Sexual dimorphism most notable in size difference with females being roughly 1.5 times size of males. Head: As for male but antennae slimmer with shorter pectinations. Thorax: As for male. Forewing length 63–70 mm, wingspan 129–148 mm (n=3); as for male but costal white patch less contrasting and appearing stretched farther along costa and more toward anal angle, overall coloration lighter than in male, particularly antemedially and submarginally. Hindwing as in male but broader and lighter due to less dark brown scales. Frenulum with numerous tightly packed bristles. Abdomen: As for male but more robust, eighth sternite and tergite simple, lacking the pits on variable sclerotization of males. Genitalia (Fig. 20) (n = 3) tergite VIII broadly rectangular with posterior margin outwardly project. Apophyses anteriores small, fingerlike; apophyses posteriores extremely fine, crisscrossing each other and held parallel to VIII segment margin, their length slightly less than VIII–IX/X intersegmental width. Lamella antevaginalis a weakly sclerotized plate embedded in membrane; lamella postvaginalis a more sclerotized band. Ductus broad, thickly membraned with a single sclerotized band embedded near terminus of ductus bursae; corpus bursae small and baglike, only moderately larger than ductus; papillae anales large and broad, papillae anales covered in relatively short, fine setae.

Life history. Unknown. All *Anurocampa* larvae reared to adults in Costa Rica resulted in *A. markhastingsi* **sp. nov.**.

Distribution. *Anurocampa abelardochaconi* **sp. nov.** has been collected with light traps in rain forest on the eastern slope of Cordillera Volcánica Central. The elevational range for the species is 400–700 m, conspicuously lower than that of *A. markhastingsi* **sp. nov.**. There is no geographic overlap of the ranges of the two newly described species.

Remarks. Initially, COI barcodes called our attention to these two morphologically cryptic *Anurocampa* in Costa Rica (Fig. 21). Further examination of the barcodes in the context of *A. mingens* from Brazil and *A.* cf. *orousseti* from French Guiana emphasize the recognition of the two newly described taxa. Although differences are low, expectedly considering limited available genetic data, the morphology suggests that the two Costa Rican taxa are more closely related to the Amazonian population of *A.* cf. *orousseti* than to *A. mingens* from southeastern Brazil. Further genetic data and sampling from across South America is warranted.

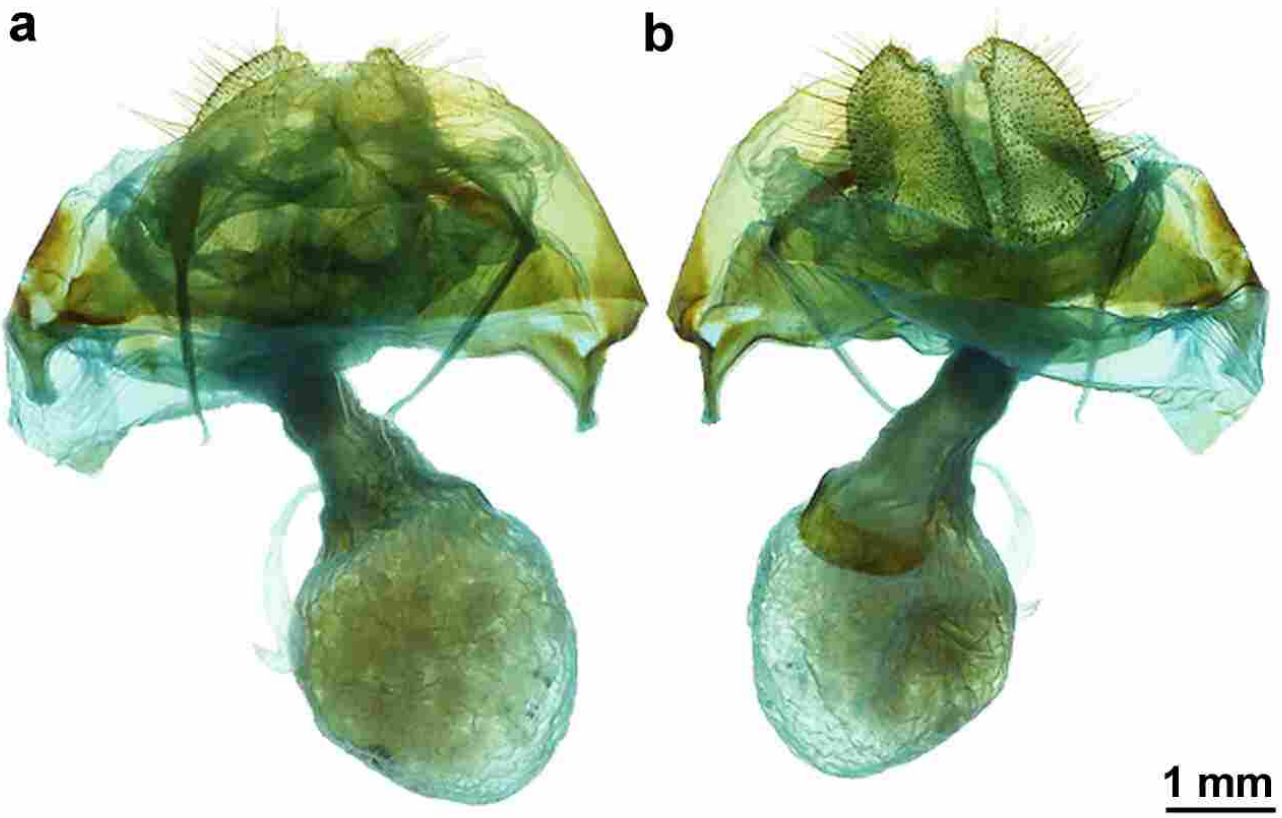

FIGURE 20. *Anurocampa abelardochaconi* **sp. nov.** (San José, Costa Rica): Female genitalia: a) dorsal view; b) ventral view.

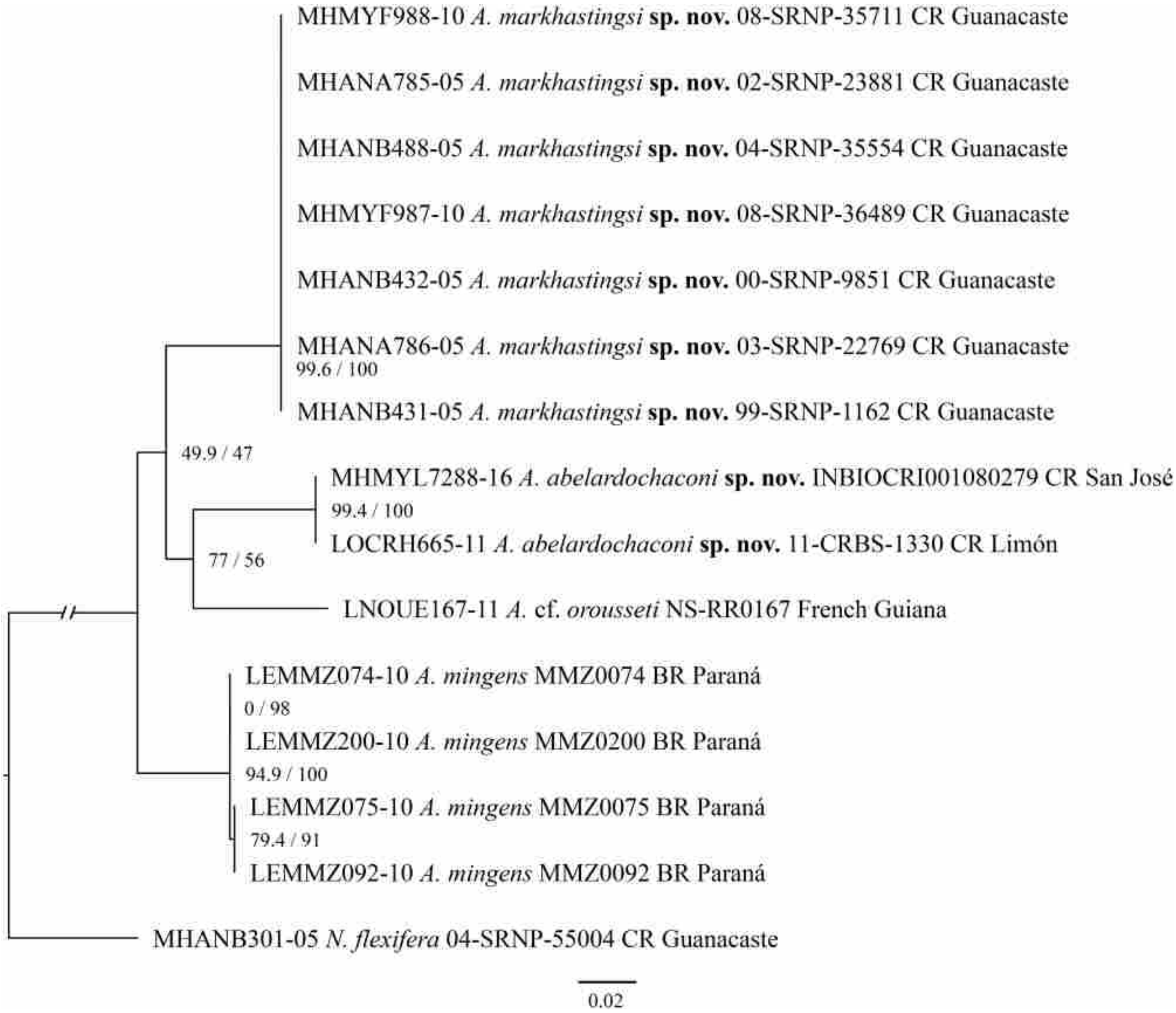

FIGURE 21. Maximum likelihood phylogenetic tree inferred with IQ-TREE based on the COI marker and rooted to *Naprepa flexifera*. Branch supports indicated as SH-aLRT/UFBoot.

Discussion

Although the larvae of *A. mingens* have not received formal description, they are commonly encountered in southeastern Brazil. The larvae are large, colorful, and showy, and regularly reported by insect-focused social media groups and citizen science initiatives such as iNaturalist.org (111 sightings of *Anurocampa* as of 16.V.2023, 19 of them larvae).

Anurocampa markhastingsi **sp. nov.** has been reared in the Área de Conservación Guanacaste, in Costa Rica (Janzen & Hallwachs 2009). However, the larvae, while similar in general shape and structure, differ widely from those of *A. mingens* in color pattern and shape of the spots. Life history of the Amazonian *A. orousseti* is so far unknown and would be an important further topic to document. We note that the *A. mingens* that we reared from Paraná differs somewhat from some other larvae photographed from southeastern Brazil on iNaturalist.org. These have a reduction of burgundy coloration, such that it is restricted to only the thoracic hump, and not present encircling the white lateral spots in all other sightings. Whether our observation is a result of captive rearing, host plant use or an indication of coloration diversity in Brazilian *Anurocampa* is not clear. We do note, however, that one larva from Campos do Jordão, São Paulo, Brazil on iNaturalist.org does have the burgundy encircling the lateral spots.

Anurocampa has been unassigned to a subfamily within the Notodontidae, since the last major treatment of Neotropical Notodontidae considered the genus *incertae sedis* along with several other genera (Becker 2014).

This assignment of *Anurocampa* to *incertae sedis* has been the case since at least Weller *et al.* (1992), but Prada-Lara *et al*. (2023) assigned the genus to the Heterocampinae based on St Laurent's phylogenomic work that is in preparation. Our examination of larval, pupal, and adult morphological characters (Table 1) also support the placement of *Anurocampa* in the most diverse Neotropical subfamily of notodontids, the Heterocampinae. While the concept of this subfamily varies tremendously depending on the worker (Becker 2014; Kobayashi & Nonaka 2016; Miller 1991; Miller *et al.* 2021), we encountered at least one of the Heterocampinae apomorphies proposed by Miller (1991) in *A. mingens*: SV setae on thoracic segments in formula 2-2-2. More recently, Miller *et al.* (2021) added the presence of a tuft of scales in the base of the forecoxa (so-called "beard tuft") as an additional character that defines the Heterocampinae, but in *A. mingens* these scales are short and less differentiated from others along the prothorax. A more in-depth investigation of this character among the Notodontidae is warranted, especially in regard to the Neotropical genera.

Anurocampa species have a pair of cteniophores on sternum 4, an important, but not universal character in Heterocampinae. The male genitalia of *Anurocampa* species are also generally simple and similar to a number of heterocampine genera (St Laurent pers. obs.). Although not yet a defined apomorphy of Heterocampinae, given the wide variability in larval morphology across the subfamily, we do note the enlarged thoracic hump in *A. mingens* and *A. markhastingsi* **sp. nov.** is reminiscent of thoracic prominences in other Heterocampinae genera, such as *Schizura* Doubleday, 1841, *Coelodasys* Packard, 1864, *Oedemasia* Packard, 1864, *Ianassa* Walker, 1855, *Euhyparpax* Beutenmüller, 1893, and *Hyparpax* Hübner [1825]. Morphology of *Anurocampa* larvae is most similar to the comparatively colorful, large, and enlarged thorax-bearing larvae of Neotropical genera *Prepana* Becker, 2014 and *Naprepa*, as per larval images available in the Janzen caterpillar database (Janzen & Hallwachs 2009). Interestingly, Becker (2014) assigned both of these genera to the Heterocampinae despite maintaining *Anurocampa* as *incertae sedis*. Ongoing phylogenomic efforts by St Laurent *et al.* (in prep.), which attempt to include global taxa of Notodontidae, with particular attention to *incertae sedis* and difficult-to-place genera, have also recovered *Anurocampa* to be closely related to *Naprepa* (which together are sister to another *incertae sedis* genus, *Lobeza*), which altogether are robustly recovered in the Heterocampinae. However, because Heterocampinae in the current sense is an extremely diverse group, with nearly 900 described species (Miller *et al.* 2021), it is possible that other available family-group names could eventually be applied to specific clades of Heterocampinae to allow for clearer designation of morphology-based apomorphies. Therefore, considering the morphology reported here and ongoing phylogenomic research, we maintain the assignment of *Anurocampa* to Heterocampinae first made in Prada-Lara *et al*. (2023) and we illustrate the continued importance of larval and adult morphology as it contributes to a stable, global Notodontidae classification.

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