

A revision of the *Acrotomodes clota* DRUCE, 1900 species-group (Lepidoptera: Geometridae, Ennominae)

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Abstract. A clade within the neotropical genus *Acrotomodes* WARREN, 1895 is revised. *Acrotomodes subusta* WARREN, 1904 is a junior synonym of *Acrotomodes clota* DRUCE, 1900 (syn. nov.). Three species are described as new: *Acrotomodes ingridae* sp. nov., *A. kunoi* sp. nov., and *A. lindae* sp. nov. The species group probably forms a monophyletic clade within the genus *Acrotomodes*, but generic placement is provisional. The *clota* species-group differs from other members of *Acrotomodes* in various characters. It does not share one of the apomorphies of the genus, the antero-dorsal process of the gnathos. All species are illustrated and their diagnostic characters are described. Members of the *clota* species-group are exclusively distributed in the montane zone of the tropical Andes.

Key words. *Acrotomodes*, Andes, Ennominae, Geometridae, new species, new synonym, Neotropical region, rain forest, cloud forest

Zusammenfassung. Eine Artengruppe innerhalb der neotropischen Gattung *Acrotomodes* WARREN, 1895 wird revidiert. *Acrotomodes subusta* WARREN, 1904 ist ein jüngeres Synonym von *Acrotomodes clota* DRUCE, 1900. Drei neue Arten werden beschrieben: *Acrotomodes ingridae* sp. nov., *A. kunoi* sp. nov. und *A. lindae* sp. nov. Die Artengruppe bildet wahrscheinlich ein Monophylum innerhalb der Gattung *Acrotomodes*. Die Zuordnung zur Gattung bleibt aber vorläufig, da sich die *clota*-Gruppe in verschiedenen Merkmalen von anderen Vertretern der Gattung *Acrotomodes* unterscheidet. Der antero-dorsale Fortsatz des Gnathos, eine Apomorphie von *Acrotomodes*, ist nicht vorhanden. Alle Arten werden illustriert und ihre diagnostischen Merkmale werden beschrieben. Vertreter der *clota*-Gruppe sind ausschließlich in der montanen Zone der tropischen Anden verbreitet.

Acronyms

AMNH	American Museum of Natural History, New York
BMNH	The Natural History Museum, London
MZUJ	Zoological Museum Jagiellonian University, Krakow, Poland
SMNS	Staatliches Museum für Naturkunde, Stuttgart
USNM	National Museum of Natural History, Smithsonian Institution, Washington D. C.
ZSM	Zoologische Staatssammlung, München

Acrotomodes clota species-group

General description. *Habitus.* Adults (Fig. 1 a–d) medium-sized to large ennomines (wingspan males: 34–43 mm, females: 42–45 mm). Antenna bipectinate in both sexes but rami very tiny in females. The head is brownish and chaetosemata are extended across the back of the head but not meeting in the middle. The labial palpi are ochreous with brown tips. Forewings are typically shaped with an angled apex region. The ground colour of the upperside is ochreous transversely striated with brown and violet. The underside is more contrasting and ochreous-yellow with red-brown markings; the terminal area is mostly brown. Both medial and postmedial lines of the forewing are formed of pronounced double brown lines. They have a characteristic and distinct shape in each of the four species. On the hindwing, the medial lines are pronounced. The postmedial line can best be seen on the underside; it has a typical shape in each species. The ground colour varies and is not a reliable character to distinguish between species. A fovea is absent. Thorax and abdomen have a similar colour as the wings. The ventral side has a more intensive ochreous-orange colour. The legs are ochreous with brown spots and rings. Sternite 3 of the male abdomen has a comb of setae. Females (known in three of four species) are generally similar in appearance. They are

Introduction

Diversity of geometrid moths is highest in the Neotropical region. Almost one third of the ca. 21000 described species occur in Central and South America (GASTON *et al.* 1995). Recent studies along an elevational gradient in southern Ecuador showed that a global hotspot of diversity of geometrid moths is in the tropical Andes (BREHM 2002, BREHM *et al.* 2003). Of 1266 species collected in an area of tropical montane habitats of ca. 40 km², about one third could not be formally identified to species level and probably needs to be described taxonomically (BREHM *et al.*, in press).

In this paper, the Andean *Acrotomodes clota* group is revised. This small group forms a distinctive clade within *Acro-*

tomodes because of the larger size and different wing shape of the group as compared with other members of the genus. PITKIN (2002) transferred two species from the ennomine genus *Hygrochroma* HERRICH-SCHÄFFER, [1855] to the genus *Acrotomodes* WARREN, 1895 because of similarities of the structure of the male genitalia. She already suspected one of the species (*A. subusta* WARREN, 1904) being a junior synonym of the other species (*A. clota* DRUCE, 1900). During the course of identification work on the Ecuadorian geometrid moth fauna, it turned out that the clade consists of a total of four different species. In this paper, one new synonymy will be established, and three new species will be described.



Fig. 1. Upper- and underside of species belonging to the *Acrotomodes clota* species-group, scale bar = 1 cm. a. *A. clota* DRUCE, 1900; b. *A. kunoi* sp. nov.; c. *A. ingridae* sp. nov.; d. *A. lindae* sp. nov.

larger than the males and more ferruginous instead of violet.

Male genitalia (Figs 2 and 3). The uncus process is extremely short. The gnathos arms join and form a 'Y' that is pointed and curved (in lateral view) in the distal part. The valves divide into a broad distal lobe and a narrow and elongated costal

lobe. The anellus has a well developed juxta and two postero-lateral processes. The gap between these processes has a distinct shape in each of the species. The shape of the valvae also varies characteristically between species. The aedeagus is very long, with a small pointed posterior process; the long and pointed vesica has basal wrinkles and five to more than

twenty minute denticles towards the apex.

Female genitalia (Fig. 4). Only known from *A. ingridae* sp. nov. (see below).

Distribution. All species occur exclusively in the montane zone of the tropical Andes (450–2675 m a.s.l.). Most specimens examined are from Ecuador, fewer from Colombia and Peru, and very few from Venezuela and Bolivia (*clota* only).

Key to the species

- 1 Males small (wingspan 34–37 mm). Male genitalia: gnathos arms are relatively long and reach far into the gap formed by the postero-lateral processes of the anellus (Fig. 2 d). The form of the gap is a narrow 'U' *A. lindae* sp. nov.
- 1* Males large (wingspan 35–43 mm). Male genitalia: gnathos arms do not reach far into the gap formed by the postero-lateral processes of the anellus (Figs. 2a–c). The form of the gap is either a broad or very broad 'U' or a very narrow 'Y' 2
- 2 Males in most cases of violet and dark appearance (but some ochreous specimens occur). Male genitalia: Distal lobes of the valvae are very broad and truncate. The gap between the postero-lateral processes of the anellus is narrow and Y-shaped. *A. ingridae* sp. nov.
- 2* Males always ochreous. Male genitalia: Distal lobes of the valvae are broad with a pointed apex. The gap between the postero-lateral processes of the anellus is very broad V- to U-shaped . . . *A. clota* DRUCE, 1900
- 2** Males always ochreous. Male genitalia: Distal lobes are bluntly truncate. The gap between the postero-lateral processes has medium-sized U-shape *A. kunoi* sp. nov.

***Acrotomodes clota* DRUCE, 1900.**

(*Hygrochroa*, misspelling of *Hygrochroa*, HERRICH-SCHÄFFER, [1855])

Holotype. Colombia: Sierra del Libano, 6000 ft. [= 1830 m], H. H. SMITH (BMNH) (genitalia illustrated in Figs 2a, 3a).

***Acrotomodes subusta* WARREN, 1904.**
(*Hygrochroma*). syn. nov.

Holotype. [Peru]: S[anto] Domingo, Carabaya, 6000 ft. [= 1830 m], Nov. [19]01, wet seas[on], (Ockenden) (BMNH) (genitalia examined).

Description. *Habitus.* Adult (Fig. 1a). Medium to large. Wingspan male (n=36) 37–43 mm, female (n=2) 42–43 mm. Female (not illustrated) like male but with a more ferruginous ground colour.

Diagnosis. Appearance relatively bright in colour as in *A. kunoi* sp. nov., and apex region more pointed than in the other species. Medial and postmedial lines of the forewing form an angle towards the costa of about 45°. Medial lines on the underside of the hindwing are often (as in Fig 1a, but not always) separate.

Male genitalia (Figs 2a, 3a). Distal lobes of the valvae broad with a more or less pointed apex. Between the postero-lateral processes is a very broad V- to U-shaped gap (broader than in the other three species). The aedeagus is more sclerotised in the distal part than in the other species. Vesica similar to that of *A. kunoi* sp. nov. but broader than in *A. ingridae* sp. nov. and *A. lindae* sp. nov.

Distribution. Specimens examined (n=38) were collected in the Andes from northern Venezuela to Bolivia. Moths other than holotypes were sampled in: Venezuela: Caracas; Colombia: Antioquia; Ecuador: Napo, Zamora-Chinchipec; Peru: River Tabaconas, Cusco; Bolivia: Rio Songo. *Acrotomodes clota* has a lower elevational distribution than the other species of the group. It was collected at 5000 ft (= 1525 m) in Colombia, between 450 m and 1973 m in Ecuador, at 2200 m in Peru, and at 750 m in Bolivia.

***Acrotomodes kunoi* sp. nov.**

Holotype. ♂, Ecuador: [Napo], Cosanga, 2150 m, 27.III.1976, N. Vénédictoff (ZSM) (genitalia illustrated in Figs 2b, 3b).

Paratypes. 1 ♂, same data as holotype (ZSM) (genitalia examined); 3 ♂, Ecuador: Napo-Pastaza, Sebundoi, between Sta. Barbara and La Bonita, September 11–15, 1977, 2600 m, L. E. PEÑA (AMNH) (genitalia examined in two); 1 ♂, Ecuador: Imbabura, Otavalo to Apuela, Sept. 8–10, 1977, 2200 m, L. E. PEÑA (AMNH) (genitalia examined); 1 ♂, Ecuador: Pichincha, E of

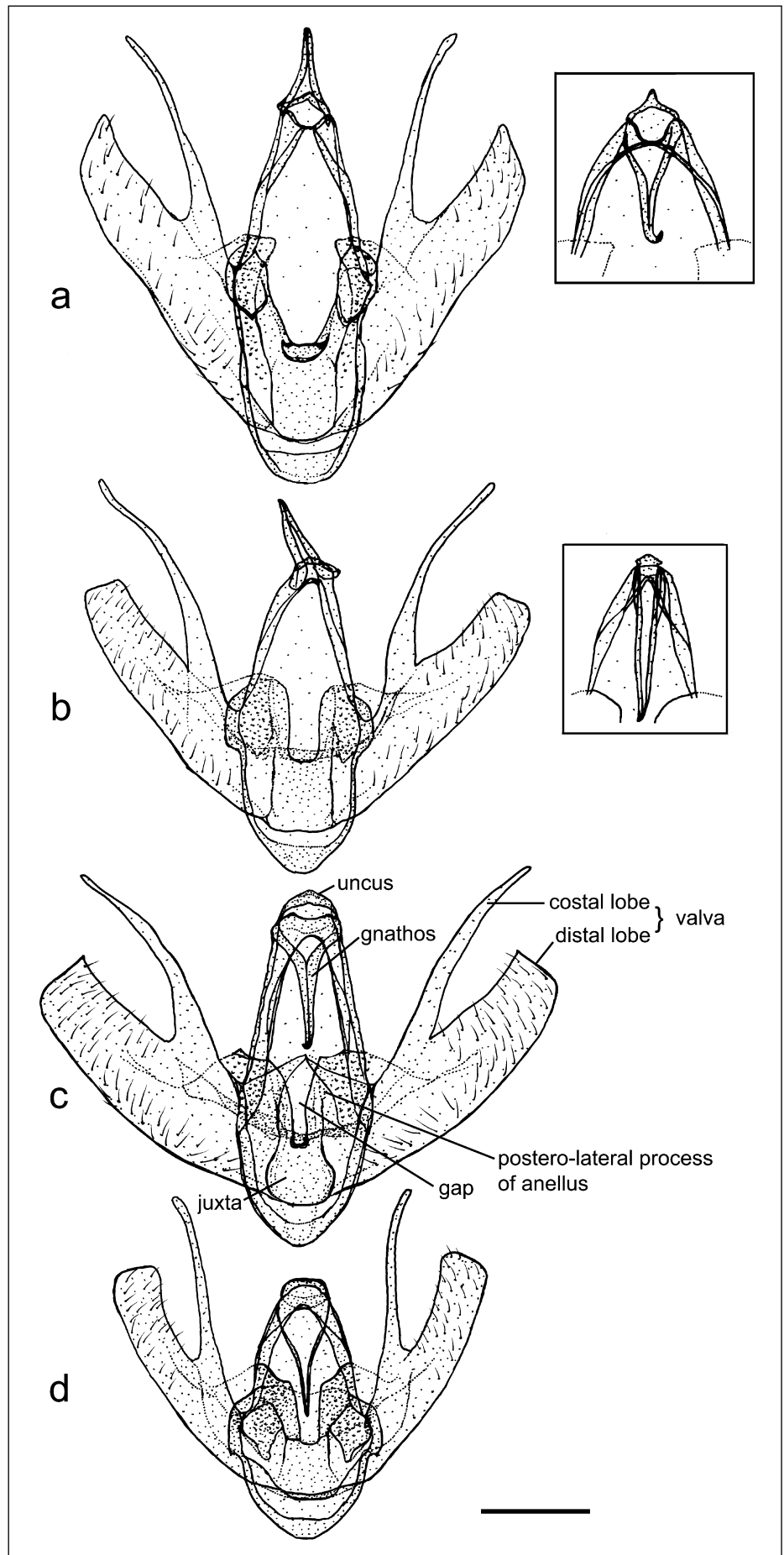


Fig. 2. Male genitalia (valvae) of the *Acrotomodes clota* group, scale bar = 1 mm. a. *A. clota* DRUCE, 1900; b. *A. kunoi* sp. nov.; c. *A. ingridae* sp. nov.; d. *A. lindae* sp. nov. In a and b, additional detail drawings of the uncus-gnathos region of other specimens were inserted because in the genitalia of the holotype specimens, the gnathos obscures the uncus.

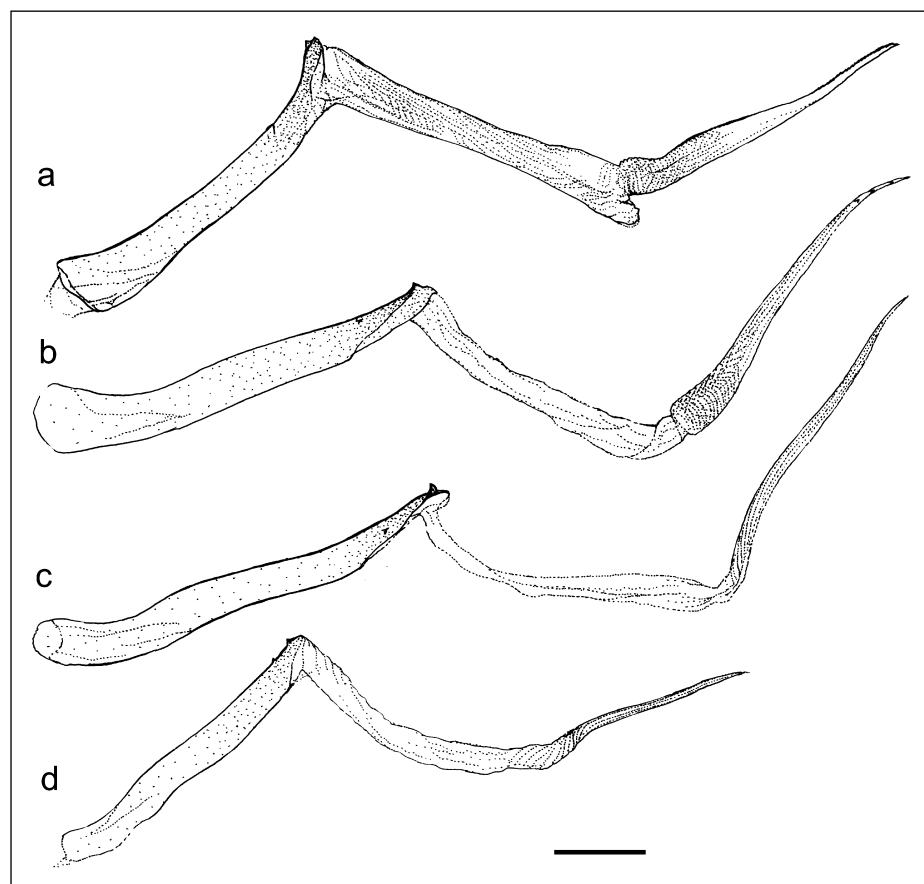


Fig. 3. Male genitalia (aedeagi) of the *Acrotomodes clota* group, scale bar = 1 mm. a. *A. clota* DRUCE, 1900; b. *A. kunoi* sp. nov.; c. *A. ingradae* sp. nov.; d. *A. lindae* sp. nov.

Tandapi, 55 km SW of Quito, 2200–2500 m, Oct 8, 1977, L. E. PEÑA (AMNH) (genitalia examined); 1 ♂ Ecuador: Santiago-Zamora, W of General Plaza on road from Cuenca (Azuay Prov[ince]) to Méndez, 2200–2400 m, Oct 18–19, 1977, L. E. PEÑA (AMNH) (genitalia examined); 1 ♂, Ecuador: Zamora-Chinchi, Estación Científica San Francisco, 3°59.52' S, 79°04.30' W, 18.x.2000, T1-8 (15), 2525 m, G. BREHM leg. (SMNS) (genitalia examined); 3 ♂, Colombia: San Antonio, Dec [19]07, 5800 ft [=1770 m], M. G. PALMER (BMNH); 1 ♂, Colombia: St. Antonio, 2000 [m], iv[19]09, DOGNIN Collection (USNM); 1 ♂, Colombia: Alto de las Cruces, 2200 [m], Cali, Marzo [19]09, DOGNIN Collection (USNM).

Derivatio nominis. The species name is dedicated to my father, Dr. KUNO BREHM.

Description. Habitus. Adult (Fig. 1b) medium sized. Wingspan male (n=14) 35–39 mm, female unknown.

Diagnosis. Of similar general appearance as *A. clota*, but slightly smaller on average. The medial and postmedial lines of the forewing are usually not as sharply angled. The double violet medial lines of hindwing underside are fused in most cases (they are usually, but not always distinguishable in *clota*).

Male genitalia (Figs 2b, 3b). Distal lobes of the valvae are not pointed as in *clota* but bluntly truncate. The gap between the postero-lateral processes has a U-shape as in *A. lindae* sp. nov., but considerably narrower than in *A. clota*, and broader than in *A. ingradae* sp. nov. The gnathos arms may extend into the gap, but not as far as in *A. lindae* sp. nov. The vesica is almost as broad as in *A. clota*, and broader than in *A. ingradae* sp. nov. and *A. lindae* sp. nov.

Distribution. Only known from Colombia and Ecuador. Specimens were collected on both, Pacific and Amazonian slopes of the Andes. The elevational range is between 1830 and 2600 m.

Acrotomodes ingradae sp. nov.

Holotype. ♂, Ecuador: Zamora-Chinchi, Estación Científica San Francisco, 3°59.52' S, 79°04.30' W, 16.xii.2000, L[icht] F[ang], T1-8 (15), 2525 m, G. BREHM leg. (SMNS) (genitalia illustrated in Figs 2c, 3c).

Paratypes. 3 ♂, Ecuador: Zamora-Chinchi, Estación Científica San Francisco 3°59.52' S, 79°04.30' W, 16.xi.2000, T1-8 (15), 2525 m,

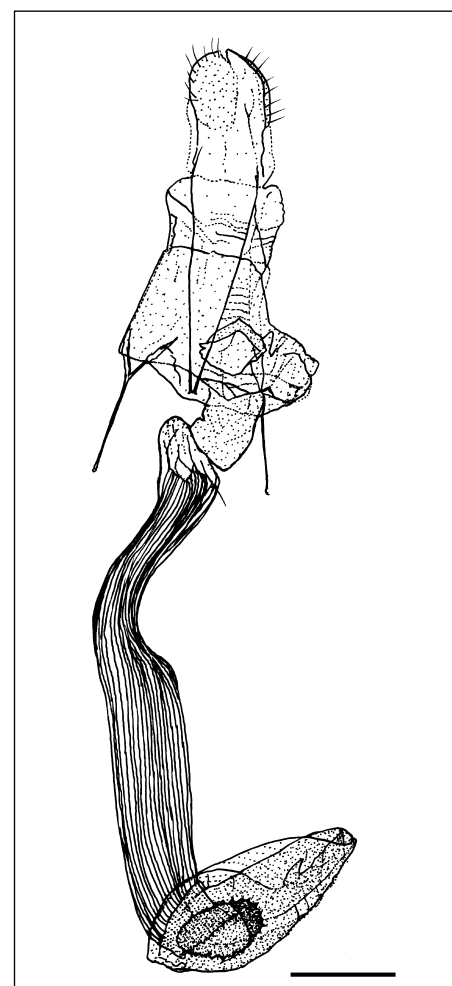


Fig. 4. Female genitalia of *Acrotomodes ingradae* sp. nov., scale bar = 1 mm. The anterior sac of the bursa copulatrix has collapsed.

D. SÜSSENBACH leg. (SMNS); 1 ♂, same location, but 18.x.2000, G. BREHM leg. (SMNS) (genitalia examined); 1 ♂, Ecuador: Zamora-Chinchi, Estación Científica San Francisco, 3°59.15' S, 79°04.56' W, 7.xi.2000, T1-7 (7), 2375 m, D. SÜSSENBACH leg. (SMNS); 1 male, same location but 9.v.1999, D. SÜSSENBACH leg. (BMNH) (genitalia examined); 1 male, same location but 3.i.2000, G. BREHM leg. (SMNS) (genitalia examined); 1 ♀, same location but 9.v.1999, D. SÜSSENBACH leg. (genitalia illustrated in Fig. 4); 1 ♂, Ecuador: Zamora-Chinchi, Estación Científica San Francisco, 3°59.56' S, 79°04.26' W, 18.x.2000, T1-9 (16) 2560 m, D. SÜSSENBACH leg. (SMNS) (genitalia examined); 1 same location but 16.xi.2000, G. BREHM leg (SMNS); 1 Ecuador: Zamora-Chinchi, Estación Científica San Francisco, 3°59.65' S, 79°04.10' W, 20.xi.2000, T1-10 (17), 2670 m, D. SÜSSENBACH leg. (SMNS); 1 ♂, Ecuador: [Loja], km 28 de la route Loja – Catamayo, 1700 m, 16.i.1975, C. HERBULOT (ZSM) (genitalia examined); 2 ♂, Ecuador: Napo: km 23 via Sta. Barbara, La Bonita, 2400 m, April 8–9, 1986, S. MCKAMEY (AMNH) (genitalia examined in one); 1 ♂, Ecuador: [Napo], km 52 de la route Pifo-Baeza, 2600 m, 2 et 3.ii. 1975, C. HERBULOT (ZSM) (genitalia examined); 1 ♂, Ecuador: [Napo], Cosanga, 2150 m, 27.III.1976, N. VÉNÉDICTOFF (ZSM) (genitalia examined).

Derivatio nominis. The species name is dedicated to my mother, INGRID BREHM.

Description. Habitus. Adult (Fig. 1c). Wingspan male (n = 16) 40–43 mm, female (n = 1) 45 mm. The female is very similar to the male, but larger and more ferruginous instead of violet.

Female genitalia (Fig. 4). The long bursa copulatrix has longitudinal ridges. The signum is a semi-open hollow dentate disk.

Diagnosis. The species is large and usually has a more colourful (violet) and darker appearance than *A. clota* and *A. kunoii* sp. nov. However, a few specimens lack the intense coloration and resemble those two species at first sight. The medial bands of the forewing have a typical zigzag shape.

Male genitalia (Figs 2c, 3c). Distal lobes of the valvae are very broad and truncate. The gap between the postero-lateral processes of the anellus is Y-shaped and is the narrowest of all four species. The vesica is narrow compared with the other two large species, *A. clota* and *A. kunoii* sp. nov.

Distribution. Only known from Ecuador. Most specimens were collected in the southern part of the country, and some were collected at Amazonian slopes in the Napo province. Elevational distribution 1700–2675 m a. s. l.

Acrotomodes lindae sp. nov.

Holotype. ♂, Ecuador: Zamora-Chinchi, Estación Científica San Francisco, 3°59.52' S, 79°04.30' W, 16.xii.2000, L[icht] F[ang], T1-8 (15), 2525 m, G. BREHM leg. (SMNS) (genitalia illustrated in Figs. 2d and 3d).

Paratypes. 1 ♂, Ecuador: Cotopaxi, La Otonga W San Fran[cisco] de las Pampas, 1900 m, May 16 1993, leg. J. S. MILLER, at light (AMNH) (genitalia examined); 5 ♂, Ecuador, Prov[ince] Cotopaxi, San Francisco de las Pampas, Otonga Res[erve], 1950 m, 30.01.2002, leg. WOJTUSIAK, PRYCY & GARLACZ (MZUJ) (genitalia examined in two); 1 ♂, Ecuador: [Pichincha], km 77 de la vielle route de Quito à Santo Domingo, 1620 m, 15 et 16.ii.1975, C. HERBULOT (ZSM); 1 ♂, Ecuador: [Napo], Route Baeza – Lumbaqui au Puente Azuela, 1530 m, 6 et 7.ii.1975, C. HERBULOT (ZSM) (genitalia examined); 1 ♂, Colombia: El Cerro, Frontino, Dept. di Antioquia, 6000 ft [= 1830 m]. 17.vi.1938 (BMNH); 1 female, Colombia: Mesopotamia, Dept. Antioquia, S[outh] A[merica], 5000 ft [= 1525 m]. (AMNH); 1 ♂,

Peru: San Martin, Rte. Olmos-Tarapoto, km 386, 14–15/02/1982, 1800 m, T. PORION (ZSM) (genitalia examined).

Derivatio nominis. The species name is dedicated to LINDA M. PITKIN, The Natural History Museum, London.

Description. Habitus. Adult (Fig. 1d). Wingspan male (n = 11) 34–37 mm, female (n = 1) 43 mm. Female like male, but has a more ferruginous ground colour.

Diagnosis. The smallest of the four species, on average, generally of darker and more intense colouring than *A. clota* and *A. kunoii* sp. nov., but medial bands of the forewing less contrasting than in *A. ingridae* sp. nov. Postmedial lines on the fore- and hindwing more wavy than in the other species.

Male genitalia (Figs. 2d, 3d). More delicate form than in the other three species. Distal lobes of the valvae relatively narrow, and rounded at apex. Unlike in the other species, gnathos arms are relatively long and reach far into the gap formed by the postero-lateral processes of the anellus. The form of the gap is a U, similar to, but narrower than that of *A. ingridae* sp. nov. The aedeagus is also delicate in form, with a narrow vesica.

Distribution. Most specimens were collected in northern Ecuador on both Pacific and Amazonian slopes. One specimen was collected in north-western Peru (ca. 7°S). This specimen differs slightly from the others in the truncate shape of the valvae, but otherwise is identical. Two specimens were collected in western Colombia. Elevational distribution 1530–2600 m a. s. l.

Discussion

Generic placement of the *Acrotomodes clota* species-group. The *Acrotomodes clota* species-group shares important characters with other species of the genus *Acrotomodes*. However, it has these characters also in common with the other related genera *Falculopsis* DOGNIN, 1913, and *Pyrinia* HÜBNER, 1818. In all three genera, the valvae are divided into costal and distal lobes, a pair of postero-lateral processes of the juxta is present, and chaetosemata are extended across the back of the head (meeting in the middle in *Falculopsis* but not in the other two

genera). The *A. clota* species-group has a typical fore wing shape that resembles those found in other members of the genus *Acrotomodes*. However, the *A. clota* species-group lacks the only reliable apomorphy that discriminates *Acrotomodes* from *Pyrinia* and *Falculopsis*: the antero-dorsal process of the gnathos (PITKIN 2002). Moreover, the male genitalia differ in having a very small uncus. The juxta never has a large sac or depression as is typical in *Acrotomodes* (PITKIN 2002). The moths are considerably larger than other members of *Acrotomodes*, and their wing pattern is distinctive in having pronounced postmedial lines (PITKIN 2002). In the female genitalia, a signum is present (Fig. 4, *A. ingridae* sp. nov.) which is not the case either in the type species of *Acrotomodes* nor *Pyrinia*. Unlike in most species of *Acrotomodes*, Sternite 3 of the male abdomen has a comb of setae. All these characters are different, but the *clota* group lacks an apomorphy that could justify the creation of a new genus.

Hence, the *clota* species-group certainly is related with the genera *Acrotomodes*, *Falculopsis* and *Pyrinia*, mainly because it shares the apomorphy of postero-lateral processes of the juxta. However, the placement in the genus *Acrotomodes*, although supported to some extent by the character of the wing shape, is provisional until a full revision of all three genera is available.

Distinction of species. All four species of the *A. clota* species-group can be distinguished relatively easily using size, wing patterns, and male genitalia. In most cases, identification is possible with careful examination of the wings and without dissecting specimens. However, in doubtful cases dissection is recommended because male genitalia allow distinction also of specimens in poor condition. *Acrotomodes subusta* is here placed in synonymy with *A. clota* because differences of wing patterns and male genitalia of the type specimens are minimal and do not allow the separation as two distinct species.

Distribution and ecology. The current state of knowledge of the distribution of the species is certainly incomplete, and all species are expected to be more widely distributed than recorded with the specimens examined in this study. However, some tendencies can be seen.

Acrotomodes clota is the most widespread species with a latitudinal range from northern Venezuela to Bolivia. It is also the species with records at the lowest elevations (450 m a. s. l. in Ecuador, 750 m in Bolivia). None of the 38 specimens examined was collected above 2200 m, in contrast with *A. ingridae* sp. nov. (up to 2675 m), *A. kunoii* sp. nov. (up to 2600 m) and *A. lindae* sp. nov. (up to 2525 m). The geographical distribution of those three species seems to be more restricted than in *clota*. So far, *A. ingridae* sp. nov. has been collected only in Ecuador – mostly on Amazonian slopes except for one specimen that was collected in south-western Ecuador (W of Loja). *A. kunoii* sp. nov. and *A. lindae* sp. nov. have a similar distribution to each other and were collected from central Colombia to southern Ecuador / northern Peru on both, Eastern and Western cordilleras. Ecuador is the only country where all four species have been found occurring sympatrically, so far. This highlights the hotspot character of this small and highly diverse country. However, more collecting data is required for a more thorough analysis of biogeographical patterns of the group. More research is also required with regard to

the ecology including knowledge of early stages and hostplants. The species could be potentially threatened since large areas of their habitats, montane rain forests, have been destroyed, and only small areas are currently protected (ARMENTERAS *et al.*, 2003).

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