A NEW SPECIES OF ACTINOTE HÜBNER FROM THE EASTERN ANDES OF ECUADOR (LEPIDOPTERA: NYMPHALIDAE: HELICONIINAE)

KEITH R. WILLMOTT, ANDRÉ V. L. FREITAS, JASON P. W. HALL, KARINA L. SILVA-BRANDÃO, AND MARLON PALUCH

(KRW) McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, FL 32611, U.S.A. (e-mail: kwillmott@flmnh.ufl.edu); (AVLF) Departamento de Zoologia, Instituto de Biologia, Universidade Estadual de Campinas, CP 6109, Cep 13083-970, Campinas, SP, Brazil; (JPWH) Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0127, U.S.A.; (KLS-B) Departamento de Entomologia, Fitopatologia e Zoologia Agrícola Esalq-USP, Av. Pádua Dias 11, Caixa Postal 9, Cep 13418-900, Piracicaba, SP, Brazil; (MP) Departamento de Zoologia, Universidade Federal de Pernambuco, Recife, PE, Brazil

Abstract.—A new species of Actinote Hübner, A. kennethi Freitas, Willmott and Hall (Lepidoptera: Nymphalidae: Heliconiinae), is described from cloud forest habitats in eastern Ecuador. Molecular sequence data and morphological characters both indicate that the new taxon is closely related to Actinote g. genitrix d’Almeida, 1922, from southeastern Brazil, and the Venezuelan Actinote genitrix costae Neild, 2008. Based on the substantial geographic isolation of these taxa, observed morphological differences and mtDNA sequence divergence, we argue for the treatment of the new Ecuadorian Actinote taxon as a distinct species.

Key Words: Actinote, Brazil, Ecuador, morphology, mtDNA sequence data

The tribe Acraeini is a compact group within the Heliconiinae, a nymphalid subfamily characterized by distinctive morphology in both the adult and immature stages (Ehrlich 1958, Penz and Peggie 2003, Freitas and Brown 2004). The tribe contains approximately 220 species distributed throughout the Afrotropical and Neotropical regions, with a few species also occurring in southeastern Asia and Oceania (Pierre 1987, Lamas 2004). The genus Actinote, sensu stricto, as defined by Paluch (2006), constitutes a clade within the otherwise African and Asian genus Acraea Fabricius, 1807 (Penz and Peggie 2003, Silva-Brandão et al. 2008b) and is represented by 31 exclusively Neotropical species (Francini et al. 2004, Lamas 2004, Paluch 2006, Paluch et al. 2006). All species for which the immature stages are known have gregarious larvae and feed exclusively on plants of the family Asteraceae (Francini 1989, Francini et al. 2005).

According to current knowledge, the peak of Actinote diversity is in southeastern Brazil, which harbors 21 species, with up to 13 species occurring at a single site (Francini 1989). Adults of Actinote often appear exceedingly similar, and females of some species are morphologically practically indistinguishable (Fran-
cini 1989, Francini and Penz 2006, Paluch 2006). Moreover, most high elevation species have restricted flight seasons and periods and are extremely localized, making them difficult to collect and resulting in poor representation in most collections (Francini 1989, Penz and Francini 1996, Francini et al. 2004, Francini et al. 2005). As a result of these phenotypic and biological traits, many new species have recently been discovered and/or described from southeastern Brazil (Penz and Francini 1996, Francini et al. 2004, Freitas unpublished data) and to a lesser extent Peru (Lamas 2003), Venezuela (Neild 2008) and Bolivia (Paluch et al. 2006).

As a result of intensive collecting efforts in the eastern Andes of Ecuador by KRW and JPWH, as part of a long-term inventory of the butterflies of that country (see www.butterfliesofecuador.com), five male specimens of an undetermined Actinote taxon have been discovered. A recently collected specimen was sent to AVLF and KLSB for molecular analysis and inclusion in a molecular phylogeny of the genus (Silva-Brandão et al. 2008b). In this analysis the Ecuadorian Actinote proved to be most closely related to Actinote genitrix d’Almeida, 1922, a species then known only from southeastern Brazil (but see Discussion below). Wing pattern and morphological characters confirmed the relationship inferred from molecular data. In this paper, we describe this new taxon and discuss its systematic position within the genus Actinote.

METHODS

The following collections were examined by MP as part of a taxonomic revision of Actinote: Instituto Oswaldo Cruz, Rio de Janeiro, Brazil; Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil; Departamento de Zoologia, Setor de Ciências Biológicas, Universidade Federal do Paraná, Curitiba, Brazil; Museu de Zoologia da Unicamp, Campinas, Brazil; and Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru. Extant type specimens or their photographs were examined by MP for all names in Actinote (sensu Lamas (2004) and Paluch (2006)), as listed by Lamas (1996, 2004). The following additional acronyms are used in the text: FLMNH – McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA; KWJH – Keith R. Willmott and Jason P. W. Hall collection, Gainesville, Florida, USA; and MECN – Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador.

Genital dissections followed standard techniques, and morphological terms for genitalia follow Klots (1956) and Eliot (1973). Terminology for wing venation follows Comstock and Needham (1918), with cells named for the veins bounding the cell. Light microscopy examination was done using a Leica MZ 12.5 at up to 100× magnification.

Molecular analyses used the Actinote data set and methodology for extraction, amplification, sequencing and alignment of DNA employed by Silva-Brandão et al. (2008b) to propose a phylogenetic hypothesis for the tribe Acraeini. A 648 bp fragment of COI, the “barcode” region, was sequenced using the methods of Silva-Brandão et al. (2008a) and used here for phylogenetic distance estimation. Neighbor-Joining (NJ) analysis (Saitou and Nei 1987) was applied to obtain graphically the phenetic distance within and between species of Actinote. MEGA 3.1 (Kumar et al. 2004) was applied for distance matrix computation using the K2P method and for the reconstruction of NJ trees. The robustness of each branch of the NJ trees was determined using the non-parametric
bootstrap test (Felsenstein 1985) with 1000 replicates.

Actinote kennethi Freitas, Willmott and Hall, new species
(Figs. 1, 2, 4)

Diagnosis. — Actinote kennethi is superficially very similar to a number of other Actinote species, especially from southeastern Brazil. However, it shares a number of morphological synapomorphies with the Brazilian Actinote g. genitrix and the Venezuelan A. genitrix costae Neild, 2008 and A. romeroi Neild and Costa, 2008, that assist in its identification. These include the shape of the valva, which is narrow, elongate, tapering, and straight in dorsal view (a unique synapomorphy), the near absence of scales in and around the discal cell of the ventral hind wing in males (a unique synapomorphy), and the presence of needle-shaped scales in the black intervenal stripes of the ventral forewing apex (a local synapomorphy, also present in A. canutia (Hopffer, 1874), A. mamita (Burmeister, 1861) and A. surima (Schaus, 1902)). The last two characters enable the species to be distinguished without dissection from other north and central Andean Actinote, including the recently described Bolivian species A. mirnae and A. mielkei (Paluch et al. 2006). Actinote g. genitrix, A. g. costae and A. kennethi appear to form a further clade, differing from A. romeroi in having a narrower subapical FW band that does not continue to the tornus and reduced or absent yellow-orange markings in the basal half of the FW.
Actinote kennethi differs from A. g. genitrix by having a slightly pinkish instead of pale yellow tinge to the forewing subapical band (in fresh specimens), a smaller intradiscal spot on the forewing, slightly more extensive orange markings on the hind wing, and much reduced black intervenal markings on the ventral hind wing. Actinote genitrix costae differs from A. kennethi by having more extensive, paler yellowish forewing subapical markings, a narrower, crescent-shaped, yellowish intradiscal spot on the forewing, and a broader black margin, paler orange markings, and more extensive black intervenal stripes on the dorsal hind wing.

Description.—Male. Forewing length of holotype 32.7 mm. Wing shape and venation: Forewing elongate, rounded at apex, distal margin angled at end of vein M₂ then approximately straight to end of vein 2A; hind wing apex and tornus smoothly rounded, distal margin slightly bulging between end of veins M₃ and M₂; hind wing veins M₁ and Rs originating independently from discal cell, discocellular vein 1d present. Dorsal surface: Ground color of both wings blackish brown, both wings faintly translucent throughout, with forewing becoming more translucent in basal half of cells 2A-Cu₂, Cu₂-Cu₁ and discal cell; roughly quadrate, pale salmon-pinkish
Fig. 3. Neighbor-joining tree constructed with K2P distances of mtDNA COI for *Actinote* species and subspecies. The values on the branches indicate bootstrap values.
marking inside forewing discal cell near distal end; indistinct, sparse, orange scaling may be present near base of forewing cell 2A-Cu₂ and along posterior basal half of discal cell; subapical band of pale, salmon-pinkish markings in forewing cells Cu₁-M₃ to M₁-R₅ comprising an isolated, small, oval spot in cell Cu₁-M₃, an almost isolated, elongate, rounded dash in cell M₃-M₂, and two contiguous oblong markings in cells M₂-M₁ and M₁-R₅; one specimen has a tiny marginal spot of similar color in cell Cu₂-Cu₁, and a sparsely scaled marginal spot of similar color in cell 2A-Cu₂. Hind wing with pale black ground color confined to an irregular marginal band 1–3 mm wide, which has prominent interdiscal stripes extending basally up to 3 mm; remainder of hind wing dull brownish orange, becoming slightly paler in anal margin, except for veins outlined
in black; very faint trace of black discal band apparent in two specimens; brownish-orange scales in discal cell oval and distally rounded (see Fig. 1C). Ventral surface: Both wings largely devoid of scales, producing a diaphanous appearance, with same markings visible as on dorsal surface, except as follows: forewing with sparse yellow-orange scaling distal of subapical band, interrupted throughout by intervenal stripes composed of needle-shaped black scales (see Fig. 1D); hind wing with sparse yellow-orange scaling around margin, becoming more scattered towards discal cell, and almost entirely absent in discal cell; intervenal black stripes in all hind wing cells, extending basally from distal margin almost to discal cell, composed of scales similar in shape to yellow-orange scales; short, black setae lining center of hind wing cell 2A-Cu2.

Head: Head black; dorsal half of frons white; labial palpi with sparse lateral scattering of white scales near base; antennae black.

Body: Thorax black, except for two lateral yellow spots near dorsal edge of metathoracic and mesothoracic meron, patagia laterally yellow; legs black; abdomen black, except pleural membrane between tergites and sternites, ventral edge tergites, dorsal edge sternites, and a ventral line, orange-yellow.

Genitalia (Fig. 2): Uncus almost straight, small clump of hairs at base; gnathos absent, tegumen narrow, not much broader than vinculum; saccus deep, of similar length to uncus+tegumen; valva elongate, curving dorsally in lateral view, straight in dorsal view, posterior tip with a slightly hooked, rounded point, broadening to approximately twice width at point of articulation with vinculum, sparsely hairy on inner surface and posterior tip; juxta elongate pentagonal, tapering ventrally; aedeagus approximately straight, tapering gradually posteriorly to end in blunt point slightly beyond aperture, posterior quarter flared in dorsal view, anterior portion slightly broadening in dorsal view, no cornuti evident; eighth sternite almost triangular, narrowing posteriorly.

Female. Unknown.

Type material.—Holotype: ♂, ECUADOR: Morona-Santiago, Rio Abanico, km. 20 Macas-Nuevo de Octubre rd., 1600 m, 2°8.0'S, 78°12.0'W, 1 Nov 1996 (K. R. Willmott) (FLMNH).

Paratypes: ECUADOR: Morona-Santiago, 1 ♀; same data as holotype (KWJH) (genitalic vial KW-07-01); 2 ♂: same locality data as holotype, 26 Oct 2007 (K. R. Willmott) (MECN, FLMNH). Napo, 1 ♂: km. 49 Tena-Loreto rd., 1300 m, 0°43.40'S, 77°43.50'W, 18 Mar 2004 (J. P. W. Hall) (KWJH) (molecular voucher KW-070605-01).

Etymology.—This species is named for KRW's father-in-law, James Kenneth Robinson, a good friend who has instilled his passion for nature and wild places in his daughter and grandson.

Distribution, habitat and ecology.—This species is known to date only from eastern Ecuador, where it occurs in Napo, Morona-Santiago and very probably Zamora-Chinchipe provinces (Fig. 4). Individuals apparently identical to this species were observed by KRW on a ridgetop above Zamora, exhibiting perching behaviour similar to that of males at other sites (see below), and almost certainly represent this species. The widespread distribution of A. kennethi within Ecuador suggests that it should almost certainly occur in northern Peru in addition to southeastern Colombia. The species has been recorded in a narrow elevational band between 1300 and 1600 m in montane forest, and all known observations have been of males on steep, forested ridgetops. Males were observed perching on the tips of prominent leaves 7–10 m above the ground in light gaps and along wide trails in the
late morning and early afternoon. They spent much time flying around a particular opening, with a slow, even flight, with few wing beats. The absence of specimens in all collections examined, including the Natural History Museum, London (Huertas personal communication), the Museo Ecuatoriano de Ciencias Naturales, Quito, and the collection of Padre Francisco Piñas, Quito (Piñas 2004), is presumably due to the species’ limited and poorly collected elevational range in addition to its high flight.

Discussion.—Actinote kennethi apparently forms a clade with A. g. genitrix and the recently discovered A. genitrix costae from the Sierra de Lema, 1400 m, in the Guiana shield highlands of southeastern Venezuela. This relationship is supported by several morphological characters mentioned in the diagnosis. Furthermore, cladistic analyses of DNA sequence characters (COI, EFlα and wingless) place A. kennethi as sister to A. g. genitrix (Silva-Brandão et al. 2008b; where A. kennethi is referred to as “Actinote sp2”), as does a neighbor joining analysis of the “barcode” region (Fig. 3).

Given the allopatry of these three taxa, and their morphological similarity, the taxonomic rank assigned to them is somewhat arbitrary. Although Neild (2008) described the Venezuelan taxon as a subspecies of A. genitrix, there is little evidence to suggest that it is more closely related to A. g. genitrix than to the new taxon described here. The only morphological characters distinguishing A. kennethi from Brazilian A. genitrix are in the wing pattern, and we therefore also considered treating kennethi as a subspecies. However, we ultimately decided to treat A. kennethi as a distinct species based on its known geographic range being so far removed from that of A. g. genitrix in southeastern Brazil (Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul states) (over 3600 km away) and A. genitrix costae in southeastern Venezuela (Bolívar state) (over 1900 km away) (see
Fig. 4). Given the rarity of the new taxa, it is likely that further collecting will expand their known ranges and reduce their relative isolation, but based on the distribution of montane habitats where they occur, the three taxa are still likely to be isolated by at least 1000 km. Such large range disjunctions suggest that the *Actinote* taxa in question have been isolated for relatively long periods of time. This suggestion is consistent with a mtDNA (COI “barcode” region) cluster analysis showing *A. kennethi* to be 1.6% divergent from Brazilian *A. genitrrix*. This level of divergence is comparable with that of other *Actinote* sister species and is just beyond the upper limit of observed intraspecific differences (Fig. 5).

Information about the still unknown immature stages could help clarify the status of *A. kennethi*, as immature stages have been shown to exhibit important morphological differences in other examples of closely related *Actinote* species (Francini 1989, Francini et al. 2004). Clearly, the recent discoveries of two new taxa related to *A. genitrrix* far removed from the range of that taxon suggest that further new taxa in this group may yet be found.

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