

CATOCYCLOTIS AEMULIUS ADELINA (RIODINIDAE) REVISITED: IT AIN'T NECESSARILY SO

Additional key words: genitalia, allometric changes, Neotropics, Brazil, Costa Rica.

Given their popularity with collectors and entomologists, butterflies are considered one of the taxonomically best-known groups of all insects. Nevertheless, revisiting apparently well known taxa with a modern eye may yield surprises. Consider the case here. The metalmark butterfly currently known as *Catocyclotis aemulius adelina* (Butler, 1872) was originally described in the genus *Lemonias* Hubner, 1907, and considered by Butler (1872) and Godman & Salvin (1879) to be a Central American species closely allied to South American *L. aemulius* (Fabricius, 1793). Subsequently in the influential *Genera Insectorum*, Stichel (1911) downgraded *adelina* to a subspecies and placed both taxa together under his genus *Catocyclotis* Stichel, 1911, and maintained this arrangement in the *Lepidopterorum Catalogus* (Stichel 1930-1931). Thus, for over 90 years *adelina* has been regarded as a subspecies of the uncommon, yet broadly distributed species *aemulius*. Nevertheless, to paraphrase the famous song from George Gershwin's folk opera *Porgy & Bess*, "... the things that you're liable, to read in the Bible, it ain't necessarily so".

During a routine comparative study of male and female genitalia we found conspicuous differences between *C. aemulius adelina* and *C. aemulius aemulius* that correspond with noticeable differences in wing color pattern. These observations suggested that these taxa represent two distinct species, as originally proposed by Butler. The purpose of this study is to reassess the status of taxa currently placed in the genus *Catocyclotis*, provide a diagnosis and illustrations of male and female genitalia of *aemulius* and *adelina*, and point to directions for future research.

Catocyclotis aemulius (Fabricius, 1793)

(Figs. 1-3)

Type species of the genus *Catocyclotis* by original designation (Stichel 1911).

Description: **Male** (Fig. 1) - Dorsal side, FW brown with a single-peaked, pale yellow mark distally on anal edge; brown areas of both FW and HW conspicuously marbled by thin light lines; HW extensively pale yellow (but less so than *adelina*), matching dorsal coloration of abdomen, and bearing marginal spots in cells Rs, M1, M2, Cu1 and Cu2 (not always a full complement of spots is present); abdominal tergites 1-2 brown, 3-8 yellow. Ventral side, HW white

and bearing marginal spots as on dorsal side. **Female** (Fig. 1) - wing pattern and color as in male; female abdomen dorsally brown with scattered pale scales that vary in density.

Genitalia: **Male** (Fig. 2) - seventh sternite with thin, elongated rami; aedeagus long with 11 spine-shaped cornuti; uncus with elongated marginal spines (longer than *adelina*); gnathos tip spatulate in ventral view; valva with two defined processes, dorsal process smoothly arched before tip in ventral view (humped in *adelina*), ventral process slightly projected, edge of ventral process with abundant, thickened setae (less abundant and thinner in *adelina*); sclerotized transtilla broader than in *adelina*; saccus tip narrow in ventral view (narrower than *adelina*). **Female** (Fig. 3) - ostium bursa with a sclerotized point that reaches the edge of abdominal segment 8; antrum (defined here as the portion of the ductus bursa posterior to the ductus seminalis) elongated, sclerotized ventrally, wrinkled near ostium bursa, and with an anterior enlargement bearing internal clusters of spines; corpus bursa rounded (even in mated females) with symmetrically positioned signa.

Distribution: Brazil, Ecuador?

Material examined: Milwaukee Public Museum (MPM) - BRAZIL: 1 male, [Santa Catarina] Joinville, 8 June 1955; 1 male, [Santa Catarina] 13 May 1933; 1 male, Rio de Janeiro, Gávea, 21 May 1956; 2 males, Rio [de Janeiro] 20 May 1934; 2 males, 1 dissected, Rio [de Janeiro] 15 May 1941; 1 male, Rio [de Janeiro] 15 May 1941; 1 male, Rio [de Janeiro] 17 June 1931; 1 male, Estado do Rio [de Janeiro], Guapy 29 May 1940; 1 male, [Rio de Janeiro] Colony Guapy 13 May 1964; 1 male, dissected, [Rio de Janeiro] Petrópolis 4 February 1962; 1 male, dissected, Barreira 18 October 1955; 1 male, no data, acquired from P. Gagarin; 1 female, Estado do Rio [de Janeiro] Guapy 13 May 1940; 1 female, Estado do Rio [de Janeiro] Guapy 13 May 1940; 2 females, 1 dissected, [Rio de Janeiro] Mundo Novo 15 May 1940; 1 female, Rio [de Janeiro] Paineira[s] 22 May 1932; 1 female, [Rio de Janeiro] Petrópolis 14 August 1963; 1 female, [Rio de Janeiro] Petrópolis 23 October 1965; 1 female, [Rio de Janeiro] Petrópolis 14 November 1963; 1 female, Rio [de Janeiro] 15 May 1941; 1 female Gávea, Rio [de Janeiro] 15 July 1935. American Museum of Natural History (AMNH) - BRAZIL: 1 male, Rio de Janeiro 4 February [19]66; 1 male, Brazil, Rio [de Janeiro] 18 August [19]11; NO DATA: 1 female.

Biology: Early stage biology unknown. This species is sexually monomorphic, and it inhabits forest areas between sea level (Xerém and Rio de Janeiro, both in Rio de Janeiro state, K. Brown pers. com.) and 900 m (label data above).

Remarks: Stichel (1911) and Seitz (1916) stated that *aemulius* occurred in 'south Brazil' (i.e., Rio de

Janeiro and surrounding areas) while *adelina* was distributed from Costa Rica to Ecuador. Although we did not examine material from Ecuador, the male specimen from Napo illustrated in D'Abrera (1994; note missing abdomen) shows a single-peaked yellow mark distally on the FW anal edge, brown areas of both FW and HW conspicuously marbled by thin light lines, and HW marginal dots - all traits of *aemulius*. Nonetheless, in the D'Abrera (1994) illustration the HW color is orange as in *adelina*. This raises the questions of whether this represents true geographical variation, if the color is a printing artifact, or if the specimen belongs to a different species. Although some of our Brazilian material is old and potentially faded, the AMNH collection includes a male specimen collected by K. S. Brown in Rio de Janeiro in 1966 that is virtually identical in color to a male collected in the same locality in 1911. Therefore, based on D'Abrera (1994) we tentatively expand the previous notion of *aemulius* distribution to include Ecuador, but caution that the constancy of HW color should be verified with more Ecuadorian material.

Catocyclotis adelina (Butler, 1872), revised status

(Figs. 1-3)

Description: Male (Fig. 1; color illustration in DeVries 1987, pl. 18) - Dorsal side, FW brown with a double-peaked dark orange mark distally on anal edge; brown areas of FW and HW faintly marbled by thin light lines (conspicuously marbled in *aemulius*), HW not marbled in some specimens; HW extensively orange (more so than *aemulius*), matching dorsal coloration of abdomen, and lacking marginal spots; abdominal tergite 1 brown, 2-8 orange. Ventral side, HW white and normally lacking marginal spots, but in one specimen from Colombia small spots were present in cells M2, Cu1 and Cu2. **Female** (Fig. 1) - wing pattern similar to male, but HW orange color replaced by pale yellow (see DeVries 1987, pl. 18) or nearly white in worn individuals; female abdomen dorsally brown with scattered pale yellow scales that vary in density.

Genitalia: Male (Fig. 2) - seventh sternite with short, broad rami; aedeagus short and lacking cornuti; uncus with elongated marginal spines (shorter than *aemulius*); gnathos tip narrow in ventral view; valva with two defined processes, dorsal process humped before tip in ventral view (smoothly arched in *aemulius*), edge of ventral process with thin setae (abundant, thickened in *aemulius*); sclerotized transtilla narrower than in *aemulius*; saccus tip in ventral view broader than *adelina*. **Female** (Fig. 3) - ostium bursa with a sclerotized point that does not reach the edge of abdominal segment 8; antrum (defined here as the portion of the ductus bursa posterior to the ductus seminalis) short, sclerotized ventrally, and broadened near ostium bursa; corpus bursa elongated with asymmetrically positioned signa.

Distribution: Costa Rica, Panama, Colombia.

Material examined: DeVries Collection - COSTA RICA: 1 male, dissected, Puntarenas, Las Alturas 24 May 1991; 1 male, Puntarenas, Las Alturas 25 May 1991; 2 males, Puntarenas, Las Alturas 25 August 1991; 1 male, Moravia de Chirripo 16 April [19]83; 1 female, dissected, [Puntarenas, Las Alturas] site 10C 22 December [19]84. American Museum of Natural History (New York) - COSTA RICA: 1 male, Cairo 27 August [19]31; COLOMBIA: 1 male, S.A., Felipe Ovalle, Q, no date; 1 male, dissected, Amazonas, Rio Cocorna 27 August 1946.

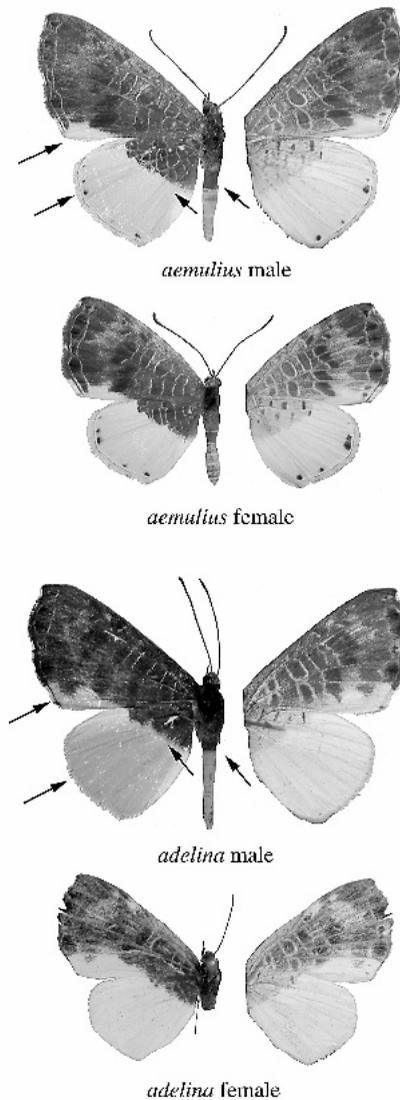


FIG. 1. Male and female habitus of *Catocyclotis aemulius* and *adelina*, dorsal view on the left, ventral on the right. Arrows point to diagnostic characters mentioned in the text. Locality data from top to bottom: *aemulius* male, Brazil (acquired from P. Gagarin); *aemulius* female, Brazil, Rio de Janeiro, Guapy; *adelina* male, Costa Rica, Cairo; *adelina* female, Costa Rica, Puntarenas, Las Alturas.

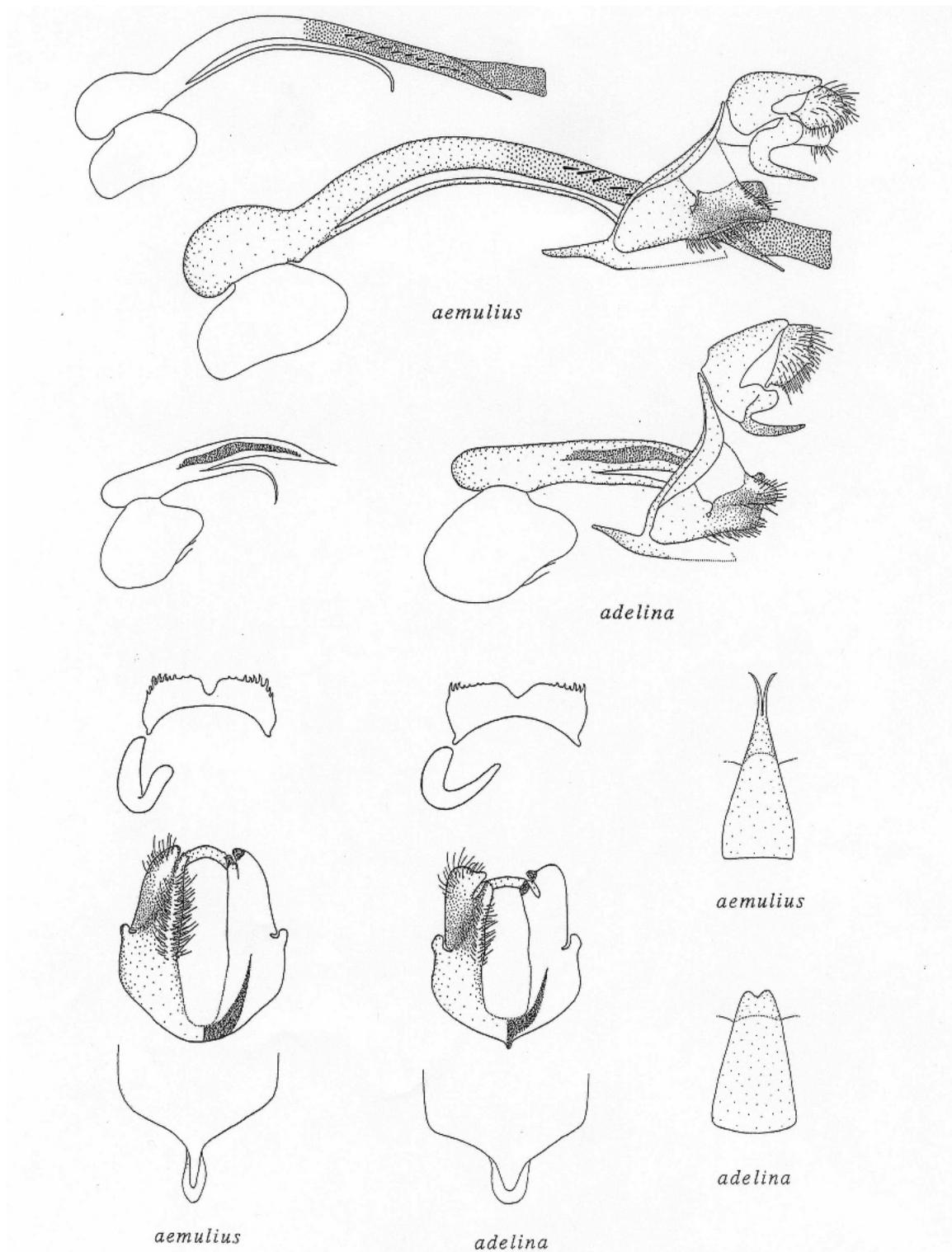


FIG. 2. Male genitalia of *Catocyclotis aemulius* and *adelina*: in lateral view, genitalic capsule and detail of aedeagus; in ventral view, details of the uncus, gnathos, valvae, saccus, and seventh sternite. Valva on the left shows shape and distribution of setae, dense stippling was applied to valva on the right to show areas that are more heavily sclerotized. Locality data: *C. aemulius*, Brazil, Barreira; *C. adelina*, Costa Rica, Puntarenas, Las Alturas.

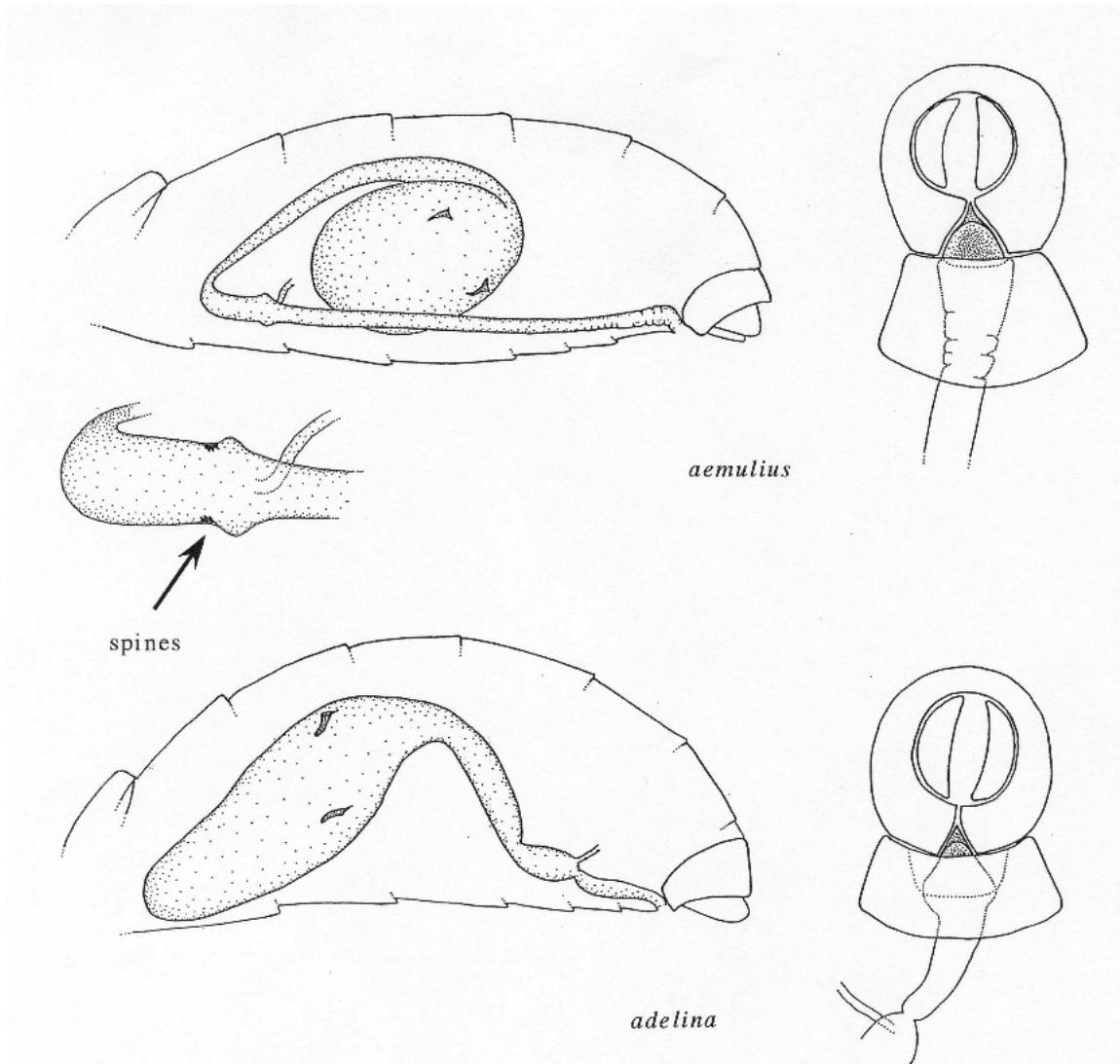


FIG. 3. Female genitalia of *Catocyclotis aemulius* and *adelina*: in lateral view, positioning of antrum+ductus bursa, ductus seminalis, and corpus bursa inside female abdomen, a detail of the ductus bursa of *C. aemulius* shows internal spines, setae show extent of sclerotization, abdomens were dissected open and their outline does not represent actual abdominal width; in ventral view, ostium bursa and seventh sternite, papillae anales are represented schematically. Locality data: *C. aemulius*, Brazil, Rio de Janeiro, Mundo Novo; *C. adelina*, Costa Rica, Puntarenas, Las Alturas.

Biology: This species is reported to occur in forest areas between 800 and 1600 m (DeVries 1987). The sexes are dimorphic. The caterpillar of *C. adelina* and its natural history bear a strong similarity to *Nymphidium* (e.g., *cachrus*, *hematostictum*), and will be described in detail elsewhere (K. Nishida in prep.). The observation that *adelina* produces a clicking sound while in flight (D'Abbrera 1994) is of particular interest, and should be verified.

Remarks: The Costa Rican specimen studied by Penz & DeVries (1999) corresponds to *adelina*.

Discussion. Although they have similar wing patterns, differences in wing markings were useful for

separating *aemulius* and *adelina*. The shape of the FW anal marking (single- or double-peaked), together with the extent of yellow or orange in the HW plus abdomen, and presence/absence of HW marginal spots, allow species determinations without dissection. These external color pattern characters can be easily used to sort specimens in collections.

The two *Catocyclotis* species studied here showed dramatic differences in male and female genitalia (Fig. 2 and 3). For example, the aedeagus of *aemulius* is much longer than that of *adelina* (Fig. 2), and corresponds to the longer female antrum+ductus bursa in *aemulius* (Fig. 3) - such correspondence has been ob-

served among many other butterfly species (CMP unpublished). Although *aemulius* and *adelina* are closely related, most parts of their genitalia differ, particularly with respect to allometric proportions. These observations suggest to us that when Stichel (1911) considered *adelina* a subspecies of *aemulius*, he did so without comparing their genitalia.

Two lines of inquiry suggest that *Catocyclotis* may include more than two species. Originally Stichel (1911) placed *elpinice* Godman, 1903 in *Catocyclotis*, but subsequently transferred it to his sentiformes section of what is now considered *Adelotypa* (Stichel 1930-31). Of interest is that the specimen of *Adelotypa elpinice* illustrated by D'Abrera (1994) bears strong phenotypic similarities to *C. aemulius* and *adelina*. While not conclusive, such observations indicate that *elpinice* may, upon closer study, be transferred back to Stichel's (1911) home for it in *Catocyclotis*. Secondly, Hall & Harvey (2002) suggested that *Catocyclotis* may include species currently classified in *Mycastor* Callaghan, 1983, but they did not allude to characters or taxa in support of their idea. Based on a cursory comparison of *C. aemulius* and *adelina* with descriptions and illustrations of male genitalia of *Mycastor* by Callaghan (1983) we offer the following observations: (a) *Catocyclotis* and *Mycastor* have a sclerotized transtilla between the valvae - a trait also present in *Nymphidium* (Penz & DeVries 1999 and in prep.); (b) *M. leucarpis* and *Catocyclotis* share a spiny uncus; (c) *M. leucarpis* and *scurrilis* seem to have a valva similar to that of *Catocyclotis*; (d) *M. scurrilis* has a saccus similar to *Catocyclotis*, and the seventh sternite resembles that of *adelina*. These characters lend support to the idea that *Mycastor* includes taxa better placed in *Catocyclotis*. However, it is evident that the total number of species embraced by *Catocyclotis* can only be verified through a comprehensive phylogenetic analysis that includes many Nymphidiini genera and species.

We thank Eric Quinter (American Museum of Natural History) for the loan of specimens under his care, K. Rozema for ideas on riordinid systematics, and anonymous reviewer for suggestions that improved the manuscript. Special thanks to Kenji Nishida for sharing his unpublished information on the biology of *C. adelina*. This study was supported in part by NSF-DEB 03-16505. This paper is dedicated to Adelina "Moreninha" Penz, George Gershwint, and Sportin' Life.

LITERATURE CITED

- BRIDGES, C.A. 1994. Catalogue of the family-group genus-group and species-group names of the Riodinidae & Lycaenidae (Lepidoptera) of the world. Published by the author.
- BUTLER, A.G. 1872. Descriptions of new butterflies from Costa Rica. *Cistula Entomologica* 1:72-90.
- CALLAGHAN, C.J. 1983. A new genus of riordinid butterflies. *Bull. Allyn Mus.* 78:1-7.
- D'ABRERA, B. 1994. Butterflies of the Neotropical region. Part VI, Riodinidae. Hill House, Australia.
- DEVRIES, P. J. 1997. Butterflies of Costa Rica and their natural history. Vol II, Riodinidae. Princeton Univ. Press, Princeton, NJ.
- GODMAN, F.D. & O. SALVIN. 1879-1901. *Insecta, Lepidoptera, Rhopalocera* (Biologia Centrali Americana). Vols. 1-3. London.
- HALL, J.P.W. & D.J. HARVEY. 2002. Basal subtribes of the Nymphidiini (Lepidoptera: Riodinidae): phylogeny and myrmecophily. *Cladistics* 18:539-569.
- HEMMING, F. 1967. The generic names of the butterflies and their type species (Lepidoptera: Rhopalocera). *Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl.* 9: 1-509.
- PENZ C.M. & P.J. DEVRIES. 1999. Higher level phylogeny of the tribe Lemoniini (Lepidoptera, Riodinidae): a preliminary assessment using adult morphology. *Am. Mus. Novitates*, 3284:1-32.
- SEITZ, A. E. 1916-20. Erycinidae. pp. 617-738. *Macrolepidoptera of the World*. vol. 5. Alfred Kernan, Stuttgart.
- STICHEL, H. 1911. Riodinidae. *Genera Insectorum* P. Whytman.
- STICHEL, H. 1930-1931, *Lepidopterorum Catalogus*. Pars 40, 41, 44. W. Junk, Berlin.

CARLA M. PENZ AND PHIL DEVRIES, *Department of Invertebrate Zoology and Center for Biodiversity Studies, Milwaukee Public Museum, 800 West Wells Street, Milwaukee, Wisconsin 53233, USA*. Current address: *Department of Biological Sciences, University of New Orleans, 2000 Lakeshore Drive, New Orleans, Louisiana 70148, USA*