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A CONTRIBUTION TO RIODINID SYSTEMATICS

(LEPIDOPTERA: RIODINIDAE)

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A REVIEW OF THE GENUS *SAROTA* (LEPIDOPTERA: RIODINIDAE)

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ABSTRACT.– A review of the genus *Sarota* Westwood, 1851, is presented which includes a brief overview of the biology, biogeography and taxonomic history of its component species, a key to the identification of adults, illustrations of all known species and subspecies (including many type specimens) with accompanying taxonomic notes and the descriptions of five new species and two new subspecies: *Sarota chloropunctata* **n. sp.**, *Sarota chocoensis* **n. sp.**, *Sarota completa* **n. sp.**, *Sarota harveyi* **n. sp.**, *Sarota willmotti* **n. sp.**, *Sarota estrada sabanilla* **n. ssp.**, and *Sarota gamelia alba* **n. ssp.**. Twenty species are recognised. Neotypes are designated for *Sarota acantus* (Stoll, 1782) and *Sarota gyas* (Cramer, 1775). The tribe Sarotini (= Charitini Auctt.) is synonymised with the tribe Helicopini (**n. syn.**), and a cladogram based on a small character matrix is used to illustrate generic relationships within the more inclusive, newly conceived tribe.

KEY WORDS: Amazon, *Anteros*, Araceae, Argentina, behavior, biogeography, Bolivia, Brazil, *Callistium*, Central America, *Charis*, Charitini, *Charmona*, Chocó, cladistics, Colombia, *Comphotis*, Costa Rica, Ecuador, *Emesis*, Fabaceae, French Guiana, Guatemala, Guyana, Helicopini, *Helicopis*, Honduras, hostplants, *Hypochrysops*, Lejuniaceae, Lycaenidae, Mexico, Neotropical, *Nymphidium*, *Ourocnemis*, Panama, Peru, *Phaenochitonia*, pheromones, ***Sarota chloropunctata*** n. sp., ***Sarota chocoensis*** n. sp., ***Sarota completa*** n. sp., ***Sarota harveyi*** n. sp., ***Sarota willmotti*** n. sp., ***Sarota estrada sabanilla*** n. ssp., ***Sarota gamelia alba*** n. ssp., Sarotini, South America, Sterculiaceae, Surinam, taxonomy, *Theope*, Tiliaceae, Trinidad, Venezuela.

The bejewelled ventral wing patterns of *Sarota* species are spectacularly distinctive and rather reminiscent of those of the Oriental lycaenid genus *Hypochrysops* C. & R. Felder, 1860. The genus *Sarota* contains a well defined, relatively homogeneous, monophyletic group of species whose close phylogenetic relationship to the genera *Anteros* Hübner, [1819], and *Ourocnemis* Bethune-Baker, 1887, is well known (Stichel, 1911, 1930; Harvey, 1987). However, while the systematic position of the genus is reasonably well established, its alpha level taxonomy has remained poorly understood, no doubt because of the great phenotypic similarities between its species and their diminutive size, and previous authors have grossly underestimated its species diversity. Seitz (1916-18) figured a mere 6 species and both Stichel (1930) and Bridges (1994) list only 10 species, no significant additions being made to our taxonomic knowledge of the genus during that intervening period. D'Abrera (1994) also misleadingly illustrates only a fraction of the diversity in *Sarota* with 6 species. For these reasons, coupled with the perpetual misidentification of species in published photographs and popular literature (see appendix) and the discovery of several new *Sarota* taxa in Ecuador during a comprehensive survey of the papilionoid fauna of that country, I decided to review the entire genus with a view to ending the aforementioned confusion and providing an illustrative benchmark against which potentially new taxa can be compared. To this end, the *Sarota* collections of the following institutions, whose acronyms are used throughout the text, were examined:

AME	Allyn Museum of Entomology, Florida Museum of Natural History, Sarasota, FL, USA
AMNH	American Museum of Natural History, New York, NY, USA
BMNH	Natural History Museum, London, England
FSCA	Florida State Collection of Arthropods, Division of Plant Industry, Gainesville, FL, USA
GWB	George W. Busby collection, Boston, MA, USA
JHKW	Jason P. W. Hall and Keith R. Willmott collection, Gainesville, FL, USA
MNHN	Musée Nationale d'Histore Naturelle, Paris, France
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA
PJD	Philip J. DeVries collection, Dept. of Biology, University of Oregon, Eugene, OR, USA
RCB	Robert C. Busby collection, Boston, MA, USA
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC, USA
ZMHU	Zoologische Museum, Humboldt Universität, Berlin, Germany

Characteristics of *Sarota*

All species in *Sarota* are essentially sexually monomorphic, typically small, often possess hindwing tails, and while usually having dull brown dorsal surfaces, have characteristic ventral surfaces. The ventral surface is predominantly shades of orange-brown with yellowish margins and all species have a double row of silver lines around the submargins of both wings, although the innermost forewing line is often broken into or inclusive of one or more proximally directed silver streaks; the basal portion of the wings consists of alternating transverse lines of small black spots and silver markings. Despite the remarkable resemblance of some *Sarota* species to certain *Anteros* species, most notably those of the "*carausius* Westwood, 1851, group" (see Hall and Willmott, 1998), the *Sarota* species can be distinguished by their less robust thoraces, typically more rounded or tailed hindwings and different genitalic structures. The male genitalia of *Sarota* are far more homogeneous than in *Anteros*, barely differing even between species groups; all species have a small serrate aedeagal cornutus that is not present in those *Anteros* species dissected and the valvae always consist of a long upper portion and typically a bluntly triangular lower portion, with a prominent basal lateral bulge, whereas in *Anteros* the lower portion is often as long as or longer than the upper portion. The upper valva arms in *Sarota* are also connected dorsally in a "V" shape by membraneous tissue toward the tips whereas in *Anteros* they are joined towards the base, often by sclerotised rods that almost enclose the aedeagus.

The slight interspecific differences in wing pattern between many sympatric species, combined with the often significant intraspecific geographic or altitudinal variation and the seemingly endless combinations of the same basic ventral markings involved, can make identifications difficult, but the genus is at least readily separated into three distinct and roughly evenly sized groups on the basis of wing shape (see Fig. 1), as partially proposed by Stichel (1930). Members of the "*chrysus* group" are considerably larger than most species of the other groups, they have distinctive hindwing tails with a pointed tornus and two long tail elements at veins M_3 and Cu_2 either side of a shorter central one and typically white or cream spots on the dorsal forewing; with few exceptions, these species are also the only ones to have orange-brown tipped antennal clubs. Species identification characters include forewing shape, the pattern of spots on the dorsal forewing, the tone of the ventral orange-brown coloration, and the ventral silver

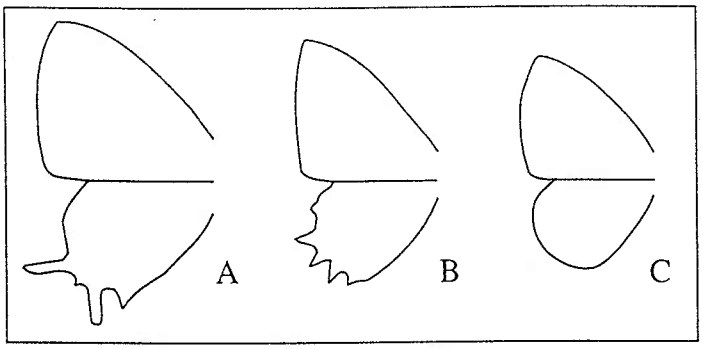

Fig. 1. Schematic drawings of *Sarota* wing shapes, highlighting hindwing differences between species groups: A) "*chrysus* group"; B) "*acanthoides* group"; C) "*gyas* group".

patterning. Members of the "*acanthoides* group" are smaller and have a pointed hindwing tornus with three smaller hindwing tail elements of roughly equal size at veins M_3 to Cu_2, often with tiny points at veins M_2 and M_1; those of the "*gyas* group" are variably sized but typically small and do not have a pointed hindwing tornus or any hindwing tails. Identification characters for both latter groups include the pattern of silver markings in the submarginal and apical areas of the ventral forewing, the extent of ventral brown background coloration, the tone of the ventral orange-brown coloration, size, leg color and in females of the "*gyas* group", the presence/absence and extent of red-brown at the distal margin of the dorsal hindwing. The monophyly of these groups, in particular the "*gyas* group", is uncertain but their recognition allows the genus to be broken up into manageable portions.

Biology

Sarota species occur almost exclusively in wet forest habitats, but at least one species, *S. craspediodonta* (Dyar), appears to be tolerant of more xeric conditions. Most are found only below 1000m but a few occur as high as 1700m and one species, *S. myrtea* Godman & Salvin, flies as high as 2400m. The "*gyas* group" probably contains the largest number of more commonly encountered species while all members of the "*acanthoides* group" are uncommon to rare and, overall, most *Sarota* species are poorly represented in collections and only a few are likely ever to be seen in the field by the casual observer or collector.

Males of most species, particularly those in the "*acanthoides*" and "*gyas*" groups, perch in small groups, typically on low vegetation 2-5m high, along forest edges, on certain isolated trees or most commonly on streamside vegetation or in large clearings nearby. They are predominantly active on their perches in the early morning from about 0630h in some cases to about 1000h and are then only more sporadically encountered as solitary individuals in a wide range of forest microhabitats throughout the remainder of the day, but especially in the late afternoon. They frequently fly out to investigate passing objects with a fast, erractic flight and often engage in aerial spiralling with other male *Sarota*, factors that, combined with their small size, can make them difficult to see. They rest both beneath and on top of leaves with their wings shut but, like their close relatives, typically keep their hindwings slightly apart; they are sometimes observed to rub their hindwings together in a manner reminiscent of lycaenids (Robbins, 1986; pers. observ.). Occasionally, diverse perching communities are found with as many as five or more species co-occuring in the same small vicinity. While each species may be partitioned to some extent in space and time, to aid their reproductive isolation (Callaghan, 1983), this is not in my experience as rigid as is often reported in *Sarota* or riodinids in general (Callaghan, 1983; Brévignon and Gallard, 1995; DeVries, 1997). While the division of perching behavior into species specific windows of time and space is clearly a characteristic phenomenon in riodinid butterflies, it is one that has large numbers of exceptions. Thus, several *Sarota* species may be found perching at the same time (although their mean activity time may be different) and on the same clump of leaves indicating the possibility that pheromonal chemistry plays a more important role in the reproductive isolation of riodinids than has previously been suggested.

Solitary females are encountered in the vicinity of male perching areas or flying low to the ground along forest edges in the understory and in lightgaps throughout most of the day. The females of two species, *S. acantus* (Stoll) (as *gyas*) and *S. chrysus* (Stoll), have been observed to oviposit on the leafy liverworts and mosses (Lejuniaceae) that grow as epiphylls on top of the old leaves of a variety of understory shrubs and these are thought to be the dominant foodplants for the genus (DeVries, 1988, 1997; DeVries *et al.*, 1994). The larvae of the only reared species, *S. acantus* (Fig. 2), are very similar to those of related genera (see DeVries, 1997; Brévignon and Gallard, 1998) in having very long dorsolateral tufts of downy white setae that may be moved in defense against ants and a cluster of bladder or balloon-like setae on the anterior edge of the prothoracic shield. Inside a rolled leaf, the long larval setae are used to surround the pupa to form a loose cocoon (DeVries, 1997).

Fig. 2. Fifth instar larva of *Sarota acantus* (photo by P. J. DeVries).