

# A NEW SPECIES OF *ENTHEUS* FROM ECUADOR

## (LEPIDOPTERA, HESPERIIDAE, EUDAMINAE)

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**Abstract** - A new species of *Entheus* is described from the Chocó region in northern Ecuador. *Entheus warreni* n. sp. belongs to the *E. matho* group and differs from other congeners by its distinctive wing pattern and subtle features in genitalia. Taxonomic problems with *Entheus* caused by the existence of cryptic species and extreme sexual dimorphism are discussed.

**Key words:** biodiversity, endemism, cryptic species, skipper butterfly, *Entheus matho*.

In his classic key, Evans (1952) characterized *Entheus* Hübner, [1819] by the combination of the following characters: the third segment of palpi is stout and spatulate, positioned close to the outer edge of the second segment; antennae bent at the beginning of nudum (segments with scaleless areas on antennal club), not distad of the beginning; vein M3 origin is in the middle between veins M2 and Cu1, not twice as far from vein Cu1 than from vein M2; and males lack costal fold. Since Evans (1952), *Entheus* has been divided into four species groups: *E. eumelus* (Cramer, 1777), *E. gentius* (Cramer, 1777), *E. priassus* (Linnaeus, 1758) and *E. matho* Godman & Salvin, 1879. *Entheus* taxa can be readily assigned to one of these groups by wing patterns in males. Females are typically more similar to each other across the groups (Evans 1952), suggesting close relationship among species and rapid evolution in males.

Males of the *E. eumelus* and *E. gentius* species groups are characterized by a broadly yellow, yellow-orange or orange hindwing (Evans 1952, Austin *et al.* 1997). Males of the *E. priassus* and *E. matho* groups possess a dark blackish-brown hindwing, in some taxa with the exception of the anal fold, which may be dorsally white or yellowish. Male genitalia are quite similar in the last three species groups, but differ in the *E. eumelus* group where they share a number of similarities with other Eudaminae taxa, for example the absence of a long process on the valval costa and more elongated valvae (Austin *et al.* 1997). In addition, *E. eumelus* group males possess white or opaque light-yellowish forewing macules, and sexual dimorphism is less expressed, at least in *Entheus eumelus* (Cramer, 1777). These two features are also shared with the skipper genera considered to be most closely related to *Entheus*, such as *Phareas* Westwood, 1852 and some species of *Hyalothyris* Mabille, 1878, suggesting that the *E. eumelus* group may be phylogenetically basal to the other species groups. Three species are currently included in this group (Mielke, 2005): *E. eumelus*, *E. ninyas* H. Druce, 1912, and *E. eumyas* Austin, O. Mielke & Steinhauser, 1997.

Males of the remaining three *Entheus* species groups have an intense yellow or orange discal forewing band and similarly colored, but frequently lighter and more opaque postdiscal bands and macules. The *E. gentius* species group is characterized by yellow or orange basal half of the forewing and almost all hindwing (except border). This group includes

four currently recognized species: *E. lemna* (A. Butler, 1870), *E. gentius*, *E. bombus* Austin, O. Mielke & Steinhauser, 1997, and *E. aureolus* Austin, O. Mielke & Steinhauser, 1997.

The *E. priassus* and *E. matho* groups are quite close in appearance, and this fact taken together with the similarities between the *E. eumelus* and *E. gentius* groups, evidence for a sister relationship between *E. priassus* and *E. matho* groups, further supported by the following suggested synapomorphies: dark brown hindwing (except anal fold in some species) and forewing bases in males, and yellow-orange or orange, but not white or yellow subapical forewing macules.

In *E. priassus* group males, the yellow-orange macule in cell M3-CuA1 is connected to the discal orange band, i.e. the base of cell M3-CuA1 is yellow-orange (there may be regions covered by dark brown scales close to the base near vein CuA1, and the macule is connected only along vein M3), and the hindwing anal fold is always brown (Evans 1952, Austin *et al.* 1997). Five species are recognized in this group: *E. telemus* Mabille, 1898, *E. latebrosus* Austin, 1997, *E. priassus*, *E. aureanota* Austin, O. Mielke & Steinhauser, 1997, and *E. curvus* Austin, 1997.

In the *E. matho* group, the very base of cell M3-CuA1 is dark blackish-brown, forming a noticeable distal notch near the middle of the orange discal band. Consequently the lighter macule in cell M3-CuA1 is well separated from the discal band, and the anal fold in many taxa is largely creamy-white or yellowish. Some taxa in the *E. matho* group have a brown anal fold, similar to the *E. priassus* group, and a wider M3-CuA1 macule. These taxa are perhaps likely to be basal in the *E. matho* group.

Available names for the taxa in the *E. matho* group were reviewed by Evans (1952), who notes just a single species -*E. matho*, divided into 4 subspecies: *E. m. matho* (syntypes examined), *E. m. latifascius* M. Hering, 1925 (including *quadratus* Bargmann, 1929 as its synonym), *E. m. aequatorius* Mabille & Boulet, 1919, and *E. m. dius* Mabille, 1898

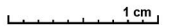
**Figures 1-13.** *Entheus warreni* n. sp. holotype ♂, in dorsal (1) and ventral view (2) with labels shown below the specimen. 3-13. Holotype genitalia in various views: 3-6. a series of dorso-lateral and lateral views, images represent rotations from close to dorsal to slightly dorso-ventral view; image 5 is the lateral view, and on 6 the tip of the left valva is folded under the uncus to reveal gnathos; 7. dorsal view; 8. left valva in dorsal view to highlighting the process of the costa; 9. ventral view; 10. caudal view, valvae opened; 11. ventro-lateral view to visualize penis; 12. Caudo-lateral view to display teeth on the caudal end of the valva; 13. Ventral view of the caudal end of penis magnified 2 times compared to other images to show cornuti.



Ecuador: Esmeraldas: Rio Churchuvi, km. 12.5 Lita-San Lorenzo Rd. 800-900m 0°53.01'N 78°30.90'W June 15 2002 I. Aldas leg.

Genitalia NVG-111029-10

HOLOTYPE ♂  
*Entheus warreni*  
Grishin



(holotype examined), discussed by Steinhauser (1989), who proposed an additional species, *Entheus crux* Steinhauser, 1989 (types examined), and listed by Mielke (2005). In addition, images of all *Entheus* taxa, including extant primary types and their illustrations from original descriptions, are shown online (Warren *et al.*, 2012). Since Steinhauser (1989), no original taxonomic work has been published on the group, but Janzen *et al.* (2011) reported and illustrated three likely undescribed species from Costa Rica that unambiguously belong to the *E. matho* group. These three species are very close to each other in facies and are similar in genitalia, but differ significantly in larval food plants, ecology, and the 654 nucleotide sequences of mitochondrial DNA region encoding the C-terminal segment of COI (DNA barcode) are also slightly divergent. Thus, they likely represent distinct biological species and exemplify cryptic species diversity in *Entheus* that has also been revealed through traditional taxonomic methods in other *Entheus* species groups (Austin *et al.* 1997, Austin 1997). The three cryptic *E. matho* group species offer valuable clues about phenotypic differences in *Entheus* that may be indicative of species-status, and provide definitive male-female associations in taxa displaying marked sexual dimorphism.

Trying to make sense of the bewildering cryptic species diversity, complex taxonomy and near impossibility of matching sexes of *Entheus* in the USNM collection, I stumbled upon a unique *E. matho* group specimen, which stood out by several prominent wing pattern characters, and was found to represent an undescribed species that is named herein. Most notably, males of no other *E. matho* group taxon (described and undescribed) possess an orange ray in the dorsal forewing costal cell, as evidenced either by the primary types or their sex association, and for the taxa with primary types presumed lost (*latifascius*, *quadratus*, and *aequatorius*) - by the original description and historic treatment of the name in literature and collections.

## MATERIALS AND METHODS

*Entheus* specimens were examined in the following collections: National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC; American Museum of Natural History (AMNH), New York, NY; McGuire Center for Lepidoptera Research (MGCL), Gainesville, FL; Carnegie Museum of Natural History (CMNH), Pittsburgh, PA; Academy of Natural Sciences Philadelphia Collection (ANSP), Philadelphia, PA; Texas A&M University Insect Collection (TAMU), College Station, TX; National History Museum, London (BMNH). Standard entomological techniques were used for dissection (Robbins 1991), i.e. the adult abdomen being soaked for 24 hours in 10% KOH at room temperature, dissected and subsequently stored in a small glycerol vial pinned under the specimen. Genitalia and wing venation terminology follow Klots (1970) and Austin *et al.* (1997), respectively. Length measurements are in metric units and were made from photographs of specimens magnified on a computer screen. Most photographs were taken using Nikon D200 camera, for specimens through a 105mm f/2.8G AF-S VR Micro-Nikkor lens; for genitalia through a "light-through" microscope.

## *Entheus warreni* Grishin, new species

(Figs. 1-13)

**Description.**— Male (Figs. 1, 2): forewing length = 23.5mm, wingspan = 45mm (holotype). Forewing apex pointed, not produced, with evenly convex termen. Dorsal forewing dark blackish-brown, transversed by a relatively narrow, orange discal band from near the costa through distal half of discal cell to outer margin in cell CuA2-2A, not extending below vein 2A, the band expanding and narrowing basad into the costal cell, where it reaches the base of the wing as a narrow orange ray (Fig. 1); no dark scales along the veins in the orange band; wide, slightly elongate, semi-romboid partly opaque yellow-orange macule in cell M3-CuA1 distad of the discal band, separated from it by less than the band's width; four conjoined, elongate, orange-yellow semi-opaque subapical macules from cells R2-R3 to R5-M1, half distance between the discal band and the apex; these followed by a pair of conjoined, trapezoid and narrower, otherwise similar, prominently offset distad (but overlapping by half of the width with subapical macules), submarginal macules in cells M1-M2 and M2-M3, latter narrower than former and located halfway between anterior distal corner of macule in M3-CuA1 and termen. Ventral forewing mostly similar to dorsal, but creamy-pale at the very base and lighter brown closer to anal margin; costal cell almost entirely orange basad the discal orange band, overscaled brown near the base, with a narrow rim of dark brown scales along the costa; anterior of discal cell rimmed with orange basad discal orange band; a few orange scales in the discal cell near the origin of CuA2 vein (Fig. 2). Hindwing almost trapezoid, angled at vein M3, dark blackish-brown above except for the large creamy-white oval patch of scales occupying almost entire anal fold (Fig. 1). Ventral hindwing dark blackish-brown with a streak of diffuse orange scales near the base along the Sc+R1 vein, orange overscaling in the costal cell (Fig. 2). Fringes dark brown on both wings. Head black with creamy white spots above and beneath eyes, at base of antennae and centrally on frons; palpi black, broadly creamy-white beneath; antennae are broken off the holotype; thorax and abdomen black, midlegs brown with orange scales.

Male genitalia (Figs. 3-13): Tegumen relatively long, ending at the cephalad end of harpe (Figs. 5, 7), with narrow, proximate, pointed pair of caudal processes (= bifurcate superuncus) (Fig. 7), their caudal end extending beyond the caudal end of uncus (Fig. 6); uncus extending to mid-harpe, caudally thin in lateral view (Figs. 5, 6), gradually bending ventrad, narrower in the middle and broadening caudad, with a narrow downturned caudal end bearing a pair of prominent lateral horn-like processes (Figs. 7, 12); gnathos is upturned and jointed ventrad in caudal half, specullose on its surfaces caudad, relatively wide in lateral view (Fig. 6), slightly narrower than caudal end of uncus in ventral view (Fig. 9); costa of valva with very long caudally directed laterally bending inwards and outwards (= broadly S-shaped) and terminally upturned process extending beyond cephalad end of harpe (Figs. 5, 7); caudal end of harpe relatively narrow, finely dentate (one tooth more prominent, Fig. 12), curved inwards (Fig. 3) and twisted at ventro-caudal corner, but dorsal corner curved outwards (Fig. 11) to form a surface with saddle point; saccus short, relatively narrow, almost triangular in ventral view (Figs. 9, 10); penis 1.3 times length of valva (Fig. 5), with a very long and narrow phallobase about 1/3 of penis length and width (Fig. 11), penis slightly bulbous in middle, narrowing and upturning caudad with long and sharply pointed lower lip (Figs. 10, 11), asymmetric caudad with a narrow keel along left side (Figs. 9, 13); two long, one almost as long and a row of about half a dozen smaller cornuti (Fig. 13).

Female: unknown or unrecognized.

**Type.**— Holotype male with the following labels: white, printed: / Ecuador: Esmeraldas: Rio / Chuchuvi, km. 12.5 Lita- / San Lorenzo Rd. 800-900m / 0° 53.01'N 78° 30.90'W / June 15 2002 I. Aldas leg. /; white, printed: / Genitalia / NVG-111029-10 /; red, printed: / HOLOTYPE ♂ / *Entheus warreni* / Grishin /. The name of the Esmeraldas province is misspelled on the label. The holotype is deposited at the National Museum of Natural History, Smithsonian Institution, Washington DC (USNM).

**Type locality.**— ECUADOR: ESMERALDAS: km 12.5 Lita - San Lorenzo Rd., Río Chuchuví, 0.883° -78.515°, 850m. This location is along the road between Alto Tambo and Lita in San Lorenzo Canton of Esmeraldas Province, a quarter mile west of the border with Carchi Province and about 20 air miles south of the border with Colombia. The specimen was apparently collected in a very wet premontane rainforest near the Río Chuchuví, about 2 miles upstream of the Río Mira. Interestingly, this exact site is also a type locality for another recently described species, *Titthorea pacifica* Willmott & Lamas, 2004 (Lepidoptera: Nymphalidae: Ithomiinae). The Chocó is a biodiversity hotspot well-known for high endemism (Gentry 1992). The GPS coordinates on the type specimen label represent the point where the Alto

Tambo-Lita road crosses the Río Chuchuví at around 710m, while the label elevation suggests that the specimen as captured somewhere along the trail that climbs up into the forest from the road to an elevation of about 900m. Given the uncertainty in the elevation specified on the label ("800-900m") it is likely that the specimen was collected in the premontane forest along the trail rather than by the road. Such discrepancies when GPS data are given for the parking site, and the collection site accessible by foot is some distance away are inevitably quite common, but might be significant when elevation changes rapidly with distance (K. Willmott, pers. comm.).

**Etymology.**— *Entheus warreni* n. sp. is named for Andrew D. Warren, senior collections manager at the McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, a brilliant lepidopterologist with unmatched, uniquely broad and deep knowledge of butterflies, and a friend of the author. The name is a masculine noun in the genitive case.

**Distribution and phenology.**— The species is known only from the holotype collected in the Chocó forest of northern Ecuador in June. Apparently, it is a rarely collected and possibly local species, since it has escaped recognition until now despite its unique appearance. While it is hard to speculate about its distribution and phenology, the type locality contains a number of species of Chocó endemic butterflies, and its apparent absence in relatively well-collected Panama suggests it may be found in other sites of western Ecuador and probably western Colombia.

**Diagnosis.**— *E. warreni* n. sp. is in the genus *Entheus* as it possesses all three characters used by Evans (1952) to circumscribe the genus (see Introduction). *E. warreni* n. sp. belongs to the *E. matho* group, because it has a largely blackish-brown hindwing and the M3-CuA1 yellow-orange macule being separate from the discal orange band. *E. warreni* n. sp. can be distinguished from other species in the *E. matho* group by the following characters:

1. Broad orange ray in the dorsal forewing costal cell narrowing from the discal band to the wing base (Fig. 1). Ventrally, costal cell is almost entirely orange basad of the discal band (Fig. 2). This single and a very prominent character is diagnostic of *E. warreni* n. sp. No other *Entheus* species in either *E. matho* or *E. priassus* groups possesses orange ground color in the basal half of the costal cell, either dorsally or ventrally, and the orange macule is restricted to the distal part of the costal cell, where it is a part of the discal orange band. However, some orange overscaling in the costal cell, especially ventrally and at the base, may be present in other *Entheus* species.

2. Extensive orange scales near the base along the Sc+R1 vein on the ventral hindwing (Fig. 2) forming a noticeable orange streak. In other species, the basal area of the hindwing is not prominently overscaled with orange along the vein Sc+R1 although uniform orange overscaling may be present in some *E. priassus* group specimens, and orange scales do not cluster to form a streak.

3. The apical orange band with two submarginal ("lower") macules prominently offset distad, i.e. only the basal half of the macule in the cell M1-M2 contacts the macule in the cell R5-M1 along the vein M2, and the distal half is bordered by the dark brown background scales along M2. Only in some specimens of an undescribed *E. matho* group species from Costa Rica ("Burns01") are the two lower macules noticeably offset (Janzen & Hallwachs 2011, Janzen *et al.* 2011), but typically to a lesser extent than that in *E. warreni* n. sp. Interestingly, some *E. priassus* group specimens display an offset similar to *E. warreni* n. sp.

4. Creamy-white oval, androconial scale patch in the anal fold. In other species this patch may be white or yellowish, or the anal fold may be entirely brown.

5. Narrow and pointed saccus, long phallobase, long superuncus reaching beyond the end of uncus and long, horn-like, outwardly pointed terminal processes of uncus, reminiscent of 'snail eyes', seem to differentiate *E. warreni* n. sp. from its congeners. However, it is impossible to estimate variation of these characters from a single specimen and to compare genitalia across several yet to be described *Entheus* species in the *E. matho* group.

## DISCUSSION

Some lepidopterous genera are hard to approach in taxonomic studies, be it because of extreme species diversity, or a large body of published work in need of critical analysis. *Entheus* is one of such genera, for several reasons. First, from a taxonomic perspective, type specimens for a number of taxa are likely lost, and old descriptions are not detailed enough to

determine which insects these names refer to. Second, as recent work has revealed, *Entheus* is rich in cryptic species that appear very similar to an untrained eye, both in wing pattern and genitalia (Austin *et al.* 1997, Austin 1997, Janzen *et al.* 2011). Third, sexual dimorphism is extreme, and matching males with females is very challenging. Finally, with the exception of a few common species, *Entheus* specimens are rare in collections, which precludes detailed comparative analysis and the study of variation. In other words, a taxonomic revision of *Entheus* would require a very significant effort. In the light of these problems, the utility of a new species description based on a single specimen in a species group that requires major revisionary work may appear questionable.

However, I believe that it is well-justified in this case and may catalyze work on *Entheus* taxonomy, if approached one step at a time. The main potential problem with description of a taxon based on one specimen may be the creation of unnecessary synonym; since intraspecific variation cannot be assessed from a sole individual, it is not uncommon that the described specimen indeed belongs to a species with an existing name. I argue that it is not the case with *E. warreni* n. sp. Indeed, the distinctness of this specimen on the one hand, and similarities between other known cryptic species in the genus on the other hand, strongly suggest a distinct biological species. And it is only fitting that this unique butterfly is named after a one-of-a-kind, unique individual, Andy Warren, whose passion for our science and keen intuition fortified by all-embracing knowledge are unmatched. Clearly it is preferable to be able to assess variation within a series of specimens, considering both sexes, and to simultaneously describe the species' biology and life history. However, given the fact that *Entheus* specimens are so rare in collections, such an increase in our knowledge is not likely to happen soon. In addition, this species appears to be phylogenetically distinctive, and its inclusion in future phylogenetic studies will be helpful for understanding *Entheus* evolution. Indeed, *E. warreni* n. sp. exhibits certain traits of the *E. priassus* group, but possesses the white anal androconial patch of *E. m. matho* Godman & Salvin, 1879 while being remarkably different from it and from the three putative undescribed species from Costa Rica (Janzen *et al.* 2011).

Finally, this study serves a purpose of highlighting once again the uniqueness of the Chocó region's fauna, and reminding us about its incredible richness and fragility. Thus it seems proper to add yet another species to *Entheus* for the benefit of future research.

## ACKNOWLEDGEMENTS

This paper is dedicated to George T. Austin, a prolific, insightful and passionate Lepidopterologist who left this world unexpectedly early. The description above is written in GTA-style and may be viewed as a continuation of his work on *Entheus* (Austin *et al.* 1997, Austin 1997). I am grateful to Robert K. Robbins and John M. Burns (National Museum of Natural History, Smithsonian Institution, Washington DC) for granting access to the collections under their care and stimulating discussions; to Olaf H. H. Mielke for discussions of *Entheus* type material, to Keith Willmott for sharing his

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