NOTES ON PERUVIAN BUTTERFLIES (LEPIDOPTERA). II. NEW HELICONIUS (NYMPHALIDAE) FROM CUSCO ANO MADRE DE DIOS

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Summary

Some notes are given on the subspeciation patterns of Heliconius aoede, H. elevatus, H. erato and H. melpomene in Perú.

INTRODUCCIÓN

In February 1975, I went on a collecting trip to the Cosñipata Valley (department of Cuzco), and the Alto Madre de Dios Valley (Madre de Dios), mainly in search for ithomines and Heliconiines. One of the main purposes of that trip was to procure more specimens of some supposedly new subspecies of Heliconius flying in that area. The journey was quite successful, and several individuals belonging to two of the new subspecies described below were obtained.

It seems that the first butterflies gathered in the Cosñipata Valley (northeastern Cuzco) were collected by Claude Gay in 1839 (Lucas, 1852-1853; Papavero, 1971; Vargas, 1974: 14). During the 1870’s, Henry Whitely obtained specimens there for O. Salvin and H. Druce (Druce, 1876). In 1898, Otto Garlepp collected there for the dealers Staudinger and Bang-Haas. During this century, some butterflies were obtained there by Jean and Celestino Kalinowski, the well-known bird-collectors, as well as by Harry Watkins.

Localities in the Marcapata Valley (Cuzco) and in northern Puno (San Gabán and inambari Vaileys, and “Mountains of Carabaya”) were explored by the Kalinowskis, G.R. Ockenden (1901-1905), and Harry Watkins (1910).

In the department of Madre de Dios itself, some small collections have been made rather recently by Pallister, Koepcke, Peña, Schunke, Luscombe, C. KalinowskI and Bauer.

However, all this wide region, constituting the Madre de Dios basin, is entomologically largely unknown, being one of the least collected áreas in Perú. Map 1 shows the localities in northeastern Cuzco, northern Puno and Madre de Dios (Madre de Dios basin), where butterfly collections have been made (based on Lamas, 1976a, and unpublished data).

INTRODUCCIÓN

En febrero de 1975, fui en un viaje de colección al valle de Cosñipata (departamento de Cuzco), y al Alto Madre de Dios (Madre de Dios), principalmente en busca de ithomines y heliconiines. Uno de los principales propósitos de este viaje fue la obtención de más especímenes de algunas supuestas nuevas subespecies de Heliconius volando en este área. El viaje fue muy exitoso, y varios individuos pertenecientes a dos de estas nuevas subespecies descritas abajo fueron obtenidos.

Se sabe que las primeras mariposas recogidas en el valle de Cosñipata (nordeste de Cuzco) fueron recogidas por Claude Gay en 1839 (Lucas, 1852-1853; Papavero, 1971; Vargas, 1974: 14). Durante los años 1870, Henry Whitely obtuvo especímenes allí para O. Salvin y H. Druce (Druce, 1876). En 1898, Otto Garlepp recogió allí para los comerciantes Staudinger y Bang-Haas. Durante este siglo, algunos mariposas fueron obtenidas allí por Jean y Celestino Kalinowski, los conocidos recopiladores de aves, así como por Harry Watkins.

Localizaciones en el valle de Marcapata (Cuzco) y en el norte de Puno (San Gabán y inambari Vaileys, y “Montañas de Carabaya”) fueron exploradas por los Kalinowskis, G.R. Ockenden (1901-1905), y Harry Watkins (1910).

En el departamento de Madre de Dios mismo, algunas pequeñas colecciones han sido recogidas recientemente por Pallister, Koepcke, Peña, Schunke, Luscombe, C. Kalinowski y Bauer.

Sin embargo, todo este vasto y desconocido área que constituye el basén de Madre de Dios, es entomológicamente tam poco conocido, siendo uno de los áreas menos recogidas en Perú. El mapa 1 muestra las localizaciones en norte-oriental de Cuzco, norte de Puno y Madre de Dios (basén de Madre de Dios), donde se han recogidas colecciones de mariposas (basadas en Lamas, 1976a, y datos no publicados).
specimens of *luscombei* the upper outer angle of dermis touches the upper inner angle of the yellow forewing band. The elements of the hindwing ray are usually more slender in *luscombei* than in *emma*. Also very similar to *H. e. latidola* Butler from eastern Ecuador and northeastern Perú (type-locality: Rio Jurua, Rio Purus, Rio Madeira, Brazil; "Guayaquil, Ecuador"), but with longer dennis.

Ty pe-material: Holotype male, Rio de las Piedras, Madre de Dios, Perú (about 12°00’S, 70°10’W), 28.vii.74 (A. Luscombe). Paratypes: Madre de Dios: One male, same data as holotype; one male, Rio de las Piedras, 25.vii.74 (A. Luscombe); one male, Puerto Maldonado, 24.vii.73 (J.M. Schunke); 3 males, 2 females, Puerto Maldonado, 1.V. 16.v., 2.vi., 7.vi., 14.vi.75 (J.M. Schunke leg.). Cuzco: One male, Pilcopata, 750 m, 6-8.vii.75 (G. Lamas); 2 males, Atalaya, 650m, 8.U.75 (G. Lamas), all in MJP, except three males from Puerto Maldonado (J.M. Schunke leg.) to be deposited in the following collections; British Museum (Natural History), London; Museu de Zoologia da USP, Sao Paulo; H. Holzinger, Wien.

This subspecies is named in honor of my friend, Anthony Luscombe, who collected the first specimens I saw of this subspecies.

HELICONIUS MELPOMENE SCHUNKEI, SSP. N.

![FIGURES 1-4 — Examples of intersubspecific hybridization in Peruvian Heliconius.](image)


Very similar to *H. m. aglaope* Felder & Felder from eastern Ecuador and northeastern Perú (type-locality: "Rio Negro, Brazil"; error), but also presenting a wide yellow forewing band, which is usually connected with the longer dennis. Also similar to *H. m. flavotenuiata* Neustetter from central-eastern Perú (type-locality: Yurimaguas, "Juanjui", Rio Huallaga, Perú), but differing from it by the longer dennis and wider forewing yellow band; the hindwing rays are usually more slender in *schunkei* than in *flavotenuiata*.

Ty pe-material: Holotype male, Shintuya Madre de Dios, Perú, 450m, 8-10.vi.75 (G. Lamas). Paratypes: Madre de Dios: One male, same data as holotype; one male, Puerto Maldonado, 180m, 17-22.vii.73 (J.M. Schunke); 8 males, 2 females, Puerto Maldonado, 2.v., 3.v., 17.v., 1.v., 3.v., 7.v., 8.v., 16.vi.75 (J.M. Schunke leg.); 2 males, one female, Rio de las Piedras, 9-9.X.74 (A. Luscombe). Cuzco: One male, "Marcapata", 47 (C Kalinowski); 4 males, Pilcopata, 750m, 6-8.vi.75 (G. Lamas), all in MJP, except three males from Puerto Maldonado (J.M. Schunke leg.) to be deposited at the British Museum (Natural History), London, the Museu de Zoologia da USP, Sao Paulo, and the H. Holzinger collection, Wien.

Individuals of this subspecies were first designated as "rubra" by Stichel (1906), who based his description on specimens from Cuzco, "Marcapata". However, the name "rubra" is invalid, because it was published as a quadrinomial (i.e., expressly referred to an infrasubspecific rank).

The subspecies is named after José M. Schunke, for his more than 50 years of collecting activities in Perú.

**DISCUSSION**

The four species studied in this paper (*aoede, elevatus, erato and melpomene*) are mimetic butterflies which have previously attracted a great deal of attention and admiration, due to the remarkable color-pattern similarities among their subspecies, inhabiting the same geographical areas, and usually being very different to subspecific populations inhabiting neighbouring areas.

It has only recently been understood that these subspecies have evolved by orthodox ways of geographical speciation, involving differentiation in isolated wet forest refugia of the Neotropics during Quaternary dry periods (Haffer, 1969; Vanzolini & Williams, 1970; Vanzolini, 1970; Vuilleumier, 1971; Brown, Sheppard & Turner, 1974; Brown, 1975; Lamas, (1973). Similarities among the color and behavi our-patterns of these four species were evolved in certain refuge areas during those dry periods.

It is presently considered (Brown, 1975) that some 38 refuge areas existed in the Neotropics during dry phases. For Perú, Brown (1975) mentions the refuges of Marañon, Huallaga, Ucayali, Chanchamayo, Inambari and Loreto. According to the results obtained from the present study, I am led to conclude that at least 6 refuges were operative in Perú east of the Andes during Quaternary times. Those refuge areas are shown on map 2 and include: (i) Upper

![FIGURES 5-6 — Examples of intersubspecific hybridization in Peruvian Heliconius.](image)
Marañon Valley; (ii) Upper Huallaga Valley; (iii) Pachitaya and Upper Ucayali Valleys; (iv) Chanchamayo and Apurímac Valleys; (v) Upper Ucayali Valley; and (vi) Upper Madre de Dios basin (Cosñipata, Marcapata, Inambari and Upper Madre de Dios Valleys; Inambari reguge of Brown, 1975).

Of these, the Marañon, Chanchamayo and Urubamba are high-altitude refuges (about 600-2000m), the Huallaga is a moderate-altitude refuge (300-1000m), and the Ucayali and Inambari are low-altitude refuges (200-600m). Brown's (1975) "Loreto" refuge looks to me as just including Napo-derived elements (formed in the low-altitude Napo refuge of Hafner, 1969), perhaps not being a refuge by itself.

A new refuge area is being proposed here, where H. erato amphitrite Riffarth and H. melpomene eurypa Riffarth were formed. This is a high-altitude refuge, which may have been located on the upper Urubamba Valley, in Cuzco. However, specimens of amphitrite and eurypa are known from the upper tributaries of the Madre de Dios (Cosñipata, Marcapata, Inambari, etc.; see map 1) and this raises the question of whether these subspecies evolved only at the Urubamba Valley and later spread to the upper tributaries of the Madre de Dios, or if this high-altitude refuge extended over the Urubamba, as well as over the other valleys. This question may only be answered when the speciation patterns of other butterflies living in the same area are better known.

Table 1 includes the subspecies of aoede, elevatus, erato and melpomene found in the six refuge areas proposed for Peru, plus the subspecies found north of the Amazon (probably formed in the Napo refuge), the subspecies which occur in extreme northwestern Peru (Tumbes; evolved in the Chimbórao refuge of Brown, 1975), and those expected to be found in extreme southeastern Peru (Tambopata and Heath Rivers; originated in the Yungas refuge of Lamas, 1973).

The assumed distributions of the subspecies of aoede, elevatus, erato and melpomene in Peru are shown on map 3. Each of the four species has developed three dennis-plus-ray subspecies inhabiting the Amazonian lowlands of Peru. The first is found in the northeastern part of the country (northern tributaries of the Amazon), the second in the central-eastern portion (southern tributaries of the Amazon), and the last in the southeastern region (Madre de Dios basin). Both the northeastern and the southeastern populations are characterized by the wide forewing yellow band, while the central-eastern subspecies present a narrower

<table>
<thead>
<tr>
<th>DISTRIBUTION</th>
<th>AOEDER</th>
<th>ELEVATUR</th>
<th>ERATOR</th>
<th>MELPOMENER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alto Marañon River and northeastern Peru</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Alto Huallaga River</td>
<td>cupidineus</td>
<td>pseudocupidineus</td>
<td>favorinus</td>
<td>amaryllis</td>
</tr>
<tr>
<td>Pachitaya and Ucayali Rivers (lower elevations)</td>
<td>Seitz, 1913²</td>
<td>Neustetter, 1931</td>
<td>Hopffer, 1874³</td>
<td>Riffarth, 1901</td>
</tr>
<tr>
<td>Chanchamayo and Apurímac Rivers (higher elevations)</td>
<td>Seitz, 1913²</td>
<td>Neustetter, 1931</td>
<td>Riffarth, 1901</td>
<td>Neustetter, 1931⁵</td>
</tr>
<tr>
<td>Madre de Dios Basin (lower elevations)</td>
<td>mana, ss. n.</td>
<td>lapis, ss. n.</td>
<td>luscombbei, ss. n.</td>
<td>schunkei, ss. n.</td>
</tr>
<tr>
<td>Alto Urubamba, Cosñipata, Marcapata and Inambari Rivers (higher elevations)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Amazonas River (northeastern Peru)</td>
<td>bartlettii</td>
<td>elevatum</td>
<td>lativitta</td>
<td>agloope</td>
</tr>
<tr>
<td>Tumbes (extreme northeastern Peru)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Yungas de La Paz (Bolivia)³</td>
<td>philipp</td>
<td>perchlor</td>
<td>vepuratus</td>
<td>penelope</td>
</tr>
</tbody>
</table>

Table 1 — Distribution of Heliconius aoede, H. elevatus, H. erato and H. melpomene in Peru (see map 3). Notes: 1. H. himera (Hewitson) may constitute an H. erato subspecies (Brown, pers. comm.); 2. The name "cupidineus" was first published as a quadrinomial by Stichel in 1906; Seitz (1913: 389) seems to have been the first to validate it (as "cupidinicus", lapus caudali); 3. The type locality of favorinus ("Bolivia, Moxos", Pavón coll.) is a mistake; the type may have been collected by the Spanish botanists Ruiz and Pavón in the upper Huallaga Valley at the end of the 18th century; 4. Approximately below 500m; 5. The name flavovenata Neustetter, 1931, seems to be the earliest available name for this subspecies; the name "cognatus" Riffarth, 1907, also applies to this subspecies, but it was published as a quadrinomial, and apparently has not been validated since; 6. Approximately above 500m; 7. Specimens of these subspecies may be expected to occur in extreme southwestern Peru (Heath and Tambopata Rivers, Puno).
yellow band. On the other hand, the southeastern sub-species differ from those of the northeast by the longer dennis, which usually touches the yellow band.

According to Brown (pers. corran.) the southeastern Perú forms with the wide yellow band and the long dennis occur as far east as southern Acre and the upper Purús and Madeira Rivers (Brazil), where these populations hybridize with those formed in central-eastern Perú (Ucayali refuge) and northern Bolivia (Yungas refuge) (see also map in Brown & Mielke, 1972).

The discovery of some hybrid specimens has shown that there is an occasional interchange of genetic material between monomorphic populations found in adjacent refuge areas. In Perú, due to new highway construction across the Andes to the Amazonian lowlands, those intergradation zones are only now beginning to be known. These highways usually cross the Andes chains at the lowest passes, and it is here that hybridization areas may be found. Of these areas, the oldest known is that between Tarapoto and Yurimaguas, in northeastern Perú, successfully worked by Otto Michael, who obtained there many "aberrations", "forms" and "varieties" (i.e., hybrids) of Morpho, Agrias and Heliconius species (Michael, 1923). There is now a rather new highway between Tarapoto (on the middle Huallaga Valley, altitude 350m) and Yurimaguas (lower Huallaga, 180m), crossing the eastern chain of the Andes, where the Huallaga opens its way to the Amazon plains through the Pongo (canyon) de Aguirre. Along this road, hybrid specimens be-

MAP 1 — Southeastern Perú, showing localities where butterfly collections have been made (arabíco numeráis). Circles indicate where Heliconius erato amphitrite and H. melpomene euryades have been collected.

tween upper Huallaga subspecies and those inhabiting the lower Huallaga have been found (see fig. 5).

Another hybridization zone is that of the "Boquerón" del Padre Abad*, where the highway going from Tingo María (upper Huallaga, 650 m) to Pucallpa (upper Ucayali, 150 m) crosses the eastern chain of the Andes (here called "Cordillera Azul"), which constitutes the continental divide between the Huallaga and Ucayali basins. Again, hybrid specimens between Huallaga- and Ucayali-derived subspecies have been found (see fig. 6).

Two other dennis-plus-ray *Heliconius* species which may have developed subspecies in the Madre de Dios basin are *H. xanthocles* and *H. demeter* Brown (pers. comm.) indicated that some specimens of *xanthocles* have been collected in southern Acre (Brazil). The recent discovery of a narrow-banded subspecies of *demeter* from the Ucayali region (Holzinger & Holzinger, 1975), very similar to the sympatric subspecies of *aoede*, *elevatus*, *erato* and *melpomene*, make it possible to predict the existence of another *demeter* subspecies in the Madre de Dios area.

![MAP 2 — Refuge areas operative in eastern Peru during Quaternary dry cycles. Horizontal hatching indicates areas below 1500m, where rain forest may have been preserved during dry periods. Cross-hatching shows some intergradation zones between refuges, which may have been covered by rain forest. 1. Marañon; 2. Huallaga; 3. Ucayali; 4. Chanchamayo; 5. Urubamba; 6. Inambari.](image)
MAP 3 — Assumed distributions (horizontal hatching) of the subspecies of Heliconius aoede, H. elevatus, H. erato and H. melpomene in Perú. Cross-hatching indicates actual or presumed hybrid zones. 1. erato cyria and melpomene cythera; 2. (erato?) himera; 3. aoede cupidineus, elevatus pseudocupidineus, erato favorinus, and melpomene amaryllis; 4. aoede cupidineus, erato microlea, and melpomene xenoclea; 5. erato amphitrite and melpomene euryades; 6. aoede bartietti, elevatus elevatus, erato lativitta, and melpomene aglaope; 7. aoede cupidineus, elevatus pseudocupidineus, erato emma, and melpomene flavotenleta; 8. aoede manu, elevatus lapis, erato luscombei, and melpomene schunki; 9. aoede phillipii, elevatus perchiora, erato venustus, and melpomene penelope.

Acknowledgments

The author is especially indebted to Dr. Keith S. Brown, Jr. (Universidade Estadual de Campinas, Sao Paulo, Brazil) and Mr. Helmuth Holzinger (Wien, Austria), who provided helpful data and made many detailed suggestions and comments on the present paper.

LITERATURE CITED


As predicted above, a new subspecies of Heliconius xanthocles Bates has been found in southeastern Peru, and is here described as follows:

Heliconius xanthocles quindecim, ssp. n.

Similar to H. xanthocles melior Staudinger from central Peru, but with wider yellow forewing band (including one or two almost isolated spots inside discal cell); dennis longer, and ray elements narrower, than in melior. In one paratype there is a small yellow spot in forewing cell Cu-Cu above; this cell is immaculate in the other specimens, except for a tiny red dot at the base of vein Cu.

Type-material: Holotype male, Quincemil, Cuzco, Peru, 21.X.75 (J. M. Schunke); two male paratypes, same data.

Further Remarks

1) Holldieh & Hinks. (1918, Appendix, Peru-Bolivia Boundary Commission, London, Royal Geographical Society) mention the presence of H. erato venustus Salvin in the border between Peru and Bolivia (southeastern Madre de Dios and northeastern Puno). H. xanthocles meliae is also mentioned from there.

2) H. himera (Hewitson) has recently been found to be conspecific with H. erato (Linnaeus) (Brown, Benson, Gilbert S Lamas, unpublished data).

3) A specimen of what appears to be a new subspecies of H. melpomene (Linnaeus) has been collected in the Marañon refuge area (Buenos Aires, near Bagua Grande, Amazonas, Peru, 1500m. 18 XI.74 (P. Hocking)). This specimen, which in now deposited at the MJP, is similar in color pattern to H. erato himera. Its formal description will be delayed until more specimens are found.

4) Both K. erato emma and H. melpomene flavotenuiata have recently been collected in Mesones Muro. Amazonas Perú. 260 m., xii. 75. This locality lies near the Pongo de Manseriche, on the Marañon River. This indicates that emma and flavotenuiata extend as far north and west as the Southern banks of the lower Marañon, and the hybridization zone between areas 6 and 7 of Map 3 should accordingly be shifted northwestward to the lower Marañon, instead of lying on the lower Huallaga River.

5) A figure published as H. xanthocles melior by Seitz (1913: pl. 77 a) represents a misidentification. In fact it closely resembles the specimens of H. melpomene schunkei, ssp. n.

6) More type-specimens of H. erato luscombei, ssp. n. and H. melpomene schunkei, ssp. n. are the following:

H. e. luscombei: Nine males, three females, paratypes, Quincemil, Cuzco, Peru. 8 x., 12 x., 13 x., 14 x., 21 x., 23 x., 24 x. 75 (J. M. Schunke); one male paratype, Mazuko, Puno, Peru, 20 VIII.72 (E. Bauer): two males, one female, paratype, Iberia, Madre de Dios, Peru. 11 VIII., 71 x., 10 IX.75 (J. M. Schunke); all in MJP, except one female paratype in the British Museum (Natural History), and one male paratype each in the American Museum of Natural History, Allyn Museum of Entomology (Sarasota) and National Museum of Natural History (Washington, D.C.).

H. m. schunkeii: Seven males, one female, paratypes, Quincemil, Cuzco, Peru. 25 x., 1 x., 12 x., 14 x., 23 x. 75 (J. M. Schunke); one male paratype, Iberia, Madre de Dios, Peru. 23 VIII.75 (J. M. Schunke); all in MJP, except one male paratype each in AMNH, AME, BM(NH) and NMNH. 