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

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SUMARIO

Se describen las siguientes subespecies nuevas de *Heliconius* del Perú: *H. aoede manu,* ssp. n., *H. elevatus lapis,* ssp. n. y *H. erato luscombei,* ssp. n., de Río de las Piedras, Madre de Dios, y *H. rnelpomene schunkei,* ssp. n., de Shintuya, Madre de Dios.

Se incluyen igualmente algunas notas sobre los patrones de especiación de las especies *aoede, elevatus, erato* y *rnelpomene* en el Perú.

SUMMARY

Heliconius aoede manu, ssp. n., *H. elevatus lapis,* ssp. n., and *H. erato luscombei,* ssp. n., from Río de las Piedras, Madre de Dios, Perú, and *H. rnelpomene schunkei,* ssp. n., from Shintuya, Madre de Dios, Perú, are described as new.

Some notes are given on the subspeciation patterns of *Heliconius aoede, H. elevatus, H. erato* and *H. rnelpomene* 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 íthomiines 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 área The journey was quite succesful, and several individuáis belonglng 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). Duríng 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 Kallnowski, 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 Kalinowskls, 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. Kalinowskl and Bauer.

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Puno and Madre de Dios (Madre de Dios basin), where butterfly collections have been made (based on Lamas, 1976a, and unpublished data).

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HELICONIUS AOEDE MANU, SSP. N.

(fig. D

This new subspecies is very similar to *H. a. bartletti* Druce from northeastern Perú and southeastern Ecuador (type locality: Santa Cruz, Río Huallaga, Peni), but differs by the longer dennis, which is usually in contact with the wide yellow forewing band.

Type-material: Holotype female, Río de las Piedras, Madre de Dios, Perú (about 12'00'S. 70?10'W), 25.viii,74 (A. Luscombe); one paratype female, Iberia, Madre de Dios, Perú, 23.V.75 (J. M. Schunke leg.); one paratype male, Puerto Maldonado, Madre de Dios, Perú, 12.viii.75 (E. Bauer); all deposited at the Museo "Javier Prado", Lima (MJP).

When Druce (1876) described *bartletti,* he mentioned two specimens, a male and female. The male was collected by Bartlett at Santa Cruz, on the Huallaga River, and represents the true *bartletti* (Brown, pers. comm.); the female was obtained by Whitely in the "Cosñipata Valley", Cuzco, and is a specimen of *manu.* Both syntypes of *bartletti* are at the British Museum (Natural History).

The subspecific ñame refers to the Manu National Park, in Madre de Dios, where this and other species wlll hopefully be preserved from extinction.

HELICONIUS ELEVATUS LAPIS, SSP. N.

(fig. 2)

Very similar to *H. e. pseudocupldlneus* Neustetter from central-eastern Perú (type-locality: Yurimaguas, Río Huallaga, Perú), but with wlder yellow band, sometimes in contact with the longer dennis on forewing, and with more slender rays on hindwing.

Type-material: Holotype male. Río de las Piedras, Madre de Dios, Perú (about 12'00'S, 70'10'W), 6.ÍX.74 (A. Luscombe); one paratype male, Quincemil, Cuzco, Perú, 18.viii.75 (E. Bauer); both in MJP.

The subspecie ñame is the Latin word for stone ("piedra" In Spanish).

HELICONIUS ERATO LUSCOMBEI, SSP. N.

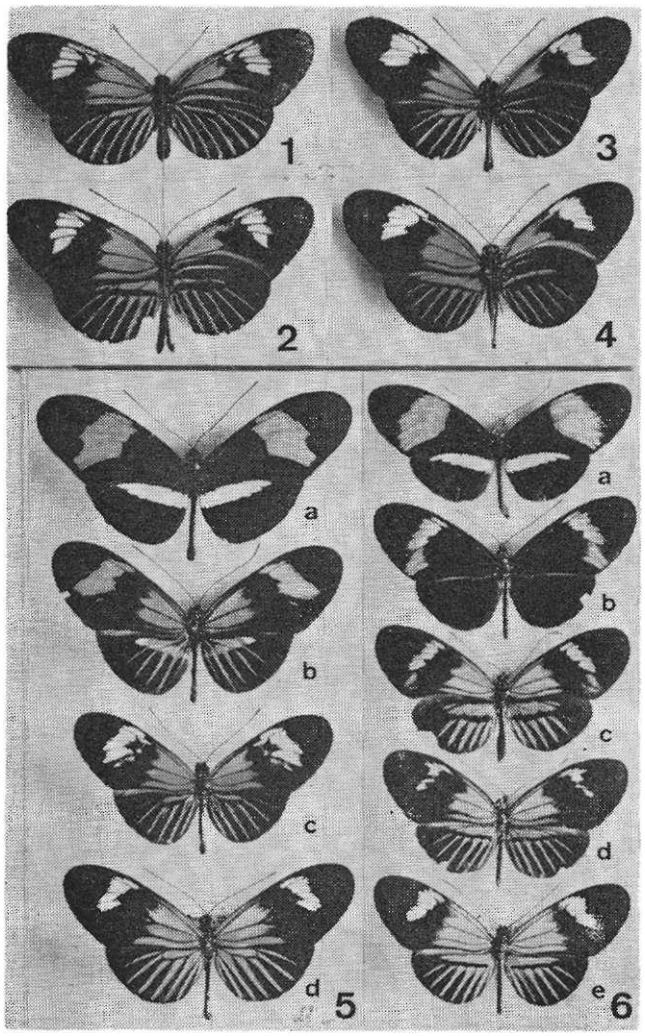
(fig. 3)

Similar to *H. e. emma* Riffarth from central-eastern Perú (type-locality: Sarayacu, Pachitea, Yurimaguas, Perú; "Archidona, Ecuador"), but presentirsg a generally wider yellow forewing band. Dennis Is also longer than In *emma;* in some

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. lativitta* 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), 26.viii.74 (A. Luscombe). Paratypes: *Madre de Dios:* One male, same data as holotype; one male, Rio de las Piedras, 25.viii.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.ii.75 (G. Lamas); 2 males, Atalaya, 650m, 8.Ü.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 Zoología 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,



FIGURES 1-4 — 1. **Heliconius aoede manu,** spp. n., holotype female; 2. **H. elevatus lapis,** ssp. n., holotype male; 3. **H. erato luscombei,** ssp. n., holotype male; 4. **H. melpomene schunkei,** ssp. n., holotype male. Dorsal (left) and ventral (rlght) wing surfaces.
FIGURES 5-6 — Examples of ¡ntersubspecific hybridization In Peruvian **Heliconius.** 5. a] **H. erato favorinus,** Tingo María, Huánuco; b) **favorinus** x **emma.** Pongo del Cainarache, San Martín; c) **favorinus** x **emma,** Pongo del Cainarache, San Martín; d) **H. erato emma,** Pucallpa, Loreto. 6. a) **H. melpomene amarylis,** Tingo María, Huánuco; b) amarylis x **flavotenuiata,** Boquerón del Padre Abad. Loreto; c) **amarylis** x **flavotenuiata,** Aguaytía. Loreto; d) **amarylis** x **flavotenuiata,** Boquerón del Padre Abad, Loreto; e) **H. erato flavotenuiata,** Pucallpa, Loreto.

HELICONIUS MELPOMENE SCHUNKEI, SSP. N.

(fig. 4)

Heliconius melpomene aglaope f. "rubra" Stichel, 1906: 26 (invalid).

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.*

7"y•pe-material: Holotype male, Shintuya Madre de Dios, Perú, 450m, 9-10.ii.75 (G. Lamas). Paratypes: *Madre de Dios:* One male, same data as holotype; one male, one female, Puerto Maldonado, 180m, 17-22.vii.73 (J.M. Schunke); 8 males, 2 females, Puerto Maldonado, 2.v., 3.v., 17.v., 1.vi., 3.v¡., 7.vi., 8.vi.,16.vi.75 (J.M. Schunke leg.); 2 males, one female, Rio de las Piedras, 8-9.X.74 (A. Luscombe). *Cuzco:* One male, "Marcapata", ¡.47 (C Kalinowski); 4 males, Pilcopata, 750m, 6-8.ii.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 Zoología da USP, Sao Paulo, and the H. Holzinger collection, Wien.

Individuáis of this subspecies were first designated as "rubra" by Stichel (1906), who based his description on specimens from Cuzco, "Marcapata". However, the ñame "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 áreas, and usually being very different to subspecific populations inhabiting neighbouring áreas.

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 áreas during those dry periods.

It is presently considered (Brown, 1975) that some 38 refuge áreas 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 áreas are shown on map 2 and include: (i) Upper

Marañon Valley; (ii) Upper Huallaga Valley; (iii) Pachitea and Upper Ucayali Valleys; (¡v) Chanchamayo and Apurímac Valleys; (v) Upper Urubamba 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 Ñapo refuge of Haffer, 1969), perhaps not being a refuge by itself.

A new refuge área is being proposedhere, where *H. erato amphitrite* Riffarth and *H. rnelpomene euryades* 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 *euryades* are known from the uper tributaries of the Madre de Dios (Cosñipata, Marcapata, Inambari, etc.; see map 1) and this raises the question of wheter 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 área are better known.

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

The assumed distributions of the subspecies of *aoede, elevatus, erato and rnelpomene* in Perú are shown on may. 3. Each of the four species has developed three dennis-plus-ray subspecies inhabiting the Amazonian lowlands of Perú. 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 región (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

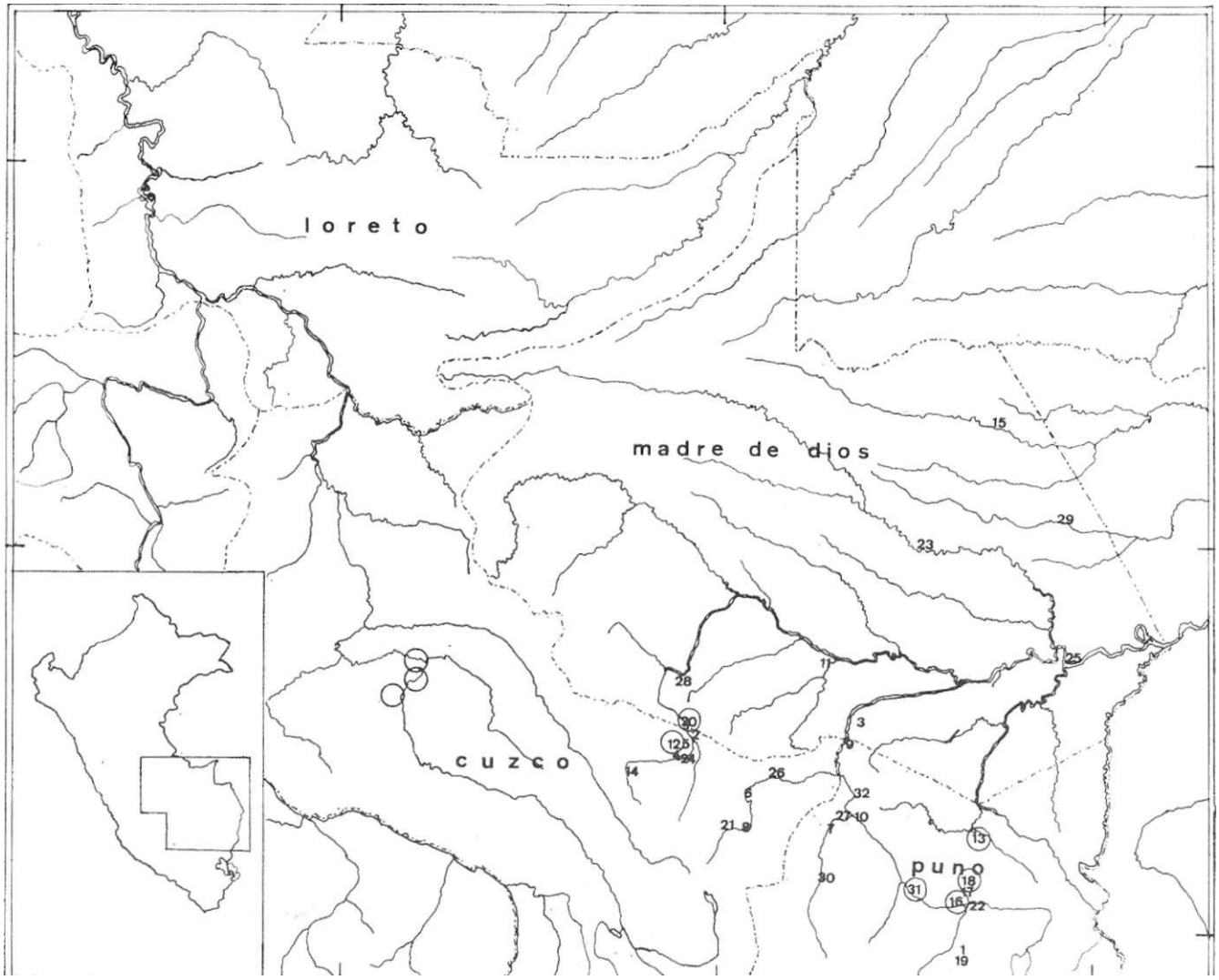
DISTRIBUTION	SPECIES			
	aoede	elevatus	erato	melpomene
Alto Marañón River and northwestern Peru	?	?	? himera (Hewitson, 1867)[1]	?
Alto Huallaga River	cupidineus Seitz, 1913[2]	pseudocupidineus Neustetter, 1931	favorinus Hopffer, 1874[3]	amaryllis Felder & Felder, 1862
Pachitea and Ucayali Rivers (lower elevations)[4]	cupidineus Seitz, 1913[2]	pseudocupidineus Neustetter, 1931	emma Riffarth, 1901	flavotenuiata Neustetter, 1931[5]
Chanchamayo and Apurímac Rivers (higher elevations)[6]	cupidineus Seitz, 1913[2]	?	microclea Kaye, 1907	xenoclea (Hewitson, 1854)
Madre de Dios Basin (lower elevations)[4]	manu, ssp. n.	lapis, ssp. n.	luscombei, ssp. n.	schunkei, ssp. n.
Alto Urubamba, Cosñipata, Marcapata and Inambari Rivers (higher elevations)[6]	?	?	amphitrite Riffarth, 1901	euryades Riffarth, 1900
Amazonas River (northeastern Peru)	bartletti Druce, 1876	elevatus Nöldner, 1901	lativitta Butler, 1877	aglaope Felder & Felder, 1862
Tumbes (extreme (northwestern Peru)	?	?	cyrbia (Godart, 1819)	cythera (Hewitson, 1869)
Yungas de La Paz (Bolivia)[7]	philipi Brown, 1975	perchlora Joicey & Kaye, 1917	venustus Salvin, 1871	penelope Staudinger, 1894

TABLE 1 — Distribution of **Heliconius aoede, H. elevatus, H. erato** and **H. rnelpomene** ¡n Perú (see map 3). **Notes:** I. **H. himera** (Hewitson) may constitute an **H. erato** subspecies (Brown, pers. comm.); 2. The ñame "cupidineus" was first published as a quadrInomial by Stichel in 1906- Seitz (1913: 389) seems to have been the first to valídate it (as "cupidiaeus", **lapsus calami);** 3. The type-locality of **favorinus** ("Bolivia, Moxós", 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 ñame **flavotenuiata** Neustetter, 1931, seems to be the earliest available ñame for this subspecies; the ñame "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 Perú (Heath and Tambopata Rivers, Puno).

yellow band. On the other hand, the southeastern subspecies 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 Rlvers (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 occasionai interchange of genetic material between monomorphic populations found in adjacent refuge áreas. 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 áreas may be found. Of these áreas, 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-



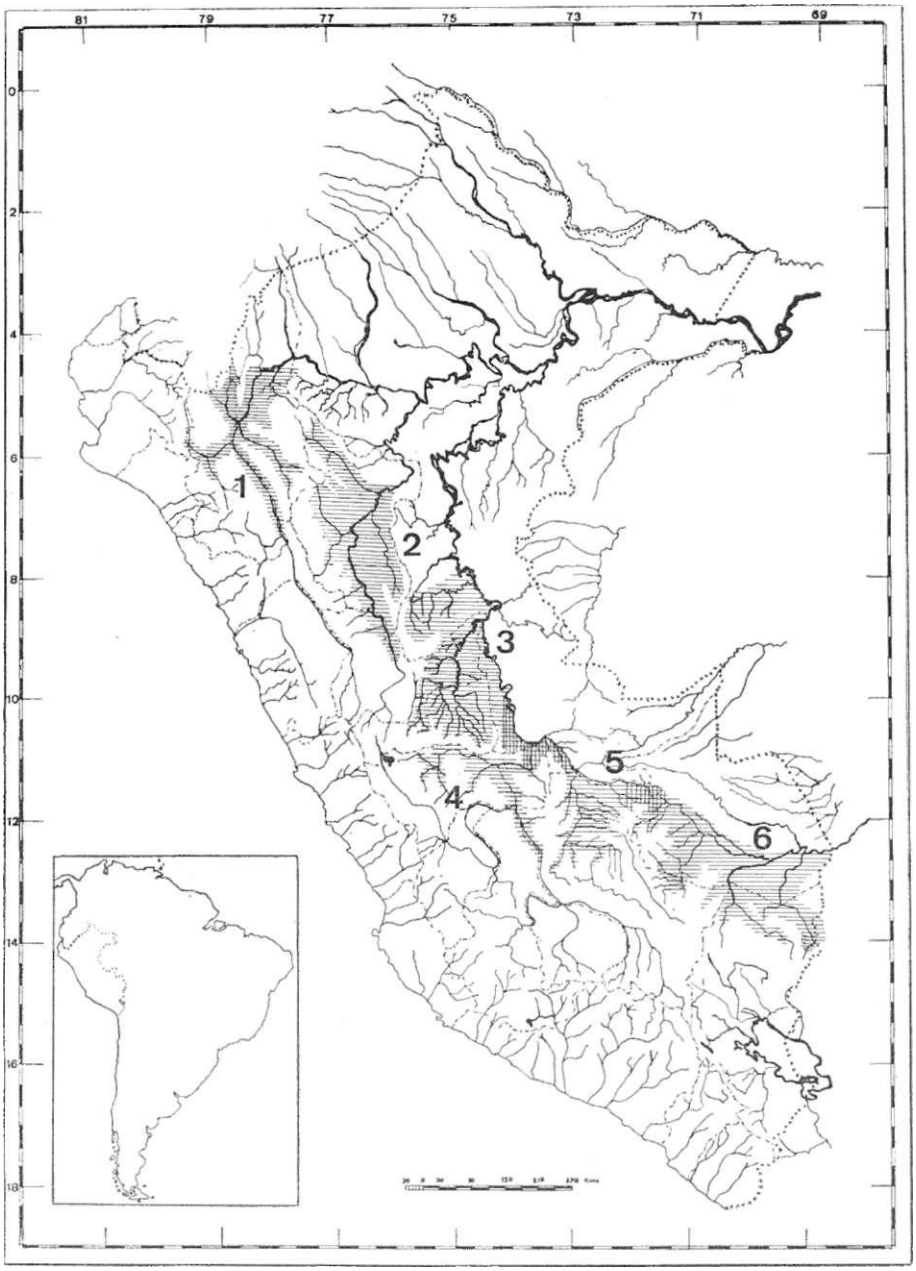
MAP 1 — Southeastern Perú, showing localities where butterfly collections have been made (arabio numeráis). Circles Indícate where Heliconius erato amphitrite and H. melpomene euryades have been collected.

1. Aguaiani; 2. Atalaya; 3. Avispas; 4. Hacienda Cajón; 5. Callanga; 6. Hacienda Caradoc; 7. Chaquimayo; 8. Chaupichaca; 9. Chiforongo- 10 Chirimayo; 11. Río Colorado; 12. Río Cosñipata; 13. Río Huacamayo; 14. Huaisampillo; 15. Iberia: 16. Río Inambari- 17 La Pampa- 18 La Unión- 19. Iimbani; 20. Río Alto Madre de Dios; 21. Marcapata; 9. Mazuko; 22. Oroya; 23. Río de las Piedras; 24. Pilcopata; 25 Puerto Maldonado 26. Quincemil; 22. Quitun; 22. Sagrario; 20. Río Salvación; 27. Río San Gabán; 22. Santo Domingo; 28. Shintuya; 29. Shiringayoc- 12 Río Tono 30. Uruhuasi; 31. Río Xucuri (= Slucurl); 32. Río Yahuarmayo.

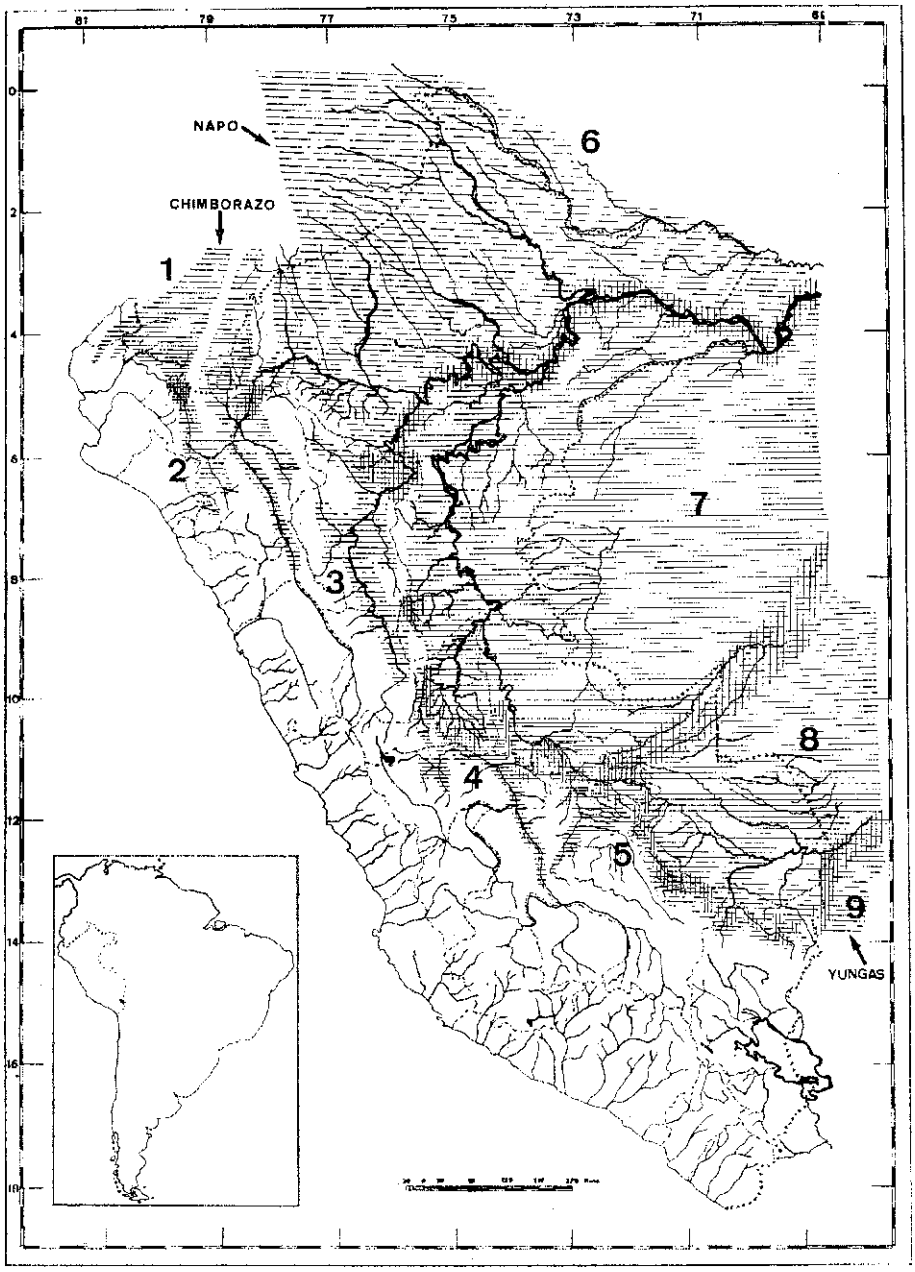
tween upper Huallaga subspecies and those inhabiting the lower Huallaga have been found (see fig. 5).

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, 150m) 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 región (Holzinger & Holzinger, 1975), very similar to the sympatric subspecies of *aoede, elevatus, erato* and *rnelpomene,* make it possible to predict the existence of another *demeter* subspecies in the Madre de Dios área.



MAP 2 — Refuge áreas operative in estern Perú during Quatemary dry c/cles. Horizontal hatching incates áreas 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.



MAP 3 — **Assumed distributions (horizontal hatching)** of **the subspecies** of **Heliconius aoede, H. elevatus, H. erato and H. melpomene ¡n Perú.** Cross-**hatching indlcates actual** or **presumed hybrid zones. 1. erato cyrbia and melpomene cythera; 2. (erato?) himera; 3. aoede cupidineus, elevatus pseudocupidineus, erato favorinus, and melpomene amaryllis; 4. aoede cupidineus, erato microclea, and melpomene xenoclea; 5. erato amphltrite and melpomene euryades; 6. aoede bartietti, elevatus elevatus, erato lativitta,** and **melpomene aglaope; 7. aoede cupidineus, elevatus pseudocupidineus, erato emma, and melpomene flavotenuiata;** 8. **aoede manu, elevatus lapis, erato luscombei, and melpomene schunkei; 9. aoede philipi, elevatus perchlora, erato venustus, and melpomene penelope.**

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POSTCRIPT

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

Heliconius xanthocles quindecim, ssp. n.

Similar to *H. xanthocles melior* Staudinger from central Perú (type-locality: Chanchamayo, Perú), but with wider yeílow 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 ¡mmaculate in the other specimens, except for a tiny red dot at the base of vein Cu.

Type-material: Holotype male, Quincemil, Cuzco, Perú, 21.X.75 (J. M. Schunke); two male paratypes, same data (19.X.75), all in MJP.

FUTHER REMARKS

1) Holdich & Hinks (1918, Appendix, Peru-Bolivia Boundary Commission. London, Royal Geographlcal Society) mention the presence of H. erato venustus Salvin in the border between Perú and Bolivia (southeastern Madre de Dios and northeastern Puno). **H.** xanthocles melete 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, unpubllshed data).

3) A speclmen of what appears to be a new subspecies of **H.** rnelpomene (Linnaeus) han been collected in the Marañen refuge área (Buenos Aires, near Bagua Grande, Amazonas, Perú, 1500m, 10.xi.74 (P. Hocking)). This specimen, which in now deposíted at the MJP, is similar in color pattern to **H. erato himera.** Its formal description will be délayed until more specimens ore found.

4) Both, **K. erato emma** and **H. rnelpomene flavotenuiata** have recently been collected in Mesones Muro. Amazonas Perú. 280m, 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 Marañen, and the hybridization zone between áreas 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 mlsidentlflcatlon. In fact ¡t closely resembles the specimens of **H. rnelpomene schunkei,** ssp. n.

6) More type-specimens of **H. erato luscombei,** ssp. n. and **H. rnelpomene schunkei,** ssp. n. are the followlng:

H. e. luscombei: Nine males, three females, paratypes, Quincemil, Cuzco, Perú. 8.x., 12.x., 13.x., 14.x., 21.x., 23.x., 24.X.75 (J. M. Schunke); orte male paratype, Mazuko, Puno, Perú, 20.viii.75 (E. Bauer); **two** males, one female, paratypes, Iberia, Madre de Dios, Perú, 11.VII1., 7.1x., 10. ix.75 (J. M. Schunke); all in MJP, except one female paratype in the British Museum (Natural History), and one male paratype each ¡n the American Museum of Natural History, Allyn Museum of Entomology (Sarasota) and National Museum of Natural History (Washington, D.C.).

H. m. schunkei: Seven males, one female, paratypes, Quincemil, Cuzco, Perú, 28.¡,, 1.x., 12.x., 14.x., 23.X.75 (J. M. Schunke); one male paratype, Iberia, Madre de Dios, Perú, 29.vII.75 (J. M. Schunke); all in MJP, except one male paratype each in AMH. AME. BM(NH) and NMNH.