Zeitschr. der Arbeitsgemeinschaft Osterr. Entomologen, 24. Jhg., 1/2, 1972 (1973)

## Literatur

BERNHAUSER, M., 1905: 13. Folge neuer Staphyliniden der paläarktischen Fauna, nebst Bemerkungen. Verh. zool. bot. Ges. W'ien, LV., p. 580-596 (587-588).
SCHEERPELTZ, O., 1966: Die neue Systematik der Großgattung Leptusa KRAATZ. (Col. Staphylinidae). Verh. zool. bot. Ges. Wien, CV/CVI., p. 5-55.
SCHEERPELTZ, O., 1972: Die bis jetzt bekannt gewordenen, paläarktischen Arten der Großgattung Leptusa KRAATZ. (Col. Staphylinidae). - I. Teil. Subgenera Leptusa s. str. Stenoleptusa und Pachygluta. Verh. zool. bot. Ges. Wien, CXII., p. 5-31; II. Teil, Subgenera Typhlopasilia und Tropidopasilia, ibid. p. 32-63.

SCHEERPELTZ, O., 1972: Die Entdeckung neuer Arten ungeflügelter, terricoler Insekten in alpinen und hochalpinen Biotopen der Alpen. (Col. Staphylinidae). Großgattung Leptusa KRAATZ. Revue Suisse de Zoologie. LXXIX, p: 419-499.
Anschrift des Verfassers: Prof. Dr. Otto SCHEERPELTZ, Naturhistorisches Museum, A-1014 Wien I., Burgring 7

## THE HELICONIANS OF BRAZIL (LEPIDOPTERA: NYMPHALIDAE). PART IV. SYSTEMATICS AND BIOLOGY OF EUEIDES TALES CRAMER, WITH DESCRIPTION OF A NEW SUBSPECIES FROM VENEZUELA

Keith S. BROWN Jr. (Rio de Janeiro) and Helmuth HOLZINGER (Wien)

## INTRODUCTION AND HISTORICAL BACKGROUND

The mimetic heliconian species Eueides tales, locally common in the Amazon Basin, western Guianas, Venezuela, and Colombia, was first described by CRAMER in the first volume (1775-1776) of his „Papillons Exotiques." The Guianian form he figured (reproduced in Figure 1) was captured in Suriname; modern collectors in (French) Guyane have not encountered the species, but it continues common in parts of (formerly British) Guyana and probably in Suriname. Like many sympatric species of heliconians and ithomiines, it possesses a succession of red, yellow, and black colors from the base to the apex of the forewing, with the hindwing essentially black on the dorsal surface. The ventral hindwing (right half of Figure 1) bears a series of red rays overlying the veins (not between the veins as in all other similarly rayed heliconians) and fused into an antesubmarginal red line, which is bordered externally by two parallel rows of paired intervenal submarginal white spots.

As Nereis Festiva thales, Jacob HUBNER illustrated in the first volume of his "Sammlung Exotischer Schmetterlinge" (1810) a different form of the same species, presumably from Pará (Figure 2), which although very similar to CRAMER's tales on the ventral hindwing surface, possesses larger yellow markings on the forewing, and well-deve-
loped red rays over the veins of the dorsal hindwing. Recognizing these differences, KIRBY, 1900 rebaptized this rayed form pythagoras, and STICHEL, 1903, unaware of KIRBY's action, renamed the same figure heraldicus.

These two forms (tales and pythagoras, plus intermediates where populations of the two meet near the Amazon and Negro Rivers) occupy nearly the entire Amazon Basin and the western Guianas; the only important variety is that of tales which lacks the rays on the ventral hindwing (Figure 3), named surdus by STICHEL, 1903. In the north-western part of the species' range (see Map), populations isolated in the past (probably during Pleistocene dry spells; see BROWN, SHEPPARD, and TURNER in preparation) have evolved into well-differentiated and still essentially isolated subspecies. In the presumed Napo refugium (HAFFER, 1969) in the upper Amazon Basin of Ecuador and Peru, the subspecies calathus STICHEL, 1909 originated and is found locally today, with the same appearance (Figure 4) as that of other rayed heliconians in this area. As with the other species, this phenotype in tales appears today in mixed populations over much of the Amazon Basin west of Manaus (Figure 5).

The unity of the various subspecies of tales was recognized early in the systematic study of the Heliconiini, and was presented in essentially complete form by STICHEL and RIFFARTH, 1905, SEITZ, 1913 (with inaccurate illustrations), and NEUSTETTER, 1929. Only the east Colombian subspecies, then known as heliconioides (auct. nec. FELDER), was maintained separate by these authors. It was correctly joined to tales in EMSLEY's more recent revision (1965). The recent discovery that the description of heliconioides FELDER, 1861 showed it to possess intervenal rays reaching nearly to the hindwing margin, and a single row of paired white submarginal dots (HOLZINGER and HOLZINGER, 1969), placed this form with the upper Amazonian species Eueides eanes HEWITSON, 1861; the eastColombian subspecies of tales (Figure 6) thus acquired the name cognatus* WEYMER, 1890. The paper which clarified this systematic aspect also discussed the synonymy of the central Colombian subspecies xenophanes FELDER, 1865 (Figure 7), and commented on some further names in the tales complex.

Other recent papers by the present authors have described a new subspecies of Heliconius xanthocles from Venezuela (HOLZINGER and HOLZINGER, 1971), and discussed the taxonomic status of Heliconius clysonymus and hygiana (idem., 1970), some new transitional forms of H. cydno (idem., 1968), the ecology and biology of the dis-

[^0]appearing primitive species $H$. nattereri (BROWN, 1970, 1972), and the species of heliconians known from Brazil, with a supplementary revision of the tribe (BROWN and MIELKE, 1972). This paper presents a complete systematic revision of the species Eueides tales, with comments on the subspecies and their distributions (including description of a new subspecies from the Sierra Perijá, Venezuela), and description of the juvenile biology of this species, which represents one of the few reported cases of evident Müllerian mimicry in Lepidopterous larvae.

## SYSTEMATICS

We have briefly presented support for the maintainance of the genus Eueides separate from Heliconius (BROWN and MIELKE, 1972); the character differences which suggest the biological validity of this separation, in contradiction to the fusion proposed by MICHENER, 1941 and adopted by EMSLEY, 1965 and other recent authors, are summarized in Table I.

The morphology of Eueides tales was amply discussed by EMSLEY, 1965; we have also illustrated a comparison of the male genitalia with those of the externally similar but not closely related species Eueides eanes (HOLZINGER and HOLZINGER, 1969), the only other rayed species in the genus. The species tales may be immediately separated from all other known heliconian species, and indeed from all other butterflies in the local mimetic complexes in which tales subspecies participate, by the ventral surface of the hindwing, which carries a unique combination of a double row of paired intervenal submarginal white spots. and red scaling, usually including welldeveloped rays, overlying the veins (actually concentrated immediately alongside the veins on both sides). Occasional individuals in the more western part of the Amazon Basin show a partial obliteration of the inner row of submarginal white dots, but still possess rays overlying the veins rather than between them; one such individual, from São Gabriel on the upper Rio Negro, was named „Eueides eanes f. lucretius" by ZIKAN, 1937 (Figure 8).

The division of Eueides tales into subspecies and acceptable named forms is delineated in the accompanying Key. Many individuals, especially found near large rivers or where two subspecies intermingle, will not correspond exactly in color pattern with the named forms pictured in Plate $I$; these, as well as two of the forms pictured (Figure 5), are not judged to be worthy of new names. The distributions and interactions of the subspecies are pictured in the Map, and further discussed below under Behavior and Genetics. The only subspecies of tales which intergrade in wellmarked hybrid zones are those found in the Amazon Basin (tales, pythagoras, cognatus, and calathus); the patterns of their separation, and the locations of the secondary hybrid zones today, strongly
suggest the action of forest refugia during dryer periods of the Pleistocene (see HAFFER, 1969; TURNER, 1971; and BROWN, SHEPPARD, and TURNER, in preparation). The sizes of the secondary contact zones between subspecies indicate appreciable mobility for the species (see below, under Behavior).

TABLE I
SIGNIFICANT CHARACTER DIFFERENCES BETWEEN EUEIDES AND HELICONIUS

Criteria

1) MORPHOLOGICAL

Female foretarsi
Signa on female bursa copulatrix

Spermatheca
Male androconia
Antenna length
2) KARYOLOGICAL
(Suomalainen, Cook, and Turner, 1972; Brown, Emmel, and Suomalainen, in prep.)
3) CHEMICAL
(Brown, 1967; Brown
and Domingues, 1971)
4) BIOLOGICAL (JUVENILE)

Egg
Head-pattern of mature larva

Chrysalis position (Turner, 1968)
5) BEHAVIORAL (ADULT)

Pollen collection (Gilbert, 1972)
Home-range near foodplant

Egg-laying by female

Eueides

Four-segmented
Often unsymmetrical and/or curved more than $90^{\circ}$
Narrow duct
Usually confined to veins on hindwing Shorter than onehalf FW radius*
$\mathrm{N}=30-32$, as in most other primitive heliconian genera*

No storage of 3-hydroxykynurenine as yellow pigment in wings or body

Heliconius

Five-segmented*
Symmetrical, curved less than $90^{\circ}$, or completely absent* Broad duct* Spread out over hindwing membrane* Longer than onehalf FW radius
$\mathrm{N}=21$ except in doris ( $\mathrm{N}=20-30$ ) and three highly evolved species in the saphogroup ( $\mathrm{N}=32-33$ or 56-59)

All species except the very evolved sapho store 3-hydroxykynurenine as a wing/body pigment*

Usually large, yellow Usually yellow, sometimes black, rarely with any stripes Hangs vertically

All species collect
Many species range far away from foodplant* Usually on a growing meristem, or on younger leaves*

[^1]The new subspecies from northwestern Venezuela partakes of characteres of the neighboring extra-Hylaean subspecies of tales [pseudeanes BOULLET \& LE CERF, 1910 (Figure 9), xenophanes FELDER (Figure 7), and cognatus WEYMER (Figure 6)], but populations intermediate between it and any of these neighboring forms are as yet unknown. To date, the new subspecies has not been collected outside of a very limited area, at moderate elevations on the eastern slope of the Sierra Perijá, which divides Venezuela from Colombia near the Caribbean Sea; it was probably derived in the Catatumbo refugium of HAFFNER, 1969 during the Pleistocene. A description follows:

## Eueidestalesfranciscus, n. ssp.

## (Figure 10)

Wing size (FW radius $32-34 \mathrm{~mm}$.) and shape, and body markings (white dots), exactly as in nominate subspecies. Forewing dorsally black; red markings reduced to two narrow lines in basal half of wing, one along the inner margin and one between the anal and cubital veins; a yellow median area, divided into a square or subtriangular spot at the distal end of the cell, and a wide compact curved band, uniform in width, lying outside the cell between the radius and vein Cu2; a short yellow streak anterior to this patch, near the costal margin. Forewing ventrally similar, either without red markings or with a narrow red streak in the basal third of the cell; 1-3 pairs of submarginal white dots above the anal angle; and a short yellow costal streak.

Hindwing dorsally black, with very limited red scaling over the basal parts of the cubital and anal veins, in some specimens also over veins Cu1 and Cu2. Hindwing ventrally as in nominate subspecies, with moderate development of red rays overlying the veins, these usually fused into a submarginal red line, and two rows of paired intervenal submarginal white dots. Costal stripe yellow, reddish at the distal tip, extending to above the end of the cell.

Sexes similar, except that the female has fuller and rounder wings and bears somewhat more red scaling at the base of the dorsal surface of the hindwing.

HOLOTYPE MALE, 28 -VIII - 1970, Tucuco, Zulia ( $1200 \mathrm{ft} .=360 \mathrm{~m}$. ). eastern slope of the Sierra Perijá, Venezuela; donated to the collection of the Facultad de Agronomia, Universidad Central de Venezuela, Maracay, by H. and R. Holzinger; Buderacky leg.

ALLOTYPE FEMALE, no date, same locality, in the collection of Harold Skinner, La Victoria, Aragua, Venezuela.

PARATYPES: One male, $30-\mathrm{X}-1960$, Tucuco, in the collection of the Facultad de Agronomia; one male. 21-VI-1969, Tucuco, in the collection of Harold Skinner; one male and two females, 26-XI1969, and one male and one female, 27-XI-1969, Tucuco, in the col-
lection of Koroku Negishi, Kanazawa, Japan; one male, 24-XI1969, Tucuco, in the collection of K. Brown, Rio de Janairo, K. Negishi leg.; two males, 18 -VII-1970, one male, 6-XI-1970, and one male, $30-\mathrm{X}-1970$, Tucuco, in the collection of H. and R. Holzinger, Vienna, Buderacky leg.

The subspecies name is a noun in apposition, in the masculine nominative singular, and is proposed in honor of Dr. Francisco Fernández Yépez of the Facultad de Agronomia in Maracay.

## MIMICRY

All of the Amazonian subspecies of tales participate in mimetic complexes, consisting principally of other dennis or dennis-rayed heliconians (which vary in close parallel over the entire Amazon area), with some additional heliconians and ithomiines, dysschematid ( $=$ pericopid) moths, and a variety of Batesian mimics among nymphalids, riodinids, pierids, and papilionids. Table II presents a synopsis of some of the Müllerian mimics in these complexes (most of the Batesian mimics are rare and little-known, as the theory predicts that they should be). The lists are based upon field experience and reliable data from recent collections within tales colonies. The extra-Amazonian subspecies have very reduced mimetic associations. It is interesting to note that many other Amazonian heliconians have differentiated to a greater degree than has tales during the Pleistocene isolations (or tales has since managed to eliminate more effectively the results of differentiation).
No subspecies of tales has yet been found in the extreme southwestern Amazon (northern Bolivia), where the predominant pattern in the dennis-rayed heliconians is a compact square yellow forewing area centered over the end of the cell (as in cognatus, Figure 6), and reduced dark red dennis and rays. This area is locally inhabited by the similar Eueides eanes heliconioides ( $=$ eanides STICHEL; see HOLZINGER and HOLZINGER, 1969), and may harbor an as yet undiscovered and similar subspecies of Eueides tales, similar to cognatus but with better ray development; specimens of typical cognatus in the Museu Nacional, Rio, labelled "San Felippe, Alto Juruá" ( $=$ Eirunepé, Amazonas) and in the Naturhistorisches Museum in Vienna, labelled „Bolivia", are almost surely mislabellings, however. Some evidence for the existence of this suspected but undiscovered subspecies near cognatus may be found in the occurence of the form barcellinus ZIKAN, 1937 (Figure 11) in southern Rondônia, where many other sympatric heliconians show at least a part of their populations with constricted forewing bands. This form was described from far north on the Rio Negro, and probably results from an infusion of cognatus genes into the pythagoras population present at Barcelos (see Map).
TABLE II. PARTIAL COMPOSITIONS OF SOME SYMPATRIC MULLERIAN
MIMICRY COMPLEXES IN WHICH EUEIDES TALES SUBSPECIES PARTICIPATE
Other heliconians ITHOMINIINAE Poorly resemble Poorly resemble
(indirect mimicry)

| tales <br> (incl. f. surdus, <br> f. aquilifer, etc. Guyana, Obidos | H. aoede astydamia <br> H. xanthocles xanthocles <br> H. melpomene meriana <br> H. erato amalfreda <br> H. demeter beebei | H. egeria egeria <br> H. burneyi catharinae <br> H. elevatus roraima <br> H. elev. tumatumari | H. numata numata <br> H. ethilla thielei <br> $H$. hecale vetustus <br> Eueides lampeto copiosus | Melinaea mneme mneme <br> Mel. mnasias tecta <br> Mel. satevis crameri <br> Mechanitis mazaeus <br> pannifera |
| :---: | :---: | :---: | :---: | :---: |
| pythagoras including f. barcellinus) Rondônia | H. aoede faleria <br> H. xanthocles paraplesius <br> H. melpomene madeira <br> H. erato amazona <br> H. erato constricta <br> H. demeter eratosignis | H. astraea subsp. <br> H. burneyi burneyi <br> H. burneyi ada <br> H. doris, f. delila <br> H. elevatus aquilina <br> 9 Eueides vibilia | H. numata forms <br> H. ethilla eucoma <br> H. hecale nigrofas- <br> Eueides isabella unifasciatus $\sigma^{7}$ ciatus | Tithorea h. harmonia Mel. mneme mauensis Mel. mnasias subsp. Mel. maenias pothete Mechanitis polymnia Forbestra equicola |
| Lower rivers Tapajós, Xingu, and Madeirn | H. aoede aoede <br> H. xanthocles vala <br> H. melpomene thelxiope <br> H. erato amazona <br> O' Heliconius demeter | H. egeria hyas <br> H. burneyi burneyi <br> H. doris, f. delila <br> H. elevatus bari r bouqueti 9 <br> Y Eueides vibilia | H. numata forms <br> H. ethilla eucoma <br> $H$. hecale fortunatus <br> Eueides isabella <br> Eueides lampeto <br> unifasciatus $\sigma^{\text {º }}$ | Tithorea harmonia <br> Mel. mneme mauensis <br> Mel. mnasias mnasias <br> Mechanitis Ianē <br> Mechanitis mazaeus <br> Mechanitis polymnia |
| calathus Eastern Ecuador | H. aoede bartletti <br> H. xanthocles melittus <br> H. melpomene aglaope <br> H. erato emma <br> H. demeter demeter <br> Eueides eanes eanes | H. a. astraea <br> H. b. burneyi <br> H. doris, f. delila <br> H. elevatus elevatus | H. numata euphone <br> H. hecale quitalena | Mel. m. menophilus Mel. maeonis maeonis Mechanitis mazaeus Forbestra truncata Hypothyris ssp. |
| f. michaeli Eastern Peru | H. aoede cupidineus <br> H. xanthocles melior <br> H. melpomene flavotenuiata <br> H. erato emma <br> H. demeter demeter <br> Eueides eanes eanes | H. a. astraea <br> H. burneyi huebneri <br> H. elevatus pseudocupidineus \& Eueides vibilia | Hel. numata euphone <br> H. ethilla adela <br> H. hecale sisyphus, <br> form felix <br> Eueides isabella <br> unifasciatus $\sigma^{7}$ | Mel. m. menophilus <br> Mel. maenas tarapotensis <br> Mel. egesta egesta <br> Mech. isthmia eurydice <br> Mechanitis mazaeus <br> Hypothryris euclea |
| cognatus <br> East-central Colombia | H. aoede lucretius <br> H. xanthocles flavosia | H. egeria asterope <br> H. burneyi lindigii <br> H. doris eratonius ㅇ Eueides vibilia <br> H. elevatus perchlora | H. numata messene H. hecale ithaka unifasciatus $\sigma^{*}$ | Melinaea i. isocomma Mel. mothone messenina Mechanitis mazaeus messenoide |

## BEHAVIOR

Adults of Eueides tales, like most members of the genus, are usually to be found within a few dozen meters, and often within less than ten meters, of their food-plant. The females, especially, spend much of the day flying around the Passiflora vines on which they place their eggs, individually, on the ventral surface of older leaves. The males indulge in much small-scale promenading, usually from five to ten meters above the ground, and demonstrate well-marked territoriality, vigorously chasing other males which pass through their area or in front of their perch. In sparse populations, these territories may be quite large, and promenading males may be found over 50 m . from the food-plant; in dense populations, the areas defended by males are correspondingly smaller.
In spite of this apparently marked home-range behavior and the extremely localized nature of tales colonies, the phenotypic composition of Amazonian populations of tales indicates that, at least at some times, the males and/or females range widely, creating effective gene-flow across large rivers and over several thousand kilometers of forest. On the north and south banks of the Rio Negro at Manaus, width about six Km. from forest to forest, populations are found of three Heliconius species (erato, demeter, and aoede), which are rather sedentary and strongly restricted to shady forest, whose phenotypic compositions indicate essentially no gene-flow of colorpattern elements across the river. More powerful flyers in the same genus (egeria, burneyi, and numata) show appreciable geneflow across the river; and E. tales populations are also much hybridized to the north and south of the river, indicating that the species is capable of crossing this distance of open water. Similarly, downriver in Obidos (north bank of the Amazonas) and Santarem (south bank), the populations of tales demonstrate the existence of considerable gene-flow across the river. This is shown, on the north bank, by the form aquilifer STICHEL, 1903 (Figure 12), with the yellow forewing pattern of pythagoras but the hindwing of tales, and by the presence of occasional rayed individuals; and, on the south bank, by the form zernyi NEUSTETTER, 1928 (Figure 13); with the tales forewing pattern and a pythagoras hindwing, and by the presence of individuals with reduced expression of the rays. Both here and in Manaus, populations on both riverbanks show variable development of the rays, while farther north away from the banks, rays are always absent, and farther south, always present. In ObidosSantarém as in Manaus, the river is an effective barrier for aoede and the dennis-rayed (more forest-restricted) forms of erato and melpomene; however, the more open-country-adapted red-banded forms of the latter two species can cross the Amazon in a variety of areas between Itacoatiara and Santarém, appearing on both banks of the river.
The west Amazonian phenotype with a reduced yellow forewing band (elimination of yellow in the cell) may be found in populations over two thousand kilometers downriver in Manaus (Figure 5); the
condensed square forewing band of cognatus may be found one thousand kilometers downstream at Barcelos, or far south in Rondônia. These data indicate appreciable expansion of these forms since their first formation, to occupy today much of the upper Amazonian aera (see Map). In this case, as the forest is continuous today over much of this area, the correspondending phenotypes of erato, melpomene, aoede, and other heliconians have also expanded to occupy similar areas. However, the cognatus-like erato reductimacula has not crossed the Colombian llanos, being replaced in them and westward to the Andes by the red-banded erato hydara. The appearance of cognatus and even pythagoras (as form barcellinius in the llanos and as far as the slopes of the eastern Colombian cordillera, and of similar-appearing subspecies of tales in other parts of Colombia and Venezuela well away from the Hylaea, indicates a tolerance by tales of dryer and more open habitats, which is not shared by Amazonian forms of erato and melpomene.

## GENETICS

The compositions of the hybrid populations produced where two or more subspecies of tales meet and mingle (see Map) permit some predictions to be made on the nature of the major color-pattern characters of this species, which may correspond to principal genes. Experimental work in crossing has not yet been performed, however, and the following discussion is necessarily rather speculative.

Dennis. The red base of the forewing is probably controlled by a single gene, possibly not homologous to those operating in the Ama-

## EXPLANATION OF THE MAP

The distribution of each of the seven subspecies of tales in the northern half of South America is indicated by an area enclosed by a heavy dark line; anywhere within this area where, suitable habitat and food-plants exist, the illustrated subspecies may be expected to occur. Known localities for the various subspecies and forms are indicated by a variety of symbols, which are assigned to names beside the respective illustrations. In cases where two or more subspecies meet and intermingle, cross-hatching - single, double, or triple (near Manaus) - defines the regions where mixed forms are to be expected: $45^{\circ}$ for calathus mixture, $135^{\circ}$ for cognatus mixture, and $80^{\circ}$ for tales mixture with the central subspecies pythagoras.

## ERKLARUNG DER KARTE

Die Verbreitung jeder der sieben Subspezies von tales in der nördlichen Hälfte Südamerikas ist durch eine das Gebiet umfassende starke schwarze Linie gekennzeichnet; überall innerhalb dieses Gebietes, wo in einem geeigneten Biotop die Futterpflanze vorkommt, ist die abgebildete Subspezies zu erwarten. Bekannte Fundorte für die verschiedenen Subspezies und Formen werden durch verschiedene Symbole gekennzeichnet; diese sind mit dem zugehörigen Namen der entsprechenden Abbildung beigefügt. Wo sich zwei oder mehr Subspezies treffen und kreuzen, ist das Gebiet, in dem Mischformen zu erwarten sind, durch Schraffierungen - einfach, doppelt oder dreifach (bei Manaus) - definiert: $45^{\circ}$ für Mischpopulationen von calathus, 1350 für solche von cognatus und $80^{\circ}$ für die von tales mit der zentralen Subspezies pythagoras.

zonian forms of Heliconius erato and melpomene. Probably simply modified to the reduced form shown by cognatus and pseudeanes; the extreme reduction to a double red line in xenophanes and franciscus is likely to be a different allele.

Ray. The unique red ray pattern over the hindwing veins of tales is surely controlled by several genes, and probably is not linked to dennis; the continous development of the rays in hybrid populations, and the great variability in almost all populations, precludes the hypothesis of a single dominant gene, as in erato and melpomene (SHEPPARD, 1963; TURNER and CRANE, 1962; TURNER, 1971). The rayed phenotype is nearly confined to the south and west of the Amazonas and Negro rivers, except for occasional crossings as discussed above.

The suppression of the rays on the ventral surface of the hindwing in surdus may be a single semi-dominant gene, as it affects populations of pythagoras across the river, and has nearly eliminated rays from all populations of tales tales except for a few in the Guianas.

Forewing band. The normal pythagoras-type band can be modified (probably more than one gene) by reduction of size of the inner and outer elements, to give the type seen in tales and surdus. A further reduction of all elements, with essential disappearance of the spot in the cell, occurs in the Obidos area and gives the form reducta NEUSTETTER, 1931 (Figure 14). The cognatus-type constricted band, produced formally by widening of the elements in M3 and Cu1 and their dislocation toward the cell, may be a separate allele, also possibly present in modified form in franciscus n. ssp.; its presence can be detected as far east as Barcelos and Manaus, and as far south as Rondônia, in Brazil. The outer band of calathus may prove to be a very distinct character; when it interacts with the cognatus or the pythagoras band, forms appear (Figure 5) in which only a small yellow spot remains, beyond the cell on the forewing. However, a specimen of pythagoras from Benjamin Constant in the Museu Nacional has only a partial reduction of the cell element, as if intermediate to calathus. This phenotype has spread north as far as La Macarena in Colombia, and east south of the Negro as far as Manaus, from its center in eastern Ecuador and Peru; it also seems to be present in a somewhat modified from in xenophanes and pseudeans. Further reduction of the forewing band in the Huallaga valley gives the form michaeli ZIKAN, 1937 (Figure 4), which also tends to have stronger and more orange hindwing rays, like other sympatric heliconian species.

Aberrations. EMSLEY, 1965 mentioned specimens from Santarém with the dennis and ray ${ }^{\text {stone-colored }}$ " rather than red. The Museu Nacional in Rio has similar aberrations in a number of species of heliconians, in which the red pigment is completely replaced by a
flat greyish-beige. This color change is probably produced by a single environment-conditioned biochemical malfunction in the synthesis of the red pigment.

The Museu Nacional also contains an unusual surdus from Obidos in which the yellow spot-band on the forewing has been enlarged to cover the entire median area, with fuzzy edges; this is apparently an individual aberration of unknown, but probably genetic, origin.

## JUVENILE BIOLOGY

The early stages of Eueides tales have been seen and studied in four widely separated areas, representing the northeastern, northwestern, and southwestern extremes and the center of the species' range; no gross regional or subspecific differences were apparent.
'The first discovery was on January 6, 1971, on the steep humid escarpment between Atkinson Field (the Georgetown, Guyana airport) and the valley of the Demerara river, less than a kilometer from the airport installations. A female of $t$. tales was observed repeatedly investigating and laying eggs under older leaves of a large vine in the Passiflora laurifolia group, which remained unidentified (no flowers were discovered). Careful subsequent inspection of all branches of this vine, which was also being visited by a female of Heliconius numata numata, disclosed four eggs, two first-stage and a thirdstage larvae of tales, all under older leaves, in addition to an egg and a mature larva of numata on younger growth. There was also discovered a most singular mature heliconian caterpillar, similar to that of numata but with far longer scoli and yellower final abdominal segments. In spite of its unique appearance (Figure 21), this larva was presumed to belong also to tales, a guess which was later confirmed by rearing up various larvae to maturity.

In October 1971, eggs and larvae of $t$. pythagoras were discovered and reared partly through in Riozinho, Rondônia, the opposite extreme of the species' range. The foodplant was once again a species in the Passiflora laurifolia group, probably undescribed but near to P. nitida and $P$. guazumaefolia. Further early stages were discovered and reared, across the Rio Negro from Manaus in October-November 1971 (hybrid population, $t$. tales $-t$. pythagoras - t. calathus) on a species very near P. laurifolia and on P. nitida; and in La Macarena in eastern Colombia in February 1972 (hybrid population, t. pythagoras - t. cognatus - t. calathus), on a species very near to P. laurifolia, also being fed upon by Heliconius numata larvae.

The egg of E. tales is similar to that of many other members of the genus (small and whitish), and the early larval stages likewise resemble those known for other species of Eueides, though somewhat darker in overall coloration. However, the late fourth- and fifthinstar larvae substitute, for the traditional Eueides color-pattern,
a strikingly different appearance almost identical to that of the larvae of Heliconius numata (Figure 23) and Heliconius melpomene (Figure 24), which frequently feed upon the same vines as tales larvae. This radical departure of the mature tales larva from the normal Eueides larval color-pattern, to adopt a much more visible white-spotted-with-black coloration, can best be rationalized as a well-marked instance of Müllerian mimicryin caterpillars (see also TURNER, 1968, and CARPENTER, 1913). The same phenomenon can also be observed in the larvae of Passiflora-feeding Dioptid moths of the day-flying genus Josia, which strongly resemble, except for the lack of scoli, all known Eueides larvae (aliphera, pavana, vibilia, isabella, and lybia) except tales. The other Eueides larvae possess a generalized longitudinally striped pattern, far more cryptic and disruptive than that of tales, and several of them live gregoriously or semi-gregariously and adopt coordinated aggresive behavior when disturbed, patterns not seen in tales. The larvae of Heliconiini are probably at least as distasteful as the adults, sequestering alkaloids, saponins, and/or cyanogenic glucosides from the passifloraceous host-plants (K. BROWN, work in progress) to which they are totally restricted. Thus, a solitary but non-aggressive larva of a highly localized species such as that of tales would acquire appreciable protection against predators, by resembling larvae of microsympatric, abundant and widespread heliconians such as those of melpomene and numata.

## DESCRIPTION OF EARLY STAGES

Egg. (Figures 15, 16): a creamy white ovoid truncated at bottom, about $0,80 \mathrm{~mm}$. in diameter and $1,05 \mathrm{~mm}$. in height, with $8-10$ horizontal ridges (irregular on hemispherical top) and 16-17 vertical ridges. Placed under an older leaf of a Passiflora in the subgenus Granadilla, series laurifoliae. On the day before hatching, the cap of the egg turns very dark (Figure 16). Duration two to seven days (normally five to six days if fertilized only when laid).
Larva translucent whitish, with a black head and very prominent dark setae, about $1,5 \mathrm{~mm}$. long when hatched. Eats by rasping the undersurface of the leaf; tolerant of other caterpillars but not gregarious. Passes through a banded phase at the end of the first instar (Figures 17 and 18), with alternate green, black, and white, occasionally with reddish, narrow rings around the thorax and abdomen. Length at end of first instar, about $4,0 \mathrm{~mm}$.; duration of instar two to seven days, often much prolonged on older or tougher leaves.

Second instar (Figure 19) essentially all black, armed with approximately equal scoli ( $1,5 x$ height of head capsule) on the head, thorax, and abdomen. Maximum length near 7 mm .; duration two to five days.
Third instar (Figure 20) still very black, but with a yellow head and a yellow-orange patch covering the dorsal half of the eighth and ninth abdominal and anal segments. All scoli black; thoracic
scoli relatively very short; head scoli $3-3,5 x$ head height, very prominent; abdominal scoli about $2,5 \mathrm{x}$ head height. A few whitish spots appear on the abdomen by the end of the instar. Maximum length about 11 mm .; duration two to four days, prolonged on older leaves.

Fourth instar initially dark as third, rapidly becoming lighter with the progressive deposition of white pigment during the instar; by the end, almost like the fifth-instar larva. All scoli dark; head scoli $3,5-4 x$ head height (about 6 mm .), abdominal scoli up to 4 mm .; head light yellow, final abdominal segments capped with yelloworange. Maximum length about 18 mm .; duration three to five days.

Fifth instar (Figure 21) white, with dark pigment spots in a pattern nearly identical to that of the mature larvae of Heliconius numata (Figure 23) and H. melpomene (Figure 24); underparts dark; head, and dorsal parts of eighth and ninth abdominal segments and anal segment, bright yellow-orange. Ocelli and all scoli black; head scoli $4,5 \mathrm{x}$ head height (up do 14 mm . long, or nearly half of the overall length of the larva); abdominal scoli up to 8 mm . long; prolegs yellow-brown. Maximum length about 30 mm .; duration near 7 days. Curls up double for a day, under a horizontal surface (generally a leaf), before pupation.

Pupa (Figure 22) as illustrated by TURNER, 1968, strongly bowed at eighth abdominal segment, to lie horizontally under the leaf surface. Color strong yellow with a few darker markings, especially paired large dorsal spots on 7 AB and between 8 AB and 9 AB ; short recurved unbranched head appendages; unbranched paired subdorsal spines on 3 AB and 4 AB ( 5 mm .), 5 AB ( 2 mm .), and 6 AB ( $1,5 \mathrm{~mm}$.), with short pointed tubercle-like spines on $2 \mathrm{TH}, 3 \mathrm{TH}, 2 \mathrm{AB}$, and 7 AB . Length 18 mm .; duration $10-14$ days.

## ACKNOWLEDGEMENTS

The authors are grateful to Harold Skinner, Francisco Fernández Yépez, Ernesto W. Schmidt-Mumm, Leoncito Denhez, Hermann Gerstner, Koroku Negishi, Stephen S. Tillett, and the curators of the Naturhistorisches Museum in Vienna (Dr. Kasy), the Carnegie Museum in Pittsburgh (Dr. Clench), the Instituto Oswaldo Cruz in Rio (José Jurberg), and the Museu Nacional in Rio (Dr. Rêgo Barros), for information, specimens, field assistance, and further valuable aid in the collection of the data for this paper. Dr. John R. G. Turner (New York) and Dr. W. W. Benson (Rio) provided helpful comments on the manuscript, and the latter aided in field studies in Colombia and Manaus. KB also thanks the Conselho Nacional de Pesquisas for a stipend as Pesquisador-Conferencista and travel expenses; the Instituto Nacional de Pesquisas da Amazônia for hospitality and assistance around Manaus; and the Banco Nacional do Desenvolvimento Econômico, the Nacional Science Foundation (Grant GB 5389 XI), CAPES, and the Conselho de Pesquisa e Ensino para Gra-
duados of the UFRJ for general financial support of chemical studies of Brazilian insects. Photographs are by K. Brown, with enlargements prepared by Jorge H. Leāo.

## SUMMARY

The mimetic heliconian species Eueides tales may be recognized by the ventral surface of the hindwing, which bears at least partial red rays overlying the veins, and a double row of paired intervenal submarginal white spots. It occurs as seven well-marked subspecies and a further six recognizable forms, over much of the Amazon Basin and Guianas, Venezuela, and Colombia; however, it is very local. The northwest Venezuelan subspecies, known so far from only one locality in the Sierra Perijá, is previously undescribed. The four Amazonian subspecies meet and intergrade over large areas; hybridized populations on the banks of the Amazon and Negro rivers indicate appreciable mobility for the species, and the occurrence of isolated subspecies in Venezuela and Colombia reveals its tolerance for dryer non-forested habitats. The juvenile forms are mostly similar to those of other Eueides species (these and many other criteria indicate good generic status for Eueides, separate from Heliconius), except for the coloration of the mature larva, which converges strongly on the appearance of the larvae of Heliconius numata and H. melpomene, common and widespread microsympatric feeders on Passifloras of the laurifolio group, to which tales larvae also seem to be restriced; this appears to be a well-marked case of Müllerian mimicry in caterpillars.

## ZUSAMMENFASSUNG

Die mimetische Heliconiinen-Art Eueides tales ist durch die zumindest auf der Hinterflügel-Unterseite teilweise vorhandenen und im Gegensatz zu allen anderen vergleichbaren Arten auf den Adern liegenden roten Strahlen, sowie durch eine doppelte Reihe paarweise in den Aderzwischenräumen der Hinterflügel-Unterseite stehender weißer Submarginalpunkte gekennzeichnet. Diese Art ist in sieben deutlich unterschiedenen Subspezies und weiteren sechs kennbaren Formen über den größten Teil des Amazonas-Gebietes und Guayanas, wie auch in Venezuela und Columbien verbreitet, tritt jedoch ziemlich lokal auf. Die Subspezies aus Nord-Venezuela, nur von einer einzigen Lokalität in der Sierra Perijá bekannt, war bis jetzt unbeschrieben. Die Verbreitungsareale der vier Amazonas-Unterarten überschneiden sich, so daß über große Gebiete Mischformen auftreten; Hybridpopulationen an den Ufern des Amazonas und Rio Negro deuten auf eine beträchtliche Beweglichkeit der Art, und das Vorkommen isolierter Unterarten in Venezuela und Columbien läßt auf eine vergleichsweise größere Toleranz der Art gegenüber trockeneren waldlosen Biotopen schließ̣en. Die Jugendstadien (eines der vielen Kriterien für den Status von Eueides als gutes, von Heliconius getrenntes Genus) sind sehr ähnlich denen der anderen Eueides-Arten mit Ausnahme der Färbung der erwachsenen Raupe; diese gleicht im Aussehen stark denen von Heliconius numata und H. melpomene,
häufigen und weitverbreiteten, mikrosympatrisch an Passifloren der laurifolia-Gruppe fressenden Arten (auch die Raupe von tales scheint an diese Futterpflanze gebunden zu sein); es muß dies als ein gutes Beispiel für den selten bekanntgewordenen Fall einer Müller'schen Mimikry bei Raupen angesehen werden.

## KEY

DEFINITION OF EUEIDES TALES: A Nymphalid Lepidopteran with a simple recurved humeral vein on the hindwing, and on the ventral surface of the hindwing complete or reduced red rays overlying the veins (especially anally), and two distinct rows of paired intervenal submarginal white spots.

## SYNOPSIS OF NAMED SUBSPECIES AND FORMS:

1. a. Forewing with basal red marks restricted to one or two narrow lines near the anal margin
b. Forewing with a well-developed basal red area, extending at least halfway distad in the cell
2. a. Dorsal surface of the hindwing with a large red basal patch, covering nearly or more than half the wing, serrate distad but not giving rise to distinct rays (central-west Colombia, very local in the Magdalena valley) (Figure 7) xenophanes FELDER ( = crystalina HALL)
b. Hindwing with very restricted red on the dorsal surface; forewing with a continuous yellow band outside the cell and a smaller square patch within it (Sierra Perijá, Venezuela) (Figure 10)
franciscus n. ssp.
3. a. Forewing yellow area roughly quadrangular, compact, centered over the end of the cell which bears a black triangular mark, otherwise unbroken by black streaks (northeastern Andes of Colombia, east through the llanos to the upper Rio Vaupés, possibly northern Bolivia also) (Figure 6) cognatus WEYMER
b. Forewing yellow area either exclusively extra-cellular, or broken into a number of separate spots by black veins, not squarish or compacted
4. a. Hindwing with very restricted red markings dorsally, usually only a few small streaks baso-anally, not reaching into the outer two-thirds of the wing
5. 

b. Hindwing with moderately to well developed red rays dorsally and ventrally, reaching into the distal two-thirds of the wing, in extreme cases fused laterally into an antesubmarginal red line
6.
5. a. Forewing yellow band continuous, extracellular, and triangular, pointing towards the inner angle; red basal area reduced to three lines, strongly divided by black veins Cu and 1A (southeastern slope of Venezuelan Andes in Barinas and Táchira) (Figure 9) pseudeanes BOULLET \& LECERF
b. Forewing yellow area composed of a number of separate spots, usually including an element within the cell, or if only a single spot beyond the cell, this very small and restricted to above vein M3 (Guianas south to the Amazon and Negro rivers, west to the Rio Branco) tales CRAMER
i. Forewing yellow area restricted to outside the cell.

> i-a. A single spot only or a relatively compact area above vein M3 (Manaus)
i-b. A series of separate spots (Obidos) (Figure 14)
f. reducta NEUSTETTER
ii. Forewing yellow area including a spot in the distal end of the cell.
ii-a. Ventral hindwing with well-developed red rays (western Guianas) (Figure 1) tales f. typ.
ii-b. Ventral hindwing with very poorly developed or no red rays (north Brazil).
ii-b-1. Extracellular area of the forewing broken up into small, subequal spots (Figure 3)
f. surdus STICHEL
ii-b-2. End-cellular and anterior extracellular spots large, the latter much elongated distad into two points (Figure 12) f. aquilifer STICHEL
6. a. Forewing yellow area exclusively extracellular, usually triangular, pointing towards the anal angle (eastern Peru, Ecuador, and Colombia, occasionally eastward as far as Manaus)
calathus STICHEL
i. Forewing yellow area limited to a small spot distad to the end of the cell (La Macarena, Manaus, and other blend areas) (Figure 5) unnamed forms
ii. Forewing yellow area larger, usually subtriangular, with elements present in M3-Cu1 (always) and in Cu1Cu2 (frequently). ii-a. Hindwing red rays not well developed; forewing
yellow area relatively larger, extending to a point
in space Cu1-Cu2 (eastern Ecuador to south-cen-
tral Colombia) (Figure 4 a)
ii-b. Hindwing rays oranger and well-developed, sometimes even fused into a submarginal line; forewing yellow area smaller and usually lacking a spot in space Cu1-Cu2 (eastern Peru) (Figure 4 b)
f. michaeli ZIKAN
b. Forewing yellow band including a small to large spot in the end of the cell (southern and western Amazon area from Belém to Barcelos, southern Venezuela, northeastern Colombia, eastern Peru, Arce, and Rondônia) pythagoras KIRBY ( = heraldicus STICHEL)
i. Forewing band broken up into small separate spots (blend areas near Amazon and Negro rivers: Santarém, Manaus, Barcelos) (Figure 13) f. zernyi NEUSTETTER
ii. Forewing band containing an elongated rectangle in the cell, and a long single yellow spot distad to the end of the cell, with two additional spots posterior to this in spaces M3-Cu1 and Cu1-Cu2.
ii-a. The spot distad to the cell extending into two long points, and the spots below it relatively small (all of southern and western Amazon area) (Figure 2) pythagoras f. typ.
ii-b. The spot distad to the cell quadrangular, not extending into two long points, and the spots below this larger, sometimes nearly fused (northwestern blend areas with cognatus, Rondônia, occasionally in the rest of the range) (Figure 11) f. barcellinus ZIKAN A lectotype of this name is designated in this paper (see explanations of Figures).

## REFERENCES TO LITERATURE CITED

BOULLET, E. \& LECERF, P., 1910: Description de formes nouvelles d'Heliconides, Bull. Museum Paris, 16: 24-26.
BROWN, K. S., JR., 1967: Chemotaxonomy and Chemomimicry: the case of 3-hydroxykynurenine, System. Zoology, Kansas, 16: 213-216.
BROWN, K. S., JR., 1970: Rediscovery of Helicoinus nattereri in eastern Brazil, Entomological News, Philadelphia, 81: 129-140.
BROWN, K. S., JR., 1972: The Heliconians of Brazil (Lepidoptera: Nymphalidae). Part III. Ecology and biology of Heliconius nattereri, a key primitive species near to extinction, and comments on the evolutionary development of Heliconius and Eueides, Zoologica, New York, 57: 41-69.
BROWN, K. S., JR., \& DOMINGUES, C. A. A., 1971: A distribuição do amino-acido 3-hidroxi-L-quinurenina nos lepidopteros, Anais Acad. Brasil. Ciencias, Rio de Janeiro, 42 (suplemento) : 211-215.
BROWN, K. S., JR., EMMEL, T. C. \& SUOMALAINEN, E., 1974: Evolutionary significance of chromosome numbers in Neotropical Lepidoptera. I. Heliconiini, in preparation.
BROWN, K. S., JR. \& MIELKE, O. H. H., 1972: The Heliconians of Brazil (Lepidoptera: Nymphalidae). Part II. Introduction and general comments, with a supplementary revision of the tribe, Zoologica, New York, 57: 1-40.
BROWN, K. S., JR., SHEPPARD, P. M., \& TURNER, J. R. G., 1973: Quaternary refugia in tropical America: evidence from differentiation in heliconian butterflies, in preparation.
CARPENTER, G. D. H., 1913: Synaposematic resemblance between Acraeine larvae, Trans. Royal Entom. Soc., London, 1912: 702-705.
CRAMER, P., 1775-76: De uitlandsche Kapellen voorkomende in de drie WaereldDeelen Asia, Africa en America. Papillons exotiques de trois parties du Monde l'Asie, l'Afrique et l'Amerique, Amsterdam (Utrecht), 1: 62, Pl. XXXVIII, Figs. C, D.
EMSLEY, M. G., 1965: Speciation in Heliconius. (Lep., Nymphalidae): morphology and geographic distribution, Zoologica, New York, 50: 191-254.
FELDER, C. \& R., 1871: Lepidoptera nova Columbiae, Wiener Ent. Monatschrift, 5: 97-111.
FELDER, C. \& R., 1865: Reise der österreichischen Fregatte Novara um die Erde, Lepidoptera, Wien, 2, II: 377-378, Pl. 46, Figs. 14-15.
GILBERT, L. E., 1972: Pollen feeding and reproductive biology of Heliconius butterflies, Proc. Nat. Acad. Sci., USA, Washingtom, 69: 1403-1407.

HALL, A., 1921: Description of three new butterflies from Colombia, The Entomologist, London, 54: 278-279.
HAFFER, J., Speciation in Amazonian forest birds, Science, Washington, 165: 131-137.
HOLZINGER, H. \& HOLZINGER, R., 1968: Heliconius cydno gerstneri, n. ssp. und zwei neue Formen von H. cydno cydnides STGR. (Lep. Nymph.), Zeitschr. der Arbeitsgemeinschaft österr. Entomologen, Wien, 20: 17-21.
HOLZINGER, H. \& HOLZINGER, R., 1969: Zur Synonymie von Heliconius (Eueides) eanes heliconioides FLDR. und $H$. (E.) tales cognatus WEYM. (Lep. Nymph.), ibid. 21: 74-69.
HOLZINGER, H. \& HOLZINGER, R., 1970: Heliconius hygianus fischeri (FASSL) comb. nov., eine Subsepcies aus West-Columbien (Lep. Nymph.), ibid., 22: 33-41.
HOLZINGER, H. \& HOLZINGER, R., 1971: Heliconius xanthocles cleoxanthe, eine neue Subspecies aus Ost-Venezuela (Lep. Nymph.), ibid., 23: 97-99.
HUBNER, J., 1810: Sammlung Exotischer Schmetterlinge, vol. I (1806-1819): Plate 10.

## PLATE I

All butterflies are black, yellow, and red or orange, and are illustrated in life size.
Figure 1. CRAMER's original figures of Papilio tales, dorsal (left) and ventral (right) surfaces.
Figure 2. HUBNER's original figures of Nereis festiva thales, now known as Eueides tales pythagoras, male (a) and female (b), dorsal (left) and ventral (right) wing surfaces.
Figure 3. Eueides tales tales f. surdus, Obidos, Pará, dorsal (left) and ventral (right) surfaces (Museu Nacional, Rio).
Figure 4. Eueides tales calathus, Sarzayacu, Oriente Ecuador, dorsal (a), (compared with holotype in the collection of the Naturhistorisches Museum, Vienna), and Eueides tales calathus f. michaeli (compared with holotype in the Instituto Oswaldo Cruz), Tingo Maria, Peru, dorsal (b) (collection K. B., Rio).
Figure 5. Eueides tales calathus $\times$ pythagoras $\times$ tales, Ponta Negra, Manaus, Amazonas, dorsal (a), and E.t. calathus $\times$ cognatus, Vista Hermosa, La Macarena, Colombia, dorsal (b) (collection K. B., Rio).
Figure 6. Eueides tales cognatus, Rio Negro, Meta, Colombia, dorsal (collection K. B., Rio).
Figure 7. Syntype of Eueides tales crystalina HALL, 1921, synonym of E. t. xenophanes FELDER, Crystalina, west Colombia, 1200 ft ., dorsal (Allyn Museum of Entomology, Sarasota).
Figure 8. Holotype of Eueides eanes f. lucretius ZIKAN, 1937, regarded here as an extreme example of $E$. tales pythagoras f. barcellinus, Sāo Gabriel, upper Rio Negro, ventral (a female, in the Instituto Oswaldo Cruz, Rio, No 27.585). A nearly identical specimen was captured by E. W. Schmidt-Mumm of Bogotá in the upper reaches of the Rio Sarare, near Pamplona in northeast Colombia.
Figure 9. Eueides tales pseudeanes, Barinitas, Barinas, Venezuela, male (a) and female (b), dorsal (collection K. B., Rio).
Figure 10. Eueides tales franciscus n. ssp., holotype male, dorsal (left) and ventral (right) surfaces, Tucuco, Perijá, Zulia, Venezuela (donated by H. \& R. Holzinger to the Facultad de Agronomia, Maracay, Aragua, Venezuela).
Figure 11. Eueides tales pythagoras f. barcellinus, Riozinho, Rondônia, female, dorsal(a) (collection K. B., Rio) and a syntype hereby designated lectotype of this name, Barcelos, Amazonas, 31-VII-1927, J. F. Zikán Collection, No 27.578 of the collection of the Instituto Oswaldo Cruz, Rio de Janeiro, labelled by the collector "Eueides tales f. pythagoras Kirby", male, dorsal (b).
Figure 12. Eueides tales f. aquilifer, Ob́idos, Pará, male, dorsal (Museu Nacional, Rio).
Figure 13. Eueides tales pythagoras f. zernyi, Santarém, Pará, male, dorsal (Museu Nacional, Rio). The type specimen, in the Naturhistorisches Museum (Wien), is a female and bears somewhat longer rays on the hindwing than the illustrated male.
Figure 14. Eueides tales tales f. reducta, Obidos, Pará, female, dorsal (Museu Nacional, Rio) (compared with holotype in the collection of the Naturhistorisches Museum, Vienna).


KIRBY, W. F., 1900: Hübner, Exotische Schmetterlinge, nouvelle edition, corrigé et augmentée, publiée sous la direction de W. F. Kirby, P. Wytsmann, Bruxelles: p. 13.

MICHENER, C. D., 1942: A generic revision of the Heliconiinae (Lepidoptera, Nymphalidae), Amer. Museum Novitates, New York, 1197: 1-8.
NEUSTETTER, H., 1928: Neue und wenig bekannte Heliconius, Intern. ent. Zeitschr., Guben, 22: 245-248.
NEUSTETTER, H., 1829: Nymphalididae: subfam. Heliconiinae, Lepidopterorum Catalogus (Ed. Strand), Junk, Berlin, 36: 1-136.
NEUSTETTER, H., 1931: Neue Heliconius, Intern. ent. Zeitschr., Guben, 25: 185-174.
SEITZ, A., 1913: Die Großschmetterlinge der Erde, Kernen, Stuttgart, 5: 375-399.
SHEPPARD, P. M., 1963: Some genetic studies of Müllerian mimics in butterflies of the genus Heliconius, Zoologica, New York, 48: 145-154.
STICHEL, H., 1903: Synonymisches Verzeichnis bekannter Eueides-Formen mit erläuternden Bemerkungen und Neubeschreibungen, Berl. ent. Zeitsch., 48: 1-34.
STICHEL, H., 1909: Beschreibung einiger neuer Heliconiidae, Soc. entomol., Steiglitz, 23: 178-179.
STICHEL, H. \& RIFFARTH, H., 1905: Heliconiidae, Das Tierreich, 22: 1-290.
SUOMALAINEN, E., COOK, L. M., \& TURNER, J. R. G., 1971: Chromosome numbers of Heliconiine butterflies from Trinidad, West Indies (Lepidoptera, Nymphalidae), Zoologica, New York, 56: 121-124.
TURNER, J. R. G., 1967: Goddess changes sex, or the gender game, System. Zoology, Kansas, 16: 349-350.
TURNER, J. R. G., 1968: Some new Heliconius pupae: their taxonomic and evolutionary significance in relation to mimicry (Lepidoptera: Nymphalidae), Journ. Zool., London, 155: 311-325.
TURNER, J. G. R., 1971: The genetics of some polymorphic forms of the butterflies Heliconius melpomene (Linnaeus) and $H$. erato (Linnaeus). II. The hybridization of subspecies of $H$. melpomene from Suriname and Trinidad, Zoologica, New York, 56: 125-157.
TURNER, J. R. G. \& CRANE, J., 1962: The genetics of some polymorphic forms of the butterflies Heliconius melpomene Linnaeus and H. erato Linnaeus. I. Major genes, ibid. 47: 141-152.
WEYMER, G. (\& MAASSEN, P.), 1890: Lepidopteren, gesammelt auf einer Reise durch Columbien, Ecuador, Peru, Brasilien, Argentinien, und Bolivien, in den Jahren 1868-1877, von Alphons Stübel, Berlin: p. 27.
ZIKAN, J. F., 1937: Neue Nymphaliden-Arten und -Formen aus Brasilien, Entomol. Rundschau, Stuttgart, 54: 328-331.

## ANSCHRIFTEN DER AUTOREN:

Dr. Keith S. Brown, Jr.<br>Centro de Pesquisas de Produtos Naturais<br>Helmuth Holzinger<br>Universidade Federal do Rio de Janeiro<br>Ilha do Fundāo, Rio de Janeiro ZC-32 - Brasilien<br>Nelkengasse 8<br>A-1080 Wien<br>Osterreich

## PLATE II

Figure 15. Egg, Manaus, Amazonas, : $: 0 \times$ life size.
Figure 16. Egg just before eclosion, Riozinho, Rondônia, $20 \times$.
Figure 17. First instar larva, Georgetown, Guyana, $10 \times$.
Figure 18. First instar larva, dorso-anal, Georgetown, Guyana, $10 \times$.
Figure 19. Second instar larva, lateral, Manaus, Amazonas, $8 \times$.
Figure 20. Third instar larva, latero-dorsal, Manaus. Amazonas, $5 \times$.
Figure 21. Mature (fifth instar) larva, latero-dorsal, Georgetown, Guyana, $2,5 \times$ (head scoli foreshortened in this view).
Figure 22. Pupa, latero-dorsal, Manaus, Amazonas, $3 \times$.
Figure 23. Heliconius numata, mature larva, lateral, Riozinho, Rondônia, $1,5 \times$.
Figure 24. Heliconius melpomene plesseni, larva in molt from fourth to fifth instar, Topo, Rio Pastaza, Ecuador, $2,5 \times$ (larvae of other subspecies are essentialy identical).


## ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database
Digitale Literatur/Digital Literature
Zeitschrift/Journal: Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen

Jahr/Year: 1973
Band/Volume: $\underline{24}$
Autor(en)/Author(s): Brown K.S., Holzinger Helmuth Karl Wilhelm
Artikel/Article: The Heliconians of Brazil (Lepidoptera: Nymphalidae). Part IV. Systematics and biology of Eueides tales Cramer, with description of a new subspecies from Venezuela. 44-65


[^0]:    * Emended from original cognata; note, however, that the preservation of author's original names, a practice which would encourage greater nomenclatural stability but which is not approved by the present International Code of Zoological Nomenclature, has been defended in heliconians by TURNER, 1987 and BROWN \& MIELKE, 1972.

[^1]:    * The aoede-group of the genus Heliconius (aoede, metharme, godmani and possibly hierax) shows a mixture of important characters of the two genera, and some major characters of its own, and seems to merit the erection of a new genus (Turner, 1968); the description of this genus is awaiting breeding studies on its members.

