

DESCRIPTION OF A NEW TROPICAL SUBSPECIES OF THE BLACK SWALLOWTAIL BUTTERFLY, *PAPILIO POLYXENES* (LEPIDOPTERA: PAPILIONIDAE) FROM VENEZUELA*

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Abstract

This paper aims to describe *Papilio polyxenes costarum*, a new subspecies, whose populations come from the Cordillera de la Costa Central of northern Venezuela. The populations of this country have traditionally been identified as belonging to the subspecies *americus* Kollar, 1850, which flies in Colombia and integrates to the new subspecies in the Andes of the Cordillera de Mérida in Venezuela, near Colombian territories. Illustrations of adults of this new subspecies were done in order to demonstrate their new status regarding other similar subspecies. Its final-instar larva on host plants of the Apiaceae family is shown.

Key words: *Papilio polyxenes costarum*, neotropical, Venezuela, polymorphism, Apiaceae, immature states.

DESCRIPCIÓN DE UNA NUEVA SUBESPECIE TROPICAL DE LA MARIPOSA COLA DE GOLONDRINA NEGRA, *PAPILIO POLYXENES* (LEPIDÓPTERA: PAPILIONIDAE) DE VENEZUELA

Resumen

Este trabajo tiene el propósito de describir a *Papilio polyxenes costarum*, subespecie nueva, cuyas poblaciones provienen de la Cordillera de la Costa Central del norte de Venezuela. Las poblaciones de este país tradicionalmente se han identificado como pertenecientes a la subespecie *americus* Kollar, 1850, la cual vuela en Colombia y se intergrada hacia la nueva subespecie en los Andes de la Cordillera de Mérida en Venezuela, próximos a las localidades de Colombia. Ilustraron adultos de esta nueva subespecie, para demostrar su nuevo estatus con respecto a otras subespecies similares, e incluso se muestra la larva del último instar sobre una de sus plantas hospedadoras de la familia Apiaceae.

Palabras clave: *Papilio polyxenes costarum*, neotropical, Venezuela, polimorfismo, Apiaceae, estados inmaduros.

INTRODUCTION

Upon having the opportunity to sort and curate swallowtail butterfly specimens at the Museo del Instituto de Zoología Agrícola at the Universidad Central de Venezuela in Maracay (MIZA) an appropriate representation of the American species of the genus *Papilio* Linnaeus, 1758, *sensu stricto* (TYLER *et al.*, 1994) was

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available for study. Most specimens belonged to subspecies of the black swallowtail (*Papilio polyxenes* Fabricius, 1775) collected from several localities of North, Central and South America. From the latter, Venezuelan material coming from the north-central coastal range, or Cordillera de la Costa, and the Andes of Mérida, was compared with neighboring countries, particularly with the tropical subspecies. It became evident that populations from the Cordillera de la Costa belong to an undescribed subspecies, despite the fact that the species has been known from this range since at least the early 20th century (RAYMOND, 1934).

Papilio polyxenes costarum, new subspecies (Figs. 1a-d)

Papilio polyxenes f. *americus*, RAYMOND, 1934, Bol. Soc. venez. Cienc. Nat., 2 (16): 307; *Papilio polyxenes* f. *americus* var. *melasina*, p. 308; *Papilio machaon americus*, FORSTER, 1948, Bol. Ent. venez., 7: 92; *Papilio polyxenes americus*, RAYMOND, 1982, Mar. Venez., pl. 32, figs. 2 & 3 (identified by F. Fernández-Y.)}

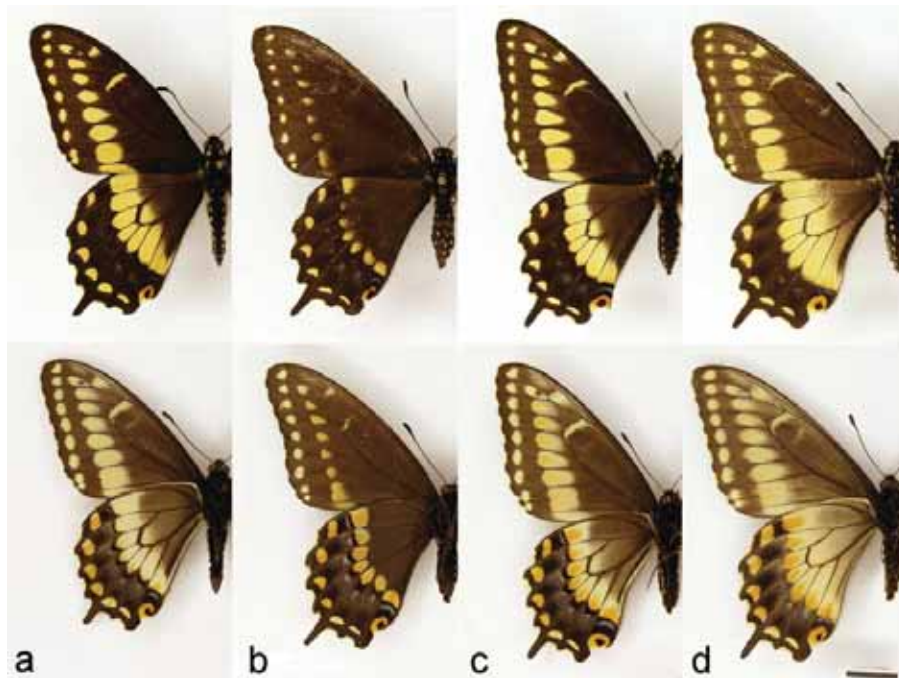


Figure 1. *Papilio polyxenes* specimens from Venezuela. a) *P. polyxenes costarum* ♂ Holotype – Miranda, La Peñita, 1270 m, XII-1974, J. Sanz, leg., ex-larva en eneldo. b) *P. polyxenes costarum*, melanic morph, ♀ Paratype - Carabobo, cr. Canoabo, Palmichal, VIII-1984, F. Fernández-Y. & C. J. Rosales leg., ex-larva en apio. c) *P. polyxenes costarum*, yellow morph, Allotype ♀ - Miranda, Núcleo El Laurel, 1200-1300 m, IX-1972, A. Montagne y J. Sanz leg. ex-larva en apio. d) *P. polyxenes costarum*, ♀ showing *P. polyxenes americus* genetic introgression, yellow morph - Lara, Pque. Nac. Yacambú, El Blanquito, 1450 m, I/II-1987, A. Chacón leg. (all in MIZA). Scale = 1 cm. (photos Q. Arias).



Figure 1-e. *Papilio americus* Kollar, 1850 Lectotype ♂. Naturhistorisches Museum Wien. Photo courtesy of G. Lamas.

Holotype: male, red handwritten label: "*Papilio polyxenes costarum* Orellana/ Holotipo/A. Orellana det., 2004", white handwritten and printed label: "Venezuela, Miranda/La Peñita, 1270 m / xii 1974, J. Sanz leg.", "en Eneldo". REFERVEN collection (Main- MIZA).

Paratypes: Melanic form: 8♂♂, 2♀♀ Distrito Federal, El Valle, vii.1950, F. Fernández Y. leg., ex-larva en umbelífera. Cría 36; 1♂ Distrito Federal, El Manantial, El Junquito, 1200 m, vi.1982, S. Vera leg., [pupal exuvium preserved]; 1♀ Distrito Federal, Bajo Seco, vii. 1982, O. Aponte leg., En anicillo nº 73 1982, [pupal exuvium preserved]; 1♂ Miranda, San Antonio de los Altos, 1350 m, i. 1956, F. Fernández Y. leg., ex-larva (8.i.1956) en anís silvestre, crisálida (12.i.1956), imago (22.i.1956), [pupal exuvium preserved]; 1♀ Miranda, Mariches, carretera de Petare, viii.1953, C. J. Rosales leg; 1♀ Yaracuy, Nirgua, vi.1962; 1♀ Carabobo, Cumbre Aguirre, xi.1951, F. Fernández Y. leg; 1♀ Carabobo, Palmichal, cr. Canoabo, viii. 1984, F. Fernández Y. y C. J. Rosales leg., ex larva en apio, [pupal exuvium preserved]; Yellow form: 1♂ Same as holotype. 3♂♂ Distrito Federal, El Manantial, El Junquito, 1200 m, vi. 1982, S. Vera leg., [pupal exuvium preserved]; 1♂ Distrito Federal, est. exp. Bajo Seco, El Junquito, 2000 m, iii.1978, C. J. Rosales leg; 2♂♂ Miranda, San Antonio de los Altos, 1350 m, i.1956, F. Fernández Y. leg., ex-larva (8-i.1956) en anís silvestre, crisálida (12.i.1956), imago (22.i.1956), [pupal exuvium preserved]; 1♂ y 1♀ Miranda, Núcleo El Laurel, 1200/1300 m, ix.1972, A. Montagne y J. Sanz leg., ex larva en apio; 1♂

idem. x.1972; 4♀♀ Distrito Federal, El Manantial, km 12 El Junquito, 1200-1300 m, vi.1982, A. Vera leg.; 1♀ Distrito Federal, km 14 carretera El Junquito, vi. 1981, D. Vargas leg; 1♀ Distrito Federal, Bajo Seco, vi. 1982, D. Grance leg., en anís de monte nº 53 1982, [larval and pupal exuviae y preserved]; 1♀ Aragua, Col. Tovar, 2000 m, v. 1978, C. Michelangelli, ex-pupa en rama de clavel; 1♀ Miranda, Bajo Seco, 1650 m, i. 1972, E. Ollarves, ex-larva en apio; 1♀ Carabobo, Palmichal, cr. Canoabo, viii. 1984, F. Fernández Y. y C. J. Rosales, ex larva en apio, pupa verde amarillo, [pupal exuvium preserved] (all in MIZA); 1♀ Miranda, Sn. Antonio de los Altos, 1300 m, i.1972, A. Montagne, ex-larva en apio (ex-MIZA. Bollino collection, Lecce-Italy); 1♀ Distrito Federal, Caracas, Las Acacias, 900m, 2. xii. 1966 P. Bermúdez leg., ex-larva (Romero family collection, Maracay-Venezuela); 1♂ Miranda, Sabaneta, near Turgua, S.E. of Caracas, 1000 m, R. DeLaFuente leg., coll. Neild 9.ii. 1980 (Neild collection, London-UK).

Diagnosis: Yellow hindwing bar is far less wide than in *P. polyxenes americus* Kollar, 1850, being similar to *P. polyxenes stabilis* Rothschild & Jordan, 1906 and *P. polyxenes sadalus* Lucas, 1852 (see Fig. 2). The bar occupies the distal quarter of discal cell and never touches the base of CuA₂. On the ventral surface of the HW, the basal quarter is less yellow, being clothed in dark gray scaling. Both surfaces of the forewing are similar to *americus*, blotches slightly smaller. A melanic form is also known, but it is indistinguishable from that of *P. p. americus* described as f. *melasina* Rothschild & Jordan, 1906.

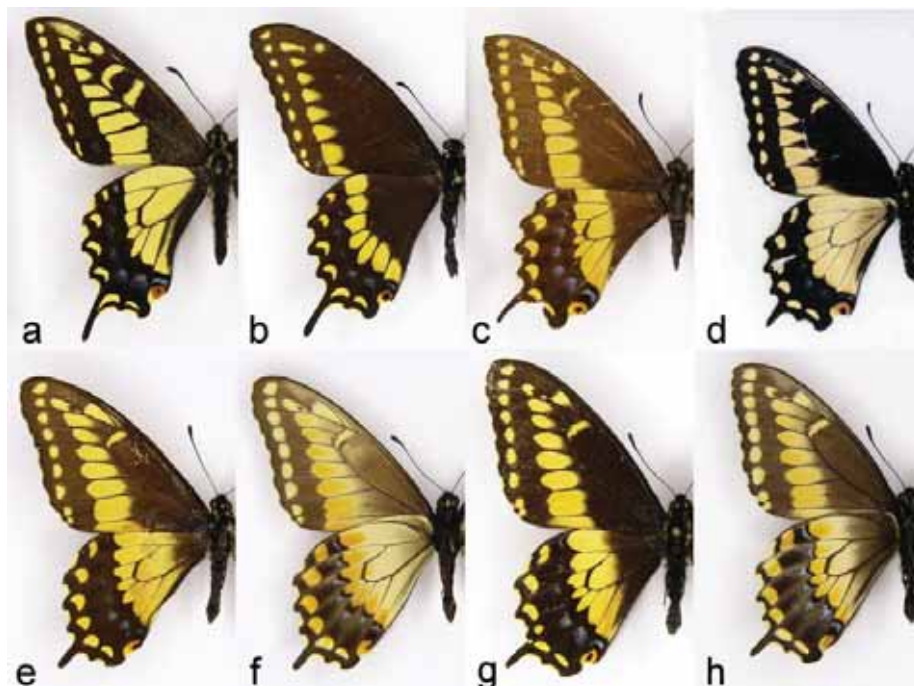


Figure 2. *Papilio polyxenes* ♂♂ specimens of representative subspecies. a) *P. polyxenes zelicaon* - USA, California, Orange County, Costa Mesa, IV-1953. b) *P. polyxenes asterius* - México, Chiapas, Muste, XI-1968, E. Welling leg. c) *P. polyxenes stabilis* - Costa Rica, Juan Viñas, 930 m, V-1932, C. Ballou

leg. d) *P. polyxenes gerardi* Holotipo –Perú, Cajamarca, road Celendín-Balsas, about 6°51'S 78°05'W, 1800-2500 m, VI-1998, Rainer Marx leg. (ex. col. Bollino, Lecce-Italia, deposited in MUSM, Lima – Perú). e) *P. polyxenes americanus* –Colombia, Cali, 1000 m, II-1973, L. Denhez leg. f) *P. polyxenes americanus* – same, ventral surface. g) *P. polyxenes sadalus* –Ecuador, Cotopaxi, Agoa, 700 m, VIII-1973, D. Velástegui leg. h) *P. polyxenes sadalus* – Same ventral surface. (All in MIZA except (d) as indicated). (photos by the author except (d) by M. Bollino).

Description: Yellow form. Body and wings black with pale yellow markings. Thoracic and cephalic appendages black. Head with two yellow spots behind the eyes and antennae. Genae yellow. Eyes dark walnut brown. Patagia and tegulae with a yellow dot/streak each (respectively). Abdomen with two dorsolateral dots on the sides of each segment. Dorsal surface: Forewing with two rows of yellow blotches. That in the median area with larger blotches, forming a straight bar interrupted at veins, starting at the distal quarter of the basal margin to the proximities of the apex. The blotch below R_3 is shifted towards the discal cell. Blotch on space R_4 is divided into a large distal one and a smaller proximal. The external row lacks a blotch on 1A. The end of discal cell has a yellow streak. Terminal edge alternates yellow streaks between veins. Hindwing with a median yellow bar, barely twice as wide as the thorax on its broadest portion, extending across the center of the wing from the inner edge to the anal edge passing through the distal end of the discal cell. The bar widens at its middle portion and abruptly acuminate at the tornal area. There, the edge is bordered by yellow from the end of the bar towards the base of the wing. Veins at end of cell that enter the bar are broadly black. A row of yellow crescents and an orange, distally graded to yellow, anal black-pupilled eyespot lies near the terminal border. Between this row and the central bar is a dusting of blue scales, much reduced towards the apex where it is totally absent. Depth of toothed terminal edge streaked with yellow. No-spatulate straight short tail at end of M_3 . Ventral surface: Background dark gray, with vestigial veins in cell (M) and basal area (CuP) yellow. Basal area slightly dusted in yellow. Same elements as on dorsal surface, only that yellow blotches are slightly larger, thus enabling the dorsal blotches see-through due to excess black. Yellow blotches with an additional smaller orange dot shifted distally on the median bar and almost completely on submarginal row. Blue scaling more produced. Distal edge of median bar lined in black. Anal and inner edge bordered in yellow.

Variations: Females differs from the male holotype in the rounder wing shape, larger size, and to some extent, in having few more submarginal blue scales; otherwise similar. A melanic morph is also known to occur on both sexes, not distinguishable from the dark morph of *P. polyxenes americanus* (= *melasina* Rothschild & Jordan, 1906). Altogether, the subspecies is fairly constant both on the yellow and dark morphs. Cordillera de Mérida populations occasionally produces individuals with broader yellow bands, having the proximal edge irregularly dusted in yellow.

Etymology: This butterfly subspecies is dedicated to my friends Mauro Costa and his recently deceased wife Clara, both having engaged in exciting studies of Venezuelan butterflies, encouraging many of us to keep along the trail. This name is appropriate considering the range of distribution, and is composed following ICZN 1999.

Biology: Larvae have been raised from several umbelliferous hostplants (Apiaceae), mainly common dill (eneldo, apio *Anethum graveolens* L.) and fennel (hinojo,

Foeniculum vulgare L.). RAYMOND (1934) describes the larvae and notes the apparent emergence of greater number of melanic individuals during drier years. Figure 3 shows a final (fifth) instar larvae. Apparently, melanic individuals occur at lower elevation on a much higher frequency than at higher elevations, but this needs to be tested. It seems also that several populations have decreased in size, particularly at lower elevations and certain valleys (ORELLANA & ERAZO, 2002) which leads to propose global warming as causing a shift to higher elevations and subsequent extinction at lower sites. The species has not been seen for several years near Canoabo in Carabobo state around 600 m.a.s.l. where it was common (N. Flauger, com pers).



Figure 3. *Papilio polyxenes costarum* ssp. n. Final (fifth) instar larva on celery. Miranda, near Colonia Tovar, Aragua state, north central Venezuela (photo: E. Arnal).

DISCUSSION

In a restricted sense, the genus *Papilio* clusters those species in ROTHSCCHILD & JORDAN'S (1906) group V Machaon (TYLER *et al.*, 1994). Under this consideration, the immense size of the genus is greatly reduced, as it has historically embraced taxa today referred to the genera *Pterourus* Scopoli, 1777; *Heraclides* Hubner, [1819]; *Sinoprinceps* Hancock, 1983; *Princeps* Hubner, [1807]; *Druryia* Aurivillius, 1881; *Achillides* Hubner, [1819]; and *Menelaides* Hubner, [1819] (HÄUSER, 2003). Moreover, several authors (including ROTHSCCHILD & JORDAN, 1906) have placed species of the tribes Troidini and Leptocircini (=Graphiini, =Luehdorfiini) in *Papilio*, hence, becoming equivalent to the whole subfamily Papilioninae. Others recommend that it is not advisable to split *Papilio* (EHRlich & MURPHY, 1982; MILLER, 1987), even though they do recognize a few subgenera (HÄUSER, 2003).

As classified in this work, the greatest diversity of *Papilio* occurs in the boreal hemisphere, comprising at least four species if vicariant theory is taken in consideration. Many accepted taxa regularly taken as species must then be considered but names of subspecific nature. The composition would be as follows: *P. alexanor* Esper, 1799 (Europe and Asia), *P. indra* Reakirt, 1866 (western North America), *P. machaon* Linnaeus, 1758 (circumboreal), and *P. polyxenes* Fabricius, 1775 (North America south to northern South America). Despite this scheme,

many insist that at least *P. hospiton* Guenée, 1839 (Corsica and Sardinia) and *P. saharae* Oberthur, 1879 (northern Africa) should be treated as full species very closely related to *P. machaon*, based on breeding experiments and other evidence. What becomes clear is that all species are highly polymorphic, with more than 60 subspecies recognized as valid for the entire genus. In the words of CLARKE & LARSEN (1986) it seems that the complex is still evolving and the relationships within the various forms are not adequately expressed in terms of the traditional specific or subspecific categories. This last may explain why there is no clear consensus on the number of species actually occurring particularly in the genus and in Papilionidae in general (SPERLING, 1987; HAGEN *et al.*, 1992; PITTAWAY *et al.*, 1994).

Of the above species, only *Papilio polyxenes* enters into equatorial latitudes, prevailing there in cool montane environments. A large array of combination and synonyms have been collected for this species (see ROTHSCHILD & JORDAN, 1906; D'ALMEIDA, 1965; TYLER *et al.*, 1994) owing to its great variability and polymorphism (Fig. 2) as well as to a lack of any unifying criteria and stable species concept until only a couple of decades ago. Southern populations of subspecies *asterius* Stoll, 1782 in Mexico seems to be of greatest variability.

The following is a brief account on the nomenclatural subject for populations under our concern. According to GODMAN & SALVIN (1893), *polyxenes* and *americus* KOLLAR (1850) were considered to be separate species during the latter half of the 19th century the former ranging from North America south to Nicaragua and Costa Rica, whereas the latter, from this last country to Ecuador, Colombia and Venezuela. ROTHSCHILD & JORDAN (1906) assumed both are conspecific and questioned the capture of *americus* from "Angostura, Orinoco" undoubtedly referring to the Ciudad Bolívar of today (Fig. 4), on the south shore of the lower Orinoco river in Venezuelan Guayana. This error was continuously extended later on by the authors of the "Biologia Centrali Americana" based on an understandable misinterpretation of the original description. KOLLAR (1850) mistook this Venezuelan locality for the true type locality of Angostura, in the Colombian department of Antioquia (LAMAS, 1994). ROTHSCHILD & JORDAN (1906) also described subspecies *stabilis* from Central America, recognized *asterius* as a subspecies of *P. polyxenes* and introduced *sadulus* Lucas, 1852 under the synonymy of *P. p. americus*. However, both *P. zelicaon* Lucas, 1852 and *P. nitra* Edwards, 1883, remained on the specific status for the reviewers of the "American Papilios". D'ALMEIDA (1965) used *P. ajax* Linnaeus, 1758 to cluster *americus*, *brevicauda* Saunders, 1868 and *polyxenes* and left *asterius* as a junior synonym. It is warranted that *ajax* was earlier "suppressed" by ROTHSCHILD & JORDAN (1906), but it was formally done so by the commission (ICZN: *Papilio ajax* Linnaeus, 1758 rejected, Opinion 286). The most recent synonymic checklist for *P. polyxenes* is given by TYLER *et al.* (1994) based upon a myriad of experimental works (REMINGTON, 1959; AE, 1960; EMMEL & EMMEL, 1964; FISHER, 1977; EMMEL & SHIELDS, 1978; FERRIS & EMMEL, 1982; SPERLING, 1987, 1993) and followed by LAMAS (2004). The last addition is the recent description of a distinctive north Peruvian subspecies (BOLLINO & VITALE, 2002).

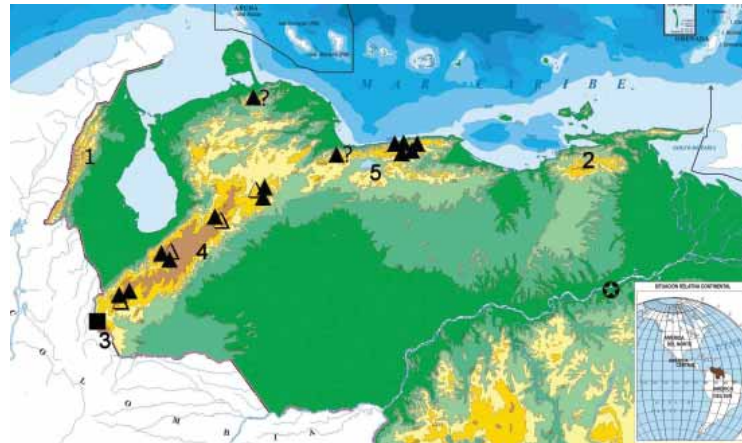


Figure 4. Distribution of *Papilio polyxenes* in Venezuela. Data from specimens deposited in MIZA. Legend: a) Solid square: *P. polyxenes* cr. *americus*. b) Solid triangle: *P. polyxenes costarum* ssp. n. c) Open triangle: *P. polyxenes costarum* × *americus*. d) Star: Ciudad Bolívar (=Angostura). 1) Sierra de Perijá. 2) Turimiquire massif. 3) El Tamá range. 4) Cordillera de Mérida. 5) Cordillera de la Costa. Questioned triangle: A single melanic specimen known (see text). Map source: Instituto Geográfico de Venezuela Simón Bolívar.

It is clearly evident that *P. polyxenes americus* is a subspecies described from Colombian material as shown by its original description (KOLLAR, 1850), subsequent literature (ROTHSCHILD & JORDAN, 1906), the material available for this study from the critical analysis of LAMAS (1994) and an examination of the lectotype specimen (Fig. 1-e). Concerning Venezuela, as it is mentioned in ROTHSCHILD & JORDAN (1906), the material from this country was taken in the vicinities of Mérida in the Andes, but the authors do not mention any locality from the central coast range, suggesting that few or none were then hosted in European collections. In this study, it became evident that some specimens from Mérida range show a close resemblance to *americus* and since authors frequently took other similar subspecies (*sadalus* and *stabilis*) as synonymous, a less broad banded *polyxenes* from Venezuela must also had been *americus* for these authors. RAYMOND (1934) is then the first to mention the species from Caracas and its surrounding (having identified it as subspecies *americus*) and notices also the melanic form *melasina*. Two specimens appeared in the facsimile edition of the watercolor paintings portrayed posthumously in his book (RAYMOND, 1982). Later, FORSTER (1948) lists the species as being collected from Caracas cited under the incorrect nomination *P. machaon americus*. Since then, all references have used the trinomial *P. polyxenes americus* (RAYMOND, 1982; ÁLVAREZ & ÁLVAREZ, 1984; ORELLANA & ERAZO, 2002; ORELLANA & GONZÁLEZ, 2003). It seems then that no one had ever before verified the status of Venezuelan black swallowtail, thus it seemed easier to assume that the name *americus* was granted for all Venezuelan populations.

CONCLUSIONS

With the large series available some conclusions can be drawn relating to the distribution of Venezuelan populations of the black swallowtail, *P. polyxenes* (please consult Fig. 4). 1) Populations from the north central coastal range (Cordillera de la Costa) with individuals showing great constancy in the phenotype, also appearing in two genetically balanced morphs, one melanic, the other yellow merit an infraespecific nomination separate from subspecies *P. polyxenes americus*, this being the purpose of this paper. 2) Andean populations in the Cordillera de Mérida, also dimorphic belong to the same subspecies, but many specimens throughout showing some gradation to *P. polyxenes americus* as evidenced by the heavy yellow dusting and widening of the yellow middle bar on the basal area of the hindwing on both surfaces (Fig.1d). This suggests some genetic introgression from *P. p. americus*. 3) Populations from the El Tamá range, a continuation of the Colombian Eastern Cordillera: despite the few individuals available (n=8), all yellow individuals show an even wider middle yellow bar and none like *P. polyxenes costarum*, these being assumed to belong nearer to *P. polyxenes americus*, though this may be the case. 4) The discontinuity of the mountains at geographical depressions may not represent genuine genetic barriers, although this has not been tested (Táchira depression, separating the El Tamá and Mérida ranges; and the Turbio-Yaracuy depression separating the Mérida range from the Cordillera de la Costa). 5) A single specimen from the Falcón range (south of Paraguaná peninsula) is melanic, and thus cannot be classified as either *andigena* or *americus*. No specimens are known from the Perijá range. The existence of the black swallowtail in the north-eastern coastal range (Turimiquire massif) and extreme north Andes at northwestern Venezuela in Perijá cannot be ruled out.

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BIBLIOGRAPHY

- AE, S.A., 1960.- A study of hybrids between *Papilio xuthus* and the *P. polyxenes/machaon* group. *Journal of the Lepidopterists' Society*, 14, 15-18.
- ÁLVAREZ-S, J.R. & ÁLVAREZ-C, J.R., 1984.- *Mariposas Diurnas de Venezuela. Introducción a su conocimiento*. Caracas, Editorial Arte. 200 pp.
- BOLLINO, M. & VITALE, F., 2002.- Una nuova sottospecie di *Papilio polyxenes* Fabricius, 1775 (Lepidoptera: Papilionidae) del Perú (Sud America). *Lambillionea*, 52, 152-155.

- CLARKE, C. & LARSEN, T.B., 1986.- Speciation problems in the *Papilio machaon* group of butterflies (Lepidoptera: Papilionidae). *Systematic Entomology*, 11, 175-181.
- D'ALMEIDA, R.F., 1965.- *Catálogo dos Papilionidae americanos*. São Paulo, Sociedade Brasileira de Entomologia. 366 pp.
- EHRlich, P. & MURPHY, D.D., 1982.- Butterflies and biospecies. *Journal of Research on the Lepidoptera*, 21, 219-225.
- EMMEL, J.F. & EMMEL, T.C., 1964.- Genetic relationships of *Papilio indra* and *Papilio polyxenes*. *Journal of Research on the Lepidoptera*, 3, 157-158.
- EMMEL, J.F. & SHIELDS, O. 1978.- Larval foodplant records for *Papilio zelicaon* in the western United States and further evidence of the conspecificity of *P. zelicaon* and *P. gothica*. *Journal of Research on the Lepidoptera*, 17, 56-67.
- FERRIS, C.D. & EMMEL J.F., 1982.- Discussion of *Papilio coloro* W.G. Wright (= *Papilio rudkini* F. & R. Chermock) and *Papilio polyxenes* Fabricius (Papilionidae). *Bulletin of the Allyn Museum*, 76, 1-13.
- FISHER, M.S., 1977.- The taxonomy and identity of *Papilio nitra* W.H. Edwards in Colorado (Papilionidae). *Bulletin of the Allyn Museum*, 47, 1-7.
- FORSTER, W., 1948.- Liste der von Pater Cornelius Vögl in Maracay und Caracas gesammelten Schemetterlinge. I. Rhopalocera. *Boletín de entomología Venezolana*, 7, 91-120.
- GODMAN, F.D. & SALVIN, O., 1893.- *Biología Centrali Americana*. London, Dulau & Co., Bernard Quaritch. vol 2, pp. 241-256.
- HAGEN, R.H., LEDERHOUSE R.C., BOSSERT J.L. & SCRIBER J.M., 1992.- *Papilio canadensis* and *Papilio glaucus* are distinct species. *Journal of the Lepidopterists' Society*, 45, 255-258.
- HÄUSER, C.L., 2003.- Papilionidae - revised GloBIS/GART species checklist (2nd draft). Prepared by Christoph L. Häuser, in cooperation with Rienk de Jong, Gerardo Lamas, Robert K. Robbins, Campbell Smith & Richard I. Vane-Wright. <<http://www.insects-online.de/gartfron.htm>> Last changes: 10th July 2003.
- KOLLAR, V., 1850.- Beiträge zur Insekten-Fauna von Neu-Granada und Venezuela. *Denkschr K Akademie Wiss Wien*, 1, 351-364.
- LAMAS, G., 1994.- Las mariposas sudamericanas descritas por Vincenz Kollar (Lepidoptera). *Revista peruana de Entomología*, 37, 55-58.
- _____, 2004.- Papilionidae. 96. pp 87-98. In: Lamas G (Ed.) Checklist: Part 4A. Hesperioidea - Papilionoidea. In: HEPPNER, J. (ed.) *Atlas of Neotropical Lepidoptera*. Gainesville. Association for Tropical Lepidoptera/Scientific Publishers.
- MILLER, J.S., 1987.- Phylogenetic studies in the Papilioninae (Lepidoptera: Papilionidae). *Bulletin of the American Museum of Natural History*, 186, 365-512.
- ORELLANA, A.M. & ERAZO, M.C., 2002.- Posible declinación poblacional de la mariposa *Papilio polyxenes americus* Kollar (Lepidoptera: Papilionidae) en el valle intra-andino de Mérida, Venezuela. *Entomotropica*, 17, 189-190.
- ORELLANA, A.M. & GONZÁLEZ, J.M., 2003.- Adiciones, rectificaciones y actualizaciones a "Mariposas de Venezuela" por Théophile Raymond. III. Castniidae y Papilionidae (Lepidoptera). *Entomotropica*, 18, 73-76.
- PITTAWAY, A.R., LARSEN, T.B., CLARKE, C.A., SMITH, C.R., CRNJAR, R. & CLARKE, F.M.M., 1994.- *Papilio saharae* Oberthür, 1879 is specifically disinct from *Papilio machaon* (L., 1758) (Lepidoptera: Papilionidae). *Entomological Gazette*, 45, 223-249.
- RAYMOND, T., 1934.- Lepidópteros de Venezuela. Familia Papilionidae. *Boletín de la Sociedad venezolana de Ciencias Naturales*, 2(16/17), 284-352.
- _____, 1982.- *Mariposas de Venezuela*. Caracas, Ediciones Corpoven. 227 pp.
- REMYNGTON, C.L., 1959.- Wide experimental crosses between *Papilio xuthus* and other species. *Journal of the Lepidopterists' Society*, 13, 151-164.
- ROTHSCHILD, W.L. & JORDAN, K., 1906.- A revision of the american Papilios. *Novitates Zoologicae*, 13, 412-752.
- SPERLING, F.A.H. 1987.- Evolution of the *Papilio machaon* species group in western Canada (Lepidoptera: Papilionidae). *Quaestiones entomologicae*, 23, 198-315.
- _____, 1993.- Mitochondrial DNA phylogeny of the *Papilio machaon* species group (Lepidoptera: Papilionidae). In: G.E. BALL & H.V. BANKS (eds.) Systematics in support of Entomology. *Memoirs of the Entomological Society of Canada*, 165, 233-242.
- TYLER, H.A., BROWN, JR K.S. & WILSON, K.H., 1994.- *Swallowtail Butterflies of the Americas*. Scientific Publishers, Gainesville, Florida. 376 pp.