

# BULLETIN OF THE ALLYN MUSEUM

3701 Bayshore Rd.  
Sarasota, Florida 33580

Published By  
The Florida State Museum  
University of Florida  
Gainesville, Florida 32611

Number 76

15 October 1982

---

## DISCUSSION OF *PAPILIO COLORO* W.G. WRIGHT (= *PAPILIO RUDKINI* F. & R. CHERMOCK) AND *PAPILIO POLYXENES* FABRICIUS (PAPILIONIDAE)<sup>1</sup>

Clifford D. Ferris<sup>2</sup> and John F. Emmel<sup>3</sup>

### INTRODUCTION

*Papilio rudkini* was originally described by J.A. Comstock (1935) as an aberrational form of *Papilio bairdii* W.H. Edwards. In 1937, the Chermock brothers described two forms of *rudkini*, and in the process elevated *rudkini* to species-group status. Miller & Brown (1981, footnote #211, p. 247) assigned the authorship of *rudkini* to F. & R. Chermock.

Typical *rudkini* (Figs. 1-3) is not sexually dimorphic, although the apices of the forewings are slightly more rounded in the females as compared to the males. The abdomen is laterally black-and-yellow striped. The two form names applied by the Chermocks represent imagines which differ in abdominal markings from typical *rudkini*. Sexual dimorphism occurs in one of these forms.

In form "comstocki", the closest to typical *rudkini*, the body is laterally striped, with yellow spots faintly visible where the yellow stripe adjoins the black. Dorsally, the inner row of yellow spots on both the FW and HW is reduced in size compared with typical *rudkini*, and the basal area of the secondaries is black, although some yellow markings extend into the inner discal area. The sexes are not dimorphic.

In the form "clarki", the sexes are strongly dimorphic. The abdomen is black with lateral rows of yellow spots as in *P. polyxenes* Fabricius. Yellow maculation on the wings is much reduced and does not extend into the inner discal area of the secondaries. A male paratype of "clarki" is shown in Figs. 4-5. An extreme male example from the southeastern Arizona tension zone (as described subsequently) is shown in Fig. 20.

<sup>1</sup>Published with the approval of the Director, Wyoming Agricultural Experiment Station as Journal Article No. JA 1177.

<sup>2</sup>Bioengineering Program, University of Wyoming, Laramie, Wyoming 82071. Research Associate: Allyn Museum of Entomology of the Florida State Museum, Sarasota, FL; Florida State Collection of Arthropods, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services, Gainesville. Research Associate in Entomology, Los Angeles County Museum of Natural History, Los Angeles, CA.

<sup>3</sup>26500 Rim Road, Hemet, CA 92343. Research Associate in Entomology, Los Angeles County Museum of Natural History, Los Angeles, CA.

In 1905, Wright described and illustrated (Plate III, f. 25) *Papilio coloro* as a "new variety" from "Colorado Desert of Southeastern California, June, 1883". In Wright's terminology, "variety" corresponded to the modern usage of subspecies. He associated *coloro* with *zelicaon* [sic=*zelicaon* Lucas].

Miller & Brown (1981) associated *coloro* (misspelled *chloro*) with *zelicaon*, and stated "Type probably destroyed in earthquake". The type was not destroyed in the San Francisco earthquake and subsequent fire. It is in the type collection in the California Academy of Sciences, and has been carefully examined by J.F. Emmel.

The type of *coloro* represents what has been called *rudkini* since 1935. Thus the taxon *rudkini* is hereby sunk as a junior synonym of *coloro*. We also feel that it is appropriate to designate an exact type locality for *coloro* based upon what is known about the areas in which Wright collected. We hereby fix the type locality of *Papilio coloro* Wright as: Whitewater Hill, west end of the Coachella Valley, Colorado Desert, Riverside County, California. This locality is consistent for *coloro* adults, it is in the immediate area where Wright collected many other Colorado Desert species, and it is easily found on maps.

The species *coloro* and *zelicaon* occupy different ecological niches; *coloro* is found in true desert areas, while *zelicaon* prefers a more mesic environment. It now remains to elaborate upon the relationship of *coloro* to *polyxenes*.

According to Emmel & Emmel (1973), the larvae, pupae, and adults of *coloro* (*rudkini* in the work cited) are polymorphic, but adult polymorphism is genetically independent of the appearance of the immature stages. Larval and pupal polymorphism is not uncommon in other West Coast species. Two examples are *Papilio indra* Reakirt, and the larvae of *Incisalia mossii bayensis* (R.M. Brown) as described in Emmel & Ferris (1972).

Excepting *Papilio indra*, the larvae of the *machaon*-complex swallowtails in North America are quite similar, especially in the last instar. Among others, Comstock (1935) mentioned this fact. The light form of the last instar larvae of *coloro* is similar to last instar *polyxenes* larvae (see Comstock, 1937).

*P. coloro* fm. "clarki" has been separated from *P. polyxenes asterius* Stoll based upon two characters: maculation and larval host preferences. Dorsally in the males, the yellow spots in the inner row on the FW tend to be ovate, rather than sharply triangular as in typical *polyxenes*. The larval host of *coloro* is usually *Thamnosma montana* Torr. & Frem. (Rutaceae), while *polyxenes* is generally reported to use members of the Umbelliferae.

In stress situations, however, as reported in Emmel & Emmel (1973), *coloro* uses hosts such as *Cymopterus panamintensis* Coult. & Rose var. *acutifolius* (C. & R.) Munz, recorded in 1966 in the Sheephole Mts. of California. In addition to *Cymopterus*, wild females of *coloro* will oviposit on other apiaceous plants as discussed subsequently. Most of these situations seem to be at the fringes of *coloro*'s range, in areas where *Thamnosma* does not grow, and ongoing *coloro* populations do not seem to exist in these localities. Apparently *coloro* cannot invade the niche occupied by *zelicaon* in these same localities, and is swamped out by that species.

Under laboratory conditions, *coloro* larvae easily accept *Foeniculum vulgare* Mill (common fennel), a cultivated umbellifer.

#### LARVAL HOST PREFERENCES OF *P. coloro* AND *P. polyxenes*

Although some as yet undiscovered factor normally causes wild females of *coloro* to oviposit on *Thamnosma* rather than members of the Umbelliferae, recent studies by J.F. Emmel clearly indicate that *coloro* is not obligatory upon the Rutaceae. The following data have been collected for localities in California:

1. Riverside Co.: Hemet. 17 October, 1977. 21 larvae, 2nd-4th instar on leaves and fruit of *Foeniculum vulgare* (along with 17 larvae, 1st-3rd instar, of *P. zelicaon*). Adults from these larvae emerged 1978-80. *P. coloro* is not established in the Hemet area, but stray adults apparently fly in following large emergences in the nearby NW Coachella Valley.
2. San Bernardino Co.: west slope of Old Woman Mts., vic. Ironwood Wash. 2 April,

1978. 9 ova and 1st instar larvae taken on leaves of *Cympoterus panamintensis* var. *acutifolius* (along with 30 ova-1st instar larvae of *P. indra fordii* J.A. Comstock & Martin). Adults emerged 1978-79. *Thamnosma montana* is present in the Old Woman Mts., but does not occur in this immediate locality.
3. Riverside Co.: west slope of San Jacinto Mts., north-facing slope south of Indian Creek, 3300' (1000m). 27 May, 1978. One first instar larva taken on upperside of leaf of *Tauschia arguta* (T. & G.) Macbr. (along with 12 ova-1st instar larvae of *P. zelicaon*). Larva was reared to 4th instar, then died of virus disease. The color pattern was typical of a 4th instar *coloro* larva. *P. coloro* is not established in this area, but does stray in during seasons of unusual abundance in the desert.
  4. San Bernardino Co.: San Bernardino Mts., north slope, Grapevine Creek canyon near Cactus Flat, 5700' (1740m). 28 May, 1978. Two ova on undersides of leaves of *Tauschia parishii* (C. & R.) Macbr.; reared to pupae on same. One pupa died; the other reared to adult with eclosion in 1979. This locality is about 5 air miles from a *coloro* population on *Thamnosma montana*. *P. coloro* is not regularly established in this locality.
  5. Riverside Co.: Hemet. 12 October, 1979. Four 2nd-3rd instar larvae on leaves of *Ruta graveolens* L. in Emmel yard (along with 10 larvae, 2nd-4th instar, of *P. zelicaon*) and reared to adults on same. Adults emerged 1980-82.
- Bauer (1955) recorded larvae of *rudkini* (= *coloro*) on *Daucus carota* L. (Umbelliferae) at Yuma, Arizona.

As a child and young adult, Ferris lived in the Middle Atlantic region, and reared and collected *P. polyxenes*. Most published references to larval hosts of this species cite members of the Umbelliferae only, although Tietz (1972) listed *Ruta graveolens* (for *P. p. asterius*). The larvae are sometimes pests on garden plantings of dill (*Anethum graveolens* L.) and parsley (*Petroselinum hortense* var.). The garden of the house in which Ferris was raised in southeastern Pennsylvania contained two mature bushes of *Ruta graveolens* (common rue, Herb o' Grace), a perennial member of the Rutaceae. Usually dill and parsley were planted in the garden annually. His source of *polyxenes* larvae was always the rue bushes, and never the dill or parsley. The only other known rue plants in the region were about a mile away in the botanical garden of the University of Pennsylvania. The factor that caused passing *polyxenes* females to oviposit on the rue in preference to the umbels present is unknown.

Figs. 6-7 show a field-caught male of *P. p. asterius* from Bucks Co. in eastern Pennsylvania. The ovate FW spots and general maculation compare directly to that of the specimens of "clarki" shown in Figs. 4, 8, 12 and 14 from western North America.

On the basis of host plant selection and phenotypy, the new combination shown below is now established. Discussion follows.

#### *Papilio polyxenes coloro* Wright [New Combination]\*

#### DISCUSSION

*Papilio coloro* is herein considered to be the western North American polymorphic expression of *Papilio polyxenes*. In the terminology of C.L. Remington, the tension zone between eastern *asterius* and western *coloro* appears to lie along a line stretching from Grant Co. in southwestern New Mexico and Cochise Co. in southeastern Arizona northwestward through Maricopa Co., Arizona, based upon wild-caught phenotypes. Discussion of phenotype relative to preferred larval hosts follows in a subsequent section. Material from the Organ Mts., Doña Ana Co., New Mexico appears to be typical *asterius*.

Figs. 8-9 show a typical male from Grant Co., New Mexico. Figs. 10-27 illustrate specimens collected on the desert at the base of the Chiricahua Mts. near Portal,

\*Scott (1981) published this combination while the present paper was undergoing initial review. He did not indicate, however, this combination to be a new trinomial.

Cochise Co., Arizona. They are arranged by sex in decreasing order of yellow maculation. Most of the specimens shown were collected by Ferris in August, 1981, although he has collected similarly maculated examples annually in this area since 1968.

1979 and 1980 were particularly dry years in the Portal area. Precipitation records for June, July and early August, 1981 (examined at the Southwestern Research Station of the American Museum of Natural History) indicated rainfall amounts well in excess of average. The desert was lush with many nectar sources, and the grass was waist deep in sections of Cave Creek Canyon, where normally it is but a few inches high. Apparently the unusual amount of moisture triggered eclosion of *Papilio polyxenes* pupae that had held over from prior seasons (see Emmel & Emmel, 1973, p. 10).

The last such population explosion of *P. polyxenes* that Ferris observed in this locality was in August, 1968. He described mating behavior in this population (incorrectly reported as *P. bairdii* W.H. Edwards, 1969). This species was observed in normal numbers in 1981 in nearby Grant Co., New Mexico. Rainfall there was average, or perhaps below average, although only 100 road miles from the Portal region.

Of the many tens of specimens observed in 1981, 56 males and 8 females were collected. Multiple specimens of each of the phenotypes were taken, but no "pure" (yellow) *coloro* phenotypes were observed or collected at Portal. The specimens illustrated in Figs. 10-27 shown an extreme range of phenotypes varying from typical *asterius* (Fig. 10) to the extreme form of "clarki" (Fig. 20). At the Portal vicinity collecting sites, both sexes were avidly nectaring at a desert sunflower (*Helianthus* sp.), and the males were frequently seen in groups of six to a dozen at puddles and moist sand.

Specimens similar to the Cochise Co. material, including the form shown in Fig. 20, are in the Ferris collection from Maricopa Co., AZ as follows: 15 mi. west of Sunflower; 5 mi. NE of Saguaro Lake.

In Cochise Co., we find extreme forms of *asterius* associated with *Thamnosma texana* (A. Grey) Torr. blending into the black forms of *coloro*. In Maricopa Co., we find the extreme (black) forms of *coloro* associated with *T. montana* blending into *asterius*. As noted subsequently, the Aravaipa Creek population in Pinal Co. exhibits complete variation from typical *asterius* to *coloro* form "clarki" in the black imagines, with an occasional nearly typical yellow *coloro*.

#### LARVAL HOST AND ASSOCIATED PHENOTYPE

Phenotypic *P. p. asterius* populations in southeastern Arizona regularly use *Thamnosma texana* as a larval foodplant, and it is probably the principal host in this region. The point at which *asterius* blends into *coloro* (tension or suture zone) occurs at points where *Thamnosma texana* ends and *T. montana* begins. The ranges of these two *Thamnosma* species do not overlap, and at their closest point, they are separated by several miles. There are undoubtedly some physiological differences between *asterius* and *coloro* in their adaptations to the two species of *Thamnosma*. *T. texana* regularly receives summer rains; *T. montana* does not. The summer leafing out of *T. texana* and the summer abundance of *asterius* seems to be a fairly regular phenomenon; the corresponding situation with *T. montana* and *coloro* is much less predictable.

Populations of *asterius* on *T. texana* in close geographic proximity to populations of *coloro* on *T. montana* produce a small percentage of typical yellow *coloro* phenotypes (about 1-3% based on a small sample). Similarly, *P. p. coloro* populations on *T. montana* in southeastern Arizona close to *asterius* populations on *T. texana* are nearly 100% the "clarki" form. Bruce Griffin (*in litt.*) has supplied data for *polyxenes* populations in southeastern Arizona as follows:

1. Pinal Co.: Aravaipa Creek. Larvae of *coloro* collected on *T. montana* from 1973 to 1977; as of 21 March, 1977, 48 adults had emerged with phenotypes as follows:

*P. p. coloro* fm. "coloro" 1=2%

*P. p. coloro* fm. "clarki" 47=98%

Black adults from this population show a complete range of phenotypes from fm. "clarki" to typical *asterius*.

2. Pinal Co.: San Manuel. Larvae of *asterius* collected on *T. texana* from 1973 to 1977; as of 21 March, 1977, 29 adults had emerged with phenotypes as follows:

*P. p. asterius* fm. "asterius" 26=90%

*P. p. asterius* fm. "coloro" 3=10%

The three "coloro" specimens all had a similar phenotype, indicating that they were probably from the same brood. They were somewhat atypical from normal "coloro", but clearly the "yellow" form. Given a larger sample from this population, we would expect the black phenotype to approach 98-99% of the total.

Fig. 28. indicates the distribution of *Thamnosma* in the tension-zone region.

Biochemical similarity among larval hosts regarding certain essential oils including anethole, methyl chavicol and anisic aldehyde (Tyler from Dethier, *in litt.*), appears to trigger oviposition by *polyxenes* females. To a human observer, the odors produced by *Thamnosma montana* and *Ruta graveolens* are virtually identical.

Although the larvae of *Papilio zelicaon* normally feed upon *Lomatium* sp. and other Umbelliferae, they can switch to Rutaceous plants as the data presented above indicate. Again certain essential oils are common to the plants involved.

While *P. polyxenes* and *P. zelicaon* occasionally share the same larval hosts and are closely related species, it should not be construed from the above that they are conspecific. Fisher (1977) demonstrated that they are separate species based upon hybridization experiments.

#### RACES OF *Papilio polyxenes*

One must refer to Rothschild & Jordan (1906) for a reasonably complete discussion of the races of *P. polyxenes*. Tyler (1975) included only a brief account. The volume on the Neotropics recently published by D'Abrera (1981) omits this species completely.

Strong yellow dorsal maculation occurs in some forms and subspecies of *P. polyxenes* as shown in Figs. 29-33. Figs. 29-30 illustrate a male *P. polyxenes asterius* fm. "pseudoamericanus" F.M. Brown from Mexico. The abdomen is more-or-less laterally striped with black and yellow, but the markings tend to be smeared rather than cleanly defined.

Figs. 31-32 show a male of *P. polyxenes stabilis* Rothschild & Jordan from Costa Rica. The sexes are not particularly dimorphic, and the abdomen is black with lateral rows of yellow spots.

Fig. 33 illustrates a male of *P. polyxenes americanus* Kollar from South America. Note the ovate FW spots. This subspecies is polymorphic in a manner similar to fm. "comstocki". The abdomen, however, is black with lateral rows of yellow spots. The pale areas in the FW cell represent rubbed areas, and not yellow pigment.

Specimens of *polyxenes* from Mexico representing the *coloro* phenotype have been examined in two Mexican collections: IPN, Mexico City (IPN); University of Mexico, Mexico City (UM). All of the *coloro* phenotypes are from the state of Veracruz with data as follows:

1. Cerro del Vigia, R. de la Maza, Santiago Tuxtla, viii. 64, 1 ♂; v.64, 1 ♀. No collector (UM).
2. San Andres, Tuxtla, 20.ix.57, 1 ♂. No collector (UM).
3. Playa Azul, Catemaco, 13.ix.58, 1 ♂; 14.vi.58, 1 ♂. No collector (UM).
4. Orizaba, no additional data, 1 ♂. (IPN).
5. Jalapa, x.44, 1 ♂. Leg. Wiochers (IPN).

In addition to the above, specimens of *P. polyxenes* close to nominate *polyxenes*, as well as the forms "ampliata" and "curvifascia" from the state of Veracruz were noted in the two collections examined.

## CONCLUSION

On the basis of the data, photographs, and arguments presented above, it seems reasonable to assign the taxon *coloro* Wright as a subspecies of *Papilio polyxenes*. This assignment was alluded to by M.S. Fisher in Ferris & Brown (1981).

The subspecies *P. p. coloro* is distributed from the deserts of Baja California and southern California eastward into Nevada and Arizona. A tension zone with the eastern subspecies *asterius* exists in southeastern Arizona and southwestern New Mexico.

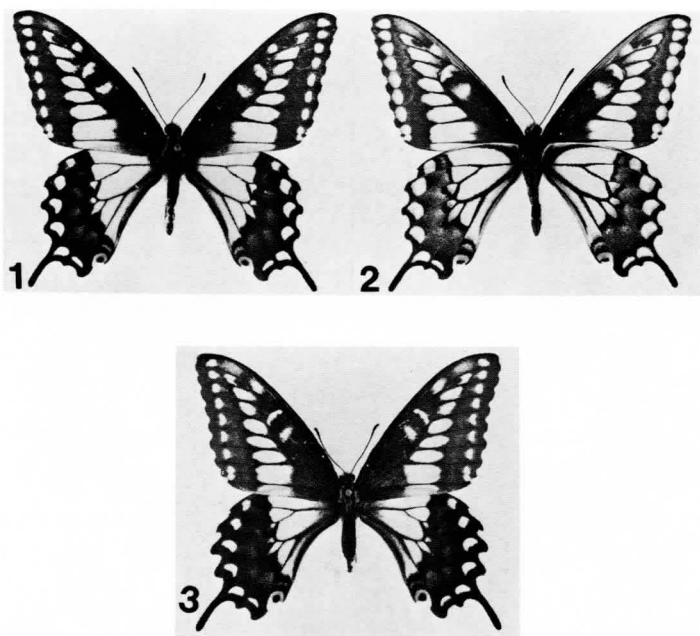
The taxon *rudkini* F. & R. Chermock is a junior synonym of *coloro*.

## ACKNOWLEDGMENTS

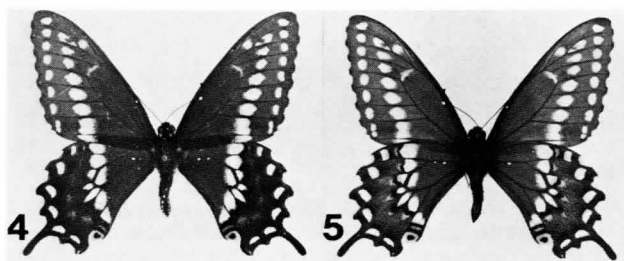
We would like to thank Dr. F. Martin Brown, Colorado Springs, CO, Bruce M. Griffin, Tucson, AZ, and Hamilton A. Tyler, Healdsburg, CA for supplying data and commenting on the original draft of this paper. Ralph A. Fisher, Jr. of Bayard, NM supplied some of the field-collected material from New Mexico used in this study. Special thanks are due Dr. Lee D. Miller and Dr. Arthur Allyn of the Allyn Museum of Entomology, Florida State Museum, Sarasota, FL for making possible the publication of this paper.

## LITERATURE CITED

- Bauer, D.L. 1955. Notes on the *Papilio machaon* complex in Arizona. *Lepid. News*, 9:7-10.
- Brown, F.M. 1942. So-called *Papilio ajax americanus* Kollar in North America (Lepidoptera: Papilionidae). *Ent. News*, 53:291.
- Chermock, F.H. & R.L. Chermock. 1937. Two new forms of *Papilio rudkini*. *Bull. So. Calif. Acad. Sci.*, 36:8-10.
- Comstock, J.A. 1935. Notes on the early stages of three butterflies and five moths from California. *Bull. So. Calif. Acad. Sci.*, 33:137-151.
- , 1937. Life history of *Papilio rudkini* (Lepid.). *Bull. So. Calif. Acad. Sci.*, 36:13-18.
- D'Abrera, B. 1981. Butterflies of the Neotropical Region, Part 1 Papilionidae & Pieridae. Lansdowne Editions, East Melbourne, Australia, xv + 172 pp., ill.
- Emmel, T.C. & J.F. Emmel. 1973. The butterflies of southern California. Natural History Museum of Los Angeles County, Science Series, 26:1-148.
- Emmel, J.F. & C.D. Ferris. 1972. The biology of *Callophrys (Incisalia) fotis bayensis*. *J. Lepid. Soc.*, 26(4):237-244.
- Ferris, C.D. 1969. Some additional notes on mating behavior in butterflies. *J. Lepid. Soc.*, 23(4):271-272.
- Ferris, C.D. & F.M. Brown, eds. 1981. Butterflies of the Rocky Mountain States. Univ. of Oklahoma Press, Norman, Okla., xix + 442 pp., ill.
- Fisher, M.S. 1977. The taxonomy and identity of *Papilio nitra* W.H. Edwards in Colorado (Papilionidae). *Bull. Allyn Mus.*, 47:1-8.
- Miller, L.D. & F.M. Brown. 1981. A Catalogue/Checklist of the Butterflies of America North of Mexico. The Lepidopterists' Society, Memoir No. 2, vii + 280 pp.
- Rothschild, W. & K. Jordan. 1906. A revision of the American Papilios. *Novitates Zoologicae*, 13(3):411-752.
- Scott, J.A. 1981. New Papilionoidea and Hesperioidea from North America. *Papilio* (new series), 1:1-12. (Privately published by the author).
- Tietz, H.M. 1972. An Index to the Described Life Histories, Early Stages and Hosts of the Macrolepidoptera of the Continental United States and Canada, vol. 1. Allyn Museum of Entomology, Sarasota, Florida, iv + 536 pp.
- Tyler, H.A. 1975. The Swallowtail Butterflies of North America. *Naturegraph Publ.*, Healdsburg, Calif., viii + 192 pp., ill.

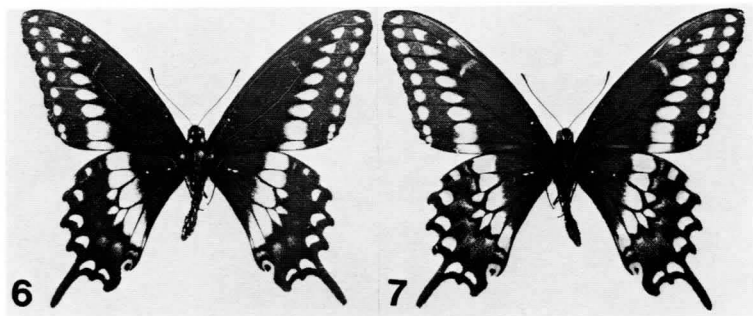


Figures 1-3: *Papilio polyxenes coloro* (= *P. rudkini*). 1-2, ♂, dorsal (1), ventral (2), Scissors Crossing, Anza Desert, San Diego Co., CA, 30.ix.67 ex-larva. (3) ♀ dorsal, same locality, 3.x.67 ex-larva.

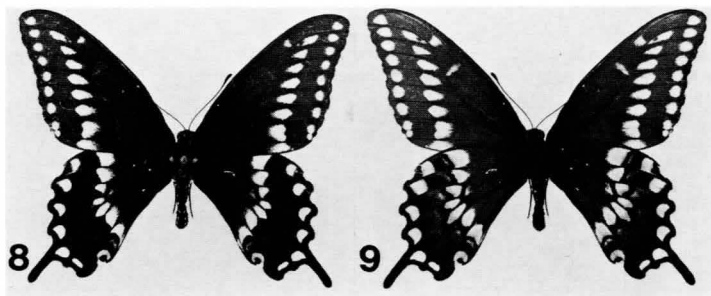


Figures 4-5: *P. polyxenes coloro* (= *P. rudkini*) fm. "clarki". Paratype ♂ no. 6, Ivanpah Mts., San Bernardino Co., CA, 8.vi.35 ex-pupa, dorsal (4), ventral (5).



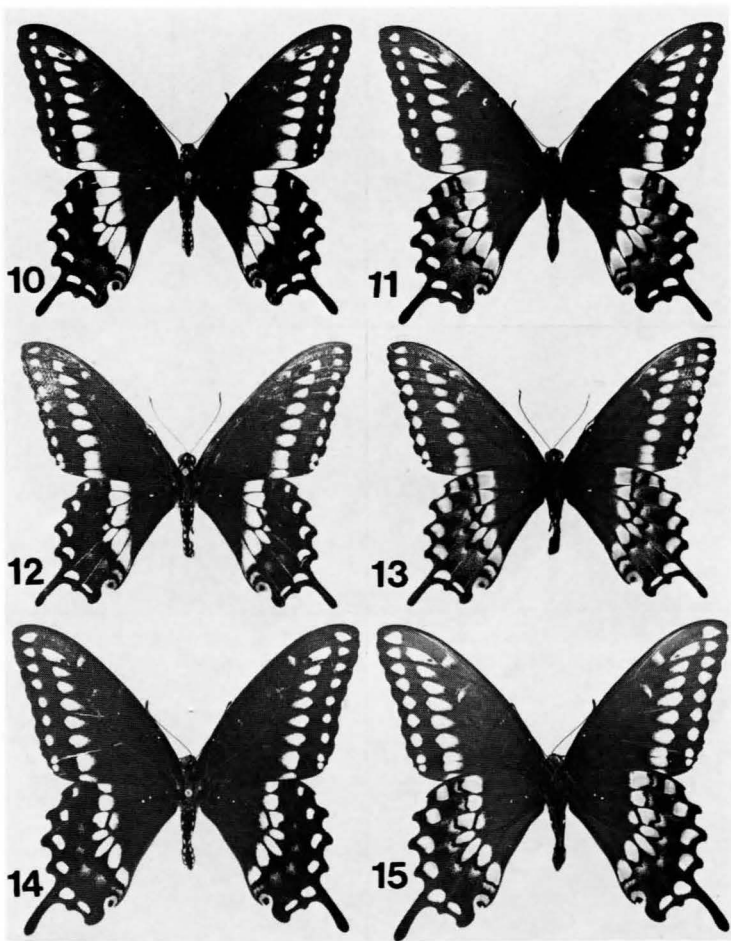


Figures 6-7: *P. polyxenes asterius*. ♂, Bursonville, Bucks Co., PA, 4.viii.56, dorsal (6), ventral (7).

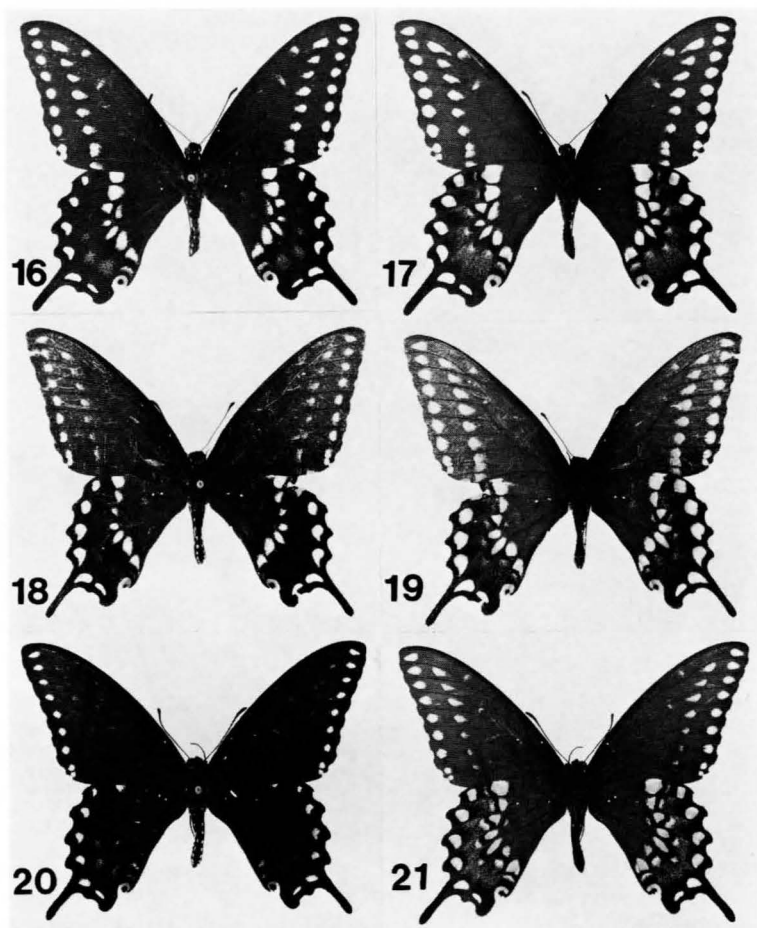


Figures 8-9: *P. polyxenes asterius*. ♂, Lake Roberts, Grant Co., NM, 11.viii.68, dorsal (8), ventral (9).

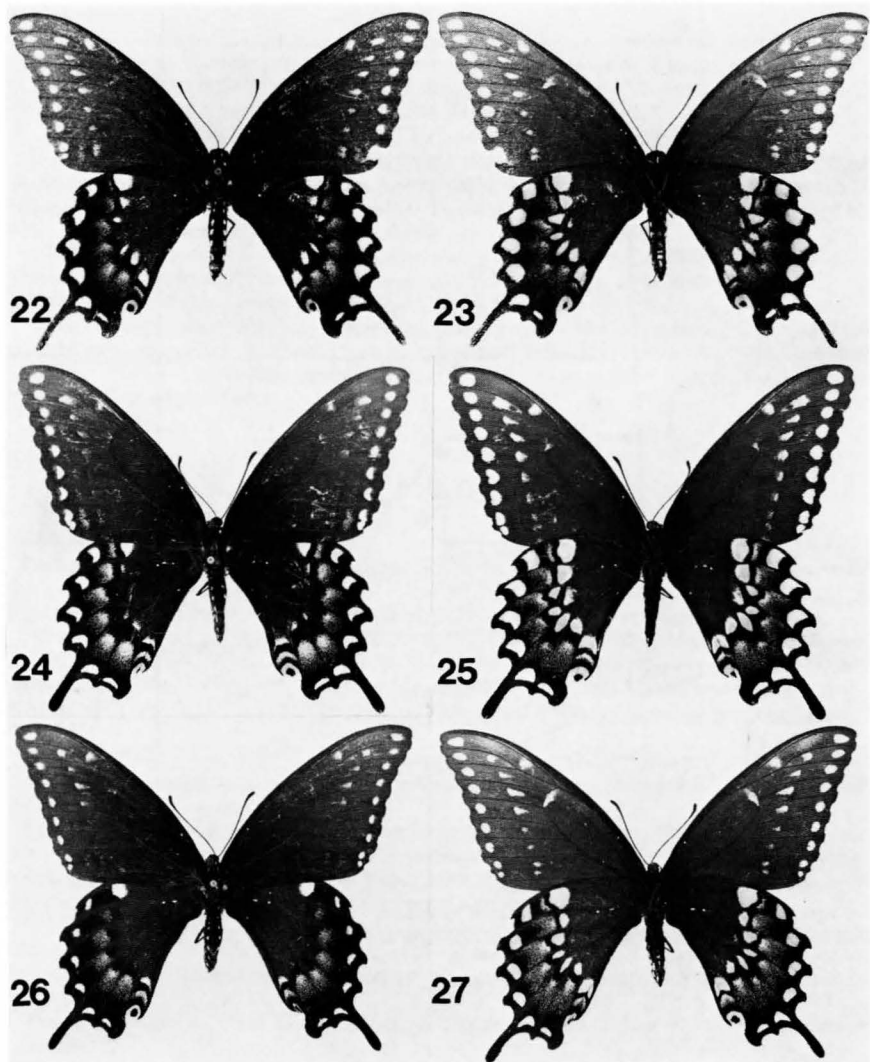




Figures 10-15: *P. polyxenes asterius* from tension zone. 10-11, ♂, U.S.F.S. Rd. 42B, ca. 5200' (1580m), nr. Portal, Cochise Co., AZ, 18-19.viii.81, dorsal (10), ventral (11). 12-13, ♂, nr. Galeyville, Cochise Co., AZ, 2.vi.73, dorsal (12), ventral (13). 14-15, ♂, T17S R31E, nr. Portal, ca. 4600' (1400m), Cochise Co., AZ, 13-14.viii.81, dorsal (14), ventral (15).



Figures 16-21: *P. polyxenes asterius* from tension zone. 16-17, ♂, same data as Figs. 10-11, dorsal (16), ventral (17). 18-19, ♂, same data as Figs. 14-15, dorsal (18), ventral (19). 20-21, ♂, extreme form, same data as Figs. 10-11, dorsal (20), ventral (21).



Figures 22-27: *P. polyxenes asterius* from tension zone. 22-23, ♀, nr. Galeyville, Cochise Co., AZ, 21.viii.68, dorsal (22), ventral (23). 24-25, ♀, same data as Figs. 14-15, dorsal (24), ventral (25). 26-27, ♀, same data as Figs. 14-15, dorsal (26), ventral (27).

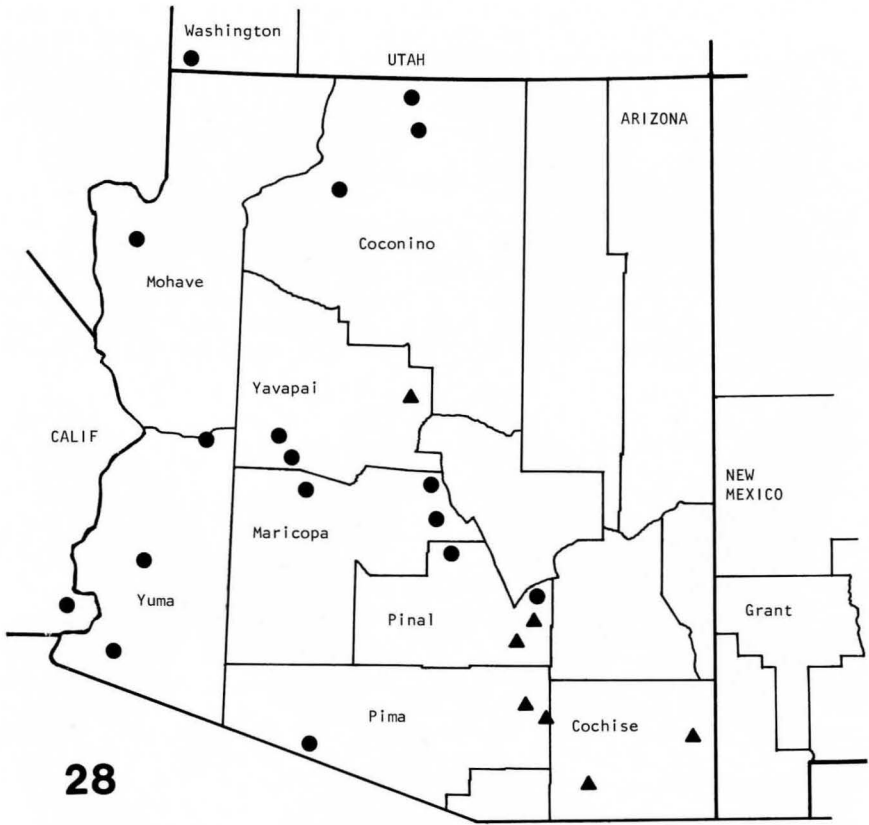
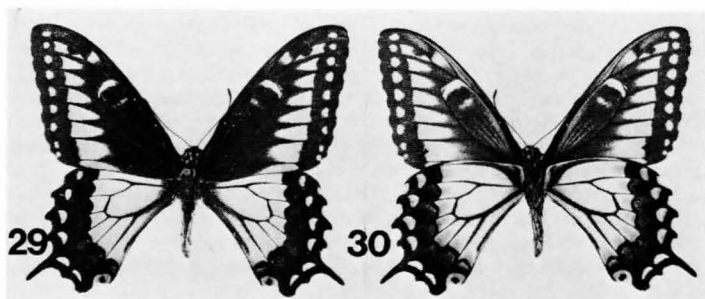
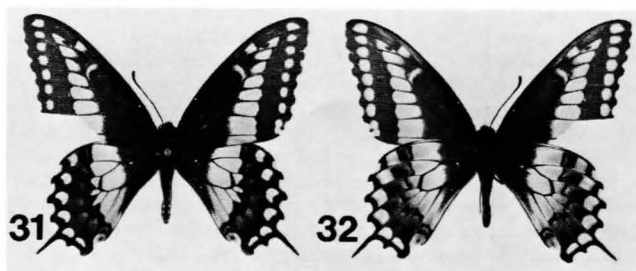


Figure 28: Distribution of *Thamnosma* in suture zone between *P. p. asterius* and *P. p. coloro*. The dots represent *T. montana* and the triangles *T. texana*.



Figures 29-30: *P. polyxenes asterius* fm. 'pseudoamericus'. ♂, Catemaco, Veracruz, Mexico, 12.x.73, dorsal (29), ventral (30).



Figures 31-32: *P. polyxenes stabilis*. ♂, Alajuela, Costa Rica, 27.xii.71, dorsal (31), ventral (32).



Figure 33: *P. polyxenes americanus*. ♂, Butamajo, Columbia, S.A., dorsal.

This public document was promulgated at a cost of \$653.25 or \$1.089 per copy. It makes available to libraries, scholars and all interested persons the results of researches in Entomology.