DISCUSSION OF PAPILIO COLORO W.G. WRIGHT
(= PAPILIO RUDKINI F. & R. CHERMOCK)
AND PAPILIO POLYXENES FABRICIUS
(PAPILIONIDAE)\(^1\)
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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.

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In 1905, Wright described and illustrated (Plate III, f. 25) *Papilio colora* 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 *colora* with *zelicaon* [sic=*zelicaon Lucas].

Miller & Brown (1981) associated *colora* (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 *colora* represents what has been called *rudkini* since 1935. Thus the taxon *rudkini* is hereby sunk as a junior synonym of *colora*. We also feel that it is appropriate to designate an exact type locality for *colora* based upon what is known about the areas in which Wright collected. We hereby fix the type locality of *Papilio colora* Wright as: Whitewater Hill, west end of the Coachella Valley, Colorado Desert, Riverside County, California. This locality is consistent for *colora* adults, it is in the immediate area where Wright collected many other Colorado Desert species, and it is easily found on maps.

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

According to Emmel & Emmel (1973), the larvae, pupae, and adults of *colora* (*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 *colora* is similar to last instar *polyxenes* larvae (see Comstock, 1937).

*P. colora* 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 *colora* 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), *colora* 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 *colora* will oviposit on other apiaceous plants as discussed subsequently. Most of these situations seem to be at the fringes of *colora*'s range, in areas where *Thamnosma* does not grow, and ongoing *colora* populations do not seem to exist in these localities. Apparently *colora* cannot invade the niche occupied by *zelicaon* in these same localities, and is swamped out by that species.

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

**LARVAL HOST PREFERENCES OF *P. colora* AND *P. polyxenes***

Although some as yet undiscovered factor normally causes wild females of *colora* to oviposit on *Thamnosma* rather than members of the Umbelliferae, recent studies by J.F. Emmel clearly indicate that *colora* 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. colora* 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 fordi 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 (1956) 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 northward 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) *colo ro* 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 *colo ro*. In Maricopa Co., we find the extreme (black) forms of *colo ro* associated with *T. montana* blending into *asterius*. As noted subsequently, the Aravaipa Creek population in Pinal Co. exhibits complete variation from typical *asterius* to *colo ro* form "clarki" in the black imagines, with an occasional nearly typical yellow *colo ro*.

**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 *colo ro* (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 *colo ro* in their adaptations to the two species of *Thamnosma*. *T. texana* regularly receives summer rains; *T. montana* does not. The summer leafting out of *T. texana* and the summer abundance of *asterius* seems to be a fairly regular phenomenon; the corresponding situation with *T. montana* and *colo ro* is much less predictable.

Populations of *asterius* on *T. texana* in close geographic proximity to populations of *colo ro* on *T. montana* produce a small percentage of typical yellow *colo ro* 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 *colo ro* 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. "colo ro" 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'Abrener (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. "pseudoamericus" 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 americus* 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).
4. Orizaba, no additional data, 1 ♂. (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 *asterias* exists in southeastern Arizona and southwestern New Mexico.

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

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LITERATURE CITED


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 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).
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. 'pseudoamerius'. ♂, Catemaco, Veracruz, Mexico, 12.x.73, dorsal (29), ventral (30).


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