

WIDE EXPERIMENTAL CROSSES BETWEEN  
*PAPILIO XUTHUS* AND OTHER SPECIES

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Since 1953 I have been conducting a series of hybridization studies of the *polyxenes-machaon* complex of the genus *Papilio* (see preliminary reports — Remington 1956, 1958). A series of papers is now in preparation on specific groups of crosses and on some general questions such as hybrid sex-ratios and hybrid sterility. The purpose of the present paper is to present the results of the two widest crosses from which we have been able to rear offspring. These were *Papilio xuthus* ♀ × *hippocrates* ♂ and *P. polyxenes* ♀ × *xuthus* ♂.

*Papilio xuthus* Linné is an Asiatic species found from Japan to upper Burma, southward into Formosa, Luzon, and Guam. Its phylogenetic relationships have been in some doubt, and it has been associated with the *polyxenes-machaon* group, the *glaucus* group, and perhaps others. The larval color pattern is not similar to that of species of either group, and the pupal form is likewise very different. Comments on the systematic position of *P. xuthus* will be found in the Discussion, below. The usual larval foods are various Rutaceæ.

*Papilio polyxenes* Linné is common in the U. S. A. west to the Rocky Mts., north to southern Canada, and with various little-known relatives extending to northern South America. The usual larval foods are Umbelliferæ only.

*Papilio hippocrates* Felder is usually placed as a sub-species of *P. machaon* Linné, but there are grounds for considering it a separate species. The broods of F<sub>1</sub> hybrids with European *machaon* are strongly deficient in females (Clarke & Sheppard 1956 and my later data). There may be a difference in chromosome number; *P. machaon* in Europe has n=30 (commonly 32 in Finland — see Federley 1938) (Lorkovič 1941), whereas *P. hippocrates* has n=31 (Maeki 1958). The wings are longer and narrower than in true *machaon*. Unlike European *machaon*, *hippocrates* has in the females a summer form of very large size and extremely dark pigmentation. It is difficult to find from the literature the exact geographic ranges of *hippocrates* and of the Chinese and Siberian populations of the *machaon* forms. *P. hippocrates* (including minor sub-races such as *amurensis* and *sachalinensis*) is abundant all over Japan and is present in Korea, Manchuria, Amurland, and Sakhalin (see Eller 1939). This relatively moist and elevated region is bounded on the west by drier plains, and it is possible that there is a gap in which no *machaon*-like *Papilio* is present, separating *hippocrates* from the *aliaska*-like *machaon* to the northeast and from the Chinese and Mongolian forms to the south and west. The usual larval foods are Umbelliferæ and Rutaceæ.

Table 1. CROSSES OF *P. XUTHUS* WITH OTHER SPECIES

Brood	Parents	Eggs			Minutes <i>in copulo</i>	Results
		laid	fertile	hatched		
324	♀ <i>pol.</i> × ♂ <i>xu.</i>	190	?	? (>8)	33+	2 ♂♂ from 8 pupæ
362	same	151	0	—	133	—
307	♀ <i>xu.</i> × ♂ <i>hip.</i>	97	?	?(9 of 72)	33	♂ from 1 pupa
309	same	24	?	4	23-29	see text
305	♀ <i>hip.</i> × ♂ <i>xu.</i>	50±	0	—	39-56	—
349	same	63	0	—	22-82	—
302	♀ <i>xu.</i> × ♂ <i>syriacus</i>	25+	0	—	51	—
304	♀ <i>glaucus</i> × ♂ <i>xu.</i>	9	0	—	48-52	—
315	same	13	13?	0	41-69	—
CONTROLS						
306	♀ <i>xu.</i> × ♂ <i>xu.</i>	25±	0	—	31	—
335	same	26	26?	26?	39-135	—
378	same	1	0	—	15-42	—
308	♀ <i>hip.</i> × ♂ <i>hip.</i>	81	many	many	7-29	—
400	♀ <i>pol.</i> × ♂ <i>sib</i>	51	51?	35	38-56	—
405A	same	30	0	—	163-219	—
409	same	38	36	29	23-265	—

## EXPERIMENTAL CROSSES

Eighteen attempts to hand-pair *P. xuthus* with other species resulted in successful initial copulation. Fifteen of these pairs remained *in copulo* for at least 20 minutes and therefore might have been at least partially fertile. However, no eggs were laid by females of the following 6 pairs: 4 (♀ *glaucus* × ♂ *xuthus*); 1 (♀ *polyxenes* × ♂ *xuthus*); and 1 (♀ *xuthus* × ♂ *hippocrates*). Table 1 shows the results of the remaining 9 *xuthus* pairings. A few explanatory comments are needed. In the column marked "Minutes *in copulo*", where there are two hyphenated numbers the actual separation was not observed; the first number is the minimum duration, the second number the maximum (e.g., ♀ 309 remained *in copulo* at least 23 minutes but not more than 29). We had to farm out some of the lots of eggs to collaborators who were not prepared to record color changes which indicate that embryonic development has begun or to keep a tally of the number hatching. Most of the queries (?) in Table 1 are from these lots.

The control crosses show, as expected, that there is a much stronger tendency for intraspecific eggs to start development and to hatch than for the interspecific crosses having *P. xuthus* as one parent. However, they also show

that a significant proportion of intraspecific eggs do not develop and a few more do not hatch. Note that the three control broods which produced no fertile eggs were from pairings which must have been of very short or very long duration. Long duration is usually caused by abnormal initial coupling, in which event insemination is not effected and disengagement is difficult. From Cross 315 ( $\text{♀ } \textit{glaucus} \times \text{♂ } \textit{xuthus}$ ) we got 13 ova, most or all of which showed the distinct mottling associated with embryonic development in eggs of *P. glaucus* Linné. None hatched.

The photographs show the color patterns of the imagines of the three parental species and the  $F_1$  hybrids from the two crosses from which adults were reared. The most distinctive differences are listed in Tables 2 and 3, along with the expression of each in the hybrids. Wing characters are those of the upperside only; no additional distinctive difference was found on the undersides. If a character in the hybrid is exactly like that of one parent and completely unlike that of the other species, the interspecific difference is probably controlled by a single Mendelian factor.

The summer generation of *P. xuthus* is strikingly different from the spring generation, having all black markings much more extensive, the blue band on the hindwing obsolescent, and so on. The *xuthus* characters in the Tables are those of the summer generation, because the  $F_1$  hybrids represent this generation and the pure *xuthus* reared simultaneously show the typical summer phenotype.

#### THE CROSS $\text{♀ } P. \textit{POLYXENES} \times \text{♂ } P. \textit{XUTHUS}$

With Brood 324 ( $F_1$  of  $\text{♀ } \textit{polyxenes} \times \text{♂ } \textit{xuthus}$ ) the mother was from stock from Connecticut, the father from a wild larva taken on tangerine at Osaka, Japan. 190 ova were laid from about 23 June to 9 July 1957. The precise numbers of ova which showed the fertility color-change and which hatched were not recorded, but several hatched of the first 145 ova laid. None of the next 32 ova hatched, and none of the final 13 ova even showed the fertility color-change. (It is usual for *Papilio* females to have decreasing fertility in the course of egg-laying, regardless of the father.) Eight larvæ were reared successfully on Umbelliferæ and pupated but only two adults emerged, both stunted, crippled males with even lower viability than with the male from Cross 307. There was no possibility of pairing them, and their abdomens apparently lacked normal testes. The two  $F_1$  hybrids are shown in Plate 1, along with *P. polyxenes*. Consult Plate 2 for characters of *P. xuthus*.

The 2  $F_1$  hybrid  $\text{♂ } \text{♂}$  from  $\text{♀ } \textit{polyxenes} \times \text{♂ } \textit{xuthus}$  are almost identical to normal  $\text{♂ } \textit{polyxenes}$ . Note in Table 2 that of the 14 most conspicuous differences between *xuthus* and *polyxenes* males, the hybrids match *polyxenes* in 11, closely resemble *xuthus* in only 1, and are intermediate in 2. This great dominance of *polyxenes* characters is also seen in its hybrids with *brucei* Edwards (Remington 1958) and with various *machaon* forms (Clarke &

Knudsen 1953, etc.). Although male *polyxenes* and *xuthus* nearly always have a prominent median black spot in the pale wedge nearest the forewing apex in the postmedian row, this spot is totally absent in both hybrids. The only other characters of the F<sub>1</sub> hybrid not shared with ♂ *polyxenes* are: lighter color in the pale markings, elongation of the second and the last two spots of the postmedian row on the hindwings, and a conspicuous dorsal pale patch on the basal half of the antennal club.

Table 2. INTERSPECIFIC DIFFERENCES BETWEEN ♂ *PAPILIO XUTHUS* AND ♂ *P. POLYXENES* AND THEIR EXPRESSION IN THE HYBRID\*

Character	<i>xuthus</i>	<i>polyxenes</i>	Hybrid
1. Pale markings:	creamy white	deep yellow	int
2. Basal ½ of FW:	4 pale streaks in cell, 2 caudad of cell	uniformly dark	<i>pol</i>
3. 2nd pale wedge from FW apex in p.m. row:	with black median spot	spotless	<i>pol</i>
4. FW discal cell:	heavily striped	single apical bar	<i>pol</i> —
5. P.m. row of pale spots on FW & HW:	most much broader than long	about as broad as long	<i>pol</i>
6. Submarginal lunules of FW:	most much longer than broad	about as long as broad	<i>pol</i>
7. Basal 1/3 of front cell of HW:	pale	dark	<i>pol</i>
8. HW p.m. pale spots:	all very long	most length = breadth	int
9. HW posterior cell:	median pale stripe to base	basal 2/3 dark	<i>pol</i>
10. Outer tail fringe:	pale	dark	<i>pol</i> —
11. Palpi & tegulæ:	whitish	black	<i>pol</i>
12. Pterothorax:	pale laterally	all black	<i>pol</i>
13. Abdomen:	whitish, with wide mid-dorsal and 4 thin subventral black bands	black with subdor- sal & subventral row of yellow spots	<i>pol</i> —
14. Basal ½ antennal club:	big dorsal pale spot	no pale patch	<i>xu</i>

\*Symbols in Tables 2 and 3 are: *xu* = exactly like *xuthus*, *hip* = exactly like *hippocrates*, *pol* = exactly like *polyxenes*, int = intermediate, *xu*— = most like *xuthus*, *hip*— = most like *hippocrates*, *pol*— = most like *polyxenes*, FW = forewing, HW = hindwing, p.m. = postmedian.

My collaborator who reared these hybrids made no notes on the larvæ. However, the larvæ of  $F_1$  *polyxenes*  $\times$  *xuthus* hybrids are undoubtedly similar or identical to those of  $F_1$  *xuthus*  $\times$  *hippocrates* hybrids described below, so there should be no difficulty in identifying the hybrid larvæ. We are not concerned with recognition of wild-caught hybrids of *xuthus*  $\times$  *polyxenes*, since the ranges of the two species are so widely exclusive that natural hybridization can not occur. This paper was written in England, and I did not have the actual hybrids nor the pupal shells with me. In the near future I expect to examine the genitalia and pupae of both kinds of hybrids. There are marked pupal and genitalic differences between *P. xuthus* and the members of the *polyxenes* - *machaon* group.

Table 3. INTERSPECIFIC DIFFERENCES BETWEEN ♂ *PAPILIO XUTHUS* AND *P. HIPPOCRATES* AND THEIR EXPRESSION IN THE HYBRID

Character	<i>xuthus</i>	<i>hippocrates</i>	Hybrid
1. Ground color:	creamy white	yellow	<i>xu</i> —
2. FW pale streaks:	1 large below discal cell, 1 large at anal margin, 4 small in discal cell	only marginal streak present; basal 1/3 of FW dark with peppering of yellow	<i>hip</i> —
3. 2nd pale wedge from FW apex in p.m. row:	with black median spot	spotless	<i>hip</i>
4. 2 transv. pale spots in FW discal cell:	>thrice as long as wide	<twice as long as wide	<i>hip</i> —
5. Black striping along veins of FW & HW:	broad	narrow	<i>xu</i>
6. HW anterior cell:	bisected by broad median black patch	no black patch on basal 2/3	<i>hip</i>
7. HW submarg. lunules:	slender	fat	<i>hip</i>
8. HW anal eyespot:	median "pupil"	no "pupil"	int
9. Length of pale zone of HW anal eyespot:	much shorter than dark zone anterad	longer than dark zone anterad	<i>xu</i>
10. Hair along anal margin of HW:	short, inconspicuous	long, prominent	<i>xu</i>
11. Outer tail fringe:	pale	dark	<i>hip</i> ?
12. Basal 1/2 antennal club:	big dorsal pale spot	faint pale spot	<i>xu</i>

#### THE CROSS OF ♀ *P. XUTHUS* $\times$ ♂ *P. HIPPOCRATES*

##### 1. ADULT.

With Brood 307 (♀ *xuthus*  $\times$  ♂ *hippocrates*) the mother was from a wild larva found on tangerine at Osaka, Japan, and the father was from a pupa from Hiroshima, Japan. 97 ova were laid about 20-30 June 1957. Of

the first 72, 9 hatched. The single pupa produced a male on 4 August. We tried to hand-pair this male with a rather old *P. xuthus* and then a *P. hippocrates*. The hybrid seemed to try feebly to copulate with the first female but would not even try with the second. The *xuthus* female was then successfully paired with another male. The general viability of the hybrid was obviously low. This male was soon killed as a study specimen (Plates 2 and 3).

The same parental combination also produced some fertility in Brood 309, and 4 larvæ hatched. Two were preserved for morphological study. Of the two kept for rearing, one died without feeding and the second accepted *Ptelea trifoliata* leaves, fed slowly, and died at the time of the first molt. The reciprocal cross (Broods 305 and 349) showed no fertility, although the copulations were of effective duration and adequate samples of eggs were laid and closely observed.

In its general aspect, the  $F_1$  hybrid from ♀ *xuthus* × ♂ *hippocrates* closely resembles summer *xuthus* and looks quite different from its (spring) ♀ parent and from *hippocrates*. But note from Table 3 that this hybrid is similar to *xuthus* in 5 detailed characters, to *hippocrates* in 6, and is intermediate in 1. As with *polyxenes* × *xuthus* hybrids, this male lacks the median black spot in the pale wedge nearest the forewing apex and thus differs from both its parent species. Experimental hybrids are essential to the recognition of natural hybrids in any group of animals. This hybrid, which should be looked for among supposed variants in Japanese collections, is easily identified in summer individuals by the following combination: ground color very pale, forewing cell below faintly streaked, pale streak partially present in posterior cell of forewing but absent just behind discal cell, "pupil" of anal eyespot present but shifted to caudad edge of pale zone, this pale zone much shorter than dark zone in front of it, no median black patch in anterior cell of hindwing, and dorsal pale patch present on basal half of antennal club.

## 2. PUPÆ.

The pupa of *P. xuthus*, seen in profile, has the mid-ventral bend about 135°; the eye-horns are very large and round-tipped and the notch between them is deep; the mid-dorsal thoracic process is long, rounded, and directed forward; and the subdorsal tubercles on abdominal segments 4-7 are low.

The pupa of *P. hippocrates* has a mid-ventral bend of about 150°; the eye-horns are small and pointed and the notch between them is very shallow; the mid-dorsal thoracic process is short, square-tipped, and directed nearly at a right angle to the axis of the pupa; and the subdorsal tubercles on segments 4-7 are very prominent.

The pupa of the  $F_1$  hybrid has a mid-ventral bend like *xuthus*; the eye-horns are rounded and large but not very long, and the notch is shallow; the mid-dorsal thoracic process and the subdorsal tubercles on segments 4-7 are shown on the color plate. The mid-dorsal markings of the abdomen resemble those of *hippocrates*, not *xuthus*.

### 3. LARVÆ.

MR. EDWARD J. AUSTIN kindly undertook to rear the larvæ of this cross. He photographed the  $F_1$  hybrid larvæ in color, and I have been able to analyse the larval characters using his excellent photographs of the hybrids and of pure *P. xuthus* which he reared simultaneously. The larvæ of *xuthus* and *hippocrates* are so completely different in color pattern that there is little use in making a character-by-character tabulation of differences.

The first instar larva of *hippocrates* is blackish, with a white transverse saddle-mark on abdominal segments 3 and 4, extending down the sides only to the spiracles. After the first instar the subdorsal tubercles on the meso- and metathorax and abdominal segments 1, 2, 5-9 are bright orange, and lateral white patches are present on the thorax and the anterior and posterior parts of the abdomen. In the last (5th?) instar the meso- and metathorax and abdominal segments 1-8 each has: a black transverse dorsal band with a pair of dorso-lateral orange spots; and a black spiracular band and a smaller subspiracular band, each with an orange spot dorsad; there is a prominent black intersegmental band behind each of these 10 segments; the ground color is greenish or whitish; and the head is pale, with bold black lines.

The first instar of *P. xuthus* has the usual white saddle-mark, but it continues cephalad on the sides of abdominal segment 2 and is medially narrowed caudad on segment 5. In the second instar there are large lateral white patches on the thorax, abdominal segments 2-3, and segments 7-8; the tubercles are not orange. The last instar is green; the head is pale, apparently unmarked; there is a continuous black subspiracular stripe along the entire body, bordered ventrally with white; on the metathorax there is a transverse black dorsal band with a lateral eyespot and bordered caudad by an ocellated pale stripe reminiscent of *P. eurymedon* Boisduval, of the *glaucus* group; on abdominal segment 1 is a slender black oblique line continuing across the dorsum and becoming very broad laterally where it fuses with the subspiracular stripe; on each side is a bold black oblique band from the anterior edge of segment 4 (meeting the subspiracular stripe) to the posterior edge of segment 5 but apparently not quite meeting the opposite stripe mid-dorsally; on segment 6 is a 3rd black oblique like that on segment 1 but not becoming very broad laterally; on segment 8 is a slender oblique black mark with the same position and form as on segments 1 and 6; each of the 4 abdominal obliques has a white cephalad edge, most prominent on segments 6 and 8; there are 2 pairs of subdorsal orange tubercles in the black oblique on segment 5.

The  $F_1$  hybrid appears to be much like *xuthus* in the first 2 instars but has the prominent orange tubercles of *hippocrates* in the 2nd instar. The mature larva has an intermediate aspect; the body is green; none of the black bands is oblique, but the dorsal transverse bands on abdominal segments 1, 5, and 6 are continuous with the sub-spiracular mark and are much broader than the bands of 2, 3, 4, 7, and 8; the intersegmental band is weaker than in *hippocrates*; the black subspiracular stripe seems to be discontinuous; 2 pairs of subdorsal tubercles are orange on the metathorax and abdominal segments 1-8; the head appears to be marked like *hippocrates*.

The F<sub>1</sub> hybrid larvæ, when given a choice, preferred *Citrus*, *Ptelea*, and *Xanthoxylum* over Carrot (*Daucus*). One larva, however, accepted the latter and fed readily on it for several days with no indication of deleterious effects. The hybrid was actually started on tangerine but mainly reared on *Xanthoxylum*, as were the pure *xuthus* larvæ.

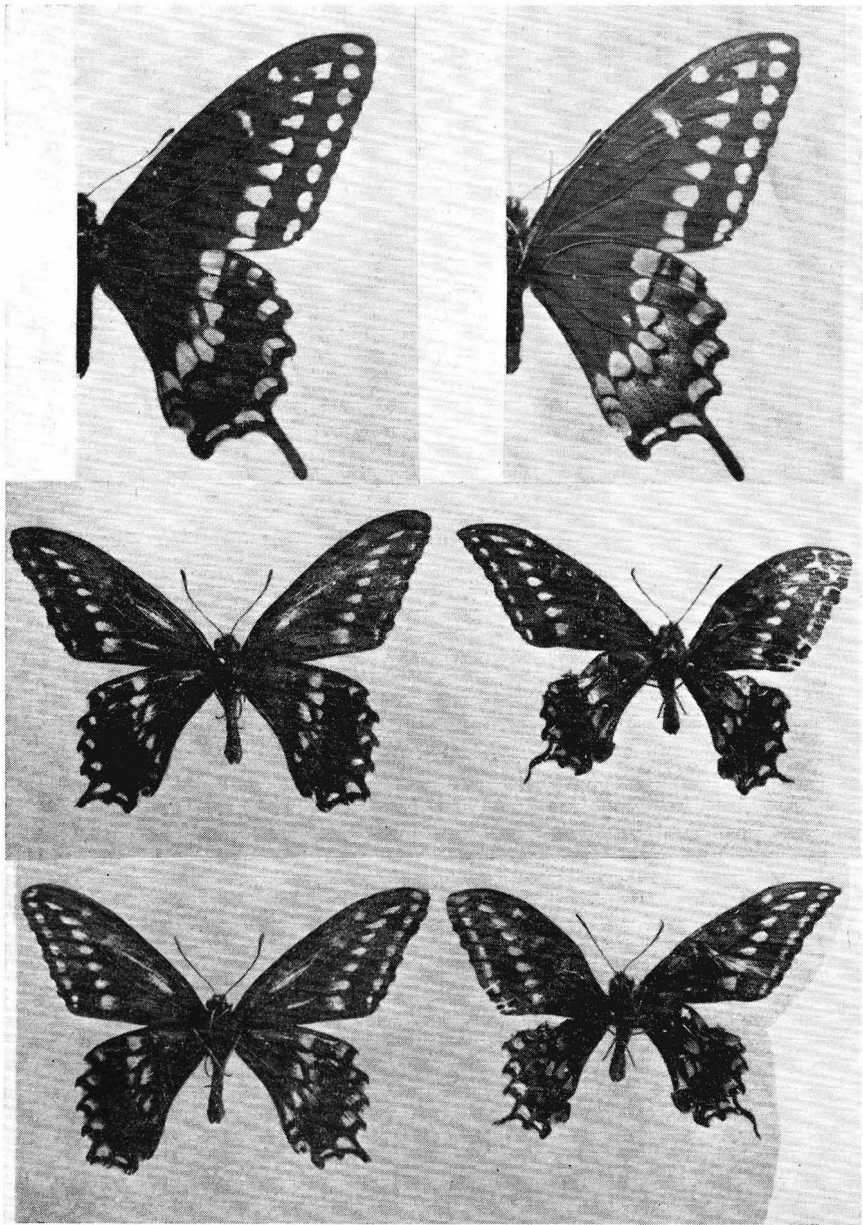
#### DISCUSSION

The extreme inviability of F<sub>1</sub> hybrids of *Papilio xuthus* crossed with both *P. polyxenes* and *P. hippocrates* was unexpected to me. Species as closely related as recent taxonomists have presumed these to be are expected to show much greater compatibility, on analogy with SpHINGIDÆ, COLIAS, and SATURNIIDÆ. It suggests that *xuthus* is not as closely related to the *polyxenes-machaon* complex as has been assumed by all taxonomists for many years. A search of the literature when I was looking at characters of the hybrid larvæ gave a promising new line of evidence. Not only are the larvæ of *P. xuthus* different from *polyxenes* and *machaon* in every aspect of color pattern, but *xuthus* closely resembles figures of *Papilio helenus* Linné and has some similarities to the figures of larvæ of *P. demoleus* Linné, *P. polytes* Linné, *P. polymnestor* Cramer, and perhaps *P. dravidarum* Wood-Mason and *P. liomedon* Moore (Fryer 1911 and Talbot 1939). The larva of *P. xuthus* is also similar to that of the African *demodocus* Esper figured by CLARK (van Son 1949), and SEITZ (1906) noted the resemblance of the *xuthus* larva to those of *bianor* Cramer, *demetrius* Cramer, and *demoleus*. JORDAN (1908) mentioned but did not consider phylogenetically the fact that the oblique-banded type of *Papilio* larva is found in "*xuthus*, *polytes*, *memnon*, *ægeus*, *bianor*, etc." The very brief larval descriptions JORDAN gave for *euchenor* Guérin, *liomedon*, *demolion* Cramer, *gigon* Felder, *nephelus* Boisduval, *ambrax* Boisduval, *phestus* Guérin, *ægeus* Donovan, *bridgei* Mathew, *rumanzovia* Eschscholtz, and *protenor* Cramer all apply to most characters of *xuthus*. All these species, like *xuthus*, feed on Rutaceæ, whereas *polyxenes*, *machaon*, and most of their near relatives feed on Umbelliferæ. There are a few of the latter feeding on Rutaceæ (e.g., *rudkini* Comstock and *machaon syriacus*) or on *Artemisia* (*oregonia* Edwards and *bairdii* Edwards).

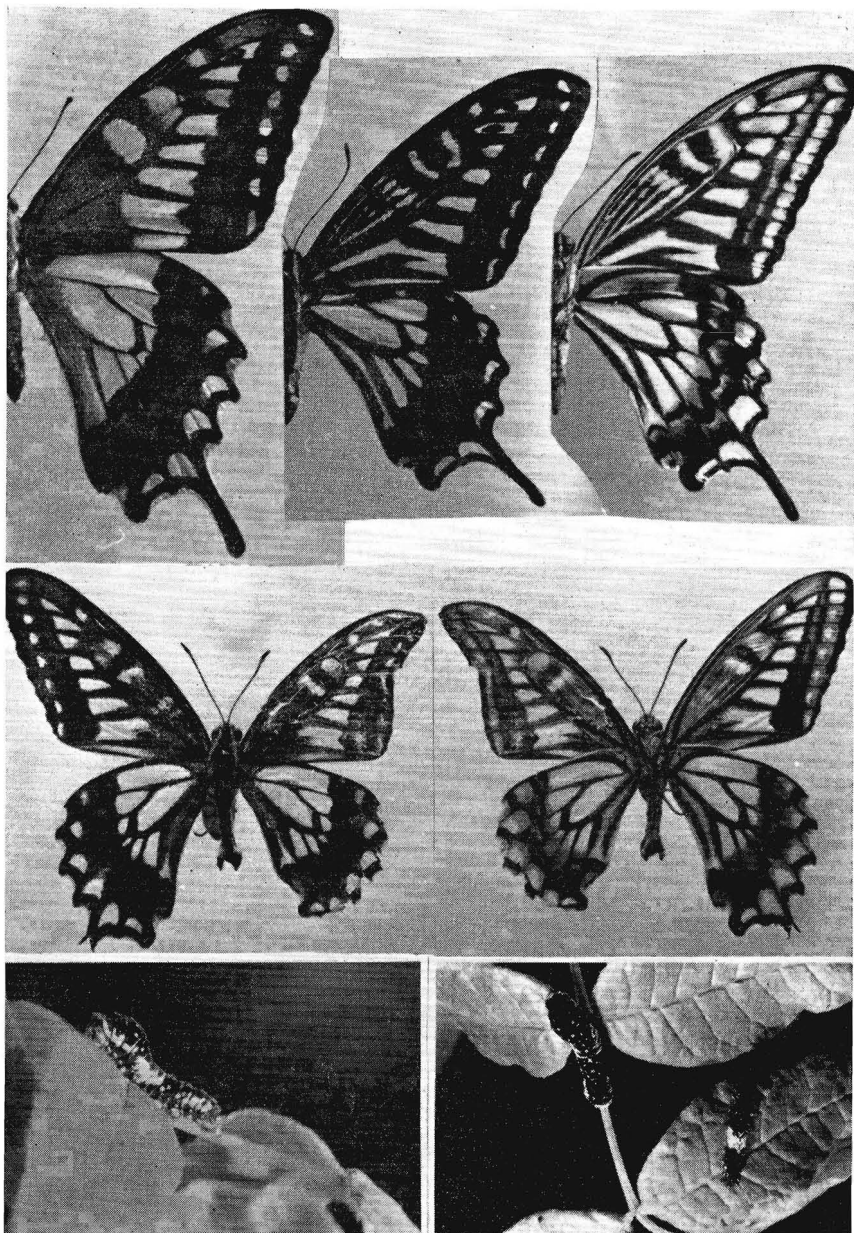
The pupa of *P. xuthus* is also very different from that of the *polyxenes-machaon* group but its form is suggested by those of *P. demodocus*, *dravidarum*, *paris*, *polytes*, *polymnestor*, etc. (but not *P. helenus*).

The hybridization results, combined with these larval and pupal similarities, leave little doubt that *xuthus* is much closer to other species of *Papilio* than to *polyxenes*, *machaon*, *hospiton* Géné, and their near relatives. Presumably the genitalic characters will give a reliable guide to affinities and will give the same answers as do the larvæ, pupæ, and hybrid compatibility. It will be fascinating to see the results of attempts to cross *xuthus* with *bianor*, *demetrius*, *helenus*, *polytes*, *memnon* Linné, *castor* Westwood, and other easily available Oriental and African species. It would be surprising indeed if the hybrids of several *xuthus* combinations with these species were not as viable and fertile as those with *polyxenes*, *hippocrates*, and *glaucus*.





Top: *Papilio polyxenes* ♂ (left upperside, right underside). Middle:  $F_1$  hybrid ♂♂ from ♀ *polyxenes* × ♂ *xuthus*, uppersides. Bottom: same hybrid ♂♂, undersides.



Top left: *Papilio hippocrates*, summer generation, upperside; top center: *P. xuthus* ♂, summer gen., upperside; top right: same ♂, underside. Middle: ♂  $F_1$  hybrid from ♀ *xuthus* × ♂ *hippocrates* (left upperside, right underside). Bottom: young larvæ of  $F_1$  hybrid ♀ *xuthus* × ♂ *hippocrates* (from color transparencies by E. AUSTIN) — right, two instars dorsal view; left, lateral view of larger of two larvæ.

How can we account for the general similarity of adults of *xuthus* to those of *machaon* (and to the *glaucus* group)? Imaginal color patterns are notoriously poor phylogenetic indicators in *Papilio*, due in many species to Batesian mimicry. The details of the color pattern of *xuthus* are close to the "dissimilis" form of *P. clytia* Linné, which is a tailless mimic of *Danaus*. This does not indicate that *xuthus* and *clytia* are closely related but rather that the color patterns may have little taxonomic significance. In fact, a mimetic explanation deserves consideration. There may be no causal relationship behind the color-pattern resemblances of *xuthus* to the *machaon* group or the *glaucus* group.

### SUMMARY

1. *Papilio xuthus*, generally considered a close relative of *P. polyxenes* and *P. machaon*, was hand-paired with them 10 times. Eggs were laid by 8 of the females and a small proportion of the eggs were fertile in 3 crosses. F<sub>1</sub> hybrids were reared to maturity in two: 2 ♂♂ F<sub>1</sub> of ♀ *polyxenes* × ♂ *xuthus*; 1 ♂ F<sub>1</sub> of ♀ *xuthus* × ♂ *hippocrates*. These 3 ♂♂ had low viability and matability.

2. Some fertile eggs were laid by a ♀ *P. glaucus* hand-paired with a ♂ *P. xuthus*, but the embryos died early.

3. The adult F<sub>1</sub> hybrids of ♀ *polyxenes* × ♂ *xuthus* have the general appearance of *polyxenes*; of 14 conspicuous differences between the two parental species, the hybrids are like *polyxenes* in 11, *xuthus* in 1, and are intermediate in 2.

4. The characters of the adult, pupa, and larva of the F<sub>1</sub> hybrids of ♀ *xuthus* × ♂ *hippocrates* are compared to those of the parental species. The adult has the general appearance of *xuthus*, but in 12 detailed characters it resembles *xuthus* in 5, *hippocrates* in 6, and is intermediate in 1. The pupæ and larvæ also have a mixture of the characters of both parents and have an intermediate aspect.

5. Differences and hybrid incompatibility between European *P. machaon* and its so-called race *hippocrates* of Japan and the adjacent mainland are discussed; *hippocrates* should be considered a separate species.

6. The extreme hybrid incompatibility between *P. xuthus* and undoubted members of the *polyxenes-machaon* group, combined with complete dissimilarity in structures and color-patterns of the larvæ and pupæ, indicate that *xuthus* has been incorrectly associated with *machaon*. The larvæ and pupæ of *xuthus* are so similar to those of *P. helenus*, *P. demodocus*, and other African and Indo-Australian species, that it is probable that *xuthus* is nearer these species and can be expected to show higher hybrid compatibility with them.

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## FOODPLANT OF *HYPAUROTIS CHRYSALUS* (LYCÆNIDÆ) IN COLORADO

Since no definite record of the foodplant of *Hypaurotis chrysalus* (Edwards) seems to have been published, I am recording some casual observations made on this point several years in western Colorado. I watched individual females lay single eggs in crevices in bark of the common scrub oak, *Quercus gambelii* Nutt., at the western approach to Rabbit Ears Pass in Routt County, at about 10 miles west of Glenwood Springs in Garfield County, and at about 8 miles east of Somerset in Gunnison County. On 10 August 1954, I took several wild females from the Garfield County locality and confined them with twigs of the oak, in the manner we often use for Theclines. One egg was laid on 12 August and one the next day, both in rough patches of bark. The females then died of overheating in the sun. The eggs were refrigerated that winter but did not hatch when brought out in spring.

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