

THE BIOLOGY OF *PAPILIO INDRA KAIBABENSIS* IN
THE GRAND CANYON

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Of the six races of *Papilio indra* Edwards, *P. i. kaibabensis* Bauer inhabits perhaps the most spectacular country in which a butterfly may be found, the sheer cliffs and rugged gorges forming the Grand Canyon of the Colorado River in northern Arizona. This swallowtail was first noted to occur in Arizona sixteen years ago (Garth, 1950) and was described as a distinct subspecies in 1955 by Bauer. Few specimens have been collected since those of the type series, almost all at the top of the rims within Grand Canyon National Park in the month of August. Nothing on the biology of this butterfly has been recorded. The present paper reports data on the ecology, distribution, and life history of *Papilio indra kaibabensis* obtained from three years of field work in the Grand Canyon. The affinity of *kaibabensis* with the *P. indra* group is corroborated by our data.

Since the type locality of *P. i. kaibabensis* is Bright Angel Point, on the North Rim of the Grand Canyon, the authors first visited this area on August 7-9, 1963. It rained daily and adults were not seen; searching of the slopes and rim around Bright Angel Point did not uncover a possible umbellifer foodplant.

The following year, we returned to the Grand Canyon to explore the lower Canyon area around Roaring Springs, another North Rim locality where this *Papilio* was known to occur. On August 22, one of us (J.F.E.) made the five-mile hike down the North Kaibab Trail. A large female *P. i. kaibabensis* was observed flying on the steep slope opposite Roaring Springs, and it attempted to oviposit on an umbelliferous plant. The butterfly was netted and kept alive, in the hope that it would be induced to oviposit (unfortunately it died the following day). In the next few hours, only three other females were seen, and one was collected. During this time, the umbelliferous plants on the slope were searched for larvae. One third-instar larva was found, and specimens of the plant were taken for identification. The single larva was reared to the fifth-instar on an intact specimen of the foodplant, but it died of disease.

In July of 1965, one of us (T.C.E.), in company with field assistant, M. K. Fosdick, revisited the Grand Canyon with the intention of finding more immature stages. On July 3, the 4,000 foot descent to the Roaring Springs area was made. A fresh male *kaibabensis* was taken on wet

sand at the spring area, and several other rather worn adults were seen. On the abundant foodplants, six larvae were found: one second-instar, one third instar, three fourth-instars, and one fifth-instar. The fifth-instar larva prepared for pupation soon after collection and the resulting pupa went into diapause; the remaining five larvae were sent to J.F.E. at Stanford University for rearing. On arrival, the second-instar was dead and the third-instar had molted. The four living larvae were placed singly on separate potted plants of *Tauschia arguta* (T. & G.) Macbr., a known foodplant of *P. i. pergamus* Hy. Edw. (Emmel & Emmel, 1963). All accepted the *Tauschia* readily and three reached maturity; the fourth was killed by ants while in the fourth-instar.

The three mature larvae all pupated successfully; one pupa died several weeks after formation from virus disease. The remaining two pupae emerged on July 28, 1965, only ten days after pupation on July 18.

DESCRIPTION OF FOODPLANT

The foodplant at Roaring Springs was identified as *Pteryxia petraea* (Jones) Coult. & Rose, using *Arizona Flora* by Kearney and Peebles (1960: p. 619). This identification was further verified by comparison of our specimens with numerous herbarium specimens of *P. petraea*.

The broad range of this plant includes extreme eastern Oregon, southern Idaho, northeastern California, and the northern half of Nevada. In Arizona the plant is found only in the Grand Canyon, where it occurs on the slopes of both rims. The four herbarium specimens of *Pteryxia petraea* at the Grand Canyon National Park Museum are from the South Rim: from 6,000 to 4,250 feet elevations on the Hermit Trail and at 7,000 feet on the South Kaibab Trail. Our work on the North Rim shows that it is abundant from 4,800 to 5,200 feet elevation on dry rocky slopes along the North Kaibab Trail. The plant may stand nearly two feet in height, and be the same size in diameter. Flowering occurs in May and June, and the herbage remains green into early September when summer rains are sufficient. This plant has a strong pungent odor detectable by a human observer from even several feet away.

HABITAT

The *Pteryxia* plants were found generally scattered on the open sunny slopes or even vertical canyon walls in the vicinity of Roaring Springs, in the arid Pinyon-Juniper belt or Upper Sonoran Life Zone. This area is about 2,000 feet lower in elevation than the Mesa County, Colorado, habitat of *Papilio indra minori*, but the general plant associations and rocky-slope habitat of these two *P. indra* races are the same.

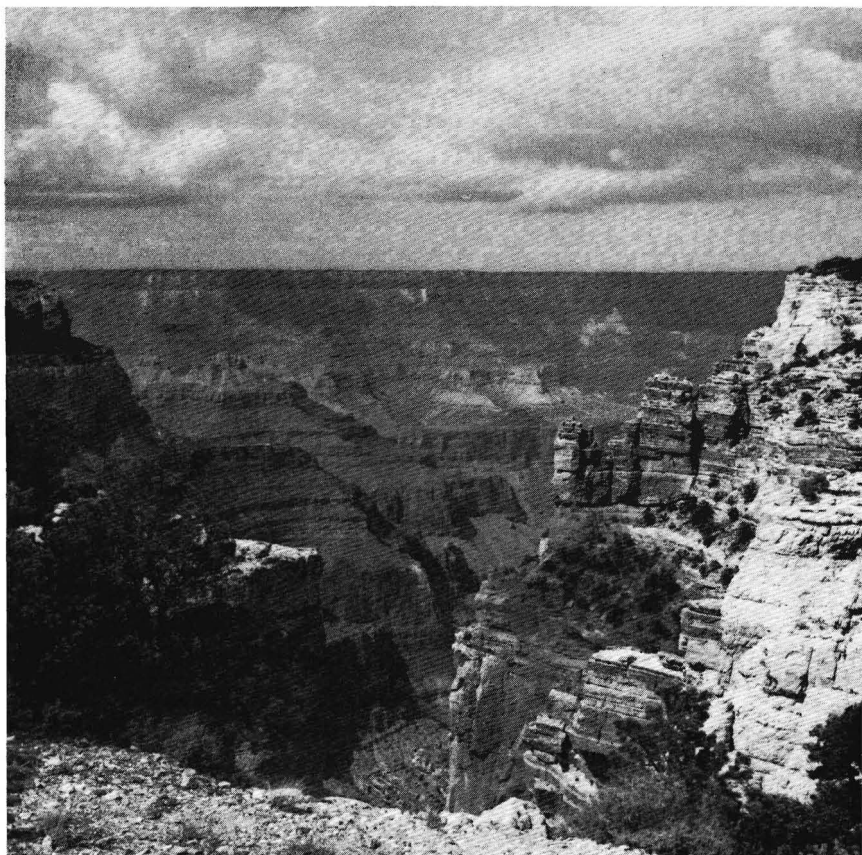


Fig. 1. The Grand Canyon of the Colorado River, Arizona, from Cape Royal on the North Rim. Male *Papilio indra kaibabensis* have been taken here, but the main breeding area is located below even the lowest rock strata visible in this photograph.

ADULT HABITS

The observed *P. i. kaibabensis* males were either taking water at mud flats along the stream at Roaring Springs or flying rapidly along the stream bottom. Most of the males (and the several females) of the type series were taken on the top of the North or South Rims (Bauer, 1955), and it is likely that the males "hill-top" like males of other *P. indra* races (even though they may ascend several thousand feet higher than their nearest foodplants, where the fresh unmated females would presumably be found!). The observed females flew rather slowly across the slopes around Roaring Springs, occasionally hovering around the outer leaves

of a *Pteryxia* plant. A tall thistle (*Cirsium* sp.) has been the only observed nectar source for the adults.

This subspecies is double-brooded, as evidenced by the presence of young larvae at the beginning of July and again in August, the immediate emergence of two of the four pupae obtained from early-July larvae, and the temporal distribution of adult specimens in collections and in our field visits. All but one specimen of the type series were taken in August (usually mid to late August), and would therefore be second brood specimens. The other type specimen was taken July 1, and our own early-July visit showed adults flying at that time. Considering the larval instars (even a fifth-instar) taken July 3, the first brood must fly from late May into early July.

Data obtained since the publication of our paper (Emmel & Emmel, 1964) on the life history of *Papilio indra minori* indicates that *P. i. minori* also has a second brood in mid summer. At present, then, two of the six subspecies of *Papilio indra* are known to have two broods a year while the other four are apparently single-brooded.

LARVAL HABITS

As in other *P. indra* subspecies, the larval habits differ among the instars. The fourth-instars remained on the petioles of the foodplant, near the base, moving to the tip of the leaf to feed. Larvae of this instar often dropped from the plant when disturbed. When not feeding, fifth-instar larvae rested near the base of the plant, under old leaves or prostrate stems. Larvae fed most heavily during the daylight hours, but also fed at night. For several hours before selecting a pupation site, the larva traveled rapidly around the potted *Tauschia* plant, stopping only when disturbed.

DESCRIPTION OF EARLY STAGES

Egg and First-Instar Larva:

No examples have been obtained, but considering the close similarity of later stages to those of *Papilio indra minori*, the egg and first-instar are probably similar to those of this western Colorado subspecies.

Second- and Third-Instar Larvae:

The general coloration and pattern is similar to that of the fourth-instar larva described below, except that the head is shiny black before the larva reaches fourth-instar.

Fourth-Instar Larva:

Length: 25 mm at maturity.

Head: Width of head capsule, 2.1 mm. Shiny jet black, with an inverted crescent-shaped mark of light orange at center and four white dots across upper margins (one pair on each side).

Body: Pattern indistinguishable from that of fourth-instar larva of *Papilio indra minori* (see Figures 2 and 3, and Emmel & Emmel, 1964). Ground color black; three rows of orange spots on each side of larva; position and shape of white "saddle" mark (on seventh abdominal segment) and other white spots as on larva of *P. i. minori*.

Fifth-Instar Larva:

Length: 42 mm at maturity, the largest of any *P. indra* race.

Head: Width of head capsule, 4.0 mm. Head capsule pattern (Figure 6) and its slight variation between larvae essentially identical to that of *P. i. minori*. Light areas in pattern red-orange, the dark areas in both subspecies black.

Body: (Figures 4 and 5). Ground color deep black. Middle of each body segment with six orange spots, three on each side (dorsal, suprastigmatal, lateral); these spots in same positions as orange spots on larvae of younger instars. First segment with a narrow anterior band of rich pink; this pink band expanding to cover anterior half of each succeeding segment, always ending posteriorly and laterally at the orange spots. Thoracic legs and abdominal prolegs black, with a medium to large white dot on each. An analogous, single subventral white dot on segments without legs, but not on anal proleg pair (where it is almost always present on *P. i. minori* larvae).

After careful comparison of these *kaibabensis* larvae with preserved examples and color transparency slides of larvae of *P. indra minori*, we conclude that the pattern and general coloration of the fifth-instar larvae of the two subspecies are essentially identical. The *P. indra kaibabensis* larvae differ only in their slightly larger size at maturity and the absence of the white spot on the rear proleg. This similarity is surprising when one considers the degree of larval color pattern divergence in the other *P. indra* subspecies, although it is clear from adult characters that *kaibabensis* and *minori* are closer to each other than to any of the remaining four races. The pupal coloration of *kaibabensis*, however, is quite distinctive.

PUPA

Male: Length, 27.5 mm. Greatest width at wing cases, 9.5 mm.

Female: Length, 30–31 mm. Greatest width at wing cases, 10 mm.

Morphologically, the pupa is identical to that of *P. i. minori*. It is also identical in size to large pupae of *minori*. However, it may be distinguished readily from pupae of all other *P. indra* subspecies in its coloration. The ground color is best described as a light tannish pink; pupae of *P. i. minori* are grayish tan or brownish tan in comparison. A finely mottled appearance is given by a rough surface with scattered tiny light

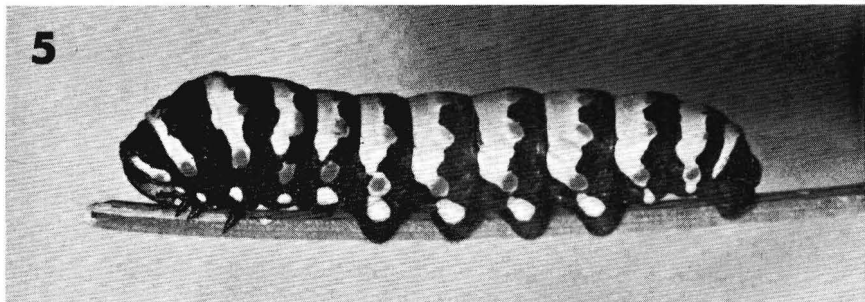
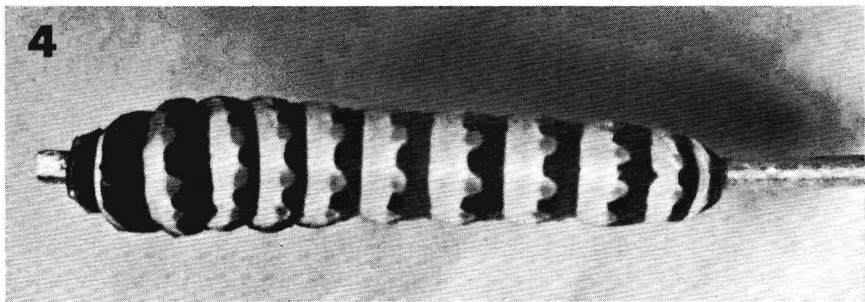
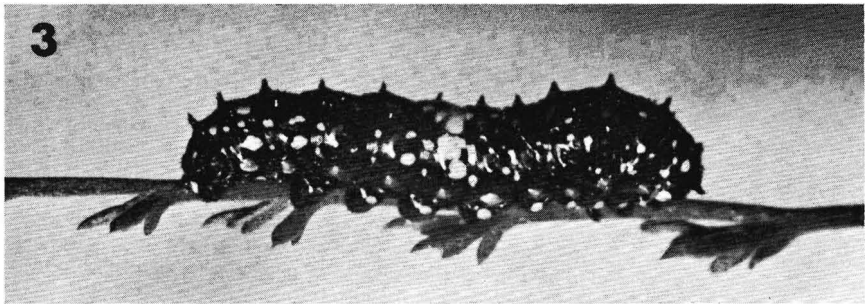
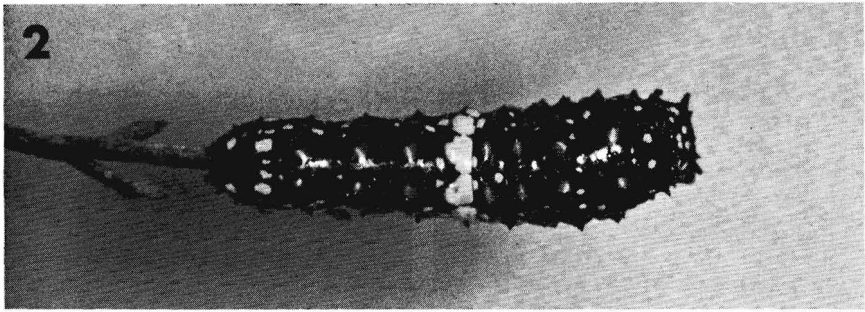


Fig. 2. *Papilio indra kaibabensis* Bauer. Fourth-instar larva, dorsal aspect. Fig. 3. Fourth-instar larva, lateral aspect. Fig. 4. Fifth- (last) instar larva, dorsal aspect. Fig. 5. Fifth-instar larva, lateral aspect.

cream-colored spots, the spots occurring on the raised portions of the surface. There are also various other scattered marks of a dark tannish pink. The light spots are more concentrated in the dorsal region, giving this area a lighter color than the surrounding tannish pink. The wing cases have much less mottling.

DISTRIBUTION OF THE SUBSPECIES

The twenty-one specimens of *Papilio indra kaibabensis* in the Grand Canyon National Park Museum collection were collected at five different localities:

Bright Angel Point (17 specimens): 8/3/38, 8/13/51, 8/2/53 (2), 8/4/53 (2), 8/5/53 (4), 8/7/53 (2), 8/13/53, 8/14/53 (2), 8/16/53 (2). Point Imperial (1): 7/28/53. Cape Royal (1): 7/29/53. Roaring Springs (1): 8/18/53. Yavapai Point (1): 8/22/44.

All the specimens but one (Yavapai Point) came from the North Rim of the Grand Canyon, and all represent second-brood adults. Bauer (1955) took one male, near Ryan Ranger Station, Kaibab Plateau, Coconino Co., Arizona, on 1 July 1952.

From our field work in the Grand Canyon area and the distribution of foodplants and museum specimens, it appears that the butterfly breeds in a narrow altitudinal zone at about 5,000 feet elevation, halfway between the North Rim (and probably also the South Rim) and the floor of the Grand Canyon.

SUMMARY

The life history stages and foodplant of *Papilio indra kaibabensis* are described from field work on the North Rim of the Grand Canyon. The life history is very similar to that of *P. i. minori*; both races are double-brooded. The foodplant is *Pteryxia petraea* (Jones) Coult. & Rose, a member of the Umbelliferae. Remarks on the ecology of the adults and larvae and known distribution of this Grand Canyon race are also given.

It is clear from the characters of the immature stages that Bauer (1955) was correct in associating this black *Papilio* with the *P. indra* group rather than with the superficially similar adults of *P. bairdi*, or another *Papilio*. It is also evident that *P. indra kaibabensis* and *P. i. minori* have diverged from each other mainly in adult characteristics, which suggests that characteristics of the immature stages in these butterflies are evolving less rapidly than those of the adults. This conservatism in larval divergence is all the more surprising when one compares these larvae with those of the other *indra* subspecies, which have diverged considerably.

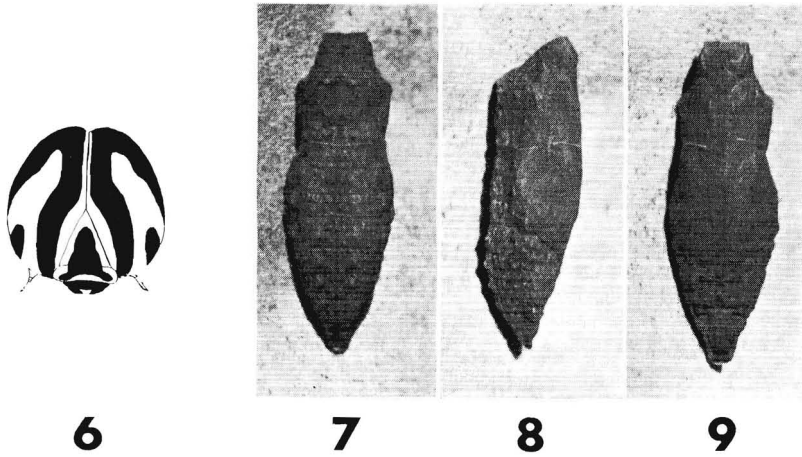


Fig. 6. *Papilio indra kaibabensis* Bauer. Detail of the head of the fifth-instar larva, frontal view. Dark areas black, light areas orange. Fig. 7, 8, 9. Pupa. Dorsal, lateral, and ventral aspects, respectively.

ACKNOWLEDGMENTS

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