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# LIFE HISTORY OF *PACHLIOPTA RHODIFER* (PAPILIONIDAE: TROIDINI)

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**ABSTRACT.** The Andaman clubtail, *Pachliopta rhodifer* (Butler), is one of three papilionids endemic to the Andaman and Nicobar islands, India. This elegant red-bodied swallowtail, with its unique red spatulate tail, previously was known only from the imago. We detail the life history of this species and discuss implications for butterfly conservation in these islands.

**Additional key words:** Aristolochiaceae, butterfly conservation, Andaman Islands, Nicobar Islands, India.

The Andaman and Nicobar islands have been identified as one of the provinces of the Indomalayan biogeographic realm requiring urgent attention to ensure adequate protection of their distinctive biological communities (Anonymous 1985, ICBP 1992). These islands are situated in the Bay of Bengal, Indian Ocean, between 6–14°N latitude and 92–94°E longitude, and consist of 306 islands. They stretch over 700 km and occupy a total area of 8249 km$^2$ (Anonymous 1986). The Andamans are separated from the Nicobars by the Ten Degree Channel, a distance of about 100 km. The two island groups have characteristic biotic elements, with each island group harboring a set of unique endemics (Anonymous 1986, Rao 1986).

On the basis of the number of endemics found in a region, Collins and Morris (1985) rate the Andaman and Nicobar islands sixteenth out of a total of 51 critical swallowtail faunas worldwide. In spite of the high priority ranking, no attempt has been made to study the life histories, food plants, and other requirements of *Graphium epaminondas* (Oberthür), *Papilio mayo* Atkinson, or *Pachliopta rhodifer* (Butler), the three endemic papilionids that are thought to be confined to Great Andaman (which includes the three neighboring islands of North, Middle, and South Andaman). Even Ferrar, who collected Lepidoptera on these islands for eight years, confined himself to the study of adults (Ferrar 1948).

Four species of *Pachliopta* are known to occur in the Andaman and Nicobar islands. Two of these, *P. coon* (Fabricius) and *P. hector* (Linnaeus), are protected by Indian law (Schedule I of the Indian Wildlife Protection Act, 1972, which came into effect on 2 October 1980). The former species is very rare and found only in the Nicobars in India; the latter is rare and confined to the Andamans and mainland India. Neither of the other two species, *P. rhodifer* and *P. aristolochiae* (F.), are considered threatened, even though the status of the endemic *P.*

*rhodifer* is not clearly known (Collins & Morris 1985). *Pachliopta rhodifer* is one of 17 species of the genus listed by Collins and Morris (1985) as requiring further monitoring and research.

We present below the results of our study on the life history of *P. rhodifer*, the only troidine swallowtail endemic to the Andaman Islands.

## Previous Collections

Ferrar (1948) states that there is a "good series" of *P. rhodifer* at the British Museum (Natural History) and at Calcutta. However, this species has proved to be elusive to those who have collected recently on these islands (Arora & Nandi 1980). Of nine expeditions from the Zoological Survey of India, Calcutta, only four succeeded in collecting this species. Cumulatively these surveys covered eight months of the year. They collected *P. rhodifer* during four months, i.e., January, March, April, and December. They collected a total of 16 males and four females. Nakamotu also succeeded in collecting four males and five females in the months of October and November 1979 (Tsukada & Nishiyama 1982).

*Pachliopta rhodifer* was known only from various places in South, Middle, and North Andamans (Ferrar 1948, Tsukada & Nishiyama 1982) until Arora and Nandi (1980) collected a male from Car Nicobar in December 1972. This male was perhaps a straggler and may have been blown over from S. Andaman to C. Nicobar (150 km). The food plant is found in the Nicobar Islands (Rao 1986), hence the butterfly could survive and breed there.

It is perhaps the scarcity of *P. rhodifer* in collections around the world that has resulted in its relatively high value in the insect trade (Smart & Smart 1982). One male specimen reportedly collected from North Andaman was listed for sale for $400 U.S. We believe that rarity in collections is more a result of the stringent regulations imposed by the Government of India rather than a reflection of the rarity of the butterfly.

## Materials and Methods

We discovered a last instar larva of *P. rhodifer* during a collecting trip to the forests of South Andaman in late October 1990. The discovery of the host of *P. rhodifer* was the key to searching for the early stages. Over a two-year period we visually searched mainly three localities for early stages: Garacharma, Mt. Harriet, and Chidiyatapu, all on the island of S. Andaman.

Upon locating host plants, which have a tendency to grow in patches, a thorough examination for eggs, larvae, and pupae was conducted. All

early stages discovered in the field were brought into the laboratory and housed in transparent, plastic jars of variable dimensions—the first and second instars in the smallest (6.5 cm high × 5 cm diameter), the third to fifth instars in medium (10 cm high × 7 cm diameter), and the final instar in the largest (19 cm high × 11 cm diameter) containers. Food (detached, whole, tender leaves) was supplied fresh every day. The rearing containers also were cleaned daily of all fecal matter and old food. Moisture that settled on the walls of the containers was wiped away with a dry cloth. A dry twig, slightly less than the height of the container, was placed diagonally in containers with final instars to facilitate pupation. All rearings were carried out in the laboratory at ambient temperature (23–30°C) and humidity (79%). Adults were released back into their habitat.

The study was conducted primarily on the main campus of the Central Agricultural Research Institute at Garacharma, approximately 6 km southwest of Port Blair on the island of S. Andaman, India. Patches of forest that have been retained in parts of the campus were found to support populations of the butterfly. Although subject to intense human intrusion, these patches continue to retain a number of plant and animal species that were a part of the original forest that once covered this area (Fig. 1). The larval food plant of *P. rhodifer* was found in a number of patches, some of which suffered more human damage than others. A large population of the immature stages was present in a relatively disturbed area where the larval food plant grew in the shrub layer close to the ground beneath the canopies of coconut, oil palm, and other trees. This area was subject to periodic weeding operations.

Additional observations were made during periodic visits to Chidiyatapu and Mt. Harriet, both situated in the southern half of S. Andaman. Although subject to less anthropogenic activities than the Garacharma site, these sites yielded fewer eggs and larvae of *P. rhodifer*, despite the fact that patches of the larval food plant at both these sites were more dense and healthier in appearance.

## RESULTS

*Thottea tomentosa* (Blume) Ding Hou (Aristolochiaceae), a low, woody, creeping under-shrub in the forests, was found to be the sole food plant of *P. rhodifer* (Figs. 1 & 2). The maximum height of the plant was 51.0 cm. Only the younger, densely tomentose terminal leaves were eaten; the lower older leaves were never fed upon. The older leaves were tougher and had a lower percentage of water than the younger leaves. After consuming most or all of the young, tender leaves of a plant, the larvae leave to find a new host plant.

We observed adults feeding on the flowers of *Vitex trifolia* L. (Ver-

benaceae), *Acacia* sp. (Mimosaceae), *Ixora* sp. (Rubiaceae) and *Intsia bijuga* (Coleb.) O.K. (Caesalpineaceae).

**Egg** (Fig. 3): Similar to other troidine eggs; pale orange with a smooth circular area on top.

**First instar:** Pale orange, partly suffused with black. Head, prothoracic shield, and anal legs deep glossy black; osmeterium pale orange. Tops of tubercles capped with about a dozen long, black setae. [This is characteristic of the early instars and unlike that of later instars.] Entire surface of body covered with minute hairs. Head capsule black in all instars.

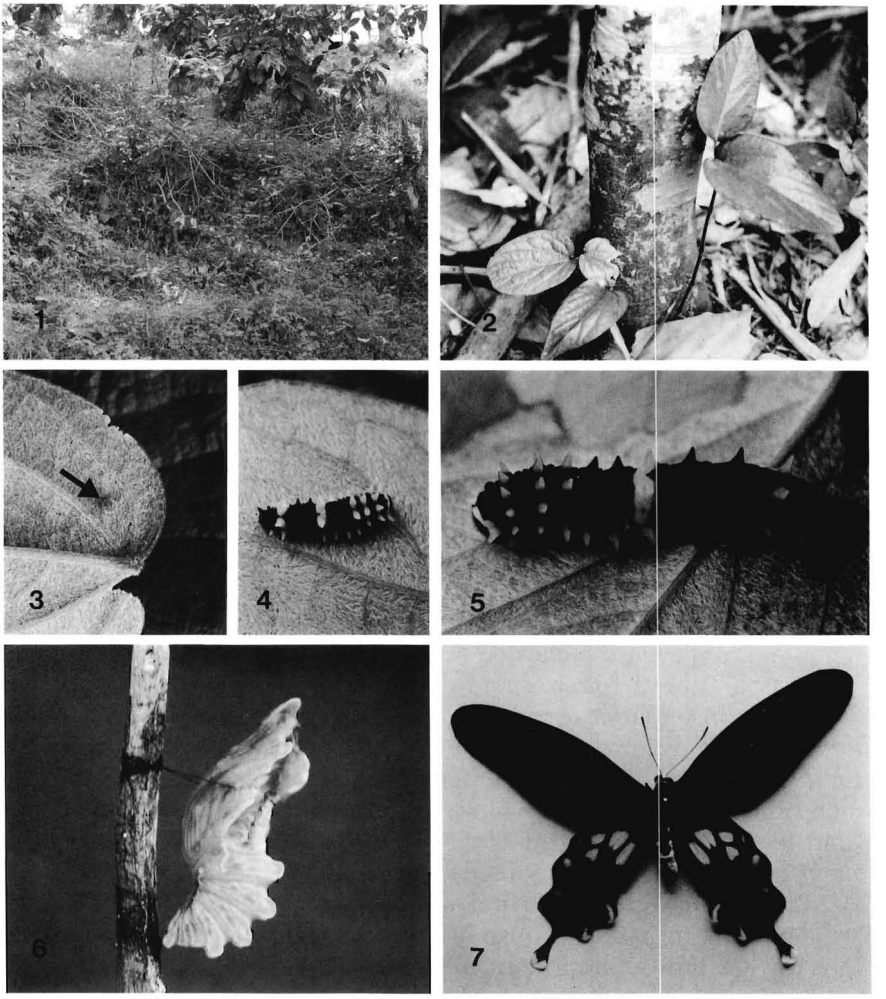
**Second instar:** All larvae with similar color pattern from this instar on. The only difference between this and the following instars is that the red bands are incomplete along the mid-dorsal line, resulting in a continuous black mid-dorsal line, obliterated in the latter instars.

**Third through sixth instars** (Figs. 4 & 5): Rich purple-black, studded with intense orange-red and a few purple-black tubercles, interspersed with narrow bright orange-red bands running along the posterior margins of abdominal segments IV and VII. Head glossy black with a number of stiff bristlelike black setae. Clypeus dirty white and translucent.

On either side of the mid-dorsal line a row of bright-red tubercles on all segments except abdominal segments II, III, V, and VI, which are intense purple-black. A sub-dorsal row of orange-red tubercles on thoracic segments only, this row absent on the abdominal segments. A subspiracular row of tubercles on all thoracic and abdominal segments, orange-red except on abdominal segments V and VI where they are black. A complete row of sub-ventral tubercles, all bright orange-red except that on the last abdominal segment which is claret. A single small ventral tubercle exclusive to the second abdominal segment. All tubercles covered with setae, black on the red tubercles, silver-grey on the black tubercles. Ventral surface black, suffused with claret.

Spiracles black, outlined in white. Spiracles on abdominal segment IV in the black area apposite, but posterior to, the orange-red band. Spiracles on abdominal segments I and II progressively dorsal than those on all other abdominal segments, which form a straight line. Consequently, the subspiracular tubercles also have the I abdominal one highest, followed a little lower by the II abdominal tubercle; the remaining tubercles occur in a similar position on each segment, forming a straight line. Distances between the subspiracular and sub-ventral tubercles are variable in the anterior segments; the prothoracic and all abdominal tubercles of the two rows very close, their bases almost touching; the two spiracles on the meso- and metathoracic segments relatively further apart. The only tubercles on the prothorax are the subspiracular and the sub-ventral, which are deep orange-red. Dorsal space between the subspiracular tubercles covered by a light, orange-red smooth pad, faintly grooved along its mid-dorsal line. Black prothoracic shield behind this pad. A short red lateral band posteriorly, on the III abdominal segment starting from the base of the subspiracular tubercle and extending up to about ⅔ the distance to the dorsal tubercle. Red band on the IV abdominal segment posteriorly notched on the mid-dorsal line. Red band on abdominal segment VII divided mid-dorsally by a rich purple-black band. Depressed black spot in red bands of abdominal segments IV (above the base of the subspiracular tubercle) and VII (antero-dorsally at base of the subspiracular tubercle).

**Pupa** (Fig. 6): Orange-brown, resembling a dry leaf. Girdle black; cream lateral markings anterior to girdle. Two red, glistening, triangular areas on either side of the mid-dorsal line on anterior end of dorsal area of thorax. Blunt, dorsal horn with faint dorsal red line and foliaceous extensions/carinae from antero-ventral region, extending laterally to abdominal segment I. Circular, red spot in mid-dorsal region of abdominal segment II. Two orange-red areas or irregular spots on abdominal segment III laterally. Sparse, minute hairs in pits on pupal surface, increasing in number around dorsal end of spiracles. Additional pair of processes on either side of dorsal horn and on lateral margins of abdominal segment I.




FIGS. 1–7. Habitat and early stages of *Pachliopta rhodifer*. **1,** Habitat of *P. rhodifer*; **2,** *Thottea tomentosa*, the larval food plant, growing at the base of a tree; **3,** Egg of *P. rhodifer*; **4,** Third instar of *P. rhodifer*; **5,** Fifth instar of *P. rhodifer*; **6,** Pupa of *P. rhodifer*; **7,** Adult male of *P. rhodifer*.

Eggs are laid singly. Females fly low over the undershrub layer, alighting on vegetation frequently, including the host plant, but do not often lay eggs. When laying an egg, the female alights on the host plant, bends her abdomen beneath the leaf surface, and lays an egg along or on one of the veins of a young leaf, but usually not on the midrib. Eggs generally are laid on the under surface of leaves of the

TABLE 1. Duration and size of the pre-imaginal stages of *P. rhodifer*.

| | Eggs | I | II | III | IV | V | VI | PP | P |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Duration (days) | | | | |
| n | 2 | 4 | 7 | 13 | 16 | 18 | 19 | 19 | 13 |
| Range | >6 | 2–4 | 2–4 | 3–6 | 4–8 | 5–7 | 7–14 | 1–4 | 15–64 |
| Mean | — | 3 | 2.83 | 3.62 | 5.13 | 5.72 | 9.63 | 1.95 | 26.69 |
| SE | — | 0.41 | 0.26 | 0.25 | 0.24 | 0.16 | 0.39 | 0.14 | 5.19 |
| | | | | | Size (cm) | | | | |
| n | — | 2 | 6 | 13 | 16 | 18 | 20 | — | 19 |
| Range | — | 0.7–0.9 | 0.6–1.0 | 0.6–1.5 | 1.3–2.2 | 2.3–3.1 | 2.8–3.7 | — | 3.1–3.8 |
| Mean | — | 0.8 | 0.85 | 1.16 | 1.67 | 2.68 | 3.31 | — | 3.44 |
| SE | — | 0.1 | 0.06 | 0.07 | 0.06 | 0.06 | 0.07 | — | 0.04 |

* Total life cycle: Mean from I instar to adult = 58.6 days = 59 days. Mean from egg to adult = over 64.6 days = over 65 days.

host plant or rarely on adjacent vegetation. Because the undersurfaces of *Thottea* leaves generally are encrusted with a layer of mud, the veins are the only places where eggs can be laid safely without being dislodged. Only one egg is laid on each leaf. On one occasion, one egg was found on a blade of grass; another was found on a cane leaf. The incubation period is at least six days, after which the first instar larvae emerge. Larvae eat the chorion and begin to feed on the tender young leaves (see Table 1 for sizes and durations of all stages).

The first instar larva appears to remain on the leaf on which it hatches; later instars move not only from one leaf to another on the same plant, but also from plant to plant. Later instars have been observed moving along the ground, probably in search of a new host plant; host plants tend to have clumped distributions. Larvae are forced to move from plant to plant because they feed exclusively on the new flush.

Although we were able to find all stages from eggs to last larval instar, we never discovered prepupae or pupae, suggesting that pupation occurs away from the host plant.

The prepupal period usually lasts about two days but in one case it lasted four days.

The total life cycle lasts about 65 days. As the eggs were collected from the field, and not from females bred in the laboratory, it was not possible to ascertain when they had been laid, leading to an uncertainty

TABLE 2. Duration and head capsule measurements of *P. rhodifer* larva when passing through seven instars (n = 1).

| | Egg | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|---|
| Duration (days) | >3 | 3 | 4 | 4 | 5 | 5 | 7 | 10 |
| Width of head capsule (mm) | — | 0.9 | 1.2 | 1.7 | 2.3 | 2.9 | 3.9 | — |

TABLE 3. Mortality pattern in captive pre-imaginal stages of *P. rhodifer* in S. Andaman.

| | Egg | I | II | III | IV | V | VI | PP | P |
|---|---|---|---|---|---|---|---|---|---|
| Total collected | 5 | 4 | 7 | 13 | 16 | 19 | 21 | 23 | 23 |
| No. dead | 3 | — | — | — | — | 1 | 1 | 3 | 9 |
| Percent mortality | 60 | — | — | — | — | 5 | 5 | 13 | 39 |

in the incubation period and consequently in the number of days taken to complete the entire life cycle.

When we searched for the eggs and larvae of *P. rhodifer* in April, the driest month in the year, we could find only one egg of the butterfly and no new flush of the food plant. On hatching, the larva had to be fed older, poor quality leaves. This individual passed through seven larval stages. Nevertheless, the total larval period did not vary from those rearings that had six instars. Dimensions of the head capsules and the durations of larval instars of this individual are presented in Table 2.

Two eggs and a third instar larva collected in the field were parasitized. The egg parasitoid was identified as *Telenomus* (*Aholcus*) sp. (Scelionidae: Hymenoptera). The larval parasitoid could not be identified, as the hymenopteran adults failed to emerge from their cocoons. A certain degree of mortality (Table 3) also was noticed while rearing the butterfly. From the first to fourth instar, all larvae survived. Mortality occurred in the egg stage and in larval instars V and VI, as well as during the prepupal and pupal stages. Mortality was highest in the egg and pupal stages.

One instance of mating in flight was observed at about 1100 h in the Garacharma farm of the C.A.R.I. campus when a pair *in copula* flew at a height of about 5–6 meters and alighted on the branch of a tree well beyond our reach. A mating pair also was seen at about 1700 h on a blade of grass along an earthen embankment at the base of Mt. Harriet.

## DISCUSSION

Thirteen genera in the tribe Troidini feed on aristolochiaceous food plants during their larval stages (Igarashi 1984). Of the four species of *Pachliopta* found in the Andaman and Nicobar islands, two are rare and their local food plants remain unknown. The other two species, *P. aristolochiae* and *P. rhodifer* (Fig. 7), feed exclusively on *Thottea tomentosa*. *Thottea tomentosa*, though only locally abundant, is much more frequent in its occurrence than *Aristolochia tagala* Cham., the only other member of the Aristolochiaceae found on these islands (Ding

Hou 1981, Rao 1986). Although we found *P. rhodifer* and *P. aristolochiae* occurring together in our study sites, we did not find them in numbers large enough to suggest intra-specific competition during the larval stage. Therefore we feel that there are no specific larval adaptations that have arisen as a result of competitive interactions. It is interesting to note that although *Thottea* is widely distributed in the Malesian region and on the Indian Subcontinent (Ding Hou 1981), *P. rhodifer* has failed to expand its range. In fact, although *T. tomentosa* occurs in both the Andaman and Nicobar islands (Rao 1986, specimens at the Botanical Survey of India herbarium, Port Blair), *P. rhodifer* apparently is restricted to Great Andaman [with the exception of the single stray record of the species from Car Nicobar by Arora and Nandi (1980)].

Open water between islands may be an effective barrier preventing dispersal of this species. Though Tsukada and Nishiyama (1982) indicate that it is an exceedingly slow flyer, our observations reveal that the species is capable of fairly fast (though not vigorous), bobbing flight when disturbed.

The presence of six larval instars, instead of the usual five as in all other Papilionidae, lends credence to classifying *P. rhodifer* as a distinct species and not as a form of *P. coon* (Miller 1987). Although the larvae may pass through an additional instar when under stress (possibly because of food of inferior quality), six instars is the norm for *P. rhodifer*.

Like all troidines, *P. rhodifer* has red-tuberculate, *Aristolochia*-feeding larvae that are aposematically colored and probably unpalatable to predators (Hancock 1983, 1988, DeVries 1987). Because we found larvae during most months of the year, we suspect that it is multivoltine, as in other *Pachliopta* species (Igarashi 1984). *Pachliopta rhodifer* lays eggs singly and the larvae are solitary feeders, thus conforming to the pattern in other *Pachliopta* (Igarashi 1984).

Tsukada and Nishiyama (1982) state that adults of *P. rhodifer* 'become active only at dusk and fly toward 5 p. m.' Our studies failed to corroborate this observation. We observed *P. rhodifer* in flight in the morning and in the evening (from 0700 h to 1800 h).

In the Oriental region, only the peripheral areas such as the Andaman Islands are rich in endemic Papilionidae (Hancock 1983). Williams et al (1991) suggest the incorporation of the extent of geneological differences into the biodiversity measure in addition to the endemicity criterion. If this is done, the Andaman Islands are likely to move further up the priority list presented by Collins and Morris (1985) because the three endemic papilionids in the Andamans belong to three different tribes—Leptocircini, Papilionini, Troidini (Hancock 1983).

This diversity of endemics, together with the fact that all endemics

so far have been reported almost exclusively from Great Andaman, indicates that butterfly conservation in the region is extremely important. The Great Andaman, which makes up well over half the area of the Andaman Islands (constituting about 70 percent of the total land area of the Andamans) has been facing great pressure from human activities. Since the mid-1800's it has been increasingly cleared of its natural vegetation to meet the growing demands of a rapidly expanding human population that favors settlements close to Port Blair, the capital of these islands. The food plants of at least two endemic species of Papilionidae, *Graphium epaminondas* and *P. rhodifer,* both of which have patchy distributions in the forests of these islands, may be facing a threat from these activities of man. There is thus an urgent need for studies of the type being conducted by Pollard (1977) to assess the status of the endemic species of Lepidoptera, particularly when the clamor for the 'development' of these islands through increased urbanization and industrialization is on the rise.

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