LIFE HISTORY OF *PURLISA GIGANTEA* IN SOUTH THAILAND (LEPIDOPTERA: LYCAENIDAE, THECLINI)

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Abstract – The immature stages of *Purlisa gigantea gigantea* (Distant, 1881) are described and illustrated for the first time. Larvae of *P. gigantea* were found feeding on *Helixanthera cylindrica* (Jack) Dans. (Loranthaceae) in southern Thailand. Chaetotaxy of first instar larvae is described in detail to facilitate phylogenetic analysis and comparison with other lycaenid taxa.

Key words: *Anthene emolus, Helixanthera cylindrica, Hypolycaena erylus, Tajuria cippus,* chaetotaxy.

The lycaenid butterfly *Purlisa gigantea gigantea* (Distant, 1881) is among the largest lycaenids in Neomalaya and is considered rare in the Malay Peninsula (Lekagul *et al.*, 1977; Pinratana, 1981; Corbet & Pendlebury, 1992). Because little has been reported concerning the biology of this species, the purpose of this paper is to document a larval host and to describe its life stages. First instar morphology is described in order to provide an accessible basis for comparison with other taxa. Chaetotaxy of first instar lycaenids can provide a suite of characters as useful as adult morphology in determining phylogenetic relationships.

In June 2000, a female *P. gigantea* was observed ovipositing on mistletoe (*Helixanthera cylindrica* (Jack) Dans. (Loranthaceae)) growing on a roadside shrub (*Melastoma* sp. (*Melastomataceae*)) in hills (*ca* 150 m elev.) near the city of Hat Yai in southern Thailand. In subsequent visits to the same area during the months of January and February in 2002 and 2003, additional female *P. gigantea* were again observed associated with *H. cylindrica* and nectaring on a common roadside weed, *Chromolaena odoratum* (L.) King & Rob. (syn. *Eupatorium odoratum* L.) (Asteraceae). A few male *P. gigantea* (Fig. 1) were discovered in deep shade resting among the interior foliage of various understory shrubs adjacent to rubber trees heavily infested with *H. cylindrica*. When disturbed, the males always flew into the shady interior of other nearby shrubs.

Inspection of *H. cylindrica* growing on various hosts, primarily rubber trees (*Hevea brasiliensis* [Willd. ex Adr. Juss.] Müll. Arg. (Euphorbiaceae)) (Fig. 2), disclosed the presence of several ova and larvae of *P. gigantea,* as well as larvae of *Anthene emolus* (Godart [1824]), *Hypolycaena erylus* (Godart [1824]), and *Tajuria cippus* (Fabricius, 1798) (all Lycaenidae) on leaves and buds. Five ova and a single 4th instar larva of *P. gigantea* were also found on *H. cylindrica* inflorescences (Fig. 3) at a later date (July). The larvae of *A. emolus,* and *H. erylus* were closely associated with the tree ant *Oecophylla smaragdina* (Fabricius, 1775), but no ants were found in association with *P. gigantea* larvae. Documented mortality of *P. gigantea* larvae was due primarily to tachinid fly parasites, while eggs were often parasitized by *Telenomus* sp. (Hymenoptera: Scelionidae). The parasite species were not identified.

Neonatal larvae of *P. gigantea* were caged on *H. cylindrica* foliage using nylon organdy sleeve cages. Some larvae were reared to maturity, while examples of each larval instar and larval exuviae were preserved to provide the basis for descriptions reported here. While the duration of each larval instar was not recorded (except as noted below), the overall duration from first instar to adult was 25 days (n=2) under field conditions. Based on cranial widths of preserved larvae and exuviae, it is probable that there are typically five larval instars.

Chaetotaxic terminology for first instar larvae largely follows Wright (1983) and Downey & Allyn (1984), as modified by Ballmer & Pratt (1992). Setal nomenclature is provisional, in part because first instar lycaenids possess additional setae beyond the standard number of primary setae found in most other Lepidoptera, and also because the numbers of setae and lenticles in some body regions vary among diverse lycaenid taxa (Ballmer, personal observation). Interpretation of setal homologies is somewhat problematic for these regions, *e.g.* prothorax (T1) and coalesced terminal abdominal segments (A9+10), but chaetotaxy remains significantly useful overall. Considerable deliberation of setal homology and nomenclature will appear as new findings in forthcoming papers. Unless otherwise noted, the discussion of setae and lenticles refers to one side of the body and illustrations are oriented with cephalad region to the left or top. Larval color is based on specimens reared on foliage, except as otherwise indicated.

Reported body lengths are based on preserved distended larvae, measured between the anterior margin of T1 and the posterior tip of A9+10. Because body length varies with larval condition and preservation technique, the values reported provide a general guide to the relationship between larval size and age. Measurements of sclerotized body regions, such as the cranium, are a more reliable guide to larval instar. Reported head widths (mean values, followed by range and number examined) were measured across the frons between the lateral cranial margins and are based on both preserved larvae and molted cranial exuviae.

Egg. (Fig. 4). White, echinoid, with smoothly rounded reticulate ridges, conferring a cratered appearance, uniformly 0.9 mm wide X 0.6 mm high (n=6); deposited singly on leaves, buds, and stems of the host plant. Duration of the egg stage is probably no greater than six days, as all field-collected ova (n=10) hatched within five days.

First instar larva. (Figs. 5, 13). Pale brownish yellow; length at maturity 2.5 mm; mean head width .33 mm (.32-.34 mm, n=5). Instar duration under field conditions was 6 days.

Most dorsal and lateral setae on first instar larvae are erect, elongate, tapered (up to 350 μ long), with rugose surface. Subdorsal

setae (SD1 & 2) (and one lateral (L) seta on some segments) are broadly spatulate (*ca* 20 µ long and similarly broad) and bent at the base nearly parallel to the body surface.

Cranium (Fig. 12). Cranium with14 setae (A1, A2, A3, AF1, P1, P2, V1, V2, V3, O1, O2, SO1, SO2, SO3) and 8 punctures (sensory pits) (AFa, Oa, Ob, Aa, Pa, Pb, Va, La) visible on anterior, dorsal, and lateral surfaces (ventral setae and punctures were not mapped); seta V2 often absent on one or both sides of the cranium. A2 is the longest seta (*ca* 100 µ), extending to the oral margin and about six times as long as A1. On the frons, a lenticle (FL) is present where seta F1 typically occurs in other Lepidoptera (Hinton, 1946); puncture Fa is mesal to FL. On the clypeus there are two setae (C1, C2) and one puncture (Ca); two setae are present on the mandible.

Prothorax (T1) (Figs. 13, 14). Prothoracic shield pyriform (*ca* 210 µ long X 250 µ wide), sclerotized, lightly pigmented, with five pairs of setae (D1, D2, SD1, XD1, XD2) and one pair of lenticles. The latter have been termed dorsal lenticles by Ballmer & Pratt (1992), although their position suggests homology with subdorsal lenticles (SDL) on other segments (especially T2). Similarly, a pair of setae located at the anterior margin of the shield, although conventionally interpreted as XD1, occupy a position homologous with SD3 setae on other segments. The most prominent setae on the shield are: XD1, D1, and D2 (230, 290, and 350 µ long, respectively, and *ca* 15 µ wide at the base). Seta XD2 is very short and slender (*ca* 15 µ long and 3.8 µ wide), located near the margin of the shield, slightly anterolateral to D1. Seta SD1 (*ca* 50 µ long and 3.8 µ wide), arising somewhat anterolateral to D2, is filiform and apically spiculate; as with other lycaenids, this is the only major primary seta which persists in identifiable form in later instars (see Fig. 17).

Elsewhere on T1, there are seven erect, tapered setae arrayed in three groups. The three anterodorsal-most setae (410, 455, and 420 µ long, respectively, from anterior- to posterior-most) are arrayed in echelon beginning slightly anterior and lateral to the shield and extending posterolaterally to a point lateral to the lateral angle of the shield. These three setae, together with the long setae of the shield, form a forward-projecting fringe along the anterodorsal margin of T1 (Fig. 13). The two anterior-most setae are not easily homologized with setae on other segments. Although sometimes interpreted as derived from minute proprioceptor setae, MSD1 and MSD2 (Duarte, et al, 2005), other interpretations are possible. The posterior-most seta in the upper echelon is here interpreted as a lateral seta (perhaps L2). Two other lateral setae, perhaps L1 and L3 (respectively, 360 and 330 µ long), are located in echelon more ventrally near the anterior margin of T1 at approximately the same level as the spiracle. A pair of shorter subventral setae (SV1 and SV2, respectively 90 and 110 µ long) is located just dorsal to the leg.

Mesothorax (T2). Prominent dorsal setae, D1 and D2 (300 and 150 µ long, respectively), directed dorsally, somewhat recurved, and tapered; D1 chalazae widely separate (*ca* 170 µ apart; D2 chalaza posterior and slightly lateral to D1; SD3 (77 µ long) clavate, inserted anterior to D1; SDL (diameter 30 µ) ventrolateral to D1; SD2 minute, broadly spatulate (*ca* 20 µ long and similarly broad), basally bent parallel to body surface, located posterior and slightly ventral to SDL; SD1 similar to SD2, placed more ventrolaterally, posterior to T1 spiracle; three lateral (L) setae (190, 180, 155 µ long, respectively, from anterior- to posterior-most) and two subventral setae (SV1 & SV2), as in T1.

Fig. 1. Adult *Purlisa gigantea*.

Metathorax (T3) (Fig. 13). Setal pattern similar to T2, but D1 chalazae less widely separated; D2 directed more posteriorly and SD3 placed anterolateral to D1; SD1 ventrolateral and slightly anterior to SD2, approximately at the same latitude as SD2 setae on A1-6; SDL diameter *ca* 40 µ.

Abdominal segments 1-2 (A1, 2) (Fig. 13). Setal pattern differs from T3 in that a supraspiracular lenticle (SSL) occurs posterolateral to SDL and slightly dorsal to SD2 (diameter *ca* half that of SDL); SD1 dorsal and slightly anterior to spiracle; five setae in lateral group; lateral lenticle present slightly anteroventral to anterior-most L seta, which is usually short and spatulate (similar to SD1 & 2); other L setae long and tapered, in two tiers, the upper tier *ca* 170 µ long, the lower tier *ca* 125 µ long; a single subventral seta (SV) (*ca* 20 µ long) and one tiny ventral seta (*ca* 4 µ long) (not shown in Fig. 13).

Abdominal segments 3-6 (A3-6) (Fig. 13). Similar to A1& 2, except anterior-most L seta usually long, tapered (as in other L setae), but occasionally short, spatulate on A3; two SV setae (the anterior-most seta sometimes vestigial); prolegs present with a pair of setae (P1, P2), a lateral series of 7-8 crochets, and a divided mesoseries of 8 crochets.

Abdominal segment 7 (A7) (Fig. 13). Similar to A3-6, except SD3 located anterior to D1; D2 absent; SDL adjacent to lateral base of D1; SD2 slightly posterolateral to SSL; four setae in lateral

group, the dorsal-most of which is minute, spatulate (as in SD1 & 2), placed about mid-way between the spiracle and LL; a single SV seta and tiny ventral seta, as in A1 & 2.

Abdominal segment 8 (A8) (Fig. 13). Boundaries with A7 and A9+10 obscure; dorsal setae absent; SDL on a short sclerotized tubular collar directed posteriorly and located posterolateral to D1 of A7; a seta ventrolateral to SDL, here interpreted as SD3, based on structural similarity to SD3 on more anterior segments, but longer (*ca* 150 µ); SSL anterodorsal to spiracle; tiny spatulate seta (SD1?) slightly dorsal and posterior to spiracle; lateral setae (L group) and lenticle (LL) as in A7; subventral and ventral setae as in A7. The lateral lenticle absent in one of five larvae examined.

Anal segment(s) (A9+10) (Figs. 13, 15). Seven erect, tapered setae arrayed along posterolateral margin, five comprising a fringe more-or-less at the same level and two placed more ventrally; the latter setae apically spiculate. The anterior-most erect fringe seta is L1 of A9; slightly anterodorsal to it (approximately at the junction of A8 and A9) is a small spatulate seta, here interpreted as a lateral seta of A9, although it could be a subdorsal seta associated with either A8 or A9. The next three upper tier setae posterior to L1 of A9 are laterals (L1-3) of A10; the posteromesal-most seta is conventionally labeled D1, although its true homology is ambiguous. A quadrate sclerotized middorsal or suranal shield has a lenticle (SDL) near its anterolateral margin and a tiny spatulate seta (SD) just mesal to the lenticle. A single SV seta is near the anterior base of the anal proleg; anal prolegs with three pairs of short setae visible on lateral and posterior aspects. The cuticle above and below the anus with numerous acuminate spinules (Fig. 13).

Second instar larva. (Fig. 6). Gray-green; body length 6.5 mm; mean head width .6 mm (.57-.64 mm, n=3); macroscopically appearing glabrous; prothoracic shield roughly diamond-shaped (*ca* 340 µ long X 300 µ wide), with filiform sensory setae (not spiculate) (*ca* 160 µ long) and scattered flattened, cordate setae (*ca* 29 µ wide); similar cordate setae, appearing more-or-less lenticular or blister-like (as in Figs. 16 - 20), scattered over dorsal and lateral body surface on all segments; few short erect acuminate setae (*ca* 20-30 µ long) subdorsally on T2 and at margin of dorsal honey gland (HG, aka dorsal nectary organ) on A7; similar, but somewhat stouter and shorter, acute setae (*ca* 10 µ long) dorsally on A6; fringe of erect, tapered setae (up to 110 µ long) at anterior margin T1, posterior margin A9+10, and below lateral fold on all segments; suranal shield absent.

Third instar larva (Fig. 7). Body length 7.3 mm; mean head width .99 mm (.94-1.05 mm, n=4); matte green, with maroon pigment patches laterally near posterior margins of A5 and A6. Most features similar to 2nd instar, but setae proportionately larger (*e.g.* erect fringe setae at anterior margin T1, posterior margin A9+10, and below lateral fold on all segments up to *ca* 150 µ long); prothoracic shield *ca* .6 mm long X .5 mm wide; eversible tubercle (ET, aka tentacular organ) present slightly posterolateral to spiracles on A8.

Fourth instar larva. Body length 14 mm; mean head width 1.52 mm (1.26-1.84 mm, n=5); coloration as in 3rd instar. A single 4th instar larva found on inflorescences was red, matching the dominant color of the flowers and stems. Setae as in 3rd instar, but proportionately larger (*e.g.* erect fringe setae at anterior margin T1, posterior margin A9+10, and below lateral fold on all segments up to *ca* 200 µ long). Prothoracic shield diamond-shaped (*ca* 1 mm long X .6 mm wide).

Fifth instar larva. Body length 30 mm, mean head width 2.59 mm (2.42-2.88 mm, n=3). Cranium with scattered short setae (*ca* 40 µ long); longer setae near the oral margin (corresponding in position to SO1, SO2, A1, and C1 (respectively *ca* 200, 135, 290,

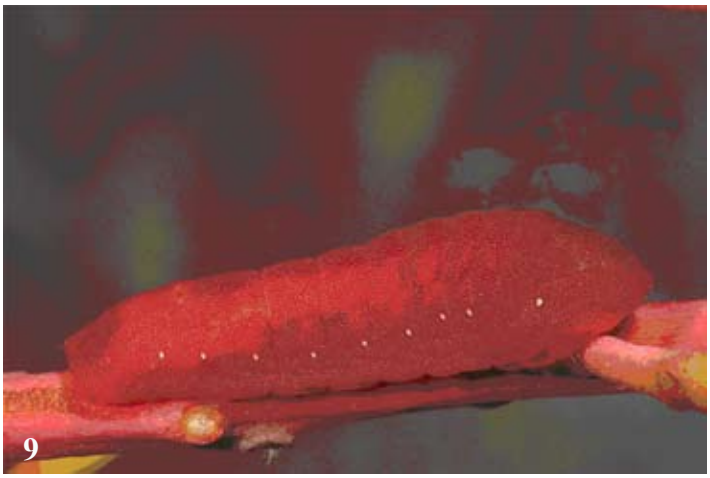
Fig. 2. *H. cylindrica*, larval host of *P. gigantea*.

Fig. 3. *H. cylindrica* inflorescence.

Fig. 4. Ova *P. gigantea* on *H. cylindrica*.

and 150 µ long); two mandibular setae. Generally onisciform, but segments A1-A5 somewhat peaked mid-dorsally (best seen in cross-section) and each partially overlapping anterior dorsal margin of the following segment. Prothoracic shield more-or-less diamond-shaped (*ca* 2 mm long X 1 mm wide) (Fig. 16). Sensory setae on prothoracic shield (Figs. 16, 17) slender, filiform (425 µ long). Body dorsum otherwise devoid of prominent erect setae, but all segments studded with low, flattened, cordate setae (in dorsal aspect appearing lenticular, as in instars 2-4), *ca* 40 µ in diameter (Figs. 16 - 20), with chalazae recessed below surrounding cuticle; a patch of scattered slender erect acuminate setae (up to *ca* 75 µ long) with recessed chalazae subdorsally on T2 (Fig. 18); A6 with similar, but somewhat shorter, stouter, erect to recurved setae dorsally; HG margin lined with short capitate setae and lenticles (Fig. 19). Numerous simple, erect, tapered setae at anterior margin T1 (up to 380 µ long) and below lateral fold (up to 700 µ long) on all segments; posterior margin of A9+10 truncate-emarginate, posterolaterally somewhat angulate, with single prominent, erect seta (200 µ long), directed posteriorly, at apex of posterolateral margin (Fig. 20). Prolegs with biordinal mesoseries of *ca* 88 crochets divided by fleshy lobe and uniordinal lateral series of *ca* 8 crochets.

In gross appearance, the 5th instar larva is similar to the 3rd and 4th instars: macroscopically glabrous; predominantly green, often



Figs. 5-9. Larvae of *P. gigantea*: Fig. 5. First instar; Fig. 6. Second instar; Fig. 7. Third instar; Fig. 8. Fifth instar, reared on leaves; Fig. 9. Fifth instar *P. gigantea*, reared on flowers.

Fig. 10 (above). Pupa *P. gigantea,* lateral aspect.
Fig. 11 (right). Pupa *P. gigantea,* anterior aspect.

with a few maroon spots, especially at posterolateral margin of A5 and A6 (as in Fig. 7), and/or obscure whitish patches and chevron markings, especially at maturity (Fig. 8). A single red larva (Fig. 9) was found (as 4th instar) on *H. cylindrica* inflorescences (Fig. 3); it was reared to maturity on *H. cylindrica* inflorescences and remained red throughout the 4th and 5th instars. This larva was reared in captivity at a mean 26.5 ±1.5°C; it fed for *ca* 3.5 days, after which it wandered inside its cage *ca* one day before producing a silken pad upon which to pupate; it then remained immobile on the silken pad for *ca* 1.5 days prior to pupation (total 5th instar duration = 6 *ca* days); the pupa was similar in coloration to those of larvae reared on foliage (Figs. 10, 11).

Pupa (Figs. 10, 11). Length 17 mm; attached by cremaster to host foliage (no girdle), erect, somewhat angular, with prominent dorsal hump comprised of anterior abdominal segments, peaking at A2. Color primarily dark green, with mid-dorsal dark brown and white (bird dropping) pattern most prominent on thorax. Macroscopically glabrous, but with numerous tiny cordate setae, as in larvae. Under field conditions the pupal stage lasted 11 days; one pupa reared under lab conditions (26.5 ± 1.5° C) from a larva found on an *H. cylindrica* inflorescence (see discussion above) eclosed after ten days.

DISCUSSION

Purlisa gigantea shares major life history features with some other members of the subtribe Iolaiti: larvae use a mistletoe larval host; 1st instar larvae have prominent series of erect dorsal and lateral setae, while later instar larvae lack such prominent setae and appear macroscopically more-or-less glabrous; in later instars very small, low, flattened cordate setae are widespread over the dorsal and lateral body surfaces, much as in South African *Epamera* and *Stugeta* (Clark & Dickson, 1971), as well as in *T. cippus* and *Jacoona anasuja* (C. & R. Felder), although not in *Tajuria isaeus* (Hewitson) and *Pratapa deva* (Moore) (Ballmer, personal observations); a dorsal honey gland first appears in the 2nd instar. The bases of cordate and short erect setae on dorsal and lateral body surfaces are recessed below the surrounding cuticular surface so that their chalazae are hardly visible, while erect setae at the anterior margin of T1, subventrally elsewhere, and bordering the HG, arise from prominent simple (and easily visible) chalazae. The pupa is erect and fastened only by the cremaster.

Purlisa gigantea may be atypical of Iolaiti in that the eversible tubercles first appear in the third instar and in having five larval instars. South African members of this subtribe are reported to have typically four larval instars (although a fifth instar sometimes occurs), while both the HG and ETs appear in the second instar (Clark & Dickson, 1971). Also, later instar *P. gigantea* larvae

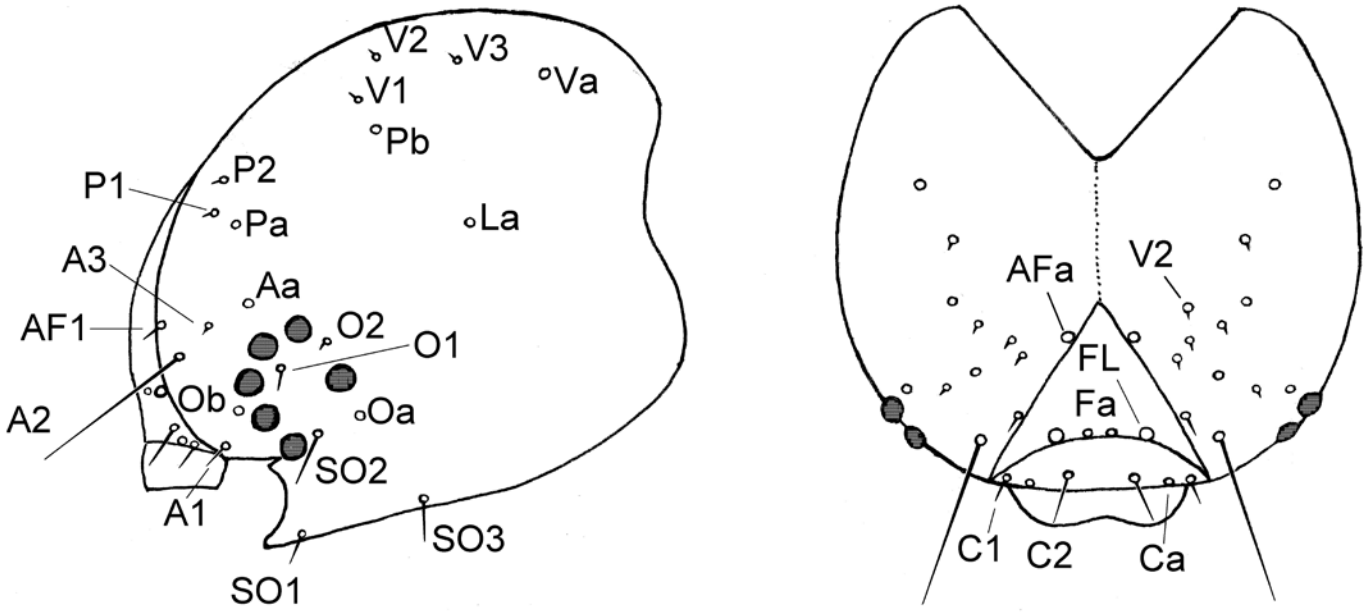


Fig. 12. First instar *P. gigantea* cranium, schematic setal pattern; lateral aspect (left) and anterodorsal aspect (right).

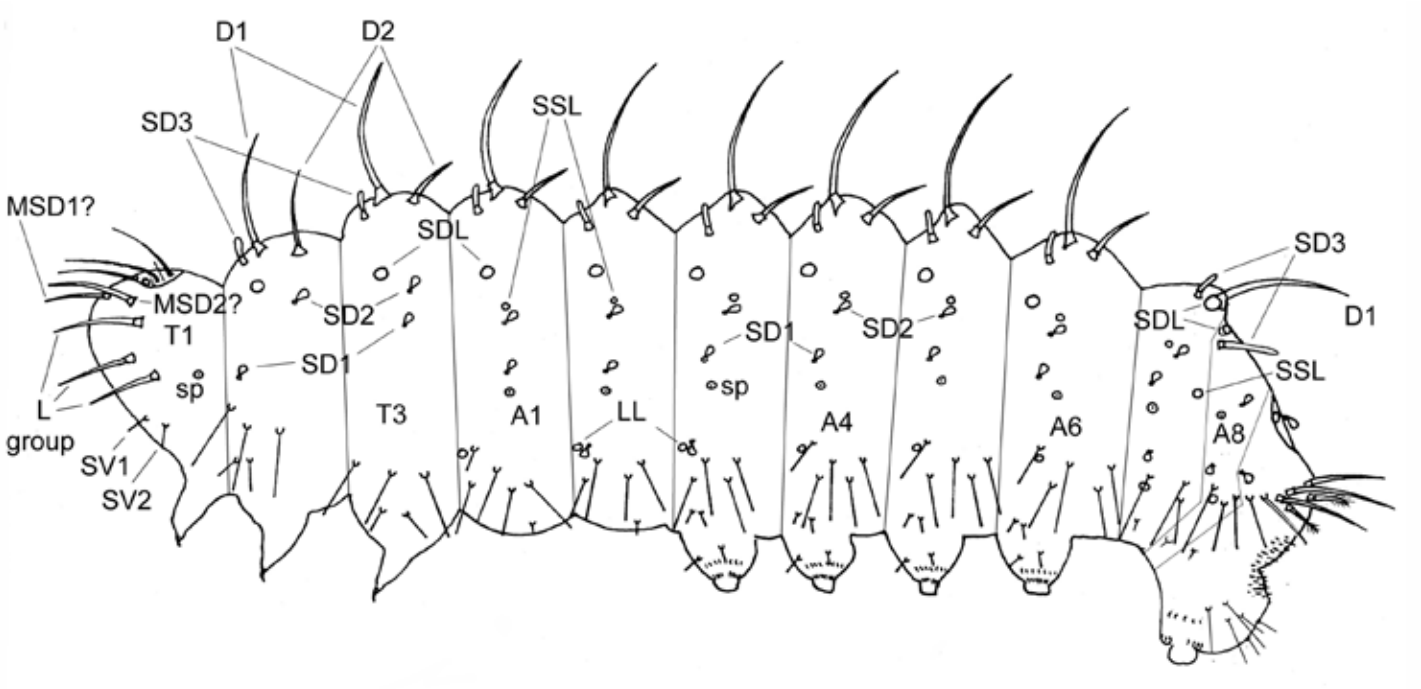


Fig. 13. First instar *P. gigantea* body, schematic setal pattern, lateral aspect.

are broadest in the thoracic and anterior abdominal segments and gradually tapered posteriorly, whereas other members of the Iolaiti are often described as "shouldered and waisted" (*i.e*. A6 is narrower than segments anterior and posterior to it) (Clark & Dickson, 1971; Eliot, 1973; Corbet & Pendlebury, 1992).

In all *P. gigantea* larval instars after the 1st, dorsal and lateral body regions have numerous very short, broad, flattened, cordate setae, while erect setae are limited to a pair of slender "sensory setae" on the prothoracic shield, groups of very short, inconspicuous, erect setae subdorsally on T2, and dorsally on A6, and short capitate (acuminate in 2nd instar) setae bordering the HG. Longer erect, tapered setae occur along the anterior margin of T1 and sublaterally on all segments. Larvae apparently are not usually ant-attended. Two primary larval color forms were observed; green larvae were found on foliage and one red larva was found on flowers. Larval and pupal color patterns provide a measure of crypsis on the host plant.

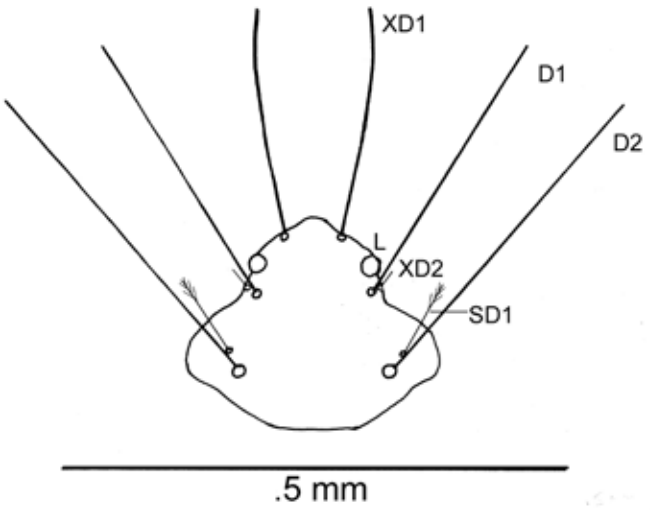


Fig. 14. First instar *P. gigantea* prothoracic shield, schematic setal pattern, dorsal view.

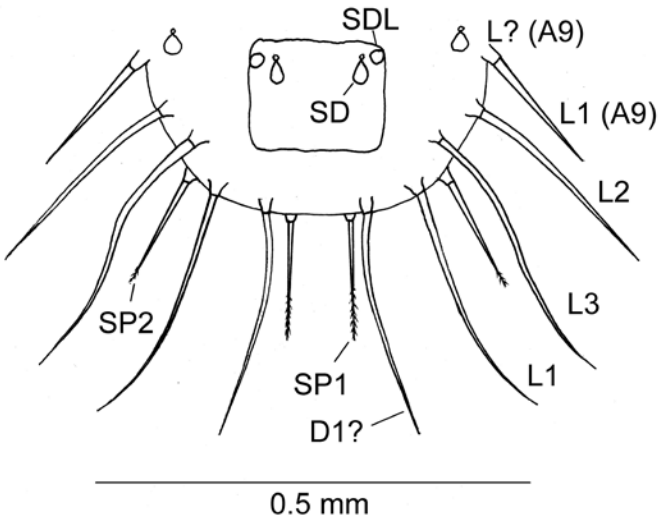


Fig. 15. First instar *P. gigantea* terminal abdominal segments (A9+10), schematic setal pattern, dorsal view.

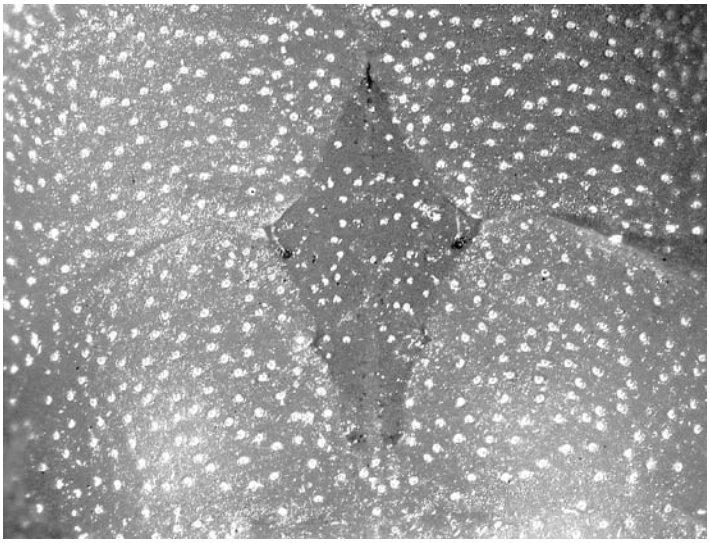


Fig. 16. Prothoracic shield, 5th instar *P. gigantea*, dorsal aspect; note sensory setae near lateral angles and numerous cordate setae.

Fig. 17. Sensory seta on prothoracic shield, 5th instar *P. gigantea*; note also cordate setae.

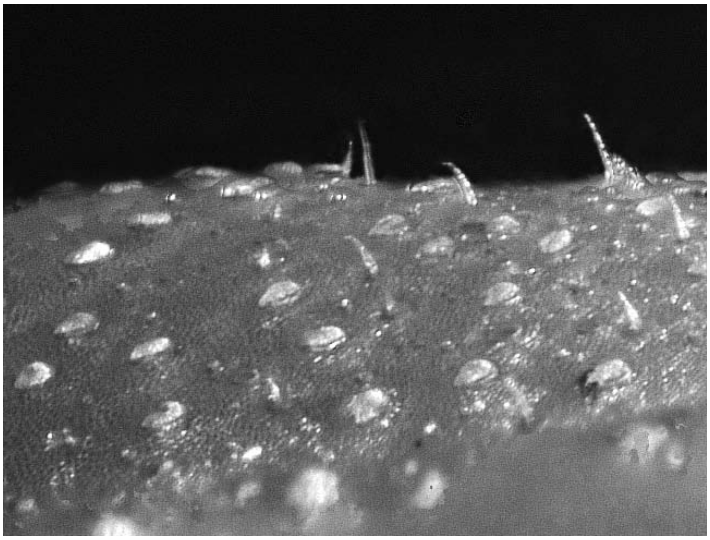


Fig. 18. Erect acuminate and cordate subdorsal setae on T2 of 5th instar *P. gigantea*.

ACKNOWDEGEMENTS

This research was carried out under permitted authority of the National Research Council of Thailand, within the scope of a research project titled "Life Histories and Systematics of Lycaenidae in Thailand". I am indebted to Dr. Banpot Napompeth of the Thailand National Biological Control Research Center (retired) and Dr. Chaweewan Hutacharern of the Royal Forest Department for advice and encouragement in establishing this project. Mr. J. F. Maxwell, Curator of the Chiang Mai University Herbarium, identified voucher plant specimens. This manuscript benefited from editorial comments and advice concerning lycaenid larval chaetotaxy offered by Drs. D.M. Wright and G.F. Pratt.

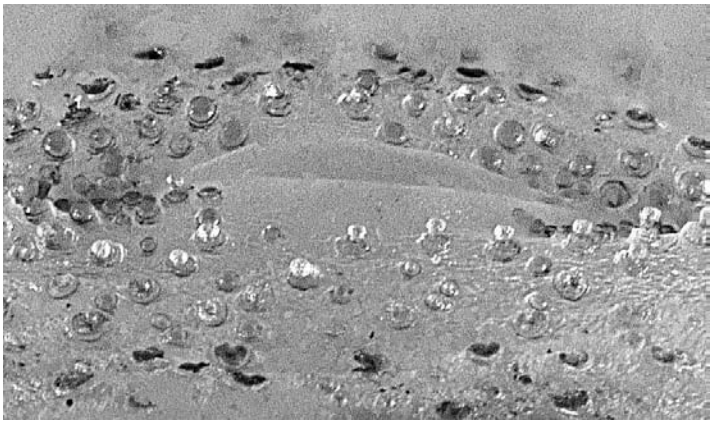


Fig. 19. Dorsal honey gland on A7 of 5th instar *P. gigantea*; note capitate setae and lenticles bordering margin of gland orifice and more distant cordate setae.

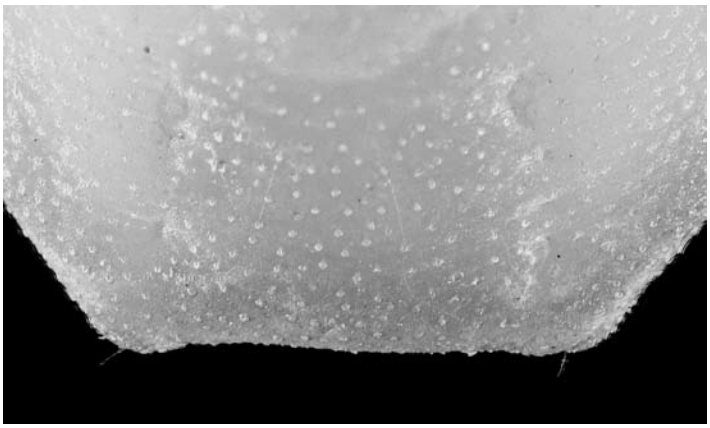


Fig. 20. Caudal margin of A9+10, *P. gigantea*; note simple erect setae at lateral angles and numerous cordate setae.

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