

The Life-History of *Actias maenas diana* Maassen in Maassen [& Weymer], 1872 from the Island of Bali, Indonesia (Lepidoptera: Saturniidae)

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Die Präimaginalstadien von *Actias maenas diana* Maassen in Maassen [& Weymer], 1872 von Bali, Indonesien (Lepidoptera: Saturniidae)

Zusammenfassung: Die Präimaginalstadien von *Actias maenas diana* Maassen in Maassen [& Weymer], 1872 (Lepidoptera: Saturniidae) aus balinesischen Populationen (Indonesien) werden beschrieben und mit denen anderer verwandter Arten aus der *maenas*-Gruppe (sensu NÄSSIG 1994) verglichen. Insbesondere werden in diesem ergänzenden Beitrag, erster Beitrag zur Kenntnis der Präimaginalstadien von *A. maenas diana* in der Entomologische Zeitschrift (Stuttgart) im Druck, Angaben zur primären Behaarung gemacht. Die Taxa der *maenas*-Gruppe (sensu NÄSSIG 1994) werden aufgelistet und taxonomische Anmerkungen zu ihrem augenblicklichen Status gemacht. Taxonomische Änderungen werden nicht vorgenommen.

Summary: In the following contribution to knowledge of the Southeast Asian wild silkmoth (Lepidoptera: Saturniidae) the preimaginal instars of *Actias maenas diana* Maassen in Maassen [& Weymer], 1872 from the island of Bali, Indonesia, are described and compared to those of related taxa of the *maenas*-group (sensu NÄSSIG 1994). This second supplementary contribution on the preimaginal instars of *A. maenas diana*, first contribution in Entomologische Zeitschrift (Stuttgart) in press, deals with the chaetotaxy of the larvae. Presently recognized taxa in the *maenas*-group (sensu NÄSSIG 1994) are listed and remarks on its taxonomic status are given. No taxonomic changes are proposed.

Key Words: Lepidoptera, Saturniidae, *Actias, maenas, diana*, Indonesia, life-history, chaetotaxy, wild silkmoth.

Introduction

In the following contribution on the knowledge of the Southeast Asian wild silkmoths (emperor moths) the preimaginal instars of the Asian moon-moth *Actias maenas diana* Maassen in Maassen [& Weymer], 1872 (Lepidoptera: Saturniidae) from the island of Bali (Bali Province), Indonesia, are described and its chaetotaxy is figured. Taxonomic changes are not proposed. NÄSSIG et al. (1999) in BROSCHE et al. (1999) proclaimed a supplementary contribution to the already existing revision of the *maenas*-group (cf. NÄSSIG 1994). *A. maenas diana* represents a taxon of the tropical *maenas*-group (sensu NÄSSIG 1994) in which the following seven taxa are included either in specific or in subspecific rank:

A. maenas maenas Doubleday, 1847

The name *leto* Doubleday, 1848 is presently treated as a junior subjective synonym of the nominotypical *maenas* from India. In the year 1847 *maenas* was described by DOUBLEDAY after a female, and in the following year the same author described *leto* after the appropriate male of *maenas*. It was unknown to DOUBLEDAY that the male and female adults before him belong to the same species which demonstrate a considerable sexual dimorphism. Though the name *leto* was already used in subordination of *maenas* by DE JOANNIS (1929) and later authors, HOLLOWAY (1987) erroneously attributed the name *leto* to the populations of *maenas* from the island of Java (*leto* was cited in subordination of *maenas* from Java).

2. *A. maenas diana* Maassen in Maassen [& Weymer], 1872 was originally described from the island of Java. Presently the name *diana* is applied in subspecific rank to the populations from Sundaland (Peninsular Malaysia, Borneo, Sumatra, Java, and Bali). NÄSSIG (1994) supposed the distribution boundary between the nominotypical subspecies *maenas* and the subspecies *diana* being present in southern Thailand. Our studies on the range and taxonomic status of *diana* are not yet completed, a publication on the results is in preparation.

Presently the name *saja* (van Eecke, 1913) is treated as a junior synonym of *maenas diana*. Though the syntype series of *saja* contains specimens from the islands of Java and Sumatra no lectotype of *saja* was designated thus far. Provided that it should be considered necessary to designate a lectotype of *saja*, a specimen from the island of Sumatra should be selected as lectotype

to obtain stability in nomenclature for the future, if further studies might reveal that the populations from Java/Bali and Sumatra are distinct on subspecific level.

The name *recta* (Bouvier, 1928) was erected for specimens from the island of Sumatra. A Corrigenda was issued by BOUVIER at a later date in which the male lectotype of *recta* was designated by subsequent designation. In the original description the name *recta* was used for a variation as the third name after a binomen, but clearly not in infrasubspecific sense, cf. ICZN (1999) Art. 45.6.4. The name *recta* presently is treated as a junior synonym of *saja*.

A. rosenbergii (Kaup, 1866) and *A. rieli* (Testout, 1942) were both described from the island of Ambon, Moluccas Province (Maluku), Indonesia. *A. rosenbergii* and *rieli* are considered doubtful taxa within the *maenas*-group (sensu NÄSSIG 1994). The descriptions of both taxa most likely were based on either mislabeled (cf. NÄSSIG 1994) or introduced specimens (cf. PAUKSTADT, L. H. & PAUKSTADT, U. in press). Thus far no further specimens of the *maenas*-group (sensu NÄSSIG 1994) were recorded from the Moluccas. The imagines, called “ekor panjang” (= long tailed) by people in the Archipelago, are unknown to local people on the islands of Seram and Ambon. NÄSSIG et al. (1996) considered *rieli* being a junior synonym of *rosenbergii* because both taxa are usually treated as conspecific by nearly all authors. Qualified studies on the status of *rosenbergii* and *rieli* are still lacking. We have to point out that the name *rieli* constitutes a junior synonym of *rosenbergii* only, if both specimens on which the names were based are either definitively originated from the island of Ambon or originated from another location, which is populated by the same taxon. Since the origin of the type material is considered doubtful the status of *rosenbergii* and *rieli* is deemed to be doubtful as well. Further studies might reveal that either *rosenbergii* and *rieli* are from the island of Ambon or from the same location outside of Ambon, in this case *rieli* should be treated as a junior synonym of *rosenbergii*, or, that *rosenbergii* and *rieli* are from different locations outside of Ambon, in this case both taxa might be even distinct. Of course, in the latter case the name *rieli* will constitute no junior synonym of *rosenbergii*. The female holotype of *rosenbergii* was figured in color by KAUP (1866) in the original description. Specimens similar to the illustration might be from the islands of Java and Sumatra, and at least those from the island of Java belong to the subspecies *diana* Maassen in Maassen [& Weymer], 1872. If further studies might reveal that *rosenbergii* and *diana* are conspecific, the name *rosenbergii* even will have priority above

diana. To maintain stability in nomenclature and due to the remaining uncertain origin of the holotype of *rosenbergii* the name *rosenbergii* herewith is proposed to be treated as a name of uncertain taxonomic position “*incertae sedis*” within the *maenas*-group (sensu NÄSSIG 1994).

3. *A. ignescens* (Moore, 1877) was first elevated to fully species rank by NÄSSIG (1994).

4. *A. philippinica philippinica* Nässig & Treadaway, 1997

5. *A. philippinica bulbosa* Nässig & Treadaway, 1997

Presently we do not believe *bulbosa* being a subspecies of the Philippine *philippinica* but of the continental Asian *maenas*, which is distributed on Borneo. Thus far no taxonomic changes are proposed because the preimaginal instars of *philippinica*, *bulbosa* and of *maenas* from the island of Borneo remain unknown. Further studies on the taxonomic status of *bulbosa* are considered necessary.

6. *A. isis* (Sonthonnax, 1897 [“1899”]) is the name commonly in use for the populations of the *maenas*-group (sensu NÄSSIG 1994) from Sulawesi and the Banggai Archipelago.

The name *latona* Rothschild & Jordan, 1901 was proposed for the populations from northern Sulawesi. TOXOPEUS (1948) cited *latona* as junior synonym of *isis*, which was followed by all subsequent authors.

The name *cotei* Testout, 1945 represents an infrasubspecific name. HOLLOWAY (1987) applied *cotei* (in subordination of *isis*) in specific status to the populations from Sulawesi, no further taxonomic remarks are present. Of course, this will not affect the status of *cotei*, which remains infrasubspecific, ICZN (1999) Art. 45.6.4.1.

7. *A. groenendaeli* Roepke, 1954 was first elevated to fully species rank by PAUKSTADT, U. & PAUKSTADT, L. H. (1992).

Despite the revision of the *maenas*-group (sensu NÄSSIG 1994) the relationships between the taxa in this species-group are considered not well known. Thus far recent comparative studies mainly based on differences in the habitus, wing coloration, wing pattern, and genitalia morphology of the taxa. Further studies have to include the morphology of the antennae of the

adults as well. The following distinct measurements were taken by us in the male antennae of taxa in the *maenas*-group (sensu NÄSSIG 1994) from different locations (average length of forewing/ average length of antenna/ average length of rami):

<i>A. groenendaeli</i> (Flores)	74.8/12.6/3.0 mm (n = 10)
<i>A. philippinica</i> (Negros)	75.1/10.9/2.3 mm (n = 10)
<i>A. isis</i> (Sulawesi)	73.2/11.1/2.5 mm (n = 10)
<i>A. maenas</i> (Thailand)	74.1/10.4/2.1 mm (n = 10)
<i>A. maenas</i> (India)	67.0/10.0/2.0 mm (n = 3)

These data indicate, that antennae of nearly the same size are present in *philippinica* and *isis*, whereas those of *maenas* are clearly smaller and those of *groenendaeli* are in average slightly larger.

The preimaginal instars of *A. maenas diana* from Bali (cf. PAUKSTADT, L. H. & PAUKSTADT, U. in press) were compared to those of *A. maenas* from India, Sumatra and Peninsular Malaysia (cf. LAMPE 1983, NÄSSIG & PEIGLER 1984, and PAUKSTADT, L. H. & PAUKSTADT, U. unpublished), *A. maenas diana* from Java (cf. TOXOPEUS 1948), and *A. groenendaeli* from Timor (cf. PAUKSTADT, U. & PAUKSTADT, L. H. 1993, 1995). In early 2000 the senior author obtained a few eggs laid by a female of *A. maenas diana* which came to light on the island of Bali. The eggs were sent to Germany and successfully reared by the junior author under laboratory conditions. Color slides of the preimaginal instars of *A. maenas* from Shillong (India) and Brastagi (Sumatra), *A. isis* from Sulawesi, and *A. groenendaeli* from Timor, which are in the slide collection of U. & L. H. PAUKSTADT, were used for comparisons. The preimaginal instars of *A. maenas* from Bali were found slightly distinct from those from Sumatra and Peninsular Malaysia. The chaetotaxy of the early stages is described and figured in this supplementary contribution on the knowledge of *A. maenas diana* from Bali. No taxonomic conclusions are drawn herein. A further contribution on the taxonomic status of the Javanese and Balinese populations of *A. maenas* is in preparation by us.

Rearing data and observations

Two females of *A. maenas diana* came to light on the 8. I. 2000 in the late evening. Collecting place: Lake Tamblingan, 1105 m, Bali, Bali Province, Indonesia. Habitat: primary mountain and mist forest. 17 eggs were laid by

one of these females on the 9. I. 2000 between midnight and early morning. The eggs were sent to Germany by air mail letter. The first larvae hatched on the 22. I. 2000 after 13 days. The 1st moulting took place on the 30. I., the 2nd moulting on the 5. II., the 3rd moulting on the 14. II., the 4th moulting on the 23. II., and the 5th moulting on the 3. III. 2000 (moulting date of the first larva respectively). Five larval instars were observed in many other rearings of taxa of the *maenas*-group (sensu NASSIG 1994). Six larval instars were counted in this winter rearing of *A. maenas diana* from Bali, the additional stage might be due to the poor quality of the foodplant. The first cocoon was spun on the 23. III., and the first adult, a female, emerged on the 23. V. 2000 after two months from cocoon. The data recorded under laboratory conditions most likely are not analogous to the data which might be observed in the wild. The rearing using evergreen oak (*Quercus* sp., Fagaceae) was difficult due to the dry leaves of the foodplant. To avoid a further drying of the leaves the larvae were kept in closed plastic boxes and were sprayed with water daily. From 5th larval instar privet (*Ligustrum ovalifolium*, Oleaceae) was served and accepted as a foodplant by remaining larvae. Only two larvae successfully reached the pupal stage.

Descriptions of the preimaginal instars

Ovum. Length ca. 2.7 mm, width 2.3 mm and height 1.7 mm, chorion ca. 0.025 mm thick. Ovum slightly smaller than in *isis*. Chorion outside milky white, covered with transparent irregular blotches. The surface is covered with a brownish, reddish brown or black secretion for affixing egg to substrate. Surface structure irregularly rounded, diameter of the depressions ca. 0.020–0.022 mm surrounded with each six aerophyles which are hexagonally placed at the border of the depressions. The inner surface of ovum white with brown or reddish brown blotches, probably caused by the secretion which is present on the outside of the ovum.

1st instar larva. Larvae when hatching approximately 7 mm long. Head glossy black, diameter 1.2 mm (in *groenendaeli* head glossy reddish brown and in *isis* black). Ground coloration yellowish orange except 1st–4th abdominal segments which are dorsally and laterally above subspiracular scoli black colored (in *groenendaeli* 1st–4th abdominal segments dorsally dark gray and in *isis* black). Prothoracic shield, anal plate, thoracic legs, and anal prolegs black, spiracles white. The larval morphology is clearly distinct from those of the related taxa *isis* and *groenendaeli*. Scoli mostly in six

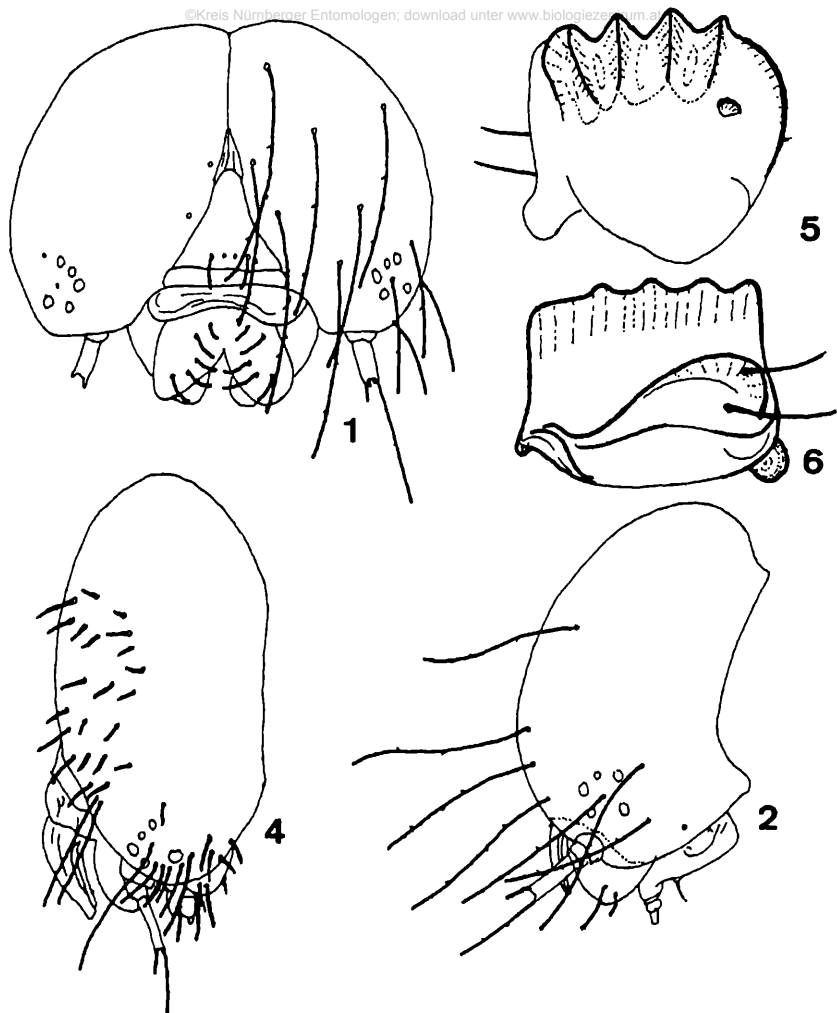


Fig. 1–6. Chaetotaxy of *Actias maenas diana* Maassen in. Maassen [& Weymer], 1872 (Indonesia, Bali) [without coding]. 1–2) head capsule of 1st instar larva, frontal and lateral view; 3–4) head capsule of mature larva, frontal and lateral view; 5–6) mandible of mature larva, 5 right rear and 6 right front. Line drawings by U. PAUKSTADT (scale lines each = 1 mm). [fig. 3 and scale lines of figs. 1–6 on p. 33]

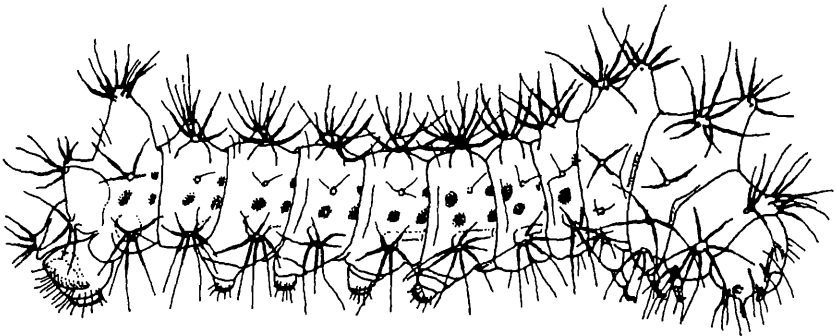
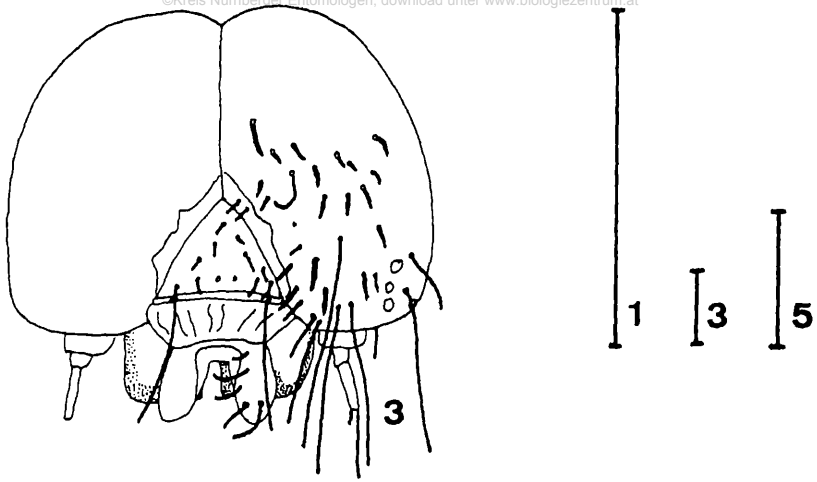


Fig. 7. *Actias groenendaeli* Roepke, 1954 (Timor). 1st instar habitus view.

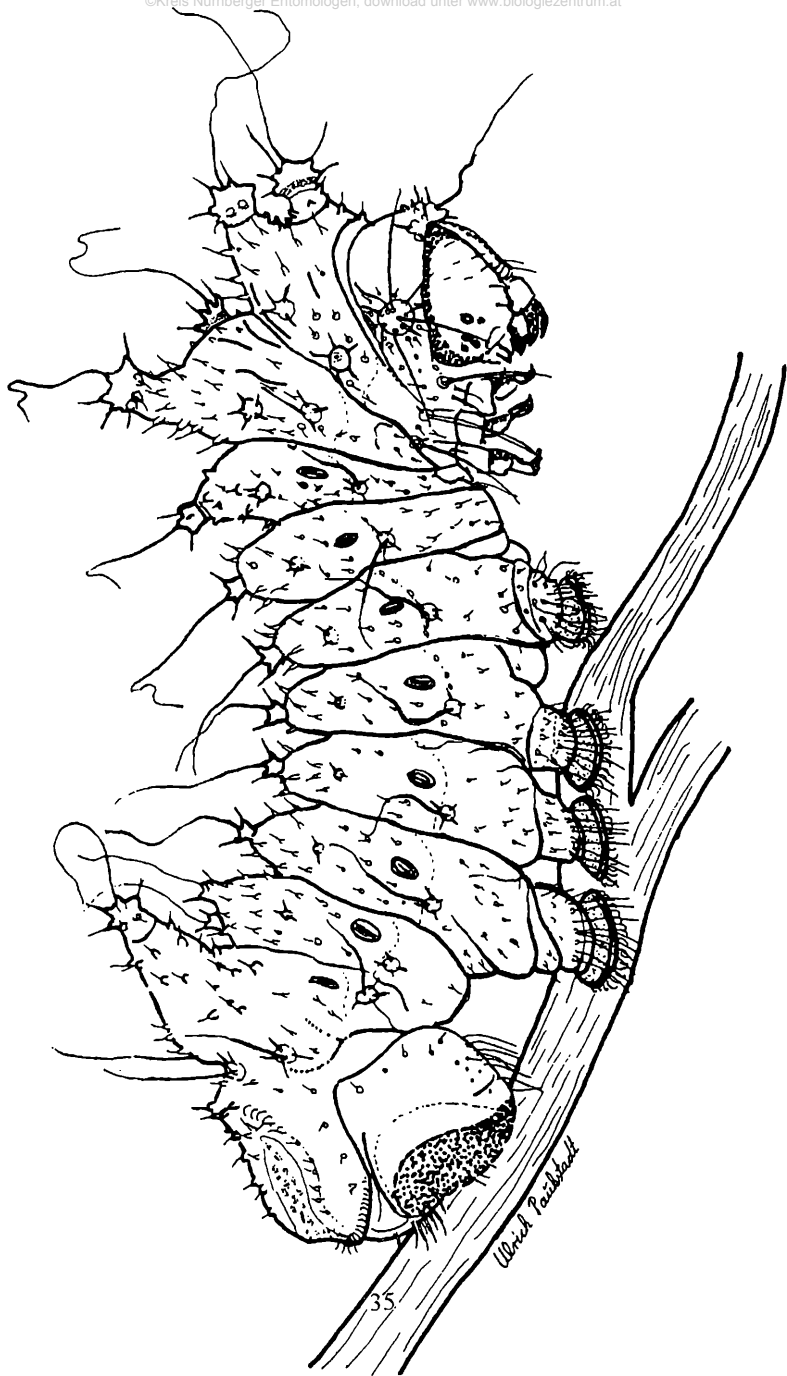
longitudinal rows. 8th abdominal segment bears a middorsal fused scolus, prothorax and 9th abdominal segment with each 4 scoli, anal plate border laterally with a single scolus each side and with strong bristles at the posterior end (in *groenendaeli* mostly all scoli supported by fleshy extensions of body (cf. fig. 7), and in *isis* fleshy extensions of body supporting scoli only dorsally on meso- and metathorax, 8th abdominal segment, and laterally on prothorax present, the latter seven fleshy extensions of body are clearly longer in *groenendaeli* than in *isis*). Subdorsal extensions of body supporting scoli approximately as long as dorsal

extensions (in *isis* clearly shorter). Mostly 6–10 long white hairs of approximately 1.7 mm length at apex of scoli, additional a longer white centered hair present at the apex of each scolus. Setae are covered with plenty of small hairs with a maximum length of 0.025 mm facing to the tip of the setae.

2nd instar larva. Head capsule dark brown, diameter 1.8 mm. Ground coloration of integument yellowish green, a yellowish longitudinal line connecting subspiracular row of orange colored scoli. Merely the fleshy extensions of body supporting scoli are yellow colored, the scolus itself (type “Sternwarze” = starwart) is pale yellowish in freshly moulted larvae and later orange colored. Dorsal and subspiracular scoli rich orange colored. Fleshy extension of body supporting middorsal scolus of 8th abdominal segment, as well as those supporting dorsal scoli of meso- and metathorax are clearly shorter than in *groenendaeli* and slightly shorter than in *isis*. Subdorsal scoli slightly reduced, but not as much as in *isis*. The scoli bear a variable number of long brownish hairs at apex, additionally each a long centered brownish hair present at apex. Bristles generally longer than in *isis*. Number of bristles higher (almost double) on middorsal scolus of 8th abdominal segment, dorsal scoli of meso- and metathorax and lateral scoli of prothorax. Abdominal prolegs and anal prolegs with white bristles. Prothoracic shield with two irregular black blotches on pale integument. These blotches are, different to those of *isis*, not interpreted as imitated “eyes” Abdominal prolegs laterally with a black transverse stripe; anal prolegs black, outer border reddish brown; spiracles white. The cuticle is covered with a tiny white speckling. With a binocular these spots are identified as enlarged hair bases.

Except in the first larval instar, the larvae of the *maenas*-group (sensu NÄSSIG 1994) are hardly distinguishable from those of the subgenus *Antheraea* Hübner, 1819 (“1816”). Significant distinctive marks are the morphology of the patch on the outside of each anal proleg and the position of the lateral longitudinal line. The patch on the outside of each anal proleg is more or less oval and not connected with the lateral longitudinal line in taxa of the *maenas*-group (sensu NÄSSIG 1994). In taxa of the subgenus *Antheraea* the patches on the outside of each anal proleg are triangular and

Fig. 8. *Actias maenas diana* Maassen in Maassen [& Weymer], 1872 (Bali). Mature larva habitus view.



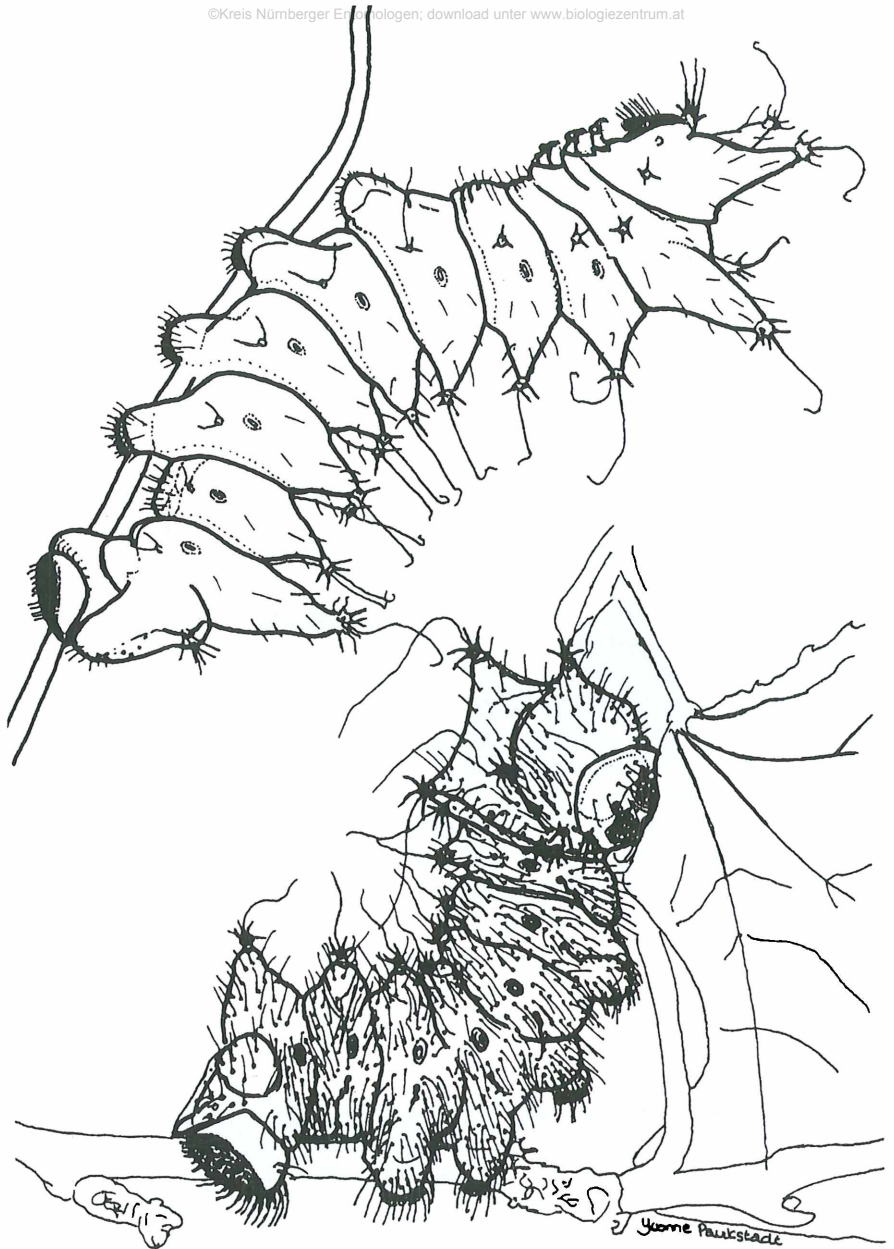
connected with the lateral longitudinal line. In *maenas* the lateral longitudinal line is connecting the subspiracular row of scoli and in taxa of the subgenus *Antheraea* this line is located between the subdorsal row of scoli and the spiracles. This line is either located subspiracularly at larvae in the genus *Actias* or supraspiracularly at larvae in the genus *Antheraea*.

3rd instar larva. Head capsule light brown, diameter approximately 2.5 mm. The larva is not much different from those of the previous instar. Ground coloration of integument light green with a conspicuous yellow line connecting subspiracular row of scoli. Cuticle covered with white enlarged hair bases supporting white or transparent setae. Spiracles white colored. Scoli mostly with a conspicuous yellow apex and pale yellow base. Subdorsal scoli slightly reduced, but not as much as in *isis*. Fleshy extension of body supporting single middorsal scolus of 8th abdominal segment, and the dorsal scoli of meso- and metathorax are clearly enlarged in comparison with those of other scoli, but not as large as in *isis* and *groenendaeli*. Patches on the outside of each anal proleg light brown with a white stripe facing cephalad. Thoracic legs and abdominal prolegs light brown. Anal plate monochrome black (in *maenas* from Sumatra and Peninsular Malaysia light brown with 20 black dots, cf. Nässig & Peigler 1984), white bordered and laterally with each one white scolus on border present. Brownish bristles at apex of scoli not reduced in size and number as in *isis*, only bristles of subdorsal scoli are reduced.

4th instar larva. Head capsule light brown, diameter 3.4–3.6 mm. Larva not much different from those of previous instar. Ground coloration of integument yellowish green, subspiracular line and white speckles still present (speckles more intensified in *isis* but less in *groenendaeli*). Subspiracular line almost reduced in *maenas* from Sumatra and Peninsular Malaysia. Scoli as in previous instar but mostly yellowish colored. The dorsal scoli of the abdominal segments and the inner sides of the dorsal scoli of the meso- and metathorax are mainly at the bases of its bristles and its centered hair pale orange colored. Remaining scoli are supported by conspicuous

Fig. 9 (top). *Actias groenendaeli* Roepke, 1954 (Timor). Mature larva habitus view.

Fig. 10 (bottom). *Actias isis* (Sonthonnax, 1897 [“1899”]) (Sulawesi). Mature larva habitus view.



fleshy extensions of body, particularly the dorsal scoli of meso- and metathorax, as well as the single middorsal scoli of 8th abdominal segment. Subdorsal scoli are less reduced than in *isis*. Thoracic legs light brown (in *isis* black). Abdominal prolegs yellowish with a black stripe at the outside. Patch on the outside of each anal proleg reddish brown and ochre, small black bordered, and with white bristles. Anal plate whitish, a dark reddish brown elongated patch in center present (in *groenendaeli* with black warts each bearing a hair and in *isis* dark red with black warts-like enlarged hair bases). In *groenendaeli* a black-red-yellow colored stripe dorsally and laterally present between 1st and 2nd abdominal segment, which is absent in *maenas* and *isis*.

5th instar larva. Head capsule reddish brown, diameter approximately 4.2–4.8 mm. Ground coloration of integument yellowish green, prothorax and anal segment yellowish. Thoracic legs reddish brown, abdominal legs laterally with a black stripe and white bristles. Prothoracic shield whitish, yellowish bordered towards the head. Spiracles mostly bluish green, subspiracular scoli colored as body, other scoli yellow. Bases of scoli of meso- and metathorax with a reddish stripe facing middorsally. Dorsal and subspiracular scoli with strong brown bristles at apex and each a centered single long soft white hair of which the uppermost part is white and the lowermost part is black colored. Enlarged hair bases of centered hairs on dorsal scoli pale orange colored. Bristles of subdorsal scoli reduced in number and size. At the outside of each anal proleg a black patch present, which is pale ochre bordered. Anal plate with a pale ochre bordered light brown patch spotted with dark brown warts bearing a white hair each (in *isis* this patch is orange colored with black warts and in *groenendaeli* light green with black warts). Cuticle white spotted, enlarged hair bases with each a white hair. The dorsal fleshy extensions of body supporting scoli and the speckling by white hair bases, are extraordinary conspicuous in this larval instar. 2nd–7th abdominal segments with a yellow line between each segment, yellow lines not as clear as in *maenas* from Sumatra and Peninsular Malaysia.

6th instar larva. Head capsule reddish brown, diameter approximately 6.0 mm. No obviously differences to the previous instar present, solely the yellowish transverse line between each abdominal segment are more conspicuous. Mature larva approximately only 8 cm long, which might be caused due to the poor quality of the foodplant during this winter rearing. In all instars the larvae show a sphinx-like resting position and when disturbed.

The thoracic legs are released from substrate and spider-like spread wide when in sphinx-like position.

In all larval instars insignificant differences in the coloration and pattern were observed between *maenas diana* from Bali and remaining populations of *maenas* from India, Peninsular Malaysia, Sumatra, and Java. The larval morphology is significant distinct in the three species *maenas*, *isis* and *groenendaeli*.

Cocoon. Coloration of the silk first whitish yellow, probably when contaminated with (rain) water and/or (sun) light becoming darker. Shape of the cocoon irregular oval, the thin wall more or less perforated. Length of the cocoon approximately 5–6 cm and diameter approximately 2.5 cm. The cocoon is either fitted directly to the twig, preferable in tendrils, or covered in one or more living camouflage leaves. Usually only those parts of the wall are perforated which are not covered with leaves. The female cocoon in this winter rearing was clearly smaller than those collected in the wild.

Pupa. Length approximately 3.5–4 cm and diameter 1.5–2 cm. Ground coloration mostly black. Antennal covers in both sexes shorter than visible covers of legs. Head with transparent (light-detecting?) “window” between eye covers. Cremaster with hooked spines at apex for affixing pupa to cocoon. Pupae in this winter rearing clearly smaller than those collected in the wild.

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