## An account of the life history of the Greater Death's Head Hawkmoth *Acherontia lachesis* (FABRICIUS, 1798) from Dauan Island, Australia

(Sphingidae, Sphingini, Acherontiina) by DAVID A. LANE & MAXWELL S. MOULDS received 6.V.2020

**Abstract**: The life history of *Acherontia lachesis* (FABRICUS, 1798) is described from observations made on Dauan Island, Torres Strait, Australia. The first colour photographs of the early larval instars are presented and aspects of the species' biology are discussed. The larval foodplant is *Clerodendrum inerme* (L.) GAERTN. (Lamiaceae).

Introduction: Previous accounts of the life history of *Acherontia lachesis* (FABRICIUS, 1798) have mostly described only the late instar larvae and pupa (e.g., DUPONT & SCHEEPMAKER, 1936; DUPONT & ROEPKE, 1941; EITSCHBERGER & IHLE, 2008, 2010; LEONG, 2011; ZOLOTUHIN & IVANOVICH, 2019). Only MELL (1922) and BELL & SCOTT (1937) describe the early instars and of these only MELL provides a description beyond a generalisation. Here we describe in detail all instars and the pupa from specimens found on Dauan Island, Torres Strait, Australia, and include the first colour photographs of all instars.

We encountered only the green larval form but two other colour forms are known, primarily in the last two instars, a yellow form and a grey/brown form. Previously a 5<sup>th</sup> instar yellow form larva was found on Dauan by CLIFF MEYER (Figs 15-17), and this larva was illustrated in black and white in MOULDS et al. (2020). This 5<sup>th</sup> instar yellow form is also herein illustrated. The yellow and grey/ brown forms are documented by DUPONT & SCHEEPMAKER (1936), BELL & SCOTT (1937), LEONG (2011) and MELL (1922). All three forms, green, yellow and grey/brown are illustrated by PITTAWAY & KITCHING on their web site 'Sphingidae of the Eastern Palaearctic' and by HOGENES in his web site 'The hawkmoths (Sphingidae, Sphinginae) of Papua Indonesia'.

All the larvae on Dauan Island were found feeding on *Clerodendrum inerme* (L.) GAERTN. (Lamiaceae), a common plant found all around the northern Australian coast from the Kimberley region to Brisbane (G. SANKOWSKY, pers. comm.). However *A. lachesis* (F.) is polyphagous in its larval foodplants and is known to feed on plants in some 29 families. A summary of all known foodplants previously recorded is provided by ROBINSON et al. (2001).

Nomenclature for larval and pupal morphology follows MOULDS et al. (2020).

#### Descriptions of the immature stages

## **Egg** (Figs 1-2)

Light green becoming pale yellow with maturity (about 24 hours prior to hatching); smooth and shiny to the naked eye but surface at magnification with very fine reticulation forming numerous shallow depressions all of similar size, which is typical of many sphingid eggs; nearly spherical, approximately 2 mm diameter. Duration at least 6 days.

## Larva (Figs 3-13, 15-17)

The 1<sup>st</sup> instar larvae are closely similar to those of *Psilogramma* species. Both have very long, slender and cylindrical bodies with a medial pair of long tubercles on the anal plate. They are best separated by the setae on the body, which are clearly bifurcate in *Acherontia* but simple in *Psilogramma*.

Discernible thoracic tubercles are present from the  $2^{nd}$  instar, becoming largest in the  $4^{th}$ , but remarkably are lost in the  $5^{th}$ . In the green form, the head is pale yellow in the first three instars, but green in the  $4^{th}$  and  $5^{th}$  (Figs 11-12). In the yellow form the head is yellow in all instars (Figs 15-17).

#### First instar (Figs 3-4)

The body is slender and cylindrical; semi-glossy; whitish to very pale yellow on hatching but after feeding becoming pale greenish tending slightly translucent with head either similarly coloured or very pale yellow; without markings. Primary setae small and inconspicuous, bifurcate, seated on very small, barely raised tubercles distinct at x 25; anal plate with a pair of very large medial tubercles. Prothoracic shield inconspicuous, with primary setae similar to those on abdomen. Spiracles inconspicuous, coloured similarly to body. True legs, ventral prolegs, claspers and anal plate similarly coloured to body except for whitish prolegs in some individuals. Caudal horn black except for pale green patch laterally at extreme base; 2.5-3.0 mm long, slender, straight or nearly so, barely tapering throughout its length to apex; apex bifurcate, the branches obtusely opposed and spread much wider than distal portion of shaft, each branch terminating in a very fine seta.

Length on hatching about 7 mm; length at maturity about 12 mm. Width of head capsule about 1.2 mm. Duration about 3 days.

#### Second instar (Fig. 5)

The body is long and slender; semi glossy, light to mid green, sometimes tending yellowish on abdominal segment 8 and beyond, also tending a little darker ventrally and along dorsal midline from internal organs; initially without markings but with maturity on some individuals oblique lateral stripes of later instars faintly visible; thorax and abdomen with numerous very small, pale yellowish green or whitish, slightly raised tubercles, a little larger on thorax, each with a very fine apically bifurcate seta; anal plate with a pair of medial tubercles larger than any other tubercles on body. Prothoracic shield indistinct, colour and tubercles similar to those on other thoracic segments. Spiracles inconspicuous, coloured similarly to or slightly paler than body. Head pale yellow; without markings. True legs, ventral prolegs, claspers and anal plate similarly coloured to body but a little paler.

Caudal horn black, sometimes with a little reddish brown at extreme base; long (about 5 mm) and thin; straight or nearly so; slightly tapering throughout its length to a bifurcate apex sometimes barely developed; with many small black tubercles irregularly spaced, some larger than others.

Length at maturity about 22 mm. Width of head capsule 1.7 mm. Duration about 3 days.

## Third instar (Figs 6-7)

The body is slender; not glossy; green, the abdomen with seven oblique lateral stripes, one each on segments 1-7, bicoloured dark green along their upper margin, yellow along their lower margin with the yellow diffusing beyond across segment; the lower end of each oblique stripe starting at the anterior segment near ventral surface then running backwards across segment to fade on to dorsal surface of the next segment, the last oblique stripe running to base of caudal horn; surface of thorax and abdomen with numerous, small, conical, pale yellow or whitish tubercles arranged in more or less transverse rows, largest on thorax, smaller on abdomen and gradually diminishing towards posterior to be virtually absent on segment 8 and beyond. Prothoracic shield indistinct with colour and tubercles similar to those on other thoracic segments. Spiracles white with a black vertical centre, a little larger on abdominal segment 7, larger again and blacker on segment 8. Head green with a yellow or pale green stripe down each cheek from vertex to base of antenna; mouthparts pale green with apices of mandibles black. True legs black apically, otherwise green; ventral prolegs and claspers dull green; anal plate dull green with a pale border, the two medial tubercles diminished.

Caudal horn either entirely black or multi-coloured, the latter very dark greenish brown on basal two-thirds except for small pale patch laterally at base, apical third dull greenish yellow with black apex; long (8.5–9.5 mm) and thin; straight or nearly so; gradually tapering throughout its length to a bifurcate apex that is sometimes barely developed; with many short, spine-like, black tubercles irregularly spaced, some larger than others.

Length at maturity about 35 mm. Width of head capsule 2.7-2.8 mm. Duration about 4 days.

## Fourth instar (Figs 8-10)

Not glossy; green, the abdomen with seven oblique lateral stripes, one each on segments 1-7, bicoloured dark greenish blue along their upper margin, yellow along their lower margin with the yellow diffusing beyond across segment; the lower end of each oblique stripe starting at the anterior segment near ventral surface then running backwards across segment to fade on the dorsal surface of the next segment, the last oblique stripe running to base of caudal horn; thorax with many short spine-like pale yellow to whitish tubercles mostly in transverse rows, the largest of these dorsal; abdomen with many low black tubercles dorsally, a few on anterior segments partly or entirely pale yellow to whitish, none present on segment 8 or beyond. Prothoracic shield indistinct with colour and tubercles similar to those on other thoracic segments. Spiracles similar in colour to adjacent body except for a bold black vertical centre. Head green with a bold black stripe down each lateral margin and a pale greenish yellow stripe down each cheek from vertex to base of antenna; mouthparts pale green with predominantly black mandibles; antennae pale greenish yellow. True legs black spotted white except for green coxa; ventral prolegs and claspers similar in colour to adjacent body, pale bluish green; anal plate dull green with a pale yellow border.

Caudal horn dull green on basal two-thirds, merging to yellow on apical third with a black tip; around 14 mm long; curved in an S-shape, gently backwards near base, strongly forwards on distal half; gradually tapering throughout its length to a small bifurcate apex; with many short, conical, spine-like tubercles irregularly spaced and similar in colour to that part of horn on which they are situated, largest on basal half or so.

Length at maturity about 68 mm. Width of head capsule 4.3 mm. Duration about 4 days.

## **Fifth instar (**Figs 11-13, 15-17)

**Green form** - Not glossy; green, the abdomen with seven oblique lateral stripes, one each on segments 1-7, bicoloured dark blue to nearly black along their upper margin, yellow along their lower margin; the lower end of each oblique stripe starting at the segment's anterior margin near its ventral surface or just a little on the previous segment, thereafter running backwards across segment to fade on the dorsal surface of the next segment, the last oblique stripe running to base of caudal horn; thorax devoid of tubercles apart from a few minute remnants; abdomen with many low black tubercles dorsally, none present on segment 8 or beyond. Prothoracic shield indistinct, without tubercles. Spiracles black with a narrow whitish perimeter. Head dull green with a bold black stripe down each lateral margin and a pale green stripe barely visible down each cheek from vertex to base of antenna; mouthparts pale brown with black mandibles; antennae whitish. True legs banded black and white except for green coxa; ventral prolegs and claspers similar in colour to adjacent ventral body, dull green but tending orange at distal margin; anal plate green with a yellow border. **Yellow form** – Similar to green form except for yellow head and body colour; the oblique lateral body stripes broadly mauve (some-

times partly blackish) above a narrow light yellow lower margin. Caudal horn in the green form dull green on basal two-thirds, merging to yellow or orange on apical third, in the yellow form entirely yellow but sometimes tending orange distally; around 12 mm long; curved in an S-shape, gently backwards near base, strongly forwards through 180° on distal half; gradually tapering throughout its length to a small bifurcate apex; with many short, conical, spine-like tubercles irregularly spaced and similar in colour to that part of horn on which they are situated, largest on basal half or so. Length at maturity about 112 mm. Width of head capsule about 7.5 mm. Duration about 7–8 days.

## Pupa (Figs 18-23)

Semi glossy, mid to dark brown, tending black in places, especially on the head, dorsally along body and around spiracular furrows. Head short and broadly rounded; smooth. Proboscis confluent with profile of head and body, its base with a pronounced row of transverse ridges either side of midline; reaching to apices of forewings. Thorax barely rugose, almost smooth; metathoracic plate with a large, walled depression either side. Forewings slightly rugose along termen. Abdominal segments 2-8 pitted along their anterior margin, mostly so across dorsal surface; spiracular furrows well developed as four deep grooves, the two central ones longest. Cremaster in dorsal view triangular and coarsely gnarled; ventrally coarsely gnarled with a deep medial groove; terminating in a pair of short spines that in dorsal view form a broad V-shape.

Length about 62 mm. Width at widest point about 17 mm. Duration during warmer months about 4 weeks.

#### Biology

The foodplant on Dauan Island was found growing in swampy or saline environments, often just beyond the tidal influence of adjacent mangrove areas (Fig. 14). The surrounding vegetation consisted mainly of paperbarks (*Melaleuca* sp.), *Pandanus* sp., and large Mango trees (*Mangifera*).

Eggs were laid singly on the underside of a juvenile foodplant leaf, usually 3-5 mm from the leaf margin. Oviposition sites appeared to be on plants growing in fairly well shaded locations.

First to third instar larvae usually rest along a midrib vein on the underside of a foodplant leaf, feeding intermittently from the leaf margin interspersed with periods of rest. Fourth and 5<sup>th</sup> instars more often rest wholly or partially on a foodplant stem, usually inverted head downwards or arched with the head downwards. They feed extensively, often devouring entire leaves before resting for short periods.

Just prior to pupation, the 5<sup>th</sup> instar green larvae develop a characteristic yellow colour dorsally extending along all segments (Fig. 13), and leaves the foodplant in search of a pupation site. For observation, one such 5<sup>th</sup> instar larva was placed in a container partly filled with friable soil to a depth of 200 mm. After wandering for a short time over the surface (about 5 minutes) it began to burrow into the soil, disappearing after a period of approximately 7 minutes. This larva was left undisturbed for one week, after which it was dug up to observe its pupation site.

The larva had burrowed to a depth of about 170 mm, and formed an underground cell chamber with neatly smoothed walls, approximately 90 mm long by 40 mm wide at its widest point, with the long axis angled downwards at about 30 degrees. The pupa was lying on the cell base with its head facing towards its future direction of exit. From the upper end of the cell a neat smooth-walled tunnel approximately 100 mm long and 20 mm wide, led towards the soil surface for a length of approximately 100 mm and inclined at approximately 60 degrees. The region beyond the upper end of this tunnel was composed of loose friable soil, with a vertical length of approximately 100 mm to the surface.

Adult moths emerge from their pupa in the chamber, climb along the inclined tunnel, and crawl through the upper layer of loose soil to reach the surface. They then climb a suitable surface to fully expand their wings, which occurs around 9-10 pm.

#### Discussion

Adult hawkmoths of the genus *Acherontia* are well known for their habit of using *Apis* bee honey as a primary source of food. MOULDS et al. (2020) in their review of the genus *Acherontia* discussed how the adults of each of the three species [*A. atropos* (LINNAEUS, 1758), *A. styx* WESTWOOD, 1847 and *A. lachesis* (F.)] have each been recorded robbing hives of different honey bee species (KITCHING, 2003, 2006), and that each may be exclusively dependant upon these separate honeybee species as their primary food source. All records of *A. atropos* feeding on honey are from hives of the European honey bee *Apis mellifera*, records of *A. lachesis* (F.) are from the giant honey bee *Apis dorsata* (KOENIGER et al., 1999, 2010), and for *A. styx* taking honey from *Apis cerana* (KOENIGER et al., 2010). There is also a single record of *A. styx* WESTW. taking honey from *Apis koschevnikovi* (KOENIGER et al., 2010), but *A. styx* WESTW. has never been recorded taking honey from *Apis dorsata* despite this species being common through the distribution of *A. styx* WESTW. Adult *Acherontia* have also been recorded feeding from fermenting fruit (CHOI et al., 2000; MOULDS et al., 2020), and also from nectar (PITTAWAY, 1993), although these observations are infrequent and may be a supplementary diet in the absence of honey.

The Asian honeybee, *Apis cerana*, has been artificially introduced through eastern Indonesia and has naturally reached Papua New Guinea (ANDERSON, 1991; SOMERVILLE, 2011), reaching the northern Torres Strait islands in 1993 (KOETZ, 2013). The spread of *A. lachesis* (F.) subsequently followed the spread of *Apis cerana* having first been detected in Papua New Guinea in 1993 (MOULDS & LACHLAN, 1998) and first recorded from Dauan in 2004 (LACHLAN & KNIGHT, 2004). However, there is no confirmation that the spread of *Apis cerana* and *A. lachesis* (F.) are correlated as there are no confirmed records of *A. lachesis* (F.) taking honey from *A. cerana*. Should there be a correlation then the potential spread of *Apis cerana* through Cape York Peninsula to the Cairns region, where it is already established (HYATT, 2012), could well lead to *A. lachesis* (F.) following. MOULDS et al. (2020) discuss the potential economic consequences should this happen.

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Figs 1-12: Acherontia lachesis. (FABRICIUS, 1798) - (1) egg showing typical colour; (2) egg just prior to hatching; (3) 1st instar soon after hatching; (4) 1st instar after feeding; (5–12) larval instars as labelled.



Figs 13-24: *Acherontia lachesis*. (FABRICIUS, 1798) - (13) pre-pupal larva; (14) habitat with larval foodplant in foreground; (15–17) 5th instar larva, yellow form; (18) pupa in its cell after excavation; (19–20) cremaster of pupa; (21–23) pupa; (24) adult at  $\circ$  rest.

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