New and revised descriptions of the immature stages of some butterflies in Sri Lanka and their larval food plants (Lepidoptera: Pieridae). Part 2: Subfamily Pierinae (in part)

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The immature stages of 14 species in the subfamily Pierinae out of the 28 species of Pieridae in Sri Lanka and their larval food plants are presented. Ten species including three endemic subspecies are documented for the first time. The remaining four species including one endemic subspecies are compared to prior descriptions and additional observations are presented. Previously reported larval food plants are confirmed and new ones identified. This study provides some base information needed for conservation management programs for butterflies in Sri Lanka and for further studies on the biology of these species. Identification notes are given for Capparis zeylanica and Capparis brevispina, two important larval food plants, which have frequently been misidentified in the literature.

Keywords: Lepidoptera, Pieridae, Sri Lanka, immature stages, conservation, larval food plants.

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Introduction

Knowledge of the immature stages and larval food plants of a butterfly species is important for conservation planning and is also useful in classification, elucidating broad-scale evolutionary patterns, understanding ecology at the community and population levels, and in ecological chemistry (DeVries 1986 and references therein). At a more practical level it enables the identification of larvae and pupae in the field, which can increase the accuracy of surveys even in the absence of adults.

However, the immature stages and larval food plants of many of the butterflies in Sri Lanka were incompletely known until a few years ago. The last major scientific publication (d’Abrera 1998) relied largely on information in Woodhouse (1949). Woodhouse published information of the immature stages and larval food plants of 191 of the 242 species of butterflies in the island known at that time. Eighty of these descriptions were based on work done in Sri Lanka, mostly based on Moore (1880–81) and published and unpublished accounts of E.E. Green, T.E. Tunnard, N. Manders and A. Willey; 111 were based on work done in peninsular India by J. Davidson, E.H. Aitken, T.R. Bell, G.F.L. Marshall, L. de Nicéville and others. Since then, little research had been published until the first of a series of papers by van der Poorten & van der Poorten in 2011.

Not only were the immature stages incompletely known, but even the distribution of butterflies in Sri Lanka was poorly known. Most of the records in
Woodhouse (1949) gave only very general locations and little ecological or habitat information.

This lack of knowledge was made evident by the first two Red List publications done in Sri Lanka in 1999 and 2007 (IUCN Sri Lanka 2000; IUCN Sri Lanka & MOENR 2007) and spurred survey work by private individuals and organizations, often sponsored by the Biodiversity Secretariat of the Ministry of Environment of Sri Lanka. The latest Red List publication (2012) was based on a dataset of over 20,000 records. It listed 21 species as CR (critically endangered) including five endemic species, 38 as EN (endangered) including ten endemic species, 40 as VU (vulnerable) including seven endemic species, 21 as NT (near threatened) including no endemic species, six as DD (data deficient) including one endemic species and 119 LC (least concern) including three endemic species (van der Poorten 2012).

A comparison of this recently collected data to the few historical records available (e.g. Ormiston 1924; Woodhouse 1949) suggests that the populations of many of the 245 species known in the country have declined and that the ranges of many species have contracted steeply. Similar to many other countries, the loss of habitats along with larval food plants seems to be the main cause for these declines.

To address these declines, the Biodiversity Secretariat of the Ministry of Environment of Sri Lanka is developing a Butterfly Conservation Action Plan. However, in order to assess the status of a butterfly species and to prepare conservation management plans, information on the biology of the species including the larval food plants and the resource needs of the adults as well as of the immature stages is a prerequisite.

The purpose of the current study is to document the immature stages and larval food plants of the butterflies in Sri Lanka to assist in the proper documentation of the status of species and to provide the baseline information necessary in conservation management planning.

In the current study (conducted from 2004 to the present and ongoing), we have documented the immature stages and larval food plants of 181 of the 245 known species of butterflies in Sri Lanka. For more details on the background and approach, see van der Poorten & van der Poorten (2011).

In Sri Lanka, there are 28 species in the Pieridae in two subfamilies: Pierinae (Tribes Colotini (1 genus, 5 species) and Pierini (9 genera, 15 species)) and Coliadinae (2 genera, 8 species). Of these 28 species, the National Red List of Sri Lanka 2012 listed two species as CR (critically endangered), 1 as EN (endangered), five as VU (vulnerable), one as NT (near threatened) and 19 as LC (least concern) (van der Poorten 2012). In Part 1, we presented the immature stages and larval food plants of eleven species in the genera Appias, Catopsilia and Eurema (van der Poorten & van der Poorten 2013). The bionomics of Catopsilia scylla, a species new to Sri Lanka, was presented in van der Poorten & van der Poorten (2012b).

In Part 2, we present the immature stages and larval food plants of 14 species of the subfamily Pierinae, tribes Pierini and Colotini. The immature stages and larval food plant of one species, Cepora nadina cingala, remain unknown. The immature stages of ten species (three of which are endemic subspecies) and their larval food plants in Sri Lanka are documented for the first time, and for three of these species, previously reported larval food plants are confirmed. The immature stages (usually only the final instar and pupa) of the remaining four species (one of which is an endemic subspecies) have been previously described from Sri Lankan material. These descriptions are compared to the findings of the current study and additional observations are presented. New larval food plants are reported and larval food plants previously reported in Sri Lanka are confirmed. Some previously reported larval food plants are not supported by this study. Comparisons are made with the same species (though not necessarily the same subspecies) as reported in other countries.

Notes are given for the identification of Capparis zeylanica L. 1762 and C. brevispina DC. 1824, two important larval food plants, which have frequently been misidentified in the literature.

Materials and methods

For general rearing methods and photographic documentation, see van der Poorten & van der Poorten (2011, 2012a). Nomenclature is based on K. Kunte (2014, in prep. and pers. comm.). Plants were identified to species if possible using several references (most notably, the series A revised handbook to the flora of Ceylon (Dassanayake (Ed.)) and an inspection of herbarium specimens at the Herbarium of the Royal Botanic Garden in Peradeniya, Sri Lanka. Where information on the duration of developmental stages is given, these data were obtained in rearings at ambient temperatures (22–34°C) at Bandarawela (07.37.01N, 80.10.57E), 70 m asl, North Western Province, Sri Lanka, unless otherwise indicated. Conventions used (applied to both the larva and the pupa): head – the head; T1–T3 – the 3 segments of the thorax; A1–A10 – the 10 segments of the abdomen. In the photographs, the head is always on the left. A complete data set of the duration of each stage and the length of the egg, larva and pupa were not recorded for all species.
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Results

Family: Pieridae, Subfamily: Pierinae
Tribe: Pierini

Leptosia nina nina Fabricius, 1793

Psyche
Figs 1–16

The immature stages of Leptosia n. nina in Sri Lanka have not been described in India. In the final instar larva and pupa of L. n. nina were described briefly by Davidson et al. (1897) (as Nychitona xiphia) and in detail by Bell (1912) (as L. xiphia). The results of the current study agree with these descriptions except for the following: a) in the larva, some specimens also have a faint blue wash above the dark supraspiracular line especially in the terminal segments (Fig. 1); and b) in the pupa, most specimens have a white spiracular line, and the color is pale green to pale brown, not quite white (Figs 2–4).

Additional notes on immature stages. 1st instar: on emergence, head and body pale yellow with long setae; after eating, body turns a pale green. 2nd: head pale orange-yellow, smaller than T1, covered with short, dark-colored setae, eyes black and distinct; body slender, more or less uniform thickness, pale yellow-green, T2–A5 darker green dorsally extending to dorsoventral margin; body transversely impressed to form 5–6 partitions per segment; each segment with pale blue tubercles (subdorsal, lateral and supraspiracular) with a single long seta, often with a clear droplet (Fig. 5). 3rd: similar to 2nd; ground color of body varies from pale green to yellow-green, additionally with a few green tubercles (Fig. 6). 4th: similar to 3rd but ground color more bluish-green except for posterior segments; droplets at tip of setae often yellow; tubercles dark green and more prominent, extending to A6; flange with glaucous wash from T1–A6; 12 mm in length (Fig. 7). 5th: 20 mm length preparation. The egg (Fig. 8), final instar and pupa look similar to those illustrated in Igarashi & Fukuda (2000) from Taiwan (subspecies not identified) except that the white subspiracular band in the final instar of the individuals in Sri Lanka is variable and usually only on posterior segments and does not extend the whole length of the larva. The egg, final instar and pupa of L. n. malayana from Singapore (Butterfly Circle 2012) and that of L. n. nina from India look similar (Saji 2013a).

Duration of immature stages (days). 1st instar (3); 2nd (1–2); 3rd (1–2); 4th (1–2); 5th (3); pupa (6).

Larval food plants. In Sri Lanka, de Nicéville & Manders (1899) reported that the larva fed on “various capers (Capparis)” and Woodhouse (1949) reported “in Colombo the larva generally feeds on Cleome aspera” and, based on Indian records, also listed Caparis heyeana [now C. buduca], C. hortensis [now C. zeylanica], C. sepia and C. religiosa [sic; probably Crateva religiosa].

The current study showed for the first time that Cardamine hirsuta L. 1753 (Brassicaceae) (S. Sanjeeva, pers. comm.), Cleome gynandra L. 1753 (H.D. Jayasinghe, pers. comm.), Capparis roxburghii DC. 1824, C. sepiaria L. 1759, C. zeylanica, Cadaba fruticosa (L.) Druce 1913, Crateva adansonii DC. 1824 and Cleome rutidosperma DC. 1824 (Capparaceae) are used as larval food plants in Sri Lanka and confirmed the use of Cleome aspera J. Koernig ex DC. 1824. Larvae feed only on tender leaves. Capparaceae have also been reported from other countries: Cleome sp. was recorded in the Andamans by Veenakumari et al. (1997) and Capparis zeylanica in India by Atluri et al. (2012). The reference paper for Rhamnaceae (Rhamnus purshifolia) from Taiwan for L. n. niobe (Robinson et al. 2001) could not be obtained but this record seems doubtful as all records of this common butterfly, except for Cardamine hirsuta, are from the Capparaceae. Though the record of Brassicaceae seems out of place for this species, Brassicaceae and Capparaceae are closely related families and many other genera of Pierids feed on Brassicaceae.

L. n. nina is found island-wide, in all climatic zones, usually below 800 m asl. Capparis roxburghii is a vine that is widely distributed in the arid, dry and intermediate zones. C. sepiaria is a vine that is widely distributed over the country except in the wetter areas and the higher elevations. C. zeylanica is a vine that is somewhat restricted in distribution in the dry and intermediate zones. Cadaba fruticosa is a shrub that is found widely in the arid and dry zones of the north and northwest. Crateva adansonii is a small tree widely distributed in the arid, dry and dry-intermediate zones. Cleome aspera is an annual herb that is widely distributed in wastelands and roadsides over most of the country. Cleome aspera is an annual herb that is widely distributed in wastelands and roadsides in the low country and dry zone (Dassanayake 1996). At least one of these plants is found wherever the butterfly has been recorded.

National Red List 2012 status. LC.

Note. There has been some confusion in the literature as to the proper identity of two species of the Capparaceae in Sri Lanka and India: Capparis zeylanica and C. brevispina. In this study, we follow Jacobs (1965). C. zeylanica (syn. C. hortensis) is a viney plant with recurved thorns and brownish-red tomentum on young twigs and inflorescences; the flowers are supra-axillary in groups of 1–5; the petals are hairy and greenish-white; the stamens are white with purple anthers upon opening (in the evening, about one hour before sunset) but turn purple within a
C. brevispina is a shrub or small tree, with straight thorns and whitish tomentum on young twigs and inflorescences, which also have cataphylls at the base; the flowers are axillary and solitary; the petals are more or less glabrous and white; the upper two petals each have a large yellow blotch at the base that turns purple within a day or two; the stamens are white with blue anthers and do not change color. The fruit is smaller than that of C. zeylanica and not as woody (Figs 13–16). C. brevispina has frequently been referred to, in error, as C. zeylanica. It is not known exactly to which plant older references for Capparis zeylanica refer though it is likely that they refer to C. brevispina.
**Delias eucharis Drury, 1773**

**Common Jezebel**

Figs 17–22

The final instar larva and pupa of *Delias eucharis* in Sri Lanka were described briefly and illustrated by Moore (1880–81). In India, they were described briefly by Davidson & Aitken (1890) and in detail by Bell (1912). The results of the current study agree with these descriptions except that a) in the larva, the ground color assumes various shades of reddish-brown and the dorsal line is green-tinted (Fig. 17) and b) the pupa varies from pale to bright yellow (Fig. 18). The pupa from India illustrated by Igarashi & Fukuda (1997) is similar but with additional markings. The immature stages from India illustrated in Saji & Bhakare (2013) look similar.

**Additional notes on immature stages.** Egg: laid in batches up to 80; often entire batches are parasitized by a braconid wasp (Fig. 19). 1st instar: head black and shiny, wider than body, with a few long white setae; body yellow-orange, each segment with a row of 8 minute dark tubercles, each with a long white hair (Fig. 20). 3rd (Fig. 21) and 4th (Fig. 22) similar to 5th. Larvae gregarious.

**Duration of immature stages (days).** Egg (4–5); larva (14–17); pupation (1); pupa (10–11); egg to eclosion of adult (32–33).

**Larval food plants.** In Sri Lanka, G. Thwaites and F.M. Mackwood reported “Loranthus” (quoted in...
Prioneris sita (C. & R. Felder, [1865])

Painted Sawtooth

Figs 23–29

The final instar larva and pupa of Prioneris sita in Sri Lanka were described briefly and illustrated by Moore (1884–1887) based on a manuscript of E.E. Green. In India, Bell (1912) also quoted Green and reported “in another pupa... there was no sign of the crimson-bordered, black-speckled spot”. The results of the current study agree with the descriptions of the larva (Fig. 23) but in the pupa, the crimson-bordered, black-speckled spot is present (Figs 24–25).

Additional notes on immature stages. Egg: creamy white with translucent base, spindle-shaped with 8 longitudinal ridges; egg often falls onto its side (Fig. 26). 1st instar: head orange, body pale yellow from T1–A3, the rest pale orange, body covered with transparent setae each with a droplet (Fig. 27). 2nd: head pale brownish-orange with minute tubercles that end in a transparent seta with a droplet at the apex; body pale yellowish-green, speckled with dark brown spots and numerous tubercles, each carrying one seta with a transparent droplet at its apex; spiracular band diffuse and dark brown; long hairs along the lateral margin without droplets at apex (Fig. 28). 3rd: similar to 2nd except A7–A10 are brownish-green; lateral margins densely marked with brown streaks and spots, particularly from A3–A9 (Fig. 29). 4th: similar to 5th but with highly reduced blue tubercles. The larva is slow-growing and sluggish in all instars.

Duration of immature stages (days). Pupation (1–2); pupa (8–9). Length (mm): prepupation (46–48).

Larval food plants. In Sri Lanka, E.E. Green reported “Capparis” (quoted in Moore 1884–1887), and Woodhouse (1949) reported Capparis tenena though the source for this record could not be traced. The current study showed for the first time that Capparis mooni Wight 1840 (Capparaceae) is used as a larval food plant. We have not been able to confirm C. tenena. Early instars feed on tender leaves only but later instars feed on more mature leaves. Various other species of Capparis have been reported for other species of Prioneris in other countries (e.g. Igarashi & Fukuda 1997). In India, Bell (1912) reported C. horrida [now C. zeylanica]. Larvae refused to feed on the leaves of C. roxburghii, C. septaria and C. zeylanica when offered to them in our studies.

P. sita is rare and seasonal and found between 600–1200 m asl. C. mooni is a somewhat uncommon, large vine found at similar elevations (Dassanayake 1996). The larval food plant has been found wherever the butterfly has been reported. This species is of particular conservation concern since it is an endangered species.

National Red List 2012 status. EN.

Belenois aurota taprobana (Moore, 1872)

Pioneer (Endemic subspecies)

Figs 30–36

The immature stages of Belenos aurota taprobana in Sri Lanka have not been described. In India, the final instar larva and pupa of B. aurota were described briefly by Davidson et al. (1897) (as B. mesentina); the egg (Figs 30–31), all instars and the pupa were described in detail by Bell (1912) (as Anapheis mesentina). The results of the current study agree with these descriptions except that a) in the final instar, the head is black, not purplish-black.

(Figs 32–33) and, b) the pupa also includes a form that is pale pink-beige with yellow tubercles, and a green form with yellow tubercles (Figs 34–36); the green form with black markings and black tubercles was not seen. The immature stages of $B. a. aurota$ from India illustrated by Saji (2013b) look similar.

Duration of immature stages (days). 5th instar (1); pupation (1); pupa (6–7). Egg to eclosion of adult: (18–20).

Larval food plants. In Sri Lanka, de Nicéville & Manders (1899) reported it feeding on $Capparis$. The current study showed for the first time that $Capparis grandis$ L.f. 1782 (H.D. Jayasinghe, pers. comm.), $Capparis sepiaria$ and $Maerua arenaria$ Hook. f. & Thomson 1875 (Capparaceae) are used as larval food plants. Field observations suggest that $M. arenaria$ is the preferred plant in the arid zone and $C. sepiaria$ in the dry zone. Early instars feed on tender leaves; later instars on more mature leaves. In India, $C. zeylanica$ was reported by Atluri et al. (2012), and Bell (1912) reported $C. sepiaria$, $C. aphylla$ [now $C. decidua$, not found in Sri Lanka], and $C. indica$ [sic] [Note: $Capparis indica$ is from the Americas so ‘$C. indica$’ likely refers to Cadaba indica which is now Cadaba fruticosa]. Cadaba fruticosa is shown as a larval food plant in India by Saji (2013b) for $B. a. aurota$.

$B. aurota taprobana$ is uncommon and tends to appear irregularly in large numbers. It is found in the dry and arid zones. Small populations establish themselves in the intermediate zone during the northeast monsoon (October–February).

$Maerua arenaria$ is common in the arid and dry zones near the coast. $C. grandis$ is found in open scrub in the dry and arid zones (Dassanayake 1996). See Leptosia n. nina for the distribution of $C. sepiaria$. At least one of these plants is found wherever the butterfly has been recorded but it is possible that other members of the Capparaceae are also used.

National Red List 2012 status. LC.

*Cepora nerissa phryne* (Fabricius, 1775)

Common Gull

Figs 37–39

The final instar and pupa of *Cepora nerissa phryne* in Sri Lanka were described briefly and illustrated by Moore (1880–81). In India, all instars and the pupa were described in detail by Bell (1913a) (as *Huphina nerissa phryne*). The results of the current study agree with the descriptions of the pupa (Figs 37–38) and final instar (Fig. 39) except that the lateral line and the subspiracular lines are indistinct. The larva and pupa illustrated in Igarashi & Fukuda (1997) from India (subspecies not indicated) are similar except for the subspiracular line. The immature stages of *C. nerissa phryne* illustrated by Saji & Ogale (2013) from India look similar.

Additional notes on immature stages. Egg: beige with orange markings. 1st instar: right after emergence – ate eggshell; body greenish-yellow with pale pink innards.

Duration of immature stages (days). Pupation (1); pupa (7–10); egg to eclosion of adult (19–23).

Length (mm): prepupation (28–33).

Larval food plants. In Sri Lanka, G. Thwaites reported it feeding on *Capparis* (quoted in Moore 1880–81). The current study showed for the first time that *Capparis sepiaria*, *C. roxburghii*, *C. moonii*, *C. zeylanica*, *C. brevispina* and *C. grandis* (Capparaceae) are used as larval food plants. Early instars feed on tender leaves; later instars on more mature leaves. In other countries, it has also been reported on *Capparis* e.g. *C. sepiaria* in the Andamans for *C. nerissa lichenosa* (Veenakumari et al. 1997), *C. zeylanica* in India (Igarashi & Fukuda 1997), and *Capparis* sp. (not *C. zeylanica*) in India (Saji & Ogale 2013).

*C. nerissa phryne* is common and widely distributed in the arid, dry and intermediate zones in both disturbed and forest habitats. See *Leptosia n. nina* and *Prioneris sita* for the distribution of the other species of *Capparis*. At least one of these plants is found wherever the butterfly has been recorded but it is possible that another member of the Capparaceae is also used.
**National Red List 2012 status.** LC.

*Cepora nadina cingala* (Moore, [1858])

**Lesser Gull (Endemic subspecies)**

The immature stages of *Cepora nadina cingala* in Sri Lanka have not been described. In the course of the current study, only a few adults have been seen, and no eggs, larvae or pupae have been found. The immature stages of *C. nadina* in Taiwan (subspecies not identified) have been illustrated by Igarashi & Fukuda (1997) and the larval food plant identified as *Capparis micracantha*. Kunte & Ogale (2013) illustrated the immature stages of *C. nadina remba* from India and listed *Capparis mooni* as the larval food plant. Veenakumari et al. (1997) identified the larval food plant of *C. nadina andamana* in the Andamans as *Capparis sepiaria*.

**National Red List 2012 status.** CR.

*Hebomoia glaucippe ceylonica* Fruhstorfer 1907

**Great Orange Tip (Endemic subspecies)**

Figs 40–47

The final instar larva and pupa of *Hebomoia glaucippe ceylonica* in Sri Lanka were described briefly and illustrated by Moore (1880–81). In India, the egg, final instar and pupa of *H. glaucippe* were described in detail by Bell (1914). The results of the current study agree with these descriptions except for the following: a) the egg turns pale orange after one day (Figs 40–41) and b) the pupa has 3 color forms: green, pinkish-yellow, and dark yellow (Figs 42–44). We have not observed the dark yellowish-green form described by Bell. The Sri Lankan specimens are similar to those from Taiwan (subspecies not identified) illustrated in Igarashi & Fukuda (1997) except that in Sri Lankan individuals the line on the head is yellow and the lateral line on the last segment is white (Figs 45–46). They are also very similar to *H. glaucippe australis* from India illustrated by Ogale & Haneesh (2013).

**Additional notes on immature stages.** 3rd instar: head pale orange-brown with numerous setae each with a droplet at the apex; body pale green T1–T2; T3–A7 much darker green; A8–A10 pale greenish-yellow; each segment transversely impressed with 5–6 furrows; entire body covered with very small tubercles, each with a seta, each with a colorless droplet at the apex (Fig. 47).

**Duration of immature stages (days).** Egg (3–4); pupa (10–11); egg to eclosion of adult (32).

**Larval food plants.** In Sri Lanka, G. Thwaites reported *Capparis* (quoted in Moore 1880–81). The current study showed for the first time that *Capparis roxburghii*, *C. sepiaria*, *C. moonii* and *Crataeva adamsonii* (Capparaceae) are used as larval food plants. Early instars feed on tender leaves; later instars on more mature ones. Capparaceae are reported in other countries: *C. sepiaria* is reported for *H. glaucippe roepstorffi* in the Andamans (Veenakumari et al. 1997).

*Hebomoia glaucippe ceylonica* is fairly common in the dry zone and less common in the intermediate zone over most of the island. See *Leptosia n. nina* and *Proneris sita* for the distribution of the larval food plants. At least one of these plants is found wherever the butterfly has been recorded but it is possible that another member of the Capparaceae is also used.

**National Red List 2012 status.** LC.
Figs 40–47. *Hebomoia glaucippe ceylonica*. 40. Egg, newly laid; 41. Egg, one day later; 42. Pupa, green form; 43. Pupa, pinkish-yellow form; 44. Pupa, dark yellow form; 45. Larva, fifth instar, close-up of head, frontal view; 46. Larva, fifth instar, lateral view; 47. Larva, third instar, dorsal view.

*Pareronia ceylanica ceylanica* (C. & R. Felder, 1865)

Dark Wanderer

Figs 48–55

The immature stages of *Pareronia c. ceylanica* in Sri Lanka have not been described. In India, the final instar larva and pupa (as *P. pingasa*) were described in detail by Bell (1914). The results of the current study agree except for the following: a) in the final instar, 1) all spiracles are dark gray, 2) all tubercles are brown and there are no subspiracular tubercles, 3) there is no brown band, only a series of pale purple spots giving the semblance of a line, running from lower posterior margin up to the spiracle, usually on T3–A10, 4) patches variable, usually a pale brown or white patch on T3 (smaller) and on A8–A10 (larger), sometimes smaller patches on other segments (Figs 48–49), and b) in the pupa the snout is either straight or only slightly upcurved (Fig. 50).

Additional notes on immature stages. Egg: spindle-shaped, broadest just above the middle, with longitudinal ridges terminating in a crown at the apex with 9 to 10 projections, slight transverse bands con-
Figs 48–55. *Pareronia ceylanica ceylanica*. 48. Larva, fifth instar, with faint lateral white patches, lateral view; 49. Larva, fifth instar, with pronounced lateral white patches, dorso-lateral view; 50. Pupa; 51. Eggs, 24 hours after being laid; 52. Larva, first instar, dorso-lateral view; 53. Larva, second instar, dorso-lateral view; 54. Larva, third instar, dorso-lateral view; 55. Larva, fourth instar, lateral view.
necting the longitudinal ridges, white when first laid, but acquires 3–4 pink transverse bands within 24 hours (Fig. 51); laid in batches of up to 8. 1st instar: newly emerged larva sandy-orange body and head with 2 tubercles on A8 and 2 anal processes each the length of A8; eats the whole eggshell, rests with head curled to the side; next day, head and area below lateral line yellow-orange, anal processes a brighter yellow-orange, body pale bluish-green with more tubercles, each with a seta topped by a droplet of liquid (Fig. 52). 2nd: head pale green mottled with brown, tubercles on head pale blue and prominent with white setae; body pale green with a discontinuous white dorsal line, tubercles in 3 rows – subdorsal, lateral and supraspiracular and darker blue than on head; T1–A10 below lateral line mottled with dark brown spots; flange below subspiracular line with numerous long white hairs that often touch the leaf at rest; A7–A9 paler green dorsally; anal processes prominent, yellow-orange in color, with long white hairs (Fig. 53). 3rd: similar to 2nd but more bluish-green with reduced brown markings and usually with white patches on T3 & A8–A10; spiracles dark gray and prominent on T1, A7, A8 (Fig. 54). 4th: similar to the 3rd but with white patches more distinct, all spiracles distinct, anal processes distinctly shorter with apex reddish-orange with black hairs (Fig. 55). The pale lateral patches have been noted to resemble clusters of cocoons or larvae of parasitoids emerging from the body of the larva. No parasitoids have been recorded on this species and perhaps these markings serve as a deterrent.

Duration of immature stages (days). Egg: (5); 1st instar (3); 2nd (2); 3rd (4); 5th not recorded; pupation (1); pupa (8); egg to eclosion of adult (17–20). Length (mm): pupa (30). Larval food plants. In Sri Lanka, there are no previous reports of larval food plants. The current study showed for the first time that *Capparis zeylanica* (Capparaceae) is used as a larval food plant. All instars eat only old, tough leaves and refuse tender leaves. The final instar straddles the margin of the leaf while feeding and resting. On the west coast, a female was observed ovipositing on *C. brevispina* and though we were unable to follow it up, it is very likely that *C. brevispina* is used as a larval food plant. In India, *Capparis heyneana* (now *C. baducca*, not found in Sri Lanka) is listed as a larval food plant by Bell (1914). In the Andamans, *Capparis* sp. was recorded for *P. ceylanica naraka* by Veenakumari et al. (1997).

*C. ceylanica* is found in the dry and intermediate zones where it is a breeding resident. It has also been recorded as a migrant in the higher elevations such as Horton Plains and Kandy. *C. zeylanica* is a vine that grows in the dry and intermediate zones. *C. brevispina* appears to have a more restricted distribution. However, given the confusion over the identification of these two species, relying on old data is problematic.

**National Red List 2012 status.** LC.

**Ixias marianne** (Cramer, 1779)

**White Orange Tip**

Figs 56–66

The immature stages of *I. marianne* in Sri Lanka have not been described. In India, the egg, all instars and the pupa were described in detail by Bell (1913b). The results of the current study agree except for the following: a) egg white when first laid, turning orange (Figs 56–57); b) 1st instar newly emerged – head pale orange-green, eats most of eggshell; next day – head dark orange-brown, first half of body orange-green, latter half yellow-orange; more green towards the end of the instar (Fig. 58); c) 2nd – head greenish-brown, A8–A10 with an obscure diffuse yellow-orange dorsal patch, a broad diffuse purplish-brown spiracular band (Figs 59–60); d) 3rd – spiracular band obscure, broader bluish-white band above and narrower reddish-brown band below (Fig. 61); e) 4th – spiracular line white bordered by reddish-brown above and below, ground color bluish-green above spiracular line and grass-green below (Fig. 62); f) 5th – band above and below spiracular line red, lower one with a touch of maroon; ground color grass green above and below spiracular line (Fig. 63) and g) pupa – black specks not always present, cell-spot often absent; cremaster brown with black spots; green form and bone-colored form as described seen but additionally transparent off-white form with brown markings was recorded (Figs 64–66). All instars sometimes rest with head and T1–A2 raised (Fig. 61). The larva and pupa looks similar to those illustrated by Haneesh & Soaman (2013) from India.

Duration of immature stages (days). Egg (3); 1st instar (2); 2nd (2); pupation (1); pupa (8–10); egg to eclosion of adult (25–27).

**Larval food plants.** In Sri Lanka, there are no published reports of larval food plants. The current study showed for the first time that *C. sepiaria*, *C. brevispina* and *C. grandis* (Capparaceae) are used as larval food plants. Early instars eat tender leaves; later instars eat more mature leaves. In India, Bell (1913b) reported the same plants as well as *I. aphylla* [now *C. decidua*], which is not found in Sri Lanka.

*I. marianne* is found in the dry and arid zones in both the north and south and occasionally in the intermediate zone. See *Cepora nerissa phryne*, *Belenois aurora taprobana* and *Leptosia n. nina* for the distribution of larval food plants. At least one of these plants is found wherever the butterfly has been
recorded but it is possible that other members of the Capparaceae are also used.

National Red List 2012 status. LC.

*IXIAS PYRENE CINGALENSIS* Moore, [1881]

Yellow Orange Tip (Endemic subspecies)
Figs 67–77

The immature stages of *Ixias pyrene cingalesensis* in Sri Lanka have not been described. In India, the egg, the last four instars and the pupa of *I. pyrene* (subspecies not specified) were described in detail by Bell (1913b). The results of the current study agree with these descriptions except for the following: a) 2nd instar – head reddish-brown, A1–A2 with a large purplish-brown subspiracular spot (Fig. 67); b) 3rd – markings on A1–A2 & A7–A9 almost black (Fig. 68); c) 4th – chocolate-colored spiracular line somewhat indistinct and interrupted, sometimes edged with white (Fig. 69); d) 5th – ground color varies from yellowish-green to grass-green (Fig. 70); and e) pupa varied in color, as described (bone-colored form with dark brown to black mottling and pale pink blotches; green form with black or dark gray mottling) and also a green form with little mottling, and a pale pink form with pale pink markings (Figs 71–74). The larva and pupa look similar to *I. pyrene* (subspecies not identified) as illustrated by Igarashi & Fukuda (1997), and to *I. pyrene sesia* in India as illustrated by Soman (2013) though the pupa of the Sri Lankan subspecies appears to be paler and the thoracic bulge more prominent.

Additional notes on immature stages. Egg pale yellow-orange when first laid, acquiring pale orange-colored blotches one day later (Figs 75–76). 1st instar (2); 2nd (2); 3rd (5); pupation (2); pupa (6–8); egg to eclosion of adult (23–28). Length (mm): newly emerged larva (3). 

Duration of immature stages (days). Egg (3–4); 1st instar (3); 2nd (2); 3rd (2); 4th (1–3); 5th (1–4); pupa (7–8). One individual collected as a larva molted 5 times (6 instars). Length: prepupation (18–22 mm); pupa 14 mm.

Larval food plants. In Sri Lanka, there are no published reports of larval food plants. The current study showed for the first time that *Capparis sepiaria* (Capparaceae) is used as a larval food plant. Early instars feed on tender leaves; later instars on more mature leaves. Capparaceae have also been reported as larval food plants in other countries. Veenakumari et al. (1997) reported *Capparis* sp. for *I. pyrene andamana*, and Igarashi & Fukuda (1997) reported *C. zeylanica* for *I. pyrene* (subspecies not identified) in northern India. We have not observed it ovipositing on *C. zeylanica* and in the lab, larvae refused *C. roxburghii*. *I. pyrene cingalesensis* is found in the arid, dry and intermediate zones where it breeds and is some-
times seen in hills during the migrations. It is more widespread than *I. marianne*. See *L. n. nina* for the distribution of *C. sepiaria*, which has been found wherever the butterfly has been recorded.

National Red List 2012 status. LC.

**Tribe: Colotini**

*Colotis amata modesta* (Butler, 1876)

Small Salmon Arab
Figs 78–88

The immature stages of *C. amata modesta* in Sri Lanka have not been described. In India, the egg, final instar larva and pupa of *C. amata* (subspecies not identified) were described in detail by Bell (1914). The results of the current study agree with these descriptions except for the following: a) in the egg, a pale brown transverse band appears just below the apex one day after being laid (Figs 78–79); eggs laid in batches up to 60–80 and many eggs fall over onto their side after being laid (Fig. 80); b) 1st instar – newly emerged larva sometimes eats one or two unhatched eggs; each seta with an amber-colored or translucent droplet at its tip (Figs 81–82); c) 2nd – droplets still present (Fig. 83); d) 3rd – subsiracular area paler green (Fig. 84); e) 4th as described (Fig. 85); f) 5th – white dorsal line bounded on both edges by a very fine yellow line (Fig. 186); and g) pupa with an additional color form – pale brown with similar markings (Figs 87–88). One individual that was collected as a small larva underwent 5 molts. The immature stages appear similar to *C. amata modesta* from India as illustrated by Bhakare & Saji (2013).

Duration of immature stages (days). 1st instar (2); 2nd (2); 3rd (2); 4th (1–3); 5th (1–4); pupa (7–8). One individual collected as a larva molted 5 times (6 instars). Length: prepupation (18–22 mm); pupa 14 mm.

Larval food plants. In Sri Lanka, de Nicéville & Manders (1899) reported it feeding on “Salvadora”. The current study confirmed *Salvadora persica* Lam. 1753 and showed that *Azima tetracantha* Lam. 1783 (Salvadoraceae) is also used as a larval food plant. Early instars eat only tender leaves; later instars eat more mature leaves. In India, Bell (1914) listed *Salvadora persica*, *S. oleoides* and *Azima tetracantha* as larval food plants for *C. amata* while Bhakare & Saji (2013) illustrate *Salvadora* sp. for *C. amata modesta*.

*C. amata modesta* is found in the dry and arid zones in the north and south, predominantly along the coast though it may also be found sparingly in the intermediate zone where its larval food plants are present. *Salvadora persica* and *Azima tetracantha* are widespread in the arid and dry zone in the
Figs 78–88. *Colotis amata modesta*. 78. Egg, newly laid; 79. Egg, one day later; 80. Eggs laid in a batch; 81. Larva, newly emerged; 82. Larva, first instar, individual on the right molting (just shedding head capsule); 83. Larva, second instar; 84. Larva, third instar; 85. Larva, fourth instar; 86. Larva, fifth instar; 87. Pupa, pale brown color form; 88. Pupa, green color form.

north and south but *S. persica* extends further north from Mannar up to Jaffna (Dassanayake 1991). At least one of these species is found wherever the butterfly has been recorded and these are the only two members of the Salvadoraceae in Sri Lanka.

National Red List 2012 status. LC.

*Colotis fausta fulvia* (Wallace, 1867)

Large Salmon Arab

Figs 89–99

The immature stages of *Colotis fausta fulvia* in Sri Lanka have not been described. In India, the egg,
final instar larva and pupa of *C. fausta* (subspecies not specified) were described in detail by Bell (1914). The results of the current study agree with these descriptions except for the following: a) in the final instar, the spiracles are sometimes green, sometimes pale brown, and with or without darker centers, and in some individuals, the ground color is yellowish-green (Figs 89–91) and b) in the pupa, as well as the bone-colored form and the green form, there is a pale pink-yellow-beige form (Figs 92–94). Egg as described (Fig. 95).

**Additional notes on immature stages.** 2nd instar: head pale brown with fine dark brown speckles; body pale grayish-green; lateral band speckled purplish-brown, more intense at mid-point of each segment; rather large, conical tubercles (subdorsal, lateral and supraspiracular), each with a seta with a clear droplet at the tip (Fig. 96). 3rd: head pale green with small, faint patch of pink at the vertex; body dark green with a distinct white broad dorsal band, flanked on either side with a pale yellow band; tubercles with a bright orange-colored droplet at the end of each seta (Fig. 97). 4th: similar to 3rd but dorsal band less distinct and extending into the head as an orange-colored band on either side of the vertical cleavage line on the vertex; eyes pale brown; ground color various shades of green (Figs 98–99). It is similar to *C. fausta fulvia* from India as illustrated by Bhakare (2013) and as described (subspecies not identified) by Naidu & Ramana (2010).

**Duration of immature stages (days).** 1st instar (4); 2nd (2); 3rd (2); pupation (2); pupa (5–9). Length (mm): prepupation (30).

**Larval food plants.** In Sri Lanka, there are no previous reports of its larval food plant. The current study showed that *Maerua arenaria* (Capparaceae) is used as a larval food plant. In India, it has been reported feeding on *Cadaba fruticosa* (Naidu & Ramana 2010, Bhakare 2013) and *Maerua arenaria* (Bell 1914).

*C. fausta fulvia* is found only in the arid zone and the coastal regions of the dry zone in the northwestern part of the island and it is uncommon and seasonal. *Maerua arenaria* is common in the arid and dry zones near the coast and is found wherever the butterfly has been recorded. It is possible that it also feeds on *C. fruticosa* in Sri Lanka as well.

**National Red List 2012 status.** VU.

**Colotis etrida limbata** (Butler, 1876)

*Little Orange Tip* (Endemic subspecies)

Figs 100–105

The immature stages of *Colotis etrida limbata* in Sri Lanka have not been described. In India, the egg, final instar larva and pupa of *C. etrida* (subspecies not specified) were described in detail by Bell (1914). The results of the current study agree with this description except for the following; a) the egg is pale orange-yellow when laid (Fig. 100); b) 5th instar – more variable than described by Bell; ground color ranges from pale green to dark green; tubercles varying shades of pale blue; all three lines of the spiracular band are variable in thickness and intensity of color; orange band above the white spiracular line covers whole segment (Figs 101–103); c) in the bone-colored form of the pupa, the green-sepia band is somewhat faint; there are several bands on the wings, the central one most prominent, each band finely reticulated and running from the costa to the end of the termen (Fig. 104); d) in addition, there is a pale purple form of the pupa – snout flesh-colored; yellow patch below the eye; yellow streak on mesothorax and metathorax in line with supraspiracular line; from A2–A10, spiracular line white, supraspiracular line bright yellow, subspiracular line dark purple but obscure from A2–A4 (Fig. 105).

**Duration of immature stages (days).** Pupa (8).

**Larval food plants.** In Sri Lanka, there are no previous reports of its larval food plant. The current study showed for the first time that *Maerua arenaria* (Capparaceae) is the larval food plant. In India, Bell (1914) recorded *Cadaba indica* [now *C. fruticosa*] and *Capparis aphylla* [now *C. decidua*, not found in Sri Lanka].

*C. etrida limbata* is found along the west coast from Chilaw north to Jaffna and then down along the east coast to Tangalle, within 16 km of the coast. *Maerua arenaria* has been recorded wherever *C. etrida limbata* has been recorded. Young or stunted plants of *M. arenaria* and *Cadaba fruticosa* are very similar but the species can be easily distinguished by the flowers and fruit.

**National Red List 2012 status.** NT.

**Colotis aurora** (Cramer, 1780)

*Plain Orange Tip*

Figs 106–114

The immature stages of *Colotis aurora* in Sri Lanka have not been described. In India, the egg, final instar larva and pupa were described in detail by Bell (1914) (as *C. eucharis*). The results of the current study agree with the description of the pupa and all three color forms (glaucous green with yellow shade; darker green with yellow wing margins; and pale yellowish-brown marbled and blotched with white and darker brown) have been recorded in Sri Lanka, and in addition, a darker brown form is also found (Figs 106–108). However, the larva described by Bell under *C. eucharis* appears to be that of

*Colotis danae*. But the description of the larva under *C. danae* matches that of *C. aurora* in Sri Lanka, except for the following: a) no plum color or brown-orange color was observed bordering the posterior spiracular line and b) the ground color ranges from grass-green to bluish-green (Figs 109–110). Further, the description and illustration of the egg does not match: in Sri Lanka, the egg is taller than broad; with 10 smooth longitudinal ridges, meeting at the apex in 6 points, with transverse ridges between the longitudinal ridges; white when first laid, turning orange within a day, without any blotches (Fig. 111). The final instar and pupa are similar to *C. aurora* from India as illustrated by Saji (2013c).

Additional notes on immature stages. 1st instar: ate the eggshell; head orange-brown, body pale brownish-orange, tubercles along subdorsal, lateral and supraspiracular lines; each tubercle with a fine hair ending in a clear droplet; lateral margins darker brownish-orange (Fig. 112). 2nd: similar to 1st except that
head and body dark green (Fig. 113). 3rd: similar to 2nd but body transversely impressed to form a series of ridges (Fig. 114).

**Duration of immature stages (days).** 1st instar (2); 2nd (2); 3rd (2); pupa (6).

**Larval food plants.** In Sri Lanka, there are no previous reports of its larval food plant. The current study showed for the first time that *Cadaba fruticosa* (Caparaceae) is a larval food plant. In India, Bell (1914) and Saji (2013c) also recorded *C. fruticosa* (as *C. indica*).
Colotis danae danae. 115. Pupa; 116. Larva, fifth instar, prepupation; 117. Larva, fifth instar, bluish-green form with yellow tubercles and lateral yellow blotches; 118. Larva, fifth instar, pale green form without lateral blotches; 119. Larva, fourth instar, dorsal view.

C. aurora is found in the arid and dry zones from Chilaw on the west coast up to Jaffna usually within 10 km of the coast. Cadaba fruticosa is a shrub that is found widely distributed in the arid and dry zones of the north and northwest and has been found wherever the butterfly has been recorded. It is possible that there is another larval food plant in the Capparaceae.
The immature stages of *Colotis danae* in Sri Lanka have not been described. In India, the final instar larva and pupa were described in detail by Bell (1914). The results of the current study agree with the description of the pupa (Fig. 115). As stated above, Bell’s description of the final instar larva of *C. eucharis* matches that of *C. danae* in Sri Lanka (and his description of *C. danae* matches *C. aurora*), except that the tubercles are not prominent (Figs 116–118). It is similar to the final instar and pupa of *C. danae* from India illustrated by Saji (2013d).

**Additional notes on immature stages.** Egg: stouter than that of *C. aurora* with 12 smooth longitudinal ridges, with transverse ridges between and meeting at the top in 8 points; white when first laid, turning dark orange within a day. 1st instar: newly hatched larva with black head, body pale brown, spines all over. 4th: head and body pale green with a dorsal white band, somewhat diffuse along its edges; tubercles subdorsal, lateral and supraspiracular, prominent and pale blue, some tubercles with a long hair ending in a droplet of amber-colored liquid (Fig. 119).

**Larval food plants.** In Sri Lanka, there are no previous reports of its larval food plant. The current study showed for the first time that *Cadaba fruticosa* (Capparaceae) is the larval food plant. In India, Bell (1914) and Saji (2013d) also recorded *C. fruticosa* (as *C. indica*) and Bell additionally recorded *Capparis sepiaria*, *Capparis divaricata* and *Maerua arenaria*.

*C. danae* is found in the arid and dry zones from Mannar on the west coast north to Jaffna. *Cadaba fruticosa* is a shrub that is widely distributed in the arid and dry zones of the north and northwest and has been found wherever the butterfly has been recorded. It is possible that *C. d. danae* also feeds on *Capparis sepiaria*, *Capparis divaricata* or *Maerua arenaria* which are also found in its area of residency.

**National Red List 2012 status.** VU.

The larval food plants used by the Pieridae described in this paper belong to Capparaceae, Loranthaceae, Salvadoraceae and Brassicaceae; this agrees with the reports of others (Kunte 2013, Igarashi & Fukuda 1997, 2000). Members of the genus *Ixias* are oligophagous or monophagous on the Capparaceae. The members of the genus *Colotis* are monophagous on the Capparaceae except for *C. amata modesta* which is oligophagous on the Salvadoraceae. *Leptosia nina*, and *Cepora nerissa* are polyphagous on the Capparaceae with an additional record of the Brassicaceae for *Leptosia*. *Belenois aurota* and *Hebomoia glaucippe* are oligophagous on the Capparaceae. *Proneris sita* and *Pareronia ceylanica*, which are both confined to Sri Lanka and India, are monophagous.

Though comparisons to larval food plants used in other countries can be informative, records specific to a particular site and habitat are crucial to understanding the biology of a species and to preparing conservation management plans (Kunte 2006, New 1995). Many of these species are confined to the north and east of the island which was largely inaccessible due to the war from 1983 to 2009 and is underdeveloped. Since the end of the war, these areas are undergoing rapid development with concomitant loss of butterfly habitats. One of the greatest threats to the butterflies of the arid zone along the coastal belt, however, is the exceptionally rapid spread of the invasive plant *Prosopis juliflora* (Sw.) DC. 1825. This very thorny shrub was introduced as a source of firewood but is not used for such because of the very long, sharp thorns. Goats love the seeds and spread them through their droppings. The plants are deep-rooted, allelopathic (Goel et al. 1989) and shade out all competition including the plants used by many species of butterflies as larval food plants. The fate of the monophagous species in these areas in particular is uncertain.

**Acknowledgements**

We thank Krushnamegh Kunte for valuable advice and taxonomic information. Devaka Weerakoon and the University of Colombo, Channa Bambaradeniya and the IUCN Sri Lanka for logistical and administrative support. Chris Darling and Doug Currie for help with references. Himesh Jayasinghe, Sarath Sanjeeva and Chamitha de Alwis for field support. Thanks to the Department of Wildlife Conservation and the Department of Forestry, Sri Lanka for permission to do this research. All photography by the first author.
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Received: November 29, 2013
Accepted: February 27, 2014