

Immature Stages of Four Bombycidae Species of Taiwan

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Abstract. The biology, morphology and host plants are reported for larvae of four bombycid moths of Taiwan. Larvae of *Bombyx mandarina formosana* (Matsumura, 1927) feed on leaves of *Morus alba* (Moraceae), *Ernolatia moorei* (Hutton, 1865) on leaves of *Ficus superba* (Moraceae), *Mustilia fusca* Kishida, 1993 on Leaves of *Trochodendron aralioides* (Trochodendraceae), and *Andraca theae* (Matsumura, 1909) on leaves of *Camellia tenuifolia* and *Thea sinensis* (Theaceae).

Key words: Bombycidae, host plant, immature stage.

INTRODUCTION

There are 13 species in eight genera of the Bombycidae in Taiwan, including *Bombyx mori* (Linnaeus, 1758), *B. mandarina formosana* (Matsumura, 1927), *B. horsfieldi* (Moore, 1860), *B. rotundapex* Miyata & Kishida, 1990, *Triuncina brunnea* (Wileman, 1911), *Trilocha varians* (Walker, 1855), *Ernolatia moorei* (Hutton, 1865), *Oberthueria formosibia* Matsumura, 1927, *Mutilla gerontica* West, 1932, *M. fusca* Kishida, 1993, *Andraca theae* (Matsumura, 1909), *A. olivacea* Matsumura, 1927, and *Primosticta fenestrata* Butler, 1880 (Heppner and Inoue, 1992; Kishida, 1993).

According to Holloway (1987), members of the Oriental Bombycidae fall into two lineages based on characters of wing venation and male genitalia. One group is typified by *Bombyx* Linnaeus, including the *Ocinara* complex, *Gunda* Walker, *Rondotia* Moore, and *Elachyophtalma* Felder. The other group is typified by *Mustilia* Walker and includes *Andraca* Walker, *Primosticta* Butler, *Oberthueria* Staudinger and *Pseudandraca* Miyata (= subfamily Oberthuerinae of Kuznezov and Stekolnikov (1985)). Bombycid eggs are variable in shape, being rather flattened spheres, and are laid in clusters, lines, or walls. Larvae are smooth, usually densely covered

with small secondary setae; prolegs are present, with crochets in biordinal mesoserries. In some genera, the thorax is swollen, particularly those of the *Bombyx* lineage. A prominent horn is usually in the center of the 8th abdominal segment. The caudal horn is strongest in the *Mustilia* group (*Pseudandraca*, *Oberthueria*) but is reduced to a hump in *Andraca*. This group appears to have a larval resting posture with anterior and posterior parts of the body held erect away from the substrate, producing a disruptive cryptic posture. Host plant records of the *Bombyx* lineage include the Moraceae (*Morus*, *Streblus*, *Ficus*, and *Artocarpus*), Rosaceae (*Malus*) and Ebenaceae (*Diospyros*), and the host plant records of the *Mustilia* lineage include the Moraceae (*Cudrania*, *Broussonetia*), Symplocaceae (*Symplocos*), Theaceae (*Camellia* and *Stewartia*), and Aceraceae (*Acer*). Pupation is in a dense silken cocoon (Holloway, 1987).

The genus *Bombyx* was established by Linnaeus (1758), based on *Phalaena mori* Linnaeus, comprising six species (*B. mori* (Linnaeus, 1758), *B. mandarina* (Moore, 1872), *B. horsfieldi* (Moore, 1860), *B. rotundapex* Miyata and Kishida, 1990, *B. shihi*, Park and Sohn, 2002, and *B. incomposita* van Eecke, 1929) distributed in East Asia. The larvae of *B. mori* are quite variable in color; the thoracic zone is swollen, and the caudal horn is reduced to a hump. *Bombyx mandarina* has a short horn, and the color

patterning is more striking and contrasting. Larvae were described by Wileman (1915); the head and body are grayish brown, segments 4 and 5 are abnormally distended dorsally; on segment 4 is a subdorsal, black ocelluslike spot, ringed internally with red and externally with black; on segment 6 is a black ocelluslike spot, ringed internally with gray and externally with black; and there is a short caudal horn. The pupa is enclosed in a flimsy yellowish cocoon spun in mulberry leaves. *Bombyx mori* and *B. mandarina* both feed on *Morus*, but the latter also feeds on *Malus* (Rosaceae) and *Diopyros* (Ebenaceae) in Japan, and on *Hibiscus rosea-sinensis* L (Malvaceae), *Diospyros* (Ebenaceae) and *Quercus variabilis* (Fagaceae) in China (Miyata, 1970; Chu and Wang, 1996). Thoracic segments of *B. incomposita* are swollen into a sphere, and the abdomen is cylindrical. The skin is pale yellow with a variegated mottling of dark purplish brown. This is weak over the thorax and in a broad dorsolateral band on each side of the abdomen so that there appear to be dark dorsal and lateral bands. In the former, each abdominal segment 1 to 7 bears a pair of small, slender, dark horns. There is a single central larger one on A8 and a much smaller pair on A9 (Holloway, 1987).

Ernolatia Walker was established by Walker (1858) based on *E. lida* Moore, 1858, and is comprised of two species. The larvae have small excrescences on T2, A2, and A5, and a horn on A8. *Mustilia* Walker was established by Walker (1865) based on *M. falcipennis* Walker, 1865, and is comprised eight species (*M. falcipennis* Walker and *M. castanea* Moore, *M. phaeopera* Hampson, *M. sphingiformis* Moore, *M. hepatica* Moore and *M. columbaris* Bulter, *M. gerontica* West and *M. fusca* Kishida).

The body of mature larvae of *M. falcipennis* Walker is dark brown, speckled with minute yellow dots within each of which is a short bristle. The first five segments are darker than the rest; beyond them there are dark dorsal stripes of varying widths, and a narrow black dorsal line of the thorax. There is an extensile sublateral flap of skin on the metathoracic and two anterior abdominal segments; below this on the forepart of the metathorax is a small, black-ringed, orange, inflatable organ. There is a long, fleshy, down-turned horn on A8. When the larva is disturbed the flap is expanded, with the head and anterior part of the thorax retracted, the inflatable organ expands to resemble an eye, and the caudal horn is swung

from side to side. Pupation is in a small cocoon of tough brown silk spun amongst leaves (Holloway, 1987).

Larvae of *M. phaeopera* Hampson are broad and flattened in front, and tapering and cylindrical behind. There is a horn on the anal segment, which is bare and tan-colored. The dorsum is darker with a dark olive spot at the anal end, and yellow spots on the sides. The entire body is spotted green; there is a yellow spot on the ventral side of each segment; the legs are pale red, and the outside of the forelegs have a yellow spot. When the larva is disturbed, it draws its head in as far as it can. Larvae feed on *Camellia caudate*. The cocoon is dark brown, pointed at one end and obtuse at the other. Larvae of *M. columbaris* are greenish brown and lighter behind, with a sphingid-like shape, and a long tail on the 11th abdominal segment; the skin of the anterior part of the body may be expanded into broad lateral wings (Strand, 1922). Larval host plants of *M. sphingiformis* Moore include *Ficus retusa* and *Fraxinus pennsylvanica* Mar. (Holloway, 1987).

Andraca Walker was established by Walker, and based on *A. bipunctata* Walker. The thoracic segments of mature larvae of the type species is tapered anteriorly and pubescent. The ground color is black, and it is striped longitudinally with white. The eighth segment is humped, with no horn. The larvae are gregarious, and in their resting posture, the anterior and posterior parts of the body are held erect off the substrate, producing a disruptive cryptic posture. Pupation is in a thin cocoon of brown silk spun among leaves (Holloway, 1987). *Trilocha* Moore was established by Moore (1855) based on *T. varians* Walker, 1855. The young larvae of the type species are gray with large subdorsal black spots on A2, and a short, fleshy, curved horn on A8. Mature larvae are dull brown, the anterior has grayish stripes, and from A2 posteriorly, the body is mottled paler dorsally and dark brown laterally; A2 has a purplish-brown, double dorsal hump, edged in front by a black crescent; a lesser but similar feature occurs on A5. Larvae feed *Streblus* and *Ficus* (Moraceae). The cocoon is boat-shaped, closely woven with white or yellow rather-papery silk. The pupa is pale yellow, and thinly chitinized (Holloway, 1987). Larvae of *Oberthueria falcigera* (Butler) were illustrated by Sugi, and have a peculiar cobra-like thorax and a long anal horn; larvae feed on *Acer*, which is unique in the Bombycidae. Chu and Wang (1996) reported that

larvae of *O. falcigera* feed on *Acer* and *Quercus* (Holloway, 1987).

Primosticta Butler was established by Butler (1855) based on *P. fenestrata* Butler, 1855. Mature larvae have color variation from greenish yellow to darkish brown marked with darker lines and paler stripes. The thorax and first abdominal segment are expanded laterally into a triangular lobe. The eighth abdominal segment bears a long, curved, fleshy horn, the end of which can curl and uncurl. Most segments have a subdorsal wart on each side that bears a black bristle. Pupation is in a small cocoon of brown silk, spun on a twig or in a clump of leaves (Holloway, 1987). In this paper, the biology, morphology and host plants for larvae of four species of Bombycid moths in Taiwan are reported.

MATERIALS AND METHODS

Females of *Bombyx mandarina formosana* (Matsumura, 1927) were collected from Shihcho, Chiayi County on January 10, 2003. Female of *Ernolatia moorei* (Hutton, 1865) were collected at Luku, Nantou County on Sept. 15, 1994. Larva of *Mustilia fusca* Kishida, 1993 was collected at Siyuan (2050m), Taichung County on April 30, 2004. Females of *Andraca theae* (Matsumura, 1909) were collected by using Mercury light on a piece of white cloth at Luku, Nantou County on September 13, 1994. Methods for the study of the morphology and biology of the insects followed Lin (1997). Larvae were put in the plastic container (27 cm x 18.5 cm x 9 cm) and provided with necessary food plants. New food plants were offered every day. All rearing were carried out in the laboratory (at a room temperature about 20-25 °C), Department of Zoology, National Museum of Natural Science, Taichung, Taiwan. The abbreviation for terms prothorax (T1), mesothorax (T2), and metathorax (T3), abdominal segments from one to ten (A1-10), and first instar larvae (L1), 2nd instar larvae (L2), 3rd instar larvae (L3), total length (TL) and terminology of larval chaetotaxy followed Stehr (1987).

Bombyx mandarina formosana (Matsumura, 1927)

Egg: Eggs laid singly on twigs or in large groups but not touching each other; egg oval, white, turning dark-brown before hatching, 1 x 0.8 mm.

Larva: First instar larva 2 mm long, head

black, width 0.5 mm, 1st thoracic segment white, with 2 verrucae, on top at least 10 setae 0.5 mm long, 1/2 white and 1/2 black, body black covered with yellow-brown verrucae; 2nd instar 3 mm long, with small head and enlarged ball-shaped thorax, dorsal whitish, each thoracic segment with 4 verrucae, body slender, black or dark brown; 3rd instar larva 4 mm long, similar to 2nd; 4th instar 5 mm long, thorax enlarged, ball-shape, dorsal white, verrucae flat, not convex, covered with short setae, each abdominal segment dorsal with 2 scoli, 8th with horn, 0.6 mm long; 5th instar larva 1~1.3 cm long; mature larva 1.5 cm long, head small, thoracic zone swollen, dorsal grayish-brown, T1 and lateral T2 and T3 and A1 whitish, A2 and A5 dorsal with 2 scoli, dorso-lateral of 2nd, and 6th abdominal segment with circular brown spot, a short horn, about 1 mm long on A8.

Pupa: Enclosed in a yellowish-green cocoon spun in mulberry leaves.

Distribution: Forests from lowlands at about 500 m to mid- elevations about 1200 m.

Food: Leaves of *Morus alba* (Moraceae).

Ernolatia moorei (Hutton, 1865)

Egg: Eggs laid in- line, touching each other; egg a flattened oval 0.8 x 0.7 mm, pale fuscous, turning black before hatching.

Larva: First instar larva 4.4 mm long, grayish brown, head white, body with long, white setae, feeds on leaves of *Ficus superba* (Moraceae), 2nd instar 6.5 mm, 3rd 1.2 cm, 4th 1.7 cm, 5th and mature larva 2.5 cm, fuscous, T2 enlarged, mid-dorsal with 2 large scoli, both mid-dorsal and lateral of T3 with 2 small scoli, x-shaped black band on A1 dorsal, A4 and mid-dorsal with 2 large, white spots, A6 with 2 small, white spots, T2, A2, and A5 mid-dorsal with 2 large scoli, dorso-posterior of each abdominal segment with 2 small scoli, on A8 with a horn, 1mm long. Mature larva pupated on Oct. 28, 1994.

Pupa: Pale brown; enclosed in a dark brown cocoon spun in *Ficus superba* leaves.

Distribution: Lowlands forests of at about 500 m to upper montane forests elevations of about 2000 m in Taiwan.

Food: Leaves of *Ficus superba* (Moraceae).

Mustilia fusca (Kishida, 1993)

Larva: Body 4.5 cm long, horn 1 cm, head and body greenish brown, A1 to A4 laterally expanded, with 3 pairs of thoracic legs, A1 with pair of small legs, A2 and A3 without legs, A5 to

A8 with prolegs, lateral with rectangular white spot, head and thorax dorsal with bluish line, A2 to A4 lateral with small white spots, dorsal with fuscous spot. Pupated on May 10, 2004.

Pupa: Pupa black, rough and rugose, not glossy; enclosed in a thin cocoon of brown silk spun among leaves of the host plant.

Distribution: Lower to upper montane forest at elevations of about 2050 m in Taiwan.

Food: Leaves of *Trochodendron aralioides* (Trochodendraceae).

***Andraca theae* (Matsumura, 1909)**

Egg: Eggs laid in- line or in- cluster on surface of leaf of host plant; egg sulfur-yellowish or pale yellow, spherical.

Larva: Larvae gregarious, 1st and 2nd instar larvae fed on back of leaves, from leaf margin and left veins, and then move to another leaf, 3rd instar larvae aggregate on the trunk, silk and become ball-shaped; larvae reddish brown, dorsolateral with white streak, body lateral with reddish-brown spots. Larvae with larval resting posture in which anterior and posterior parts of the body held erect off the substrate, producing a disruptive cryptic posture. Mature larvae disperse, and cocoon spun on branches or fallen leaves, or underground; after 1 or 2 days, pupation occurs.

Pupa: Pupae reddish brown, rough and rugose, not glossy.

Distribution: Lower to upper montane forests at elevation of 500~2000 m in Taiwan.

Host plants: Leaves of *Camellia tenuifolia* and *Thea sinensis* (Theaceae).

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Fig. 1. A-D, *Bombyx mandarina formosana*. A, Female; B, eggs; C, larva; D, cocoon; E-H, *Ernolatia moorei*. E, Male; F, copulating male and female; G, larva; H, pupae. Scale bar = 1 cm.

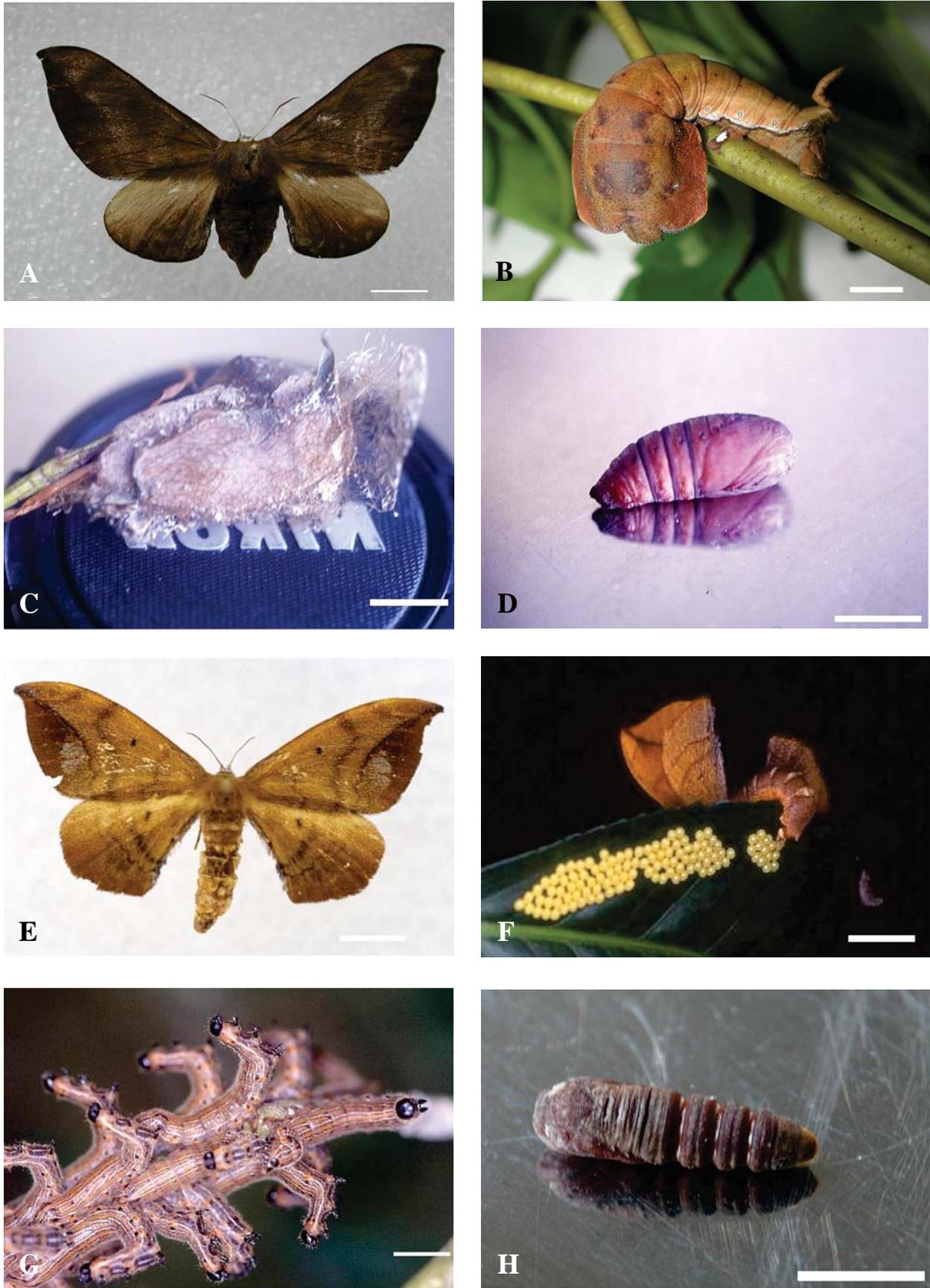


Fig. 2. A-D, *Mustilia fusca*. A, Female; B, larva; C, cocoon; D, pupa; E-H, *Andraca theae*. E, Male; B, female laying eggs (photo by S. K. Tseng); G, larvae; H, pupa. Scale bar = 1 cm.

臺灣產四種蠶蛾科幼生期及其寄主植物

林政行

國立自然科學博物館動物學組

本文報導臺灣產四種蠶蛾科：臺灣野蠶蛾 *B. mandarina formosana* (Matsumura, 1927), 黑點白蠶蛾 *Ernolatia moorei* (Hutton, 1865), 鈎翅蠶蛾 *Mustilia fusca* Kishida, 1993, 及茶蠶蛾 *Andraca theae* (Matsumura, 1909) 幼生期形態、生活習性及其寄主植物。

關鍵詞：幼生期，寄主植物，蠶蛾科。