

Larval Morphology and Host Plants of Drepanidea (Lepidoptera: Drepanidae) in Southern Taiwan

Y. C. Sen Taiwan Forestry Research Institute, Taipei, Taiwan

C. S. Lin* National Museum of Natural Science, Taichung, Taiwan

ABSTRACT

The morphology and host plants are reported for larvae of 13 genera and 16 species of Drepanidae: *Albara reversaria opalescens* (Warren, 1897), *Callidrepana patrana* (Moore, 1866), *Drepana pallida nigromaculata* (Okano, 1959), *Hypsomadius insignis* Butler, 1877, *Leucobrepis excisa* (Hampson, 1893), *Macrauzata minor* Okano, 1959, *Macrocilix maia* (Leech, 1888), *Macrocilix mysticata flavotincta* Inoue, 1988, *Microblepsis violacea* (Buter, 1889), *Nordstromia lilacina* (Moore, 1888), *Oreta loochooana* Swinhoe, 1902, *Strepsigonia diluta takamukai* (Matsumura, 1927), *Tridrepana arikana* (Matsumura, 1921), *Tridrepana flava* (Moore, 1879), *Tridrepana unispina* (Watson, 1957), and *Zusidava serratilinea* (Wileman, 1917).

Key words: Drepanidae, larvae, morphology, host plant.

Introduction

Drepanidae is the only family included in the superfamily Drepanoidea (Common, 1990). It includes the three subfamilies of the Drepaninae, Thyatirinae and Cykliinae, all of which are treated as families of the Geometridea by some authors. Forbes (1924) and Munroe (1982) distinguished the Drepanoidea from the Geometridea. Drepanidae and Thyatiridae are regarded as separate families within the Drepanoidea. According to Minet (1991), the Drepanoidea includes the Drepanidae and Epicopeiidae, while the Drepanidae regard as separate families, i.e. Thyatiridae, Cykliidae, and Drepanidae. Drepanidae contains about 120 genera and 650 species

in the world (Minet 1983; Scoble and Edwards, 1988). It consists of three subfamilies, i.e., the Thyatirinae, Cykliidae and Drepaninae. The Drepaninae contains some 70 genera and about 450 species in the world (Minet and Scoble, 1999) and is well developed in Palearctic Asia and in the Oriental region, but is absent from the Neotropical region and from New Guinea (Minet and Scoble, 1999).

Drepanid moths usually have broad wings, and the forewings often are angulose or falcate, so they have been given the name of "hook-tip moths". Adults are usually nocturnal, but a few species fly during the day. Eggs are of the flat type, roughly oval or elliptical;

*Correspondence address
e-mail: cslin@mail.nmns.edu.tw

the chorion is either smooth or variously sculptured, often with parallel, longitudinal ribs; eggs are usually laid in small groups, occasionally singly or in short rows. The last instar larva has a globular or dorsally bifid head; segments T2 to A8 have at least two pairs of secondary setae; numerous secondary setae are occasionally present. The Drepanini has a prothoracic, eversible vesicle between seta SV and the coxa (Minet, 1985). The thorax and abdomen sometimes have dorsal protuberances or elongated processes. The Drepanini often has a few modified setae (Minet, 1985). Anal prolegs are vestigial, without crochets in the Drepaninae. Ventral prolegs are well developed on A3-A6. Proleg crochets are uniordinal or more often in biordinal mesoserries. Most of the Drepaninae have a conspicuously elongated anal shield caudal (Minet and Scoble, 1999). Most larvae are arboreal feeders. They may be gregarious when young. By day, they live either exposed or concealed in rolled-up leaves or between leaves, which are tied together.

In Japan, Nakajima (1970) and Sugi *et al.* (1987) illustrated larval and pupal morphologies of the Drepanidae and reported their larval host plants. Inoue (1982) reported the larval host plants of 19 species of the Drepanidae in Japan. In Taiwan, Heppner and Inoue (1992) listed 20 genera and 31 species and Chang (1989) illustrated 19 genera and 27 species of the Drepanidae. There is a paucity of information about the immature stages of the Drepanidae. In this paper, we present morphologies of the immature stage and larval host plants of 13 genera of 16 species of the Drepanidae in Taiwan.

Materials and Methods

In order to attract moths, we used a mercury light or a black light and with a white cloth curtain. We kept females in a

small plastic vial with a piece of white strip of paper. Females usually laid eggs in the vials, and we collected them and kept in another container until hatching occurred. The egg stage lasted 5 to 7 days, but sometimes eggs over-wintered and did not hatch until the next spring. The egg stage lasted several months. In that case, conservation of the eggs became important. Once a female laid her eggs, we killed it, and pinned it as a specimen, cataloged it in the collection, and keyed it to genus and species. The recorded food plants and other information such as life history were checked. Rearing initiated once the larval food plants were selected. If no related information was available, then we applied a trial and error method; that is, we put several possible food plants in the container in order to feed the larvae, until we found which plants were selected.

We kept five to ten newly hatched larvae in plastic containers and provided them with necessary food plants every day, and described the larval feeding behavior, biology, and morphological characteristics. We photographed the larvae and killed some of the mature larvae with hot water. Specimens were dipped in the KAAD solution (kerosene 10%, alcohol 70%, acetic acid 10%, and dioxen 19%) for 3 h, and then were preserved in 80% alcohol. All of the experiments were conducted at room temperature (about 26-28 °C) in the Shanping Station, Liukuei Forest Research Institute, Shanping, Kaoshiung. Abbreviations for terms follow Stehr (1987): total length (TL), prothorax (T1), mesothorax (T2), metathorax (T3), abdominal segments from 1 to 10 (A1-10), first-instar (L1), 2nd-instar (L2), 3rd-instar (L3), 4th-instar (L4), and 5th-instar larvae (L5).

Results

There are 19 genera and 33 species

of Drepanidae in the Shanping area. Larval morphology and food plants of 13 genera and 16 species of Drepanidae are presented in these studies; 16 species were reared from eggs to maturity and pupated, with only 1 species not undergoing eclosion. Larval morphology and host plants are listed as follows.

1. *Albara reversaria opalescens* (Warren, 1897)

Egg: Laid singly; eggs yellow, turning orange-red before hatching; hatch in 6 days.

Larva: L1 gray, chorion not eaten, feed on leaf surface. L5 with black head, T1 to T3 dorsolateral with a pair of black spots, T3 dorsolateral with fuscous tubercles, T2 to A10 dorsal with black circular spot, much larger on T2 and A1. Spiracles fuscous, oval, much larger on T1. A3 to A5 from central dorsolateral with oblique line; A10 dorsolateral with fuscous spot. TL: 22 to 25 mm, horn 4 mm long. Mature larva fixes body with silk to the base of leaf and curves leaf margins where it pupates. Hatching to prepupa in 25 to 26 days, prepupa to pupa in 4 days.

Pupa: Concealed, brown, about 12 to 14 mm long. Adult eclosion in 12 days.

Distribution: Forests of Indonesia, India, mainland China, and Taiwan

Food: Leaves of *Quercus variabilis* (Fagaceae).

2. *Callidrepana patrana* (Moore, 1866)

Egg: Laid singly, eggs yellow, turning to red before hatching, hatches in 5 days.

Larva: L1 yellowish brown, chorion not eaten; L2 and L3 body yellowish brown; L4 body black. L5 head and body black, T1 to T3 and A2 lateral with large, yellow appendages; each dorsal body segment with a short tubercle, horn, 6 mm long, anterior 1/3 with a black spot; TL: 24 to 28 mm. At rest, head and thorax curl toward lateral abdomen, horn

flat or raised up, looking like bird droppings. Mature larva curls leaf margin with fixed posterior end by silk at mid-rib, pupates inside. Hatching to prepupa in 21 days, prepupa to pupa in 2 days.

Pupa: Concealed, fuscous, A1 to A3 dorsal with triangular, brown protrusion. Adult eclosion in 8 days.

Distribution: Forests of Nepal, India, Cambodia, Thailand, mainland China, Japan, and Taiwan.

Food: Leaves of *Rhus succedanea* and *R. ambiguus* (Anacardiaceae).

3. *Drepana pallida nigromaculata* (Okano, 1959)

Egg: Laid singly, eggs oval, pale yellow, turning dark yellow before hatching; hatch in 5 days.

Larva: L1 with black head and gray body with pale bands across T1, A1, and A7; interlaces leaves together, and feeds co white ventral, with large black spots; body lateral with black spots except on T1, A1, A4, A5, A9, and A10; feeds concealed between leaves. L5 with fuscous head, body pale yellow, covered with pale setae; T1 to T3, A2 to A3, and A6 to A9 dorsal with a pair of black spots, dorsolateral and ventrolateral with a pair of tubercles, with 1 or 2 pale setae, much larger on T1. TL: 23 mm, horn short, 0.8 mm in length, covered with black setae. Last-instar larva rests on lower surface of leaves, more exposed than earlier instars. Mature larva firmly interlaced leaves together with strong silk and constructs pupation site between leaves. Hatching to prepupa in 30 days; prepupa to pupa in 2 to 3 days.

Pupa: Concealed, green with brown markings, about 13 mm long, caudal ends with 3 pairs of setae of similar size.

Distribution: Forests of low to middle elevations from northern India and Burma to Vietnam, mainland China, and Taiwan.

Food: Leaves of *Alnus formosana*

(Betulaceae).

4. *Hypsomadius insignis* Butler, 1877

Egg: Laid singly, eggs yellow, turning red before hatching, hatch in 9 days.

Larva: L5 with black head and body; T2 dorsal with a small tubercle; spiracle yellow, much larger on T1, A7, and A8; thoracic and abdominal legs and basal abdomen covered with short, white hairs; TL: 24 to 30 mm; horn yellowish brown, 12 to 13 mm long, covered with small, short black tubercles. Mature larva turns over leaf, which become like a funnel, and pupated in side. Hatch to prepupa in 31 days, prepupa to pupa in 4 days.

Pupa: Concealed, yellowish brown, 16 to 19 mm long; posterior caudal without spine like setae.

Distribution: Forests of Japan and Taiwan.

Food: Leaves of *Daphniphyllum glaucescens oldhamii* var. *oldhamii* (Daphniphyllaceae).

5. *Leucobrepis excisa* (Hampson, 1893)

Egg: Laid singly, eggs yellow, turning red before hatching, hatch in 5 days.

Larva: L5 head orange yellow, with 10 black setae, body yellowish brown, A1 and A2 dorsal with a pair of short tubercles, A8 dorsal with a large distinct tubercle, spiracle white, TL: 25 to 30 mm; horn brown, short, 1 mm in length. Mature larva curls leaf tip and fixes it with silk, pupates inside. Hatching to prepupa in 19 days, prepupa to pupa in 2 days.

Pupa: Concealed, yellowish brown, 11 to 12 mm long; posterior caudal with 3 pairs of spine like setae, similar in size.

Distribution: Forests of Taiwan

Foods: Leaves of *Elaeocarpus sylvestris* (Elaeocarpaceae)

6. *Macrauzata minor* Okano, 1959

Egg: Laid singly, eggs yellow,

turning red before hatching, hatch in 5 days.

Larva: L1 with black head and body, chorion not eaten. Intermediate instars (L2 to L4) with head and body black, and always covered with feces. L5 with black head and body, head, thorax, and A3 to A6 covered with white wax. At rest, head and thorax curl to posterior end of abdomen, looks like bird droppings, caudal end with specialized appendages related to sound making, TL: 45 to 50 mm. Horn thin and narrow, needle like, yellow-white, 2 mm long. Mature larva curls leaf tip and fixes it with silk, pupates inside. Hatching to prepupa in 27 days, prepupa to pupa in 2 days.

Pupa: Concealed, brown, posterior end with 3 pairs of spine-like setae. Adult eclosion in 14 days.

Distribution: Forests of Taiwan.

Foods: Leaves of *Castanopsis formosana* and *Quercus variabilis* (Fagaceae).

7. *Macrocilix maia* (Leech, 1888)

Egg: Laid singly; eggs oval, white, turning red after 2-3 days, then becoming black before hatching; hatch in 7 to 8 days.

Larva: L1 gray, chorion not eaten, feeds on leaf surface. L2 also feeds on leaf surface and disperses. L5 head black with yellow setae, body black, subdorsal line with 2 yellow bands, in between the 2 bands with 3 fine yellow lines. T1, T3, and A9 dorsal and lateral with a pair of pale protrusions. A1 with a pair of pointed protrusions, T2 and A9 with a pair of fuscous protrusion. A2 to A8 dorsal with 2 pairs of small, pale blue tubercles, with 3 black setae. Spiracle yellow, area in between upper spiracle line and subdorsal line from A2 to A7 with orange-red band, basal line and upper spiracular line yellow; thoracic and abdominal legs with long, pale setae, anal leg reduced, caudal end specialized and became pointed protrusion, TL: 25

mm. Hatching to prepupa in 29 to 30 days; prepupa to pupa in 2 days.

Pupa: Concealed, brown. Adult eclosion in 7 days.

Distribution: Forests of India, Japan, and Taiwan.

Food: Leaves of *Quercus variabilis* (Fagaceae).

8. *Macrocilix mysticata flavotincta* Inoue, 1988

Egg: Laid singly, occasionally in short rows of 24 eggs; eggs oval, pale yellow, turning orange-red in 2 days, then gray before hatching; hatch in 5 days.

Larva: L1 with pale brown head, body grayish brown; chorion not eaten, and feed on leaf surface. L2 also feeds on leaf surface, but L4 eats from leaf edge. L5 with yellow-brown head, having brown spots and pale setae; body fuscous, with pale setae; T1 to T3, A4, and A6 to A7 lateral with milky-white spot; spiracles white; anal legs reduced and caudal becoming a short spine. Last instar larva rests with raised posterior part of body (A7-A10); when disturbed, head curls sideways against abdomen and setose tubercles on A1 spread flat. Mature larva spins silk and cures the leaf, making a compact oval, whitish cocoon where it pupates. Hatching to prepupa in 27 to 28 days, prepupa to pupa in 2 days.

Pupa: Partially exposed, yellowish brown, about 13 mm long. Caudal with 3 pairs of setae, central pair much longer than the other 2 pairs, setae with curved hook. Adult eclosion at 8 days.

Distribution: Forests of India, Japan and Taiwan.

Food: Leaves of *Castanopsis formosana* and *Pasania konishii* (Fagaceae).

9. *Microblepsis violacea* (Butler, 1889)

Egg: Laid singly, eggs milky white, turning red before hatching; hatch in 6

days.

Larva: L1 gray, chorion eaten. L5 with fuscous head. T1 dorsal with 2 distinct black circular spots. Spiracle fuscous, much larger on T1. TL: 25 mm, horn length 3 mm long, yellow with pale setae. Mature larva spins silk and is fixed at tip or base of leaf where it pupated. Hatching to prepupa in 23 to 24 days, prepupa to pupa in 2 days.

Pupa: Yellowish brown, about 13 mm long, caudal with 3 pairs of spines with hook like setae, central pair 2 to 6 times longer than the other 2 pairs.

Distribution: Forests of India and Taiwan.

Food: Leaves of *Castanopsis formosana* (Fagaceae).

10. *Nordstromia lilacina* (Moore, 1888)

Egg: Laid singly occasional in stacks of 2-5 eggs; eggs oblate with sculpturing, pale yellow, turning orange-red before hatching; hatch in 3 days.

Larva: L1 gray, A10 carried in raised position, rests on middle of the eaten surface, chorion not eaten, feeds on leaf surface. L5 pale yellow, body flattened, dorsolateral with 2 brown spots, but lacking on T2 and T3; spiracles brown, much larger on T1. At rest, body curls to side with broad thoracic margin overlapping abdomen; when disturbed, scratches leaf surface with posterior portion of abdomen, and make sharp clicking sounds by pounding mandibles against leaf; TL: 22 mm, horn pale yellow, terminal fuscous, horn 2 mm long. Mature larva curves leaf and fixes it with silk, pupates near edge of folded leaf. Hatching to prepupa in 28 days, prepupa to pupa in 2 days.

Pupa: Concealed, pale yellow, about 17 mm long, caudal ends with 3 pairs of hook like setae, central pair much longer. Adult eclosion in 8 days.

Distribution: Forests of India, mainland China, and Taiwan.

Food: Leaves of *Quercus variabilis*

(Fagaceae).

11. *Oreta loochooana* Swinhoe, 1902.

Egg: Laid singly, eggs yellow, turning red before hatching, hatch in 6 days.

Larva: L5 with yellowish-brown head and body, T2 dorsal with fleshy tubercle; spiracle black, much larger on T1 and A8; thoracic and abdominal legs and basal abdomen covered with long, white setae, TL: 24 to 26 mm; horn long, 12 to 14 mm in length, covered with pale brown, short tubercles. Mature larva pupates on leaf surface. Hatching to prepupa in 29 days, prepupa to pupa in 2 days.

Pupa: Fuscous, 15 mm in length, posterior end with 3 pairs spine-like setae.

Distribution: Forests of Japan, Korea, mainland China, and Taiwan.

Food: Leaves of *Viburnum odoratissimum* and *V. luzonicum* var. *formosanum* (Caprifoliaceae).

12. *Strepsigonia diluta takamukai* (Matsumura, 1927).

Egg: Laid singly; eggs oval, yellow, and turning orange-red before hatching, hatch in 5 days.

Larva: L1 yellow white, chorion not eaten. L5 with black head and body, T1 dorsal with 8 black, wavy bands, arranged in 4 rows, the 2nd much larger and distinct; spiracle black, much larger on T1; TL: 23 mm, horn short, 1 mm in length. Mature larva curls leaf and fixes it with silk, pupates inside.

Hatching to prepupa in 27 to 28 days, prepupa to pupa in 1 to 2 days.

Pupa: Concealed, yellowish brown, TL: 11 mm, caudal end fuscous, with 3 pairs of hook like setae, central pair much longer. Adult eclosion in 8 days.

Distribution: Forests of India and Taiwan.

Food: Leaves of *Engelhardia roxburgiana* (Juglandaceae).

13. *Tridrepana arikana* (Matsumura, 1921)

Egg: Laid singly, eggs oval, yellow, turning red before hatching; hatch in 5 days.

Larva: L1, head and body pale yellow, chorion not eaten, feed on leaf surface. L5 head and body black, with white spot; T2, T3, A2, and A8 dorsal with tubercles, curled upside down like a fern leaf; anal proleg reduced, and becoming a pair of large, yellow appendages; horn curved and long, curved part about 2 mm long. At rest, head and thorax curl backward and overlap abdomen laterally, like bird droppings. When disturbed, scratches leaf surface with posterior portion of abdomen, and makes sharp clicking sounds by rapidly pounding mandible against leaf as in *Nordstromia*. Mature larvae curves leaf margin and fixes it with silk at leaf tip where it pupates, pupation site a thin cocoon near edge of folded leaf. TL: 30 to 36 mm. Hatching to prepupa in 21 days, prepupa to pupa in 2 days.

Pupa: Concealed, green with white spots, 16-21 mm long, head with antenna like protrusion; T1 dorsal with 2 pairs of black circular spots; T2 to A3 dorsal with column like tubercles, caudal pair with a short protrusion and having 3 pairs of setae, similar in size. Adult eclosion in 11 days.

Distribution: Forests of mainland China, India, and Taiwan.

Foods: Leaves of *Sapindus mukorossi* and *Koelreuteria elegans formosana* (Sapindaceae).

14. *Tridrepana flava* (Moore, 1879).

Egg: Laid singly, eggs oval, yellow, turning red before hatching, hatch in 6 days.

Larva: L1 yellowish brown, chorion not eaten. L2 and L3 body yellowish brown, L4 fuscous. L5 body fuscous, covered with black setae, terminal one branched. TL: 36 to 40 mm. Mature larva

curls leaf margin and fixes it with silk, pupates inside. Hatching to prepupa 35 days, prepupa to pupa in 2 days,

Pupa: Concealed, body yellowish white, A2 to A4 dorsal with large spot green. Anterior with a pair of white antenna like protrusions, caudal with 3 pairs of black setae.

Distribution: Forests of mainland China, India, Java, Malaysia, and Taiwan.

Food: Leaves of *Eurya japonica* (Theaceae).

15. *Tridrepana unispina* (Watson, 1957)

Egg: Laid singly, eggs yellow, turning red before hatching, hatch in 5 days.

Larva: L1 pale yellow, chorion not eaten, feed on leaf surface. L5 with fuscous head and body; T2, T3, A2, and A8 dorsal with a pair of long, curved tubercles, much longer on T2 and T3. Caudal end with a pair black valve-shaped appendage; horn long, about 7 to 8 mm in length, covered with fuscous setae, TL: 24 to 28 mm. Mature larva curls leaf margin and fixes it with silk at leaf tip, pupates inside. Hatch to prepupa in 26 days, prepupa to pupa in 2 days.

Pupa: Golden brown, T6 to T8 ventral golden brown; anterior with a pair of antenna like protrusions, T2 to A3 dorsal with column like tubercle, caudal short, with 3 pairs of spines, similar in size.

Distribution: Forests of mainland China, Japan, and Taiwan.

Food: Leaves of *Castanopsis formosana* (Fagaceae).

16. *Zusidava serratilinea* (Wileman, 1917)

Egg: Laid singly, eggs yellow, turning to red before hatching, hatch in 5 days.

Larva: L1 reddish brown, chorion not eaten; intermediate instar (L2 to L4)

reddish brown. L5 head yellow brown, margin with blackish violet line, body green, spiracles black, T1 and A8 much larger; TL: 24 to 26 mm; horn short, 1 mm in length, black violet. Mature larva fixes terminal end with silk at mid-rib, then pupates inside. Hatching to prepupa in 23 days, prepupa to pupa in 2 days.

Pupa: Concealed, green, 7 to 9 mm long, posterior with 3 pairs of spine like setae. Adult eclosion in 9 days.

Distribution: Forests of Taiwan.

Foods: Leaves of *Prunus phaeosticta phaeosticta* (Rosaceae).

Discussion

In the Drepanidae, eggs are laid singly or in stacks of two-three near leaf margin or at the apex of serrations, occasionally in short rows of two-four eggs. Eggs are oval or oblate, usually yellow and turn red or orange before hatching. Eggs of the Drepanidae can be separated from eggs of the Thyatiridae and Cyclidiidae as follows. Most thyatirid eggs are laid singly on or near the leaf margin, are spherical, usually white to cream yellow, and do not change color before hatching. Cycliid eggs are laid on leaf surface in hexagonally arrayed patches in a single layer, without close packing between the eggs; eggs are flat spherical, shiny and translucent white and do not change color before hatching. The chorion found eaten in the Cyclidiidae, but not in the Drepanidae or Thyatiridae.

Larvae of Drepanidae have a peculiar morphology, often with a few modified setae (Minet, 1985); the anal proleg is vestigial. L1 usually are exposed feeders, but in some genera, larvae are concealed feeders, such as in the early immature stages of *Macrauzata* (from L1 to L4) which covered with frass, and L5 feed exposed on leaf surfaces of host plants, but larvae mimic bird droppings for protection. Some larvae feed concealed between leaves fixed with silk.

L1 and L2 of *Drepana* weave leaves together with silk and feed concealed on leaf surfaces of *Alnus* in Taiwan. L3, L4, and L5 feed on leaf edges at the periphery of their webbed retreat. When they are disturbed, larvae tightly coil in their retreat. In *Nordstroemia*, larvae primarily feed concealed, but larvae do rove about. Larvae have explanate outgrowths, as a larva moves along the leaf surface, it will slightly up-lift itself and then recover as it stops and feeds. When at rest, it remains in a posture with the head curled laterally. It is interesting to note that in the Thyatiridae, larvae of both *Thyatira* and *Habrosyne* feed on *Rubus* spp. (Rosaceae) where they weave the leaves together tightly with silk creating a retreat where they feed in concealment.

Most larvae in the subfamily Drepaninae feed on exposed position, for example, larvae of the genus *Macrocilis* usually wander around on a leaf surface with the posterior part of their body raised. Larvae of exposed feeders usually engage in mimicry and have enlarged setose tubercles and cryptic coloration. A typical example is *Macrocilis mysticat flavotincta*, where larvae feed on leaf surfaces of *Quercus* spp. (Fagaceae). In *Macrauzata*, larvae mimic bird droppings when at rest; but when disturbed, they will raise and brandish a bizarrely modified suranal shield in order to terrify the enemy, such as seen in caterpillars of *M. minor*. In *Callidrepana*, larvae also mimic blackened bird droppings, for example, *C. patrana* larvae that feed on *Rhus* spp. (Anacardiaceae). In *Tridrepana*, larvae possess elaborate retractile tentacles of elastic cuticles, which can uncoil and extend when the body is contracted. At rest, larvae of *T. unispina* are cryptic, but when disturbed, larvae suddenly flare and expand their bodies in order to terrify the enemy. Most larvae in the subfamily Oretinae are also exposed feeders. Caterpillars usually have

cryptic coloration or counter-shading, and may have an inflatable dorsal process.

Some larvae of the Drepanidae are not very host-plant specific. Even within the same genus, different species may utilize completely different food plants. In Taiwan, there are three species of *Tridrepana*. The larval host plants of these species belong to different families. *T. arikan* fed on *Koelreuteria formosana* (Sapindaceae), *T. unispina* fed on *Castanopsis formosana* (Fagaceae), and *T. flava* feed on *Eurya* sp. (Theaceae). *Leucobrepis excisa* feeds on *Elaeocarpus sylvestris* (Elaeocarpaceae), but *L. fenestraria* did not feed on *E. sylvestris*. The host plant of *L. fenestraria* is still unknown. *Oreta loochocana* feeds on *Viburnum* spp. (Caprifoliaceae), but larvae of *O. extensa* were found on leaves of *Wendlandia formosana*.

Some larvae feed on host plants in the same family. For example, larvae of *M. mysticata flavotincta* and *M. maia* feed on host plants of the Fagaceae. In Taiwan, there is only one species of *Callidrepana*, and it fed on *Rhus* spp. (Anacardiaceae). In Japan and mainland China, they also feed on similar host plants. Larval host plants of *Drepana* include *Alnus* spp, and *Betula* spp. (Betulaceae). Larvae of *Zusidava serratilinea* feed on *Prunus phaeosticta* (Rosaceae).

Mature larvae build a shelter for pupation by using host plant leaves or debris on the ground in the Cythridae, Drepanidae and Thyatiridae. But many mature larvae in the Drepaninae stay on the leaf tips of host plant, curling both sides of the leaf margin and fixing them with one of two pieces of silk, with a bundle of silk attached to the cremastral hook. The exposed pupa usually has mimetic or aposematic coloration. Pupae of *Callidrepana* are fixed by one piece of silk only, which is similar to pupae in the Papilionidae. Most pupae of the Drepanidae have three pairs of enlarged cremastral setae. Structures of the

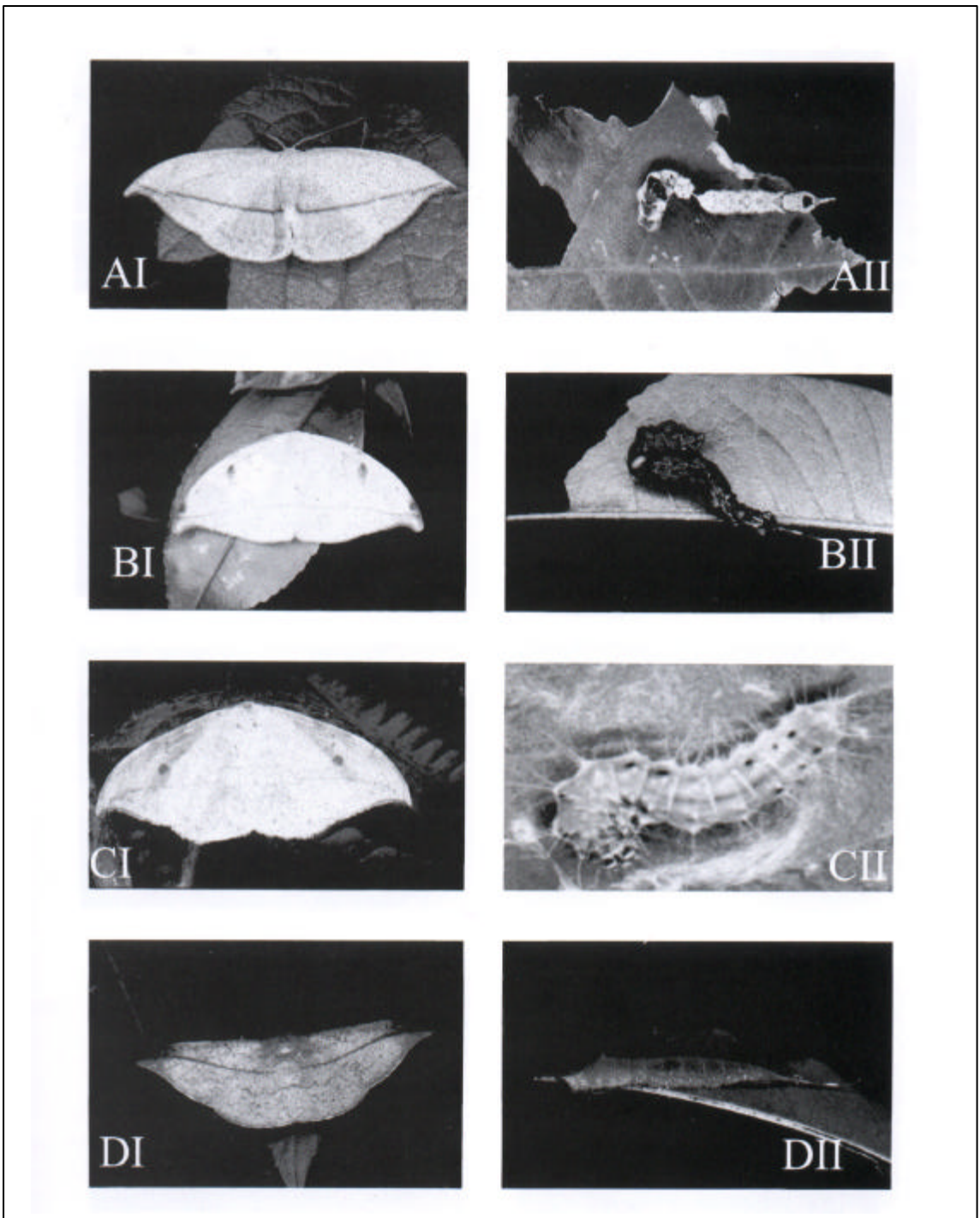


Fig. 1. Adults (I) and larvae (II) of the Drepanidae in southern Taiwan.

- A. *Albara reversaria opalescens* (Warren, 1897).
- B. *Callidrepana patrana* (Moore, 1866).
- C. *Drepana pallida nigromaculata* (Okano, 1959).
- D. *Hypsomadius insignis* Butler, 1877.

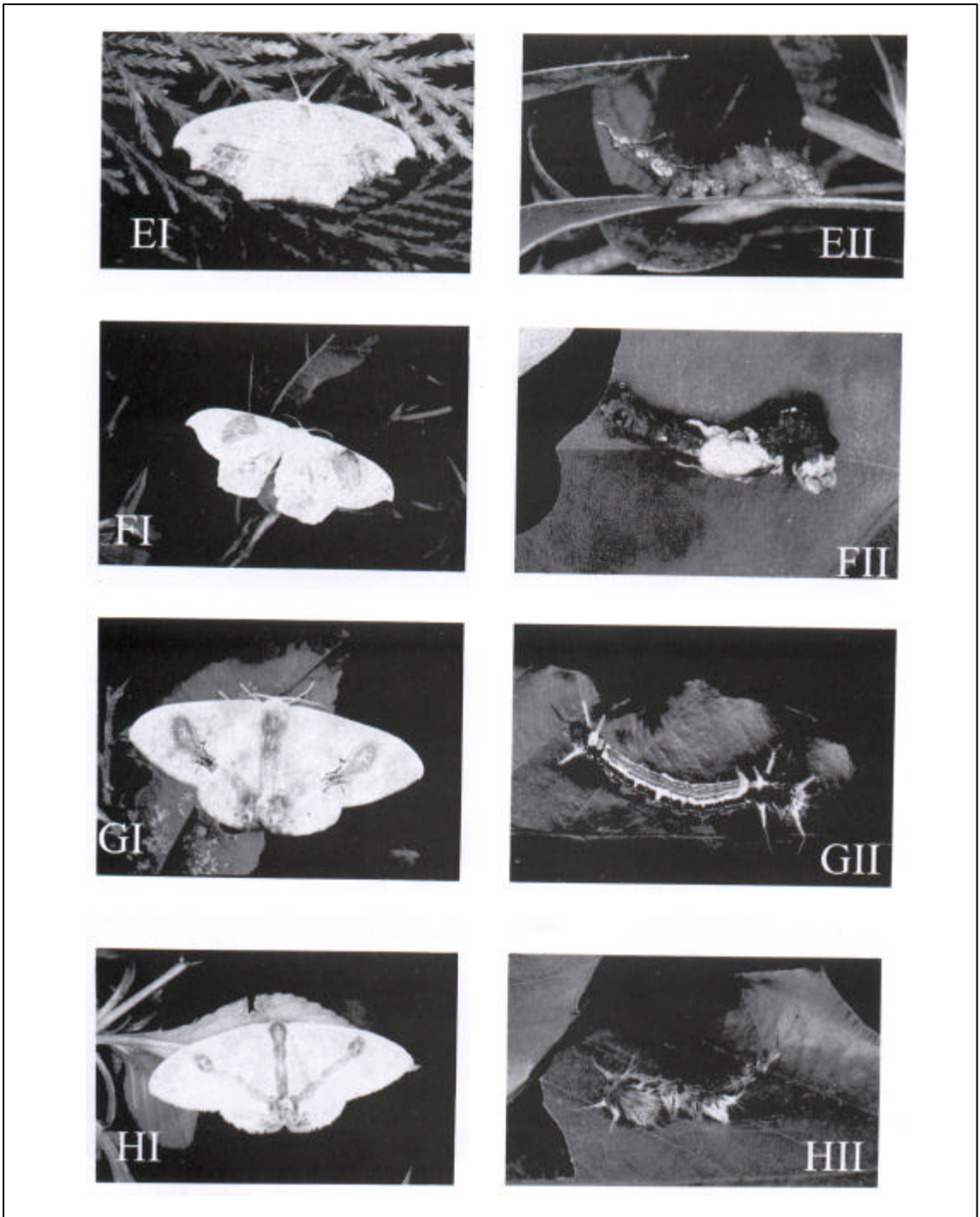


Fig. 1. Adults (I) and larvae (II) of the Drepanidae in southern Taiwan.

E. *Leucobrepis excisa* (Hampson, 1893).

F. *Macrauzata minor* Okano, 1959.

G. *Macrocilix maia* (Leech, 1888),

H. *Macrocilix mysticata flavotincta* Inoue, 1988.

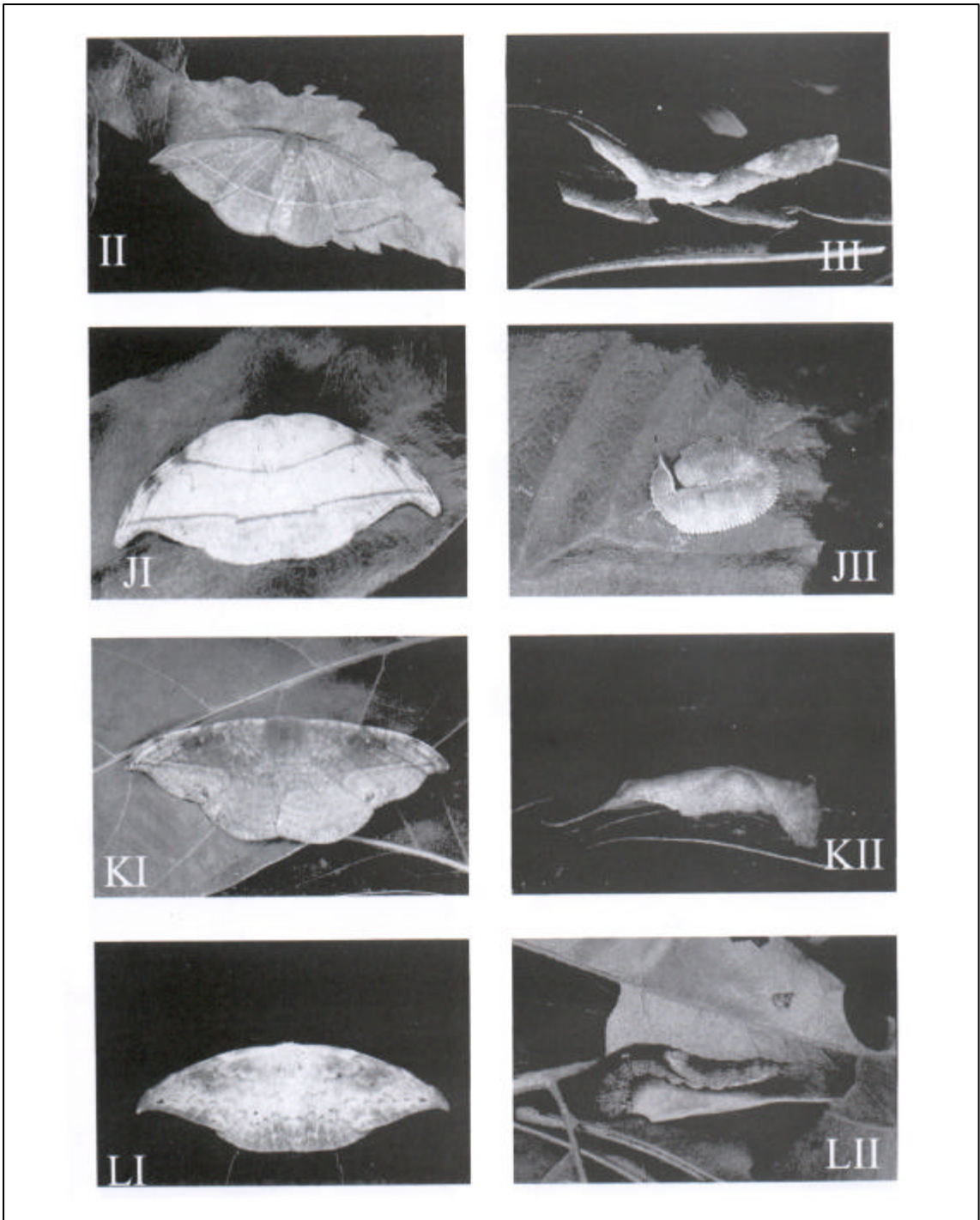


Fig. 1. Adults (I) and larvae (II) of the Drepanidae in southern Taiwan.

- I. *Microblepsis violacea* (Buter, 1889).
- J. *Nordstromia lilacina* (Moore, 1888).
- K. *Oreta loochooana* Swinhoe, 1902.
- L. *Strepsigonia diluta takamukui* (Matsumura, 1927).

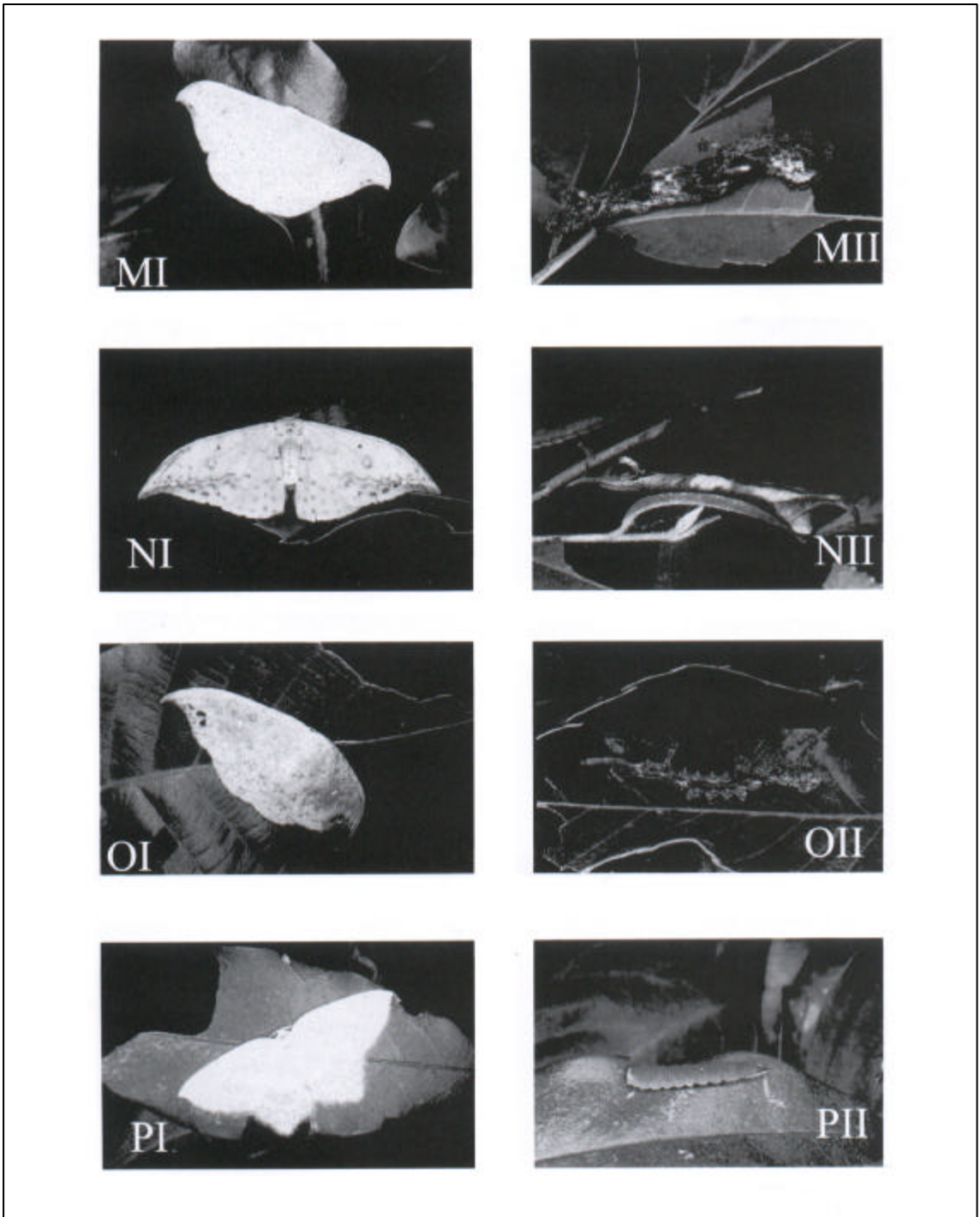


Fig. 1. Adults (I) and larvae (II) of the Drepanidae in southern Taiwan.

M. *Tridrepana arikana* (Matsumura, 1921).

N. *Tridrepana flava* (Moore, 1879).

O. *Tridrepana unispina* (Watson, 1957).

P. *Zusidava serratilinea* (Wileman, 1917).

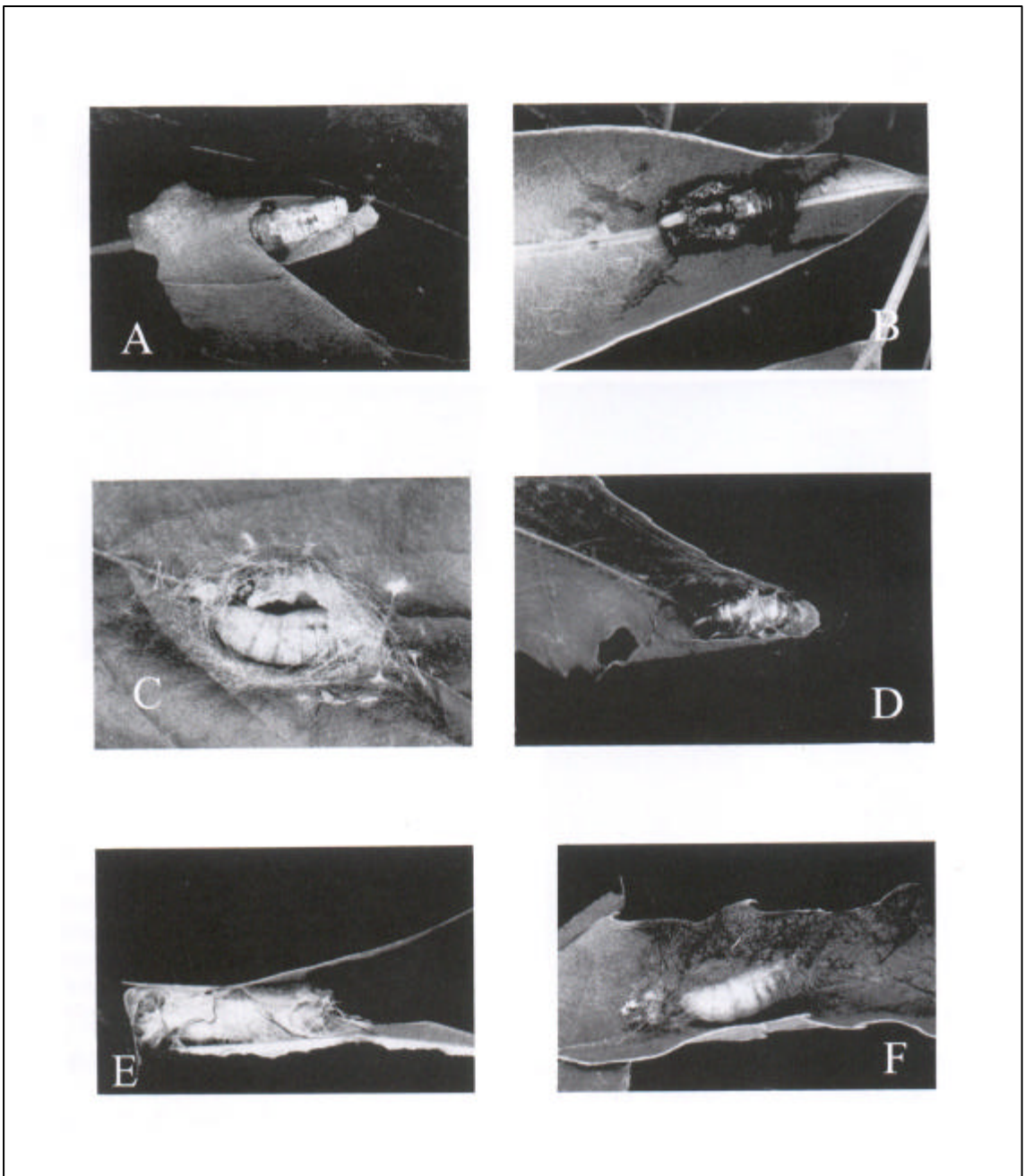


Fig. 2. Pupae of the Drepanidae in southern Taiwan.
 A. *Albara reversaria opalescens* (Warren, 1897).
 B. *Callidrepana patrana* (Moore, 1866).
 C. *Drepana pallida nigromaculata* (Okano, 1959).
 D. *Leucobrepsis excisa* (Hampson, 1893).
 E. *Macrocilix mysticata flavotincta* Inoue, 1988.
 F. *Nordstromia lilacina* (Moore, 1888).

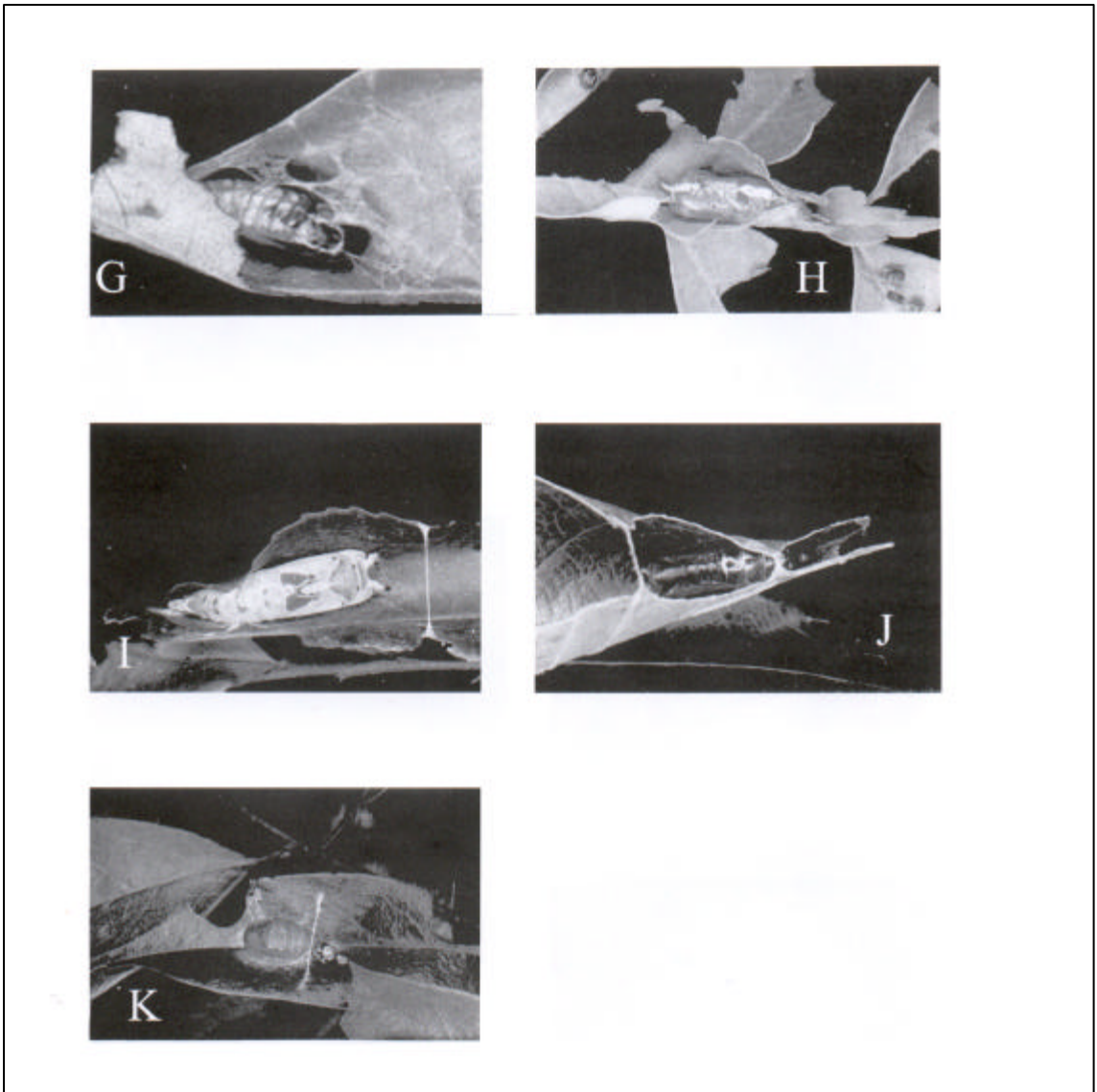


Fig. 2. Pupae of the Drepanidae in southern Taiwan.

- G. *Strepsigonia diluta takamukai* (Matsumura, 1927); H. *Tridrepana arikana* (Matsumura, 1921).
 I. *Tridrepana flava* (Moore, 1879); J. *Tridrepana unispina* (Watson, 1957).
 K. *Zusidava serratilinea* (Wileman, 1917).

cremastral hooks are varied, with some reduced and some highly modified becoming a curious cleft, such as in *Callidrepan*. All pupae of the Thyatiridae have four pairs of modified setae or hooks, and the inter-segmental regions at the terminal abdominal segments are modified. Pupae of the Cycliidae have

two pairs of cremastral hooks in addition to the secondary setae.

Prepupae and pupae produce sound by stridulation in the Drepanidae. When disturbed, prepupae of *Nordstoemia* produce a loud pounding sound from the pupal retreat, which is well covered and has a small opening. When a prepupa

vibrates the anterior portion of its body, stridulating mandibles make the pounding sound, which is accompanied by scratching sounds made by the horn being scratched on the leaf. When disturbed, pupae of *Macrauzata* also produce sounds by scratching the dorsal ridge on the retreat.

When disturbed, some larvae of Drepanidae produce rustling sounds by scratching the dorsal abdominal segments on the leaf surface. The enlarged and modified setae on the posterior end of the abdomen in some larvae of Drepanidae serve as a stridulating organ and are related to sound making, such as in larvae of *Drepana* and *Nordstoemia*. It may also serve as a defensive organ in concealed feeders for getting rid of other larvae, such as the larvae of *Tridepana*.

Acknowledgments

We gratefully acknowledge H. N. Chang, Department of Forestry, Institute of Forestry, and S. H. Yen, Department of Biology, National Chung-Shan University for their valuable information and comments. Sincere thanks when a prepupa vibrates the anterior portion of its body are given to two anonymous reviewers who provided valuable comments on this manuscript. This research was supported by funds from Taiwan Forestry Research Institute (Contribution No.201).

References

- Chang, B. S.** 1989. Illustrated Moths of Taiwan. Vol. 1. Taiwan Museum, Taipei. pp. 108-151 (in Chinese).
- Common, I.F.B.** 1990. Moths of Australia. Melbourne Univ. Press, Carlton.
- Forbes, W.T.M.** 1924. Lepidoptera of New York and neighboring states. Primitive forms, Microlepidoptera, Pyraloids, Bombyces. Mem. Cornell Univ. Agric. Exp. Stn. 68: 1-729.
- Heppner, J. B., and H. Inoue.** 1992. Lepidoptera of Taiwan. Vol. 1. Part 2: Checklist. Association for Tropical Lepidoptera. Scientific Publishers, Florida. pp. 152-153.
- Inoue, H.** 1982. Moths of Japan Vol. 1. Text Kodansha, Tokyo. pp. 412-418. (in Japanese).
- Minet, J.** 1983. Etude morphologique et phylogenetique des organes tympaniques des Pyraloidea. 1-Generalites et homologues (Lepidoptera: Glossata). Ann. Soc. Entomol. Fr. (N.S.) 19: 175-207.
- Minet, J.** 1985. Definition d'un nouveau genre au sein des Drepanidae palearctiques (Lepidoptera: Drepanoidea). Entomol. Gallica 1: 291-304.
- Minet, J.** 1991. Tentative reconstruction of the ditrysian phylogeny (Lepidoptera: Glossata). Entomol. Scand. 22: 69-95.
- Minet, J. and M. J. Scobe.** 1999. The Drepanoid/ Geometroid assemblage. In: N. P. Kristensen, ed. Lepidoptera, Moths and Butterflies Vol. 1: Evolution, Systematics, and Biogeography. Walter de Gruyter. Berlin. New York.
- Munroe, E. G.** 1982. Lepidoptera. Vol. 2. pp. 612-651. In: S. P. Parker, ed. Synopsis and Classification of living organisms. McGraw-Hill, New York.
- Scobe, M. J. and E. D. Edwards.** 1988. *Hypsidia* Rothschild: a review and a reassessment (Lepidoptera: Drepanoidea, Drepanidae). Entomol. Scand. 18: 333-353.
- Nakajima, H.** 1970. A contribution to the knowledge of the immature stages of Drepanidae occurring in Japan. Tinea 8: 167-184.
- Sugi, S.** 1987. Larvae of larger moths in Japan. Kodansha, Tokyo. pp. 20-27 (in Japanese).

Received Nov. 8, 2001

Accepted Dec. 3, 2001

臺灣南部鉤蛾(鱗翅目:鉤蛾科)幼蟲之形態與寄主植物

沈勇強 行政院農業委員會林業試驗所森林保護系 台北市南海路

林政行* 國立自然科學博物館動物組 臺中市館前路一號

摘 要

本文描述十六種鉤蛾包括單帶鉤蛾(*Albara reversaria opalescens* (Warren, 1897)), 漆樹鉤蛾(*Callidrepana patrana* (Moore, 1866)), 一點鉤蛾(*Drepana pallida nigromaculata* (Okano, 1959)), 交讓木山鉤蛾(*Hypsomadius insignis* Butler, 1877), 四窗帶鉤蛾(*Leucobrepis excisa* (Hampson, 1893)), 台灣窗翅鉤蛾(*Macrauzata minor* Okano, 1959), 刺啞鈴帶鉤蛾(*Macrocilix maia* (Leech, 1888)), 啞鈴帶鉤蛾(*Macrocilix mysticata flavotincta* Inoue, 1988), 灰褐鉤蛾(*Microblepsis violacea* (Buter, 1889)), 黑點雙帶鉤蛾(*Nordstromia lilacina* (Moore, 1888)), 接骨木山鉤蛾(*Oreta loochooana* Swinhoe, 1902), 枯葉紋鉤蛾(*Strepsigonia diluta takamukai* (Matsumura, 1927)), 銀星黃鉤蛾(*Tridrepana arikana* (Matsumura, 1921)), 黃鉤蛾(*Tridrepana flava* (Moore, 1879)), 白點黃鉤蛾(*Tridrepana unispina* (Watson, 1957))及波帶白鉤蛾(*Zusidava serratilinea* (Wileman, 1917))等幼蟲之形態與寄主植物。

關鍵詞：鉤蛾科、幼蟲、形態、寄主植物。