



HOKKAIDO UNIVERSITY

Title	IMMATURE STAGES OF SOME INDIAN CASSIDINAE (COLEOPTERA : CHRYSOMELIDAE)
Author(s)	Takizawa, Haruo
Citation	Insecta matsumurana. New series : journal of the Faculty of Agriculture Hokkaido University, series entomology., 21, 19-48
Issue Date	1980-07
Doc URL	https://hdl.handle.net/2115/9807
Type	departmental bulletin paper
File Information	21_p19-48.pdf



IMMATURE STAGES OF SOME INDIAN CASSIDINAE
(COLEOPTERA: CHRYSOMELIDAE)

By HARUO TAKIZAWA

Research Trips for Forest and Agricultural Insects in the Subcontinent of India (Hokkaidô University, University of Calcutta, and Zoological Survey of India Joint Project) [Grants-in-Aid for Overseas Scientific Survey, Ministry of Education, Japanese Government, 1978, No. 304108; 1979, No. 404307], Scientific Report No. 6.

Abstract

TAKIZAWA, H. 1980. Immature stages of some Indian Cassidinae (Coleoptera: Chrysomelidae). *Ins. matsum. n. s.* 21: 19-48, 2 tables, 15 figs.

Fourteen species of the subfamily Cassidinae from India are described of their immature stages: *Laccoptera quatuordecimnotata*, *L. quadrimaculata*, *Aspidomorpha spaethi*, *A. dorsata*, *A. furcata*, *A. sanctaecrucis*, *A. miliaris*, *Chiridopsis bipunctata*, *C. promiscula*, *Oocassida cruenta*, *Cassida (Taiwania) obtusata*, *C. (Taiwania) sp. 1*, *C. (Taiwania) sp. 2*, and *Silana farinosa*. Based on these and other 15 species which were observed by myself mostly in Japan, biological characters of the tribes Cassidini and Aspidomorphi are discussed. From the shape of the fecal cover, the genus *Laccoptera* may have a closer relation to the genus *Cassida* rather than to *Aspidomorpha*. Further, characters of the immature stages are reviewed for 12 among 19 tribes of the subfamily based on the literature.

Author's address. Biological Research Center, the Japan Tobacco & Salt Public Corporation, Hatano, Kanagawa, 257 Japan.

Contents

Introduction	21
Descriptions	
<i>Laccoptera quatuordecimnotata</i>	21
<i>Laccoptera quadrimaculata</i>	22
<i>Aspidomorpha spaethi</i>	23
<i>Aspidomorpha dorsata</i>	25
<i>Aspidomorpha furcata</i>	26
<i>Aspidomorpha sanctaecrucis</i>	27
<i>Aspidomorpha miliaris</i>	28
<i>Chiridopsis bipunctata</i>	30
<i>Chiridopsis promiscula</i>	31
<i>Oocassida cruenta</i>	32
<i>Cassida (Taiwania) obtusata</i>	34
<i>Cassida (Taiwania) sp. 1</i>	35
<i>Cassida (Taiwania) sp. 2</i>	36
<i>Silana farinosa</i>	37
Characters of the immature stages of tribes	39
Acknowledgements	44
References	45
Appendix: A list of cassidine genera of which immature stages are known, with brief notes on their characters	45

INTRODUCTION

During the Research Trips for Forest and Agricultural Insects in the Subcontinent of India, I observed and collected a lot of chrysomelid larvae. Based on this material, descriptions of the immature stages are given for 14 species of the subfamily Cassidinae. As recent works on the larvae of Cassidinae are mostly fragmental and deal with individual descriptions, an attempt is made to characterize the tribes Cassidini and Aspidomorphini on the immature stages with further material collected by myself in Taiwan, Korea and Japan. On this occasion other tribes are roughly reviewed on the basis of known immature stages.

DESCRIPTIONS

Lacoptera quatuordecimnotata (Boheman)

Last instar larva. Body flat and obovate, about 12 mm in length and 6 mm in breadth, with 16 pairs of lateral projections and a pair of supra-anal processes; dorsum dark brown with dense chitinous platelets; with microsetae which lack chitinous platelets around their bases; lateral projections light brownish, covered with many spinules; thoracic and 1st 2 abdominal sternites white-yellow without chitinous platelets.

Head oval, dark brown except for yellowish brown stripes along frontal sutures; 5 large, black ocelli present on each side, 4 of them are lined almost straightly; cordal suture obscurely connected with endo-carina, both weakly demarcated; frontal suture weak; vertex with 3 short setae on each side; frons with 6 short setae on each side; antenna 2-segmented, with basal segment narrow and weakly chitinized; the 2nd long cylindrical with a minute conical appendix apically; clypeus with a pair of setae, de-chitinized anteriorly; labrum semi-circular with a distinct notch medially on anterior margin; lower mouth-parts well developed; labial palpus 1-segmented; mentum-submentum not chitinized; cardo small, fused with stipes; mandible 6-dentate, with an additional small tuberculation below 1st tooth; teeth rather dull at apex. Prothorax with a pair of large sub-pentagonal black shields, and with 4 pairs of short robust projections; the 1st (numbered from the innermost to the lateral, and then backwardly) as long as 2nd, distinctly longer than 3rd. Mesothorax with 3 pairs of lateral projections; mesothoracic spiracle distinctly larger than abdominal ones; metathorax with 2 pairs of lateral projections, each as long as 5th; meso- and metathorax dorsally with a transverse fold. Abdomen with a pair of lateral projections on each segment; relative length of lateral projections: 15th > 1st \approx 2nd > 4th \approx 9th > 3rd \approx 5th \approx 6th \approx 7th \approx 8th \approx 10th \approx 11th \approx 16th > 12th \approx 14th > 13th; 15th twice as long as 13th; 9th shorter than 1/3 width of 1st abdominal segment; supra-anal processes long, slender and sinuate, 2.3 times as long as 15th (Fig. 15); 1st abdominal spiracle distinctly larger than others; each segment divided into 2 transverse areas by a fold; anal process cylindrical, with a longitudinal sulcus near apex.

Pupa. Body long oval and glabrous, about 12 mm in length and 7 mm in breadth; dorsum light brown with blackish patches. Head largely dark brownish, angularly produced at occiput. Pronotum flat, depressed anteriorly; narrowly but deeply incised medially on anterior margin, with about 80 marginal spinules, of which 2 pairs on the anterior margin are distinctly longer than others; with dark

brownish patches medially and stained with the same color near margins; scattered with minute tuberculations near margins and medially. Meso- and metathorax dorsally with obscure dark patches; elytral area dark brown, longitudinally striate with minute tuberculations; 1st to 5th abdominal segments each produced into a broad, well-developed lateral projection on each side; 1st projection rectangular at apex, with a long apical spinule; 2nd to 5th each acuminate at apex with 8 to 15 spinules; spiracles elevated on 1st and 2nd abdominal segments, nearly as high as wide on 3rd to 5th segments; 6th segment with a minute spinulelike process ventrolaterally; 7th laterally and 8th ventrolaterally with a slender acute projection; 9th with a pair of long slender apical processes which are situated widely apart and reach 4th segment when applied to the dorsum.

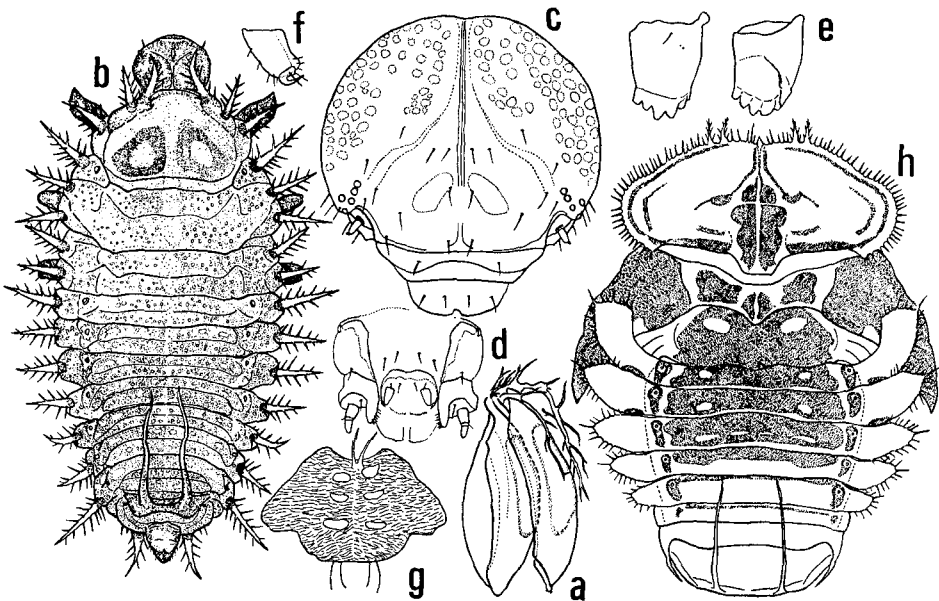


Fig. 1. *Laccoptera quatuordecimnotata* (Boheman)

a, egg-case (lateral view). — Full grown larva. b, dorsal view; c, head-capsule; d, lower mouth-parts; e, mandible (left, lateral view; right, buccal view); f, mesothoracic tarsus; g, fecal mass (shield type). — h, pupa.

Hosts. *Ipomoea* sp. (Convolvulaceae).

Specimens examined. 6 larvae, 1 pupa, 9-xii-1978, Kallar (ca. 1000 m), Nilgiri Hills, Tamil Nadu.

Notes. Eggs are laid on the leaf-surface each in a transparent egg-case with feces. The mature larva bears a large triangular mass of feces on the cast skins of the 4 preceding larval instars, and pupates with all the cast skins and feces. The specific identification of the immatures was based on the association of larvae and adults on one and the same host plant.

Laccoptera quadrimaculata (Thunberg)

References. Gressitt, 1952: 537; Hoffman, 1933: 259-260.

Last instar larva. Body smaller, about 8 mm in length and 4.5 mm in breadth; pale brownish, dorsum dark brownish laterally by dense chitinous platelets. Head

weakly chitinized; frons very strongly depressed; frontal suture obscure, represented by a de-chitinized white stripe; mandible 6-dentate, with rather acute teeth. Pronotum with 1st and 2nd lateral projections connected basally; relative length of lateral projections: 1st=2nd=3rd=4th=6th=9th=15th=16th >8th=10th >5th=7th=11th=14th >12th=13th; 1st less than twice as long as the 12th, half as long as supra-anal processes; 9th less than 1/3 width of 1st abdominal segment.

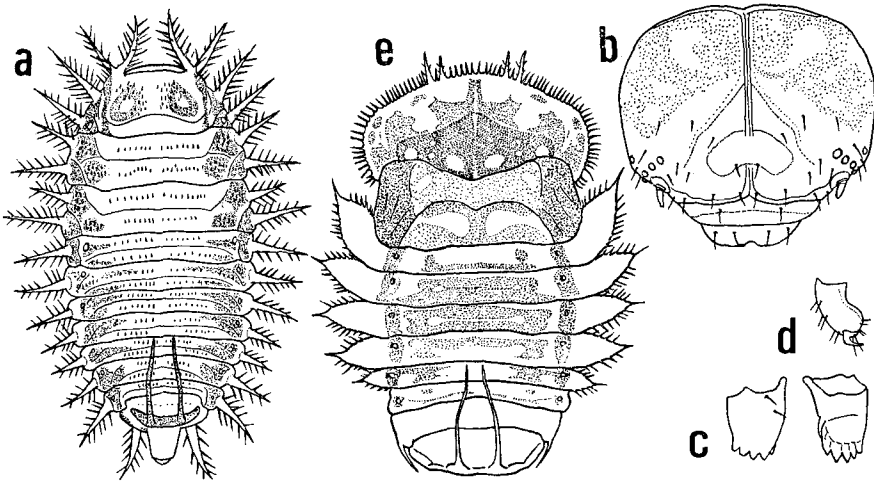


Fig. 2. *Laccoptera quadrimaculata* (Thunberg)
Full grown larva, a, dorsal view; b, head-capsule; c, mandible (as in Fig. 1);
d, mesothoracic tarsus. — e, pupa.

Pupa. Body long oval, about 8 mm in length and 5 mm in breadth; light brown with large blackish patches on dorsum; thorax largely dark brown. Pronotum with about 80 rather long marginal spinules; median sulcus indistinct. Abdomen with spiracles on 4th and 5th segments almost twice as high as wide; 1st segment with lateral projection simply acuminate at apex; 6th with a short but distinct slender process ventromarginally; 8th with lateral process bent inwardly; 9th with apical processes situated much closely to each other.

Host. *Ipomoea* sp. (adults, Convolvulaceae).

Specimens examined. Exuviae of 1 pupa on a leaf of host, 1-xi-1978, Solan (ca. 1100 m), Himachal Pradesh.

Notes. This is a common pest of sweet potato and its biology was given by Hoffman. It is similar to the preceding species in biological characters. The description of the last instar larva is based on material collected in Taiwan (4 larvae feeding on *Ipomoea* sp., Tongpu (ca. 1000 m), Nantou Hsien, Taiwan, 5-vii-1977).

Aspidomorpha spaethi Maulik

Last instar larva. Body long obovate, about 8.8 mm in length and 4.6 mm in breadth; the surface densely covered with short white silvery hairs originated from host leaves; dorsum densely covered with short setae; yellowish white with 1st to

3rd, 6th and 8th lateral projections, a pair of oblique stripes on each of thoracic segments, and supra-anal processes dark brown. Head weakly chitinized; antenna with basal segment narrowly chitinized, 2nd long cylindrical; cordal suture connected with endo-carina; frontal suture indistinct, represented by an obscure white stripe; vertex with about 5 short setae on each side; frons rather densely covered with short setae; mandible 6-dentate; maxillary palpus 2-segmented; labium not delimited from mentum-submentum by a chitinous band. Pronotum distinctly convex medially, with a pair of obscure dark patches; 1st and 2nd lateral projections fused basally; mesothoracic spiracle larger than abdominal ones, as high as wide. Abdomen with spiracles raised, almost as high as wide on 1st to 3rd, 6th and 7th segments, twice as high as wide on 4th and 5th; relative length of lateral projections: $4th \cong 6th \cong 15th > 2nd \cong 3rd \cong 8th \cong 9th \cong 16th > 1st \cong 10th \cong 11th > 12th > 13th \cong 14th > 5th > 7th$; 6th longer than twice the 7th; 9th longer than 1/2 width of 1st abdominal segment; supra-anal processes chitinized, sinuate and distinctly longer than 4th lateral projection, and twice as long as 13th.

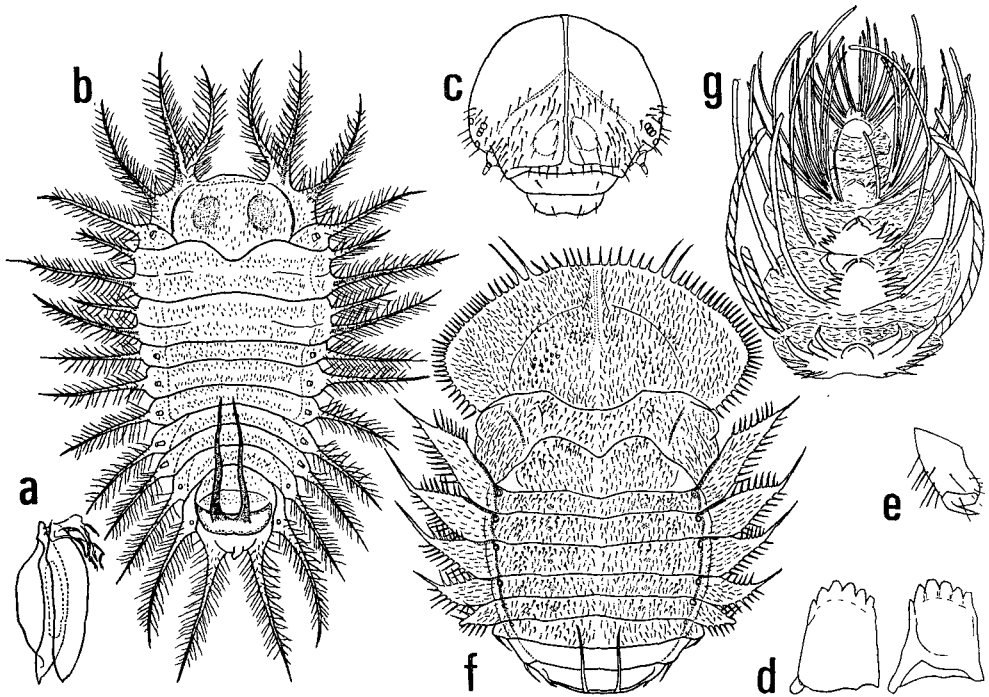


Fig. 3. *Aspidomorpha spaethi* Maulik
a, egg-case. — Full grown larva. b, dorsal view; c, head-capsule; d, mandible (as in Fig. 1); e, mesothoracic tarsus. — Pupa. f, dorsal view; g, cast skins and fecal mass (filament type).

Pupa. Body flat and oval, about 9 mm in length and 7 mm in breadth; pale brown, more or less darker on lateral margins of each segment; dorsum densely covered with short setae except for 7th to 9th abdominal segments glabrous; stained with dark brown around bases of these setae. Pronotum depressed antero-

laterally with about 80 marginal spinules, of which 2 pairs on the anterior margin are twice as long as the others. Abdomen with 5 pairs of slender leaflike lateral projections; spiracles raised, higher than wide on 3rd to 6th segments; 6th segment angularly produced laterally, with a long slender process, bent ventrally, on each side; 7th and 8th each with a similar process ventrally on each side, the process on 8th as long as mesothoracic length; 9th with apical processes slender and straight, reaching 5th abdominal segment.

Hosts. *Ipomoea* sp. (Convolvulaceae).

Specimens examined. 11 larvae & 4 pupae, Kallar (ca. 1000 m), Nilgiri Hills, Tamil Nadu, 9, 12-xii-1978; 5 larvae, Mettupalayam View (ca. 1000 m), Nilgiri Hills, Tamil Nadu, 10-xii-1978.

Notes. Eggs are laid singly in a brownish transparent case. The larvae bear the cast skins of all the preceding instars and are furnished with long narrow filaments of blackish feces, which are protruded above the dense white hairs originated from the host plant. Pupation takes place with all the cast skins and feces retained. The 1st instar larva has the head more sparsely covered with setae; frontal suture lacking; supra-anal processes long, each furnished with some 20 long setae (Fig. 14). Some larvae were reared to adults.

Aspidomorpha dorsata (Fabricius)

References. Maulik, 1919: 275-277.

Last instar larva. Body long obovate and flat, strongly narrowed posteriorly, about 9 mm in length and 4.5 mm in breadth; pale green with a pair of crescent marks on pronotum, 1st abdominal spiracle and supra-anal processes dark brown; lateral projections slender, 9th slightly shorter than half the width of 1st abdominal segment. Head round, weakly chitinized; cordal suture connected with

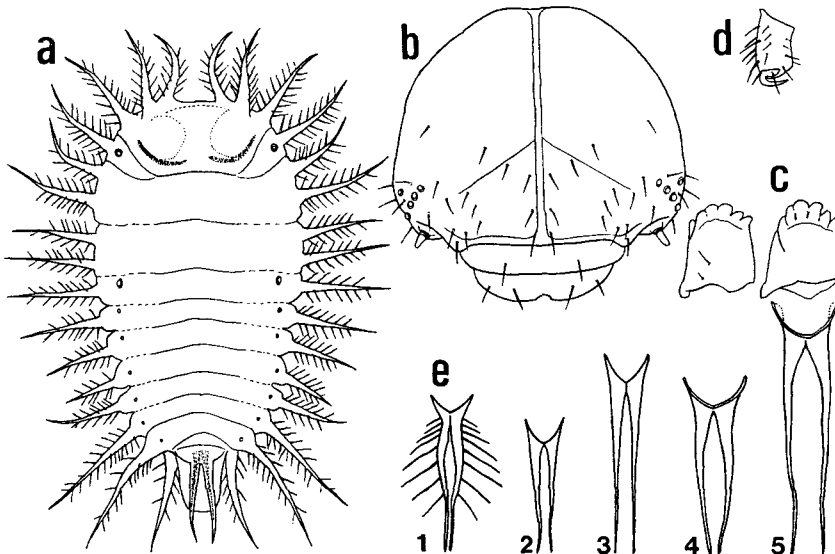


Fig. 4. *Aspidomorpha dorsata* (Fabricius)
Full grown larva. a, dorsal view; b, head-capsule; c, mandible (as in Fig. 1); d, mesothoracic tarsus; e, supra-anal processes (Numerals indicate larval instars).

endo-carina; frontal suture obscure; vertex with about 3 short setae on each side; frons with about 12 short setae on each side; ocelli black; antenna 2-segmented, with basal segment narrow and weakly chitinized, 2nd long cylindrical with a minute appendix apically; labrum incised at anterior margin; mandible 6-dentate, with first 3 teeth weakly denticulate; lower mouth-parts weakly chitinized; maxillary palpus 2-segmented; labial palpus 1-segmented; labium not delimited from mentum-submentum by a chitinous band. Pronotum roundly depressed on each side of median line; 1st and 2nd lateral projections connected basally; relative length of lateral projections: 15th > 3rd \approx 4th \approx 6th \approx 14th > 1st \approx 2nd \approx 8th \approx 9th \approx 10th \approx 16th > 5th \approx 7th \approx 11th \approx 13th > 12th; 15th twice as long as 12th; mesothoracic spiracle as large as 1st abdominal one, each slightly higher than wide; supra-anal processes weakly chitinized and slender, almost twice as long as 10th lateral projection; anal process stout.

Hosts. *Ipomoea* sp. (Convolvulaceae).

Specimens examined. 1 larva, Kallar (ca. 1000 m), Nilgiri Hills, Tamil Nadu, 10-xii-1978.

Notes. Pupation takes place with all the cast skins retained. First instar larva has the supra-anal processes furnished with about 7 pairs of distinct setae. A few larvae were reared to adults, on which the specific identification was based.

Aspidomorpha furcata (Thunberg)

References. Gressitt, 1952: 528-535.

Last instar larva. Body flat and long oval, about 7 mm in length and 3.5 mm in breadth; pale green with a pair of crescent marks on pronotum, mesothoracic and 1st abdominal spiracles, and supra-anal processes light brown to dark brown; 5th and 7th lateral projections light brownish; lateral projections rather stout, 9th slightly shorter than half the width of 1st abdominal segment. Head round, weakly chitinized; cordal suture connected with endo-carina; frontal suture obsolete; vertex with about 3 short setae on each side; frons with about 11 short setae on each side; antenna 1-segmented, with basal segment not chitinized; labrum deeply incised at anterior margin; mandible 6-dentate with well-demarcated teeth. Pronotum with about 10 short setae arranged laterally to median line and on crescent marks; 1st and 2nd lateral projections connected at very bases; relative length of lateral projections: 15th > 2nd \approx 3rd \approx 4th \approx 6th \approx 8th \approx 9th \approx 14th > 1st \approx 5th \approx 7th \approx 10th \approx 16th > 11th \approx 13th > 12th; 15th slightly shorter than twice the 12th; mesothoracic spiracles as large as 1st abdominal one, each lower than wide; supra-anal processes sinuate and slender, slightly shorter than twice the 15th lateral projection; anal process stout.

Pupa. Body glabrous, flat and oval, about 6 mm in length and 4.5 mm in breadth; pale green with obscure transverse patches on abdomen and apical processes on 9th segment light brown to dark brown. Pronotum with about 70 short marginal spinules, of which 2 pairs on the anterior margin are longer than the others; 1st to 5th abdominal segments each with a leaflike lateral projection which is rather acutely narrowed to apex; spiracles as high as wide; 6th to 8th segments each with a slender spinule-like process at lateral margin, the process on 7th distinctly longer than others; apical processes of 9th segment slender, reaching 4th abdominal segment.

Host plants. *Ipomoea* sp. (Convolvulaceae).

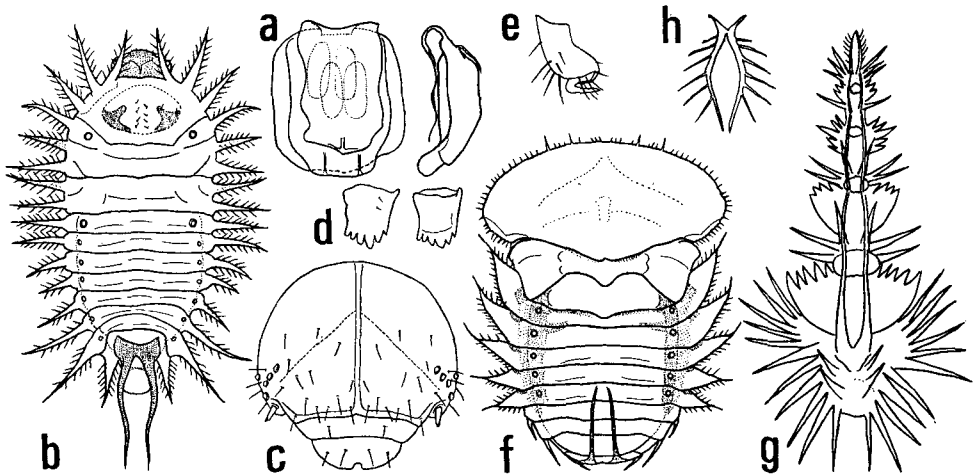


Fig. 5. *Aspidomorpha furcata* (Thunberg)

a, egg-case (left, lower view; right, lateral view). - Full grown larva. b, dorsal view; c, head-capsule; d, mandible (as in Fig. 1); e, mesothoracic tarsus. - Pupa. f, dorsal view; g, cast skins. - h, supra-anal processes of 1st instar larva.

Specimens examined. 2 larvae & 1 pupa, Calcutta, West Bengal, 15-x-1978; 4 larvae & 1 pupa, Mettupalayam View (ca. 1000 m), Nilgiri Hills, Tamil Nadu, 10-xii-1978.

Notes. Two to three eggs are laid in a transparent brownish egg-case. The larvae bear the cast skins of all the preceding instars but no feces on the supra-anal processes. Pupation takes place with all the cast skins retained. As in case of *A. dorsata* the 1st instar larva has the supra-anal processes each furnished with about 6 long setae (Fig. 14). The specific determination was based on adults which were reared from larvae. Gressitt gave a good account of the biology of this species.

Aspidomorpha sanctaecrucis (Fabricius)

References: Maulik, 1919: 273-274.

Last instar larva (based on a broken specimen). Body largely dark brownish; lateral projections long and rather densely covered with spinules. Head brown, with dark brownish band along frontal sutures; cordal suture connected with endocarina; frontal suture indistinct; vertex with about 3 short setae on each side; frons with about 20 short setae on each side; mandible 5-dentate, with round, not well-defined teeth. Pronotum narrowly but distinctly incised at middle on anterior margin; 1st and 2nd lateral projections fused basally; relative length of lateral projections: 9th > 11th > 14th > 7th > 5th > 13th; 9th projection almost twice as long as 5th, and 2.5 times as long as 13th; supra-anal processes well chitinized and slender, distinctly longer than 9th projection.

Pupa. Body glabrous and oval, about 10 mm in length and 7.5 mm in breadth; cream yellow with dorsum largely light brown to dark brown, and scattered with dark brown dots. Pronotum with a large sub-triangular median patch and with about 60-70 marginal spinules of different lengths, of which 2 pairs on the anterior margin are stouter. Mesothorax with elytral portion granulose. Abdomen with a leaflike lateral projection on 1st to 5th segments; 1st projection

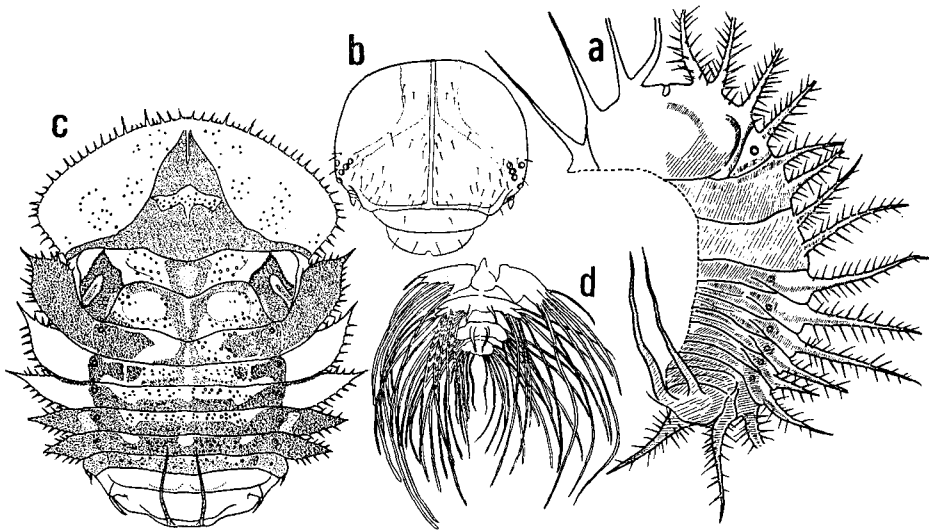


Fig. 6. *Aspidomorpha sanctaerucis* (Fabricius)

Full grown larva. a, dorsal view; b, head-capsule. - Pupa. c, dorsal view; d, cast skins and fecal mass.

almost rectangular near apex; spiracles slightly elevated, but lower than wide; 6th to 8th segments each with a spinule-like process at lateral margin; the process on 8th strongly bent inwardly and invisible from above; 9th abdominal segment with slender apical processes reaching middle of 5th segment.

Host plants. *Ipomoea* sp. (Convolvulaceae).

Specimens examined. 1 dead larva & 17 pupae, Dehra Dun, Himachal Pradesh, 2-5-xi-1978.

Notes. Two to three eggs are laid side by side in a single brownish transparent egg-case and about 10 cases are piled up into a single ootheca. The larvae bear the cast skins of all the preceding instars and a large mass of long filamentous feces on the dorsum. Pupation takes place with all the cast skins and feces retained. The 1st instar larva has the supra-anal processes furnished with about 7 long setae (Fig. 14). The specific determination was based on adults which were reared from part of the pupae collected.

Aspidomorpha miliaris (Fabricius)

References. Maulik, 1919: 270-273.

Last instar larva. Body long oval, about 12 mm in length and 6 mm in breadth; cream yellow with head and legs largely, lateral projections and supra-anal processes, small spots on body surface dark brown; lateral projections rather short with yellowish white spinules; spiracles slightly elevated, lower than wide; mesothoracic and 1st abdominal spiracles larger than others. Head well chitinized, with broad yellowish stripes along endo-carina and cordal and frontal sutures; cordal suture obscurely connected with endo-carina; vertex with about 5 short setae on each side, and covered with small round patches; frons medially depressed with about 30 short setae on each side; clypeus anteriorly de-chitinized; labrum deeply incised at anterior margin; antenna 2-segmented; mandible 6-dentate;

labium delimited by a weakly chitinized band from mentum-submentum. Pronotum with a small dark patch on each side of median line; 1st and 2nd lateral projections separated at their bases; meso- and metathorax each with 2 pairs of small spots near anterior margin. First to 7th abdominal segments each with 2 pairs of small spots near anterior margin and a smaller one medio-posteriorly on dorsum, on venter with 2 pairs of larger spots; relative length of lateral projections: 15th > 16th > 14th > 3rd = 8th = 9th > 2nd = 4th = 10th > 11th = 12th = 13th > 1st > 5th > 7th; 9th about 1/3 as long as the width of 1st abdominal segment; 15th twice as long as 7th; supra-anal processes widely separated, distinctly longer than 15th projection.

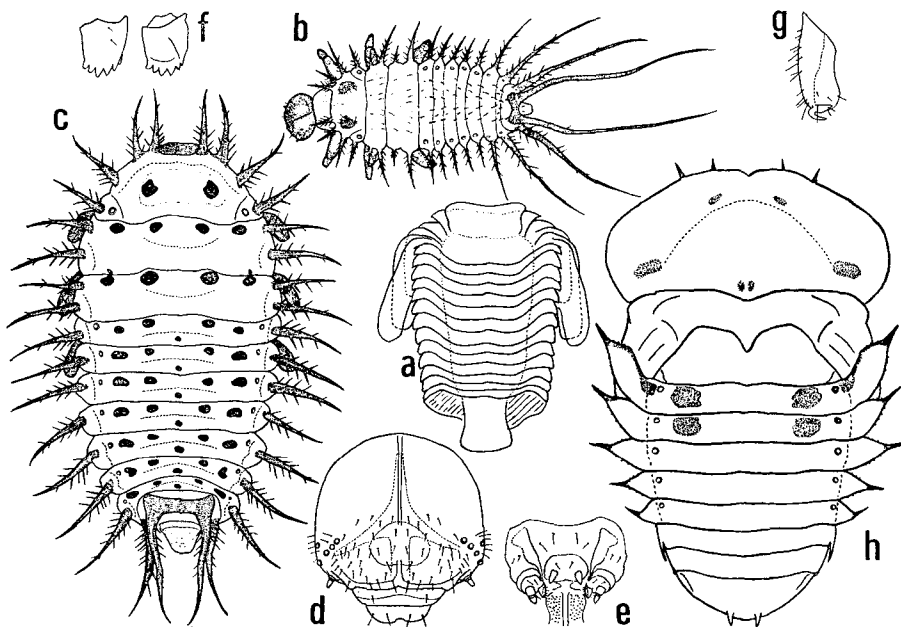


Fig. 7. *Aspidomorpha miliaris* (Fabricius)
 a, ootheca. - b, 1st instar larva. - Full grown larva. c, dorsal view; d, head-capsule;
 e, lower mouth-parts; f, mandible (as in Fig. 1); g, mesothoracic tarsus. - h, pupa.

Pupa. Body rather elongate, about 12 mm in length and 7.5 mm in breadth; almost glabrous and fresh yellow with 3 pairs of small spots on pronotum, a pair of large spots on each of 1st 2 abdominal segments, and apices of leaflike lateral projections black: 1st lateral projection narrowly stained with black along antero-interior margin. Pronotum convex medially, with 2 pairs of stout spines on anterior margin; abdomen on each of 1st to 5th segments with a leaflike lateral projection, which has several granule-like processes instead of spinules; 1st segment with large spiracle almost as high as wide: 2nd to 5th spiracles lower than wide; 6th and 7th segments each with a distinct lateral spinule; 8th with a short one ventrolaterally; 9th with a pair of short apical processes.

Host plants. *Ipomoea* sp., (Convolvulaceae).

Specimens examined. A lot of specimens covering all stages, Calcutta, West Bengal, 15-x-1978.

Notes. Four eggs are laid side by side in a brownish egg-case and about 20 cases are piled up into an ootheca. The larvae bear the cast skins of all preceding instars but no feces. The full grown larva, however, casts off the exuviae and pupates. The first instar larva has the last 3 lateral projections and the supra-anal processes extremely long. Unlike other congeners, the 1st instar larva lacks distinct long setae on the supra-anal processes (Fig. 14). The larvae live in group and pupate together, and when resting they make an oval mass, with the heads directed to the center.

Chiridopsis bipunctata (Linné)

Last instar larva. Body obovate, about 6-7 mm in length and 2.5-3 mm in breadth; glabrous and cream white with head, pronotal patches and supra-anal processes light brown to brown; lateral projections in 16 pairs, slender and furnished with spinules; mesothoracic spiracle larger than others and as high as wide; spiracles pale, slightly elevated, at most as high as wide on 4th to 7th abdominal segments. Head light brown except for a yellowish stripe along frontal sutures; vertex with many dark brownish patches and with about 3 short setae on each side; frons depressed medially with about 9 short setae on each side; endo-carina and cordal suture distinct; frontal suture obsolete; antenna 2-segmented with basal segment weakly chitinized, and with the 2nd long cylindrical; ocelli black; labrum weakly emarginate medially; mandible 6-dentate, with 1st tooth acute and small; maxillary palpus 2-segmented; labium not delimited from mentum-submentum by a chitinized band. Prothorax with 1st and 2nd lateral projections fused basally; relative length of lateral projections: 15th > 1st = 2nd = 3rd = 4th = 6th = 16th > 8th

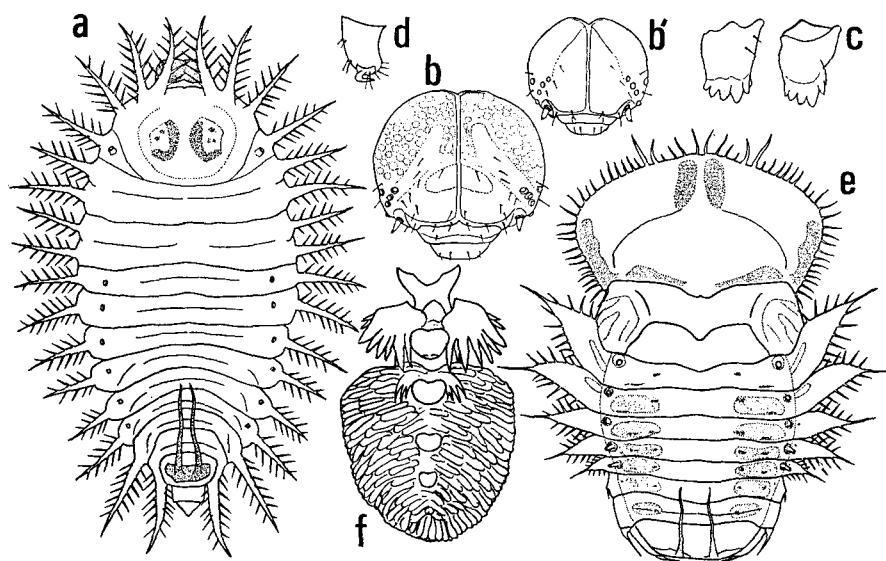


Fig. 8. *Chiridopsis bipunctata* (Linné)
Full grown larva. a, dorsal view; b, head-capsule (b' for 1st instar larva); c, mandible (as in Fig. 1); d, mesothoracic tarsus. - Pupa. e, dorsal view; f, cast skins and fecal mass (spade type).

$\approx 9\text{th} > 5\text{th} \approx 10\text{th} > 7\text{th} \approx 11\text{th} \approx 14\text{th} > 12\text{th} \approx 13\text{th}$; 15th 1.5 times as long as 13th; 9th about 1/3 as long as the width of 1st abdominal segment; supra-anal processes slender and sinuate, twice as long as 9th projection (Fig. 15); 8th abdominal segment with a pair of weakly chitinized patches ventrally.

Pupa. Body oblong, strongly narrowed posteriorly, about 7 mm in length and 4 mm in breadth; glabrous and cream yellow with obscure dark patches, dark brown and tuberculate around spiracles. Pronotum with about 60 marginal spinules, of which 2 pairs on the anterior margin are distinctly stouter and longer than others; dorsum wrinkled antero-medially and sparsely granulose, obscurely stained with dark brown at basal and lateral margins and antero-medially; mesothorax granulose and striped with dark brown on elytral portion. Abdomen with leaflike lateral projections on 1st to 5th segments; 1st projection angulate at middle of interior margin; each segment with a broad obscure patch laterally; spiracles largely elevated on 1st segment, as high as wide on 1st 3 segments, more than twice as high as wide on 4th, and 1.5 times as high as wide on 5th; 6th abdominal segment with a short spinule-like process ventromarginally, 7th with a long one which is as long as the segment, 8th with a shorter one strongly bent inwardly; 9th with apical processes long, slender and weakly chitinized; abdomen subquadrate at apex.

Host plants. *Ipomoea* sp. (Convolvulaceae).

Specimens examined. 3 larvae and 4 pupae. Coimbatore, Tamil Nadu, 5-13-xii-1978.

Notes. The larvae bear a thin mass of feces which are massed over the cast skins. The pupa also retains all the cast skins and feces. The 1st instar larva has the frontal sutures divaricate near the posterior margin of the head.

Chiridopsis promiscula (Fabricius)

Last instar larva. Body cream yellow, about 6-7 mm in length and 3 mm in breadth. Head with labrum very distinctly incised at anterior margin; antenna with basal segment very strongly chitinized. Abdomen with spiracles rather flat, those on 4th to 7th segments lower than wide; relative length of lateral projections: $15\text{th} > 1\text{st} \approx 2\text{nd} \approx 3\text{rd} \approx 4\text{th} \approx 8\text{th} \approx 9\text{th} \approx 10\text{th} \approx 16\text{th} > 6\text{th} > 5\text{th} \approx 7\text{th} \approx 11\text{th} > 14\text{th} > 12\text{th} > 13\text{th}$; 15th twice as long as 13th.

Pupa. Body flat, about 6 mm in length and 4 mm in breadth; cream yellow with striae on elytral portion, abdomen around spiracles, and a pair of spots on each segment dark brown; pronotum with about 66 marginal spinules, of which the 3 innermost pairs are longer, 2 pairs on the anterior margin distinctly robuster than but almost as long as the neighbourings; 1st abdominal segment with the leaflike projection rather roundly expanded along interior margin.

Host plants. *Ipomoea* sp. (Convolvulaceae).

Specimens examined. 2 larvae & 2 pupae, 5-xii-1978, Top Slip (ca. 500 m), Anaimalai Hills, Tamil Nadu.

Notes. The larvae attach their feces to the cast skins mostly on marginal areas, so that the fecal mass is much thinner than in the preceding species. The specific determination was based on a larva-adult association on one and the same host at Anaimalai. Though the distinction between *bipunctata* and *promiscula* is difficult with the limited material at hand, the former seemed rare at this locality. The identification is still rather tentative.

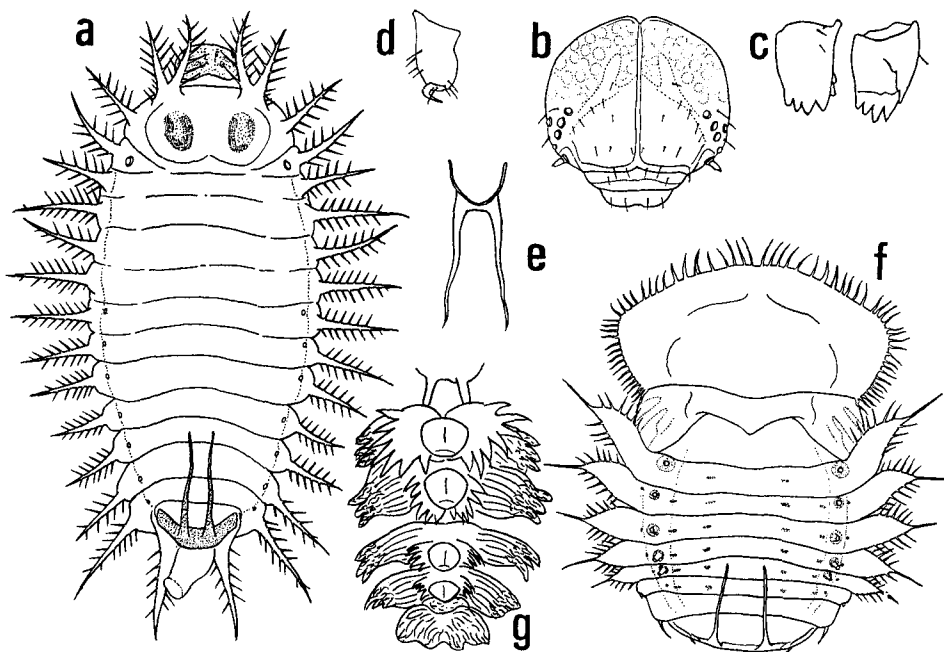


Fig. 9. *Chiridopsis promiscula* (Fabricius)

Full grown larva. a, dorsal view; b, head-capsule; c, mandible (as in Fig. 1); d, mesothoracic tarsus; e, supra-anal processes. — Pupa. f, dorsal view; g, cast skins and fecal mass.

Oocassida cruenta (Fabricius)

References. Maulik, 1912: 279–280.

Last instar larva. Body flat and long obovate, rather strongly narrowed posteriorly, about 7 mm in length and 3.5 mm in breadth; fresh green with supra-anal processes dark brown, lateral projections light brown; mesothoracic and 1st 2 abdominal spiracles dark brown; claws brown; rather densely covered with small scale-like setae, with 16 pairs of stout lateral projections. Head oval, weakly chitinized; with 5 ocelli on each side; cordal suture obscurely connected with endocarina; frontal suture indistinct; vertex with about 3 setae on each side; frons with about 5 setae on each side; antenna apparently 1-segmented, with basal segment not chitinized; the 2nd short cylindrical with a minute appendix apically; maxillary palpus fused into one segment which is almost fused with palpiger; labial palpus 1-segmented; mandible 5-dentate with 2 additional weak denticulations on upper side. Prothorax with 1st and 2nd lateral projections arising from a common base; mesothoracic spiracle brownish, large and almost as high as wide; relative length of lateral projections: 1st = 2nd = 3rd = 4th = 6th = 8th = 9th = 10th > 16th > 11th = 12th > 5th = 7th > 13th = 14th = 15th; meso- and metathorax each with 2 transverse rows of scale-like setae. Abdomen with 1st abdominal spiracle brown, as large as mesothoracic one; 2nd to 7th pale and small, as high as wide; each segment with 2 rows of scale-like setae; 9th lateral projection about 1/3 as long as the width of 1st abdominal segment; supra-anal processes strongly chitinized, almost 2/3 as long

as body, and 5 times as long as 1st lateral projection, fused into a rod-like process for basal 3/5, then split into 2 parallel branches and gradually narrowed to apex; rather densely covered with setae on basal 2/5 and with thin silvery hairs on the rest; anal process long cylindrical.

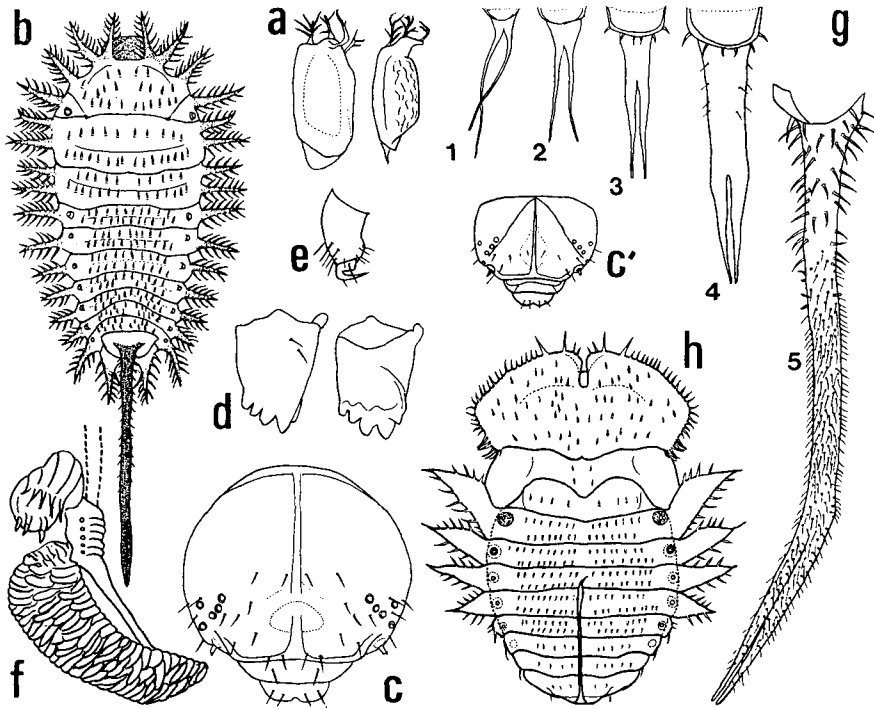


Fig. 10. *Oocassida cruenta* (Fabricius)

a, egg-case (left, upper view; right, lateral view). – Full grown larva. b dorsal view; c, head-capsule (c' for 1st instar larva); d, mandible (as in Fig. 1); e, mesothoracic tarsus; f, cast skins and fecal mass (mass type); g, supra-anal processes (as in fig. 4). – h, pupa.

Pupa. Body oval, about 7 mm in length and 5 mm in breadth; pale green with 1st and 2nd abdominal spiracles blackish, 3rd to 5th brownish; body covered with minute scale-like setae. Pronotum deeply and narrowly incised at middle on anterior margin, with about 64 marginal spinules, of which 2 pairs on the anterior margin are longer. First 4 abdominal segments with leaflike projections furnished with spinules; 1st abdominal spiracle largely tuberculate and produced, 4 times as large as 2nd; 3rd to 5th spiracles smaller; 5th to 7th abdominal segments each with an acute slender process ventromarginally; 8th and 9th each with a similar lateral process ventrally; 9th with a slender apical process which is 1/3 as long as body and slightly dilated and hooked near apex.

Host plants. *Ziziphus* sp. (Rhamnaceae).

Specimens examined. 6 larvae & 3 pupae, Coimbatore, Tamil Nadu, 5-8-xii-1978.

Notes. Eggs are laid singly on the leaf-surface in a brownish egg-case streaked

with feces. The larvae bear cast skins covered with a large mass of feces. Pupation takes place on the leaf-surface with only the cast skin of the 5th instar retained. The first instar larva has the head almost truncate posteriorly; antenna 2-segmented; frontal suture arising near posterior margin. The specific determination was based on the association of immature stages and adults on one and the same host plant. This species is characteristic in the shape of the larval supra-anal processes, which are united into a long common stem basally. This very peculiar type of the supra-anal process may be explained by terms of allometry. As shown in Fig. 10, the 1st instar larva has paired supra-anal processes of usual type, which gradually develop into the ultimate shape by the elongation of the stem. A similar elongation of the stem is known in *Cassida (Taiwania) sauteri* (Spaeth), in which the degree of elongation agrees with that in the 3rd instar larva of *cruenta*. In one examined specimen belonging to the 4th instar, the body is largely chitinized and dark brown except for the dorsum around the spiracles and the venter of the 3rd to 8th abdominal segments; lateral projections pale except for the bases which are dark brownish.

Cassida (Taiwania) obtusata Boheman

References. Gressitt, 1952: 537-539.

Last instar larva. Body long, weakly narrowed posteriorly, about 5.5 mm in length and 2.5 mm in breadth; glabrous and pale green with supra-anal processes light brownish; spiracles elevated, almost as high as wide; 9th lateral projection slightly longer than 1/3 width of 1st abdominal segment. Head narrowed to vertex; cordal suture distinctly connected with endo-carina; frontal suture almost vestigial; vertex with about 3 short setae on each side; frons with about 7 short setae on each side; antenna 1-segmented, with a minute apical process; clypeus anteriorly dechitinized; labrum rather deeply incised at anterior margin; lower mouth-parts weakly chitinized; maxillary palpus 2-segmented; stipes indistinct, fused with palpiger; labial palpus 1-segmented; labium not delimited by a chitinous band from mentum-submentum; mandible 6-dentate. Pronotum with 1st and 2nd lateral projections fused at base, with 1st distinctly shorter than 2nd; relative length of lateral projections: 15th \approx 16th > 2nd \approx 3rd \approx 4th \approx 6th \approx 8th > 9th \approx 10th \approx 14th > 1st > 5th \approx 7th \approx 11th \approx 12th \approx 13th; 15th 1.5 times as long as 13th; supra-anal processes slender, twice as long as 13th.

Pupa. Body oval, about 5 mm in length and 3 mm in breadth; pale green with spiracles and apices of lateral projections light brown; dorsum obscurely stained with light brown. Pronotum with about 40-50 stout marginal spinules, of which 2 pairs on the anterior margin are distinctly longer and stouter than others: at posterior angle a few spinules fused together basally; 1st to 5th abdominal segments with leaflike lateral projection which ends apically in a long spinules; spiracles elevated, as high as wide on 1st, 2nd and 5th segments; on 3rd and 4th, spiracles strongly produced and 3 times as long as wide; 6th and 7th segments each with a spinule-like process ventromarginally; 8th with a similar one laterally on venter; 9th segment with a pair of slender apical processes, which reach middle of 6th segment.

Host plants. *Alternanthera sessilis* R. Br. (Amaranthaceae).

Specimens examined. A lot of larvae & pupae, Calcutta, West Bengal, 18-x-1978.

Notes. The larvae bear the cast skins of all the preceding instars and a large

mass of light brownish feces on the supra-anal processes. Pupation takes place with all the cast skins and feces retained. The specific determination was based on the adults which were reared from the larvae.

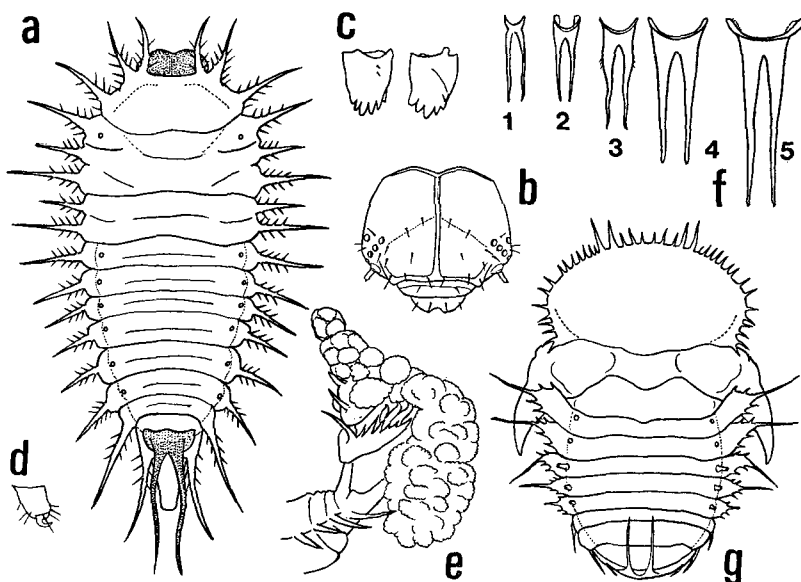


Fig. 11. *Cassida (Taiwania) obtusata* Boheman

Full grown larva. a, dorsal view; b, head-capsule; c, mandible (as in Fig. 1); d, mesothoracic tarsus; e, cast skins and fecal mass; f, supra-anal processes (as in Fig. 4). - g, pupa.

Cassida (Taiwania) sp. 1

Last instar larva. Body oblong, narrowed posteriorly, about 6 mm in length and 2.5 mm in breadth; pale yellow with supra-anal processes light brown; dorsum covered with scale-like setae; lateral projections slender, rather thickly covered with spinules; spiracles elevated, higher than wide; mesothoracic and 1st abdominal spiracles larger than others. Head round; cordal suture connected with endo-carina; frontal suture almost absent; vertex with a few short setae on each side; frons with about 11 short setae on each side; antenna 1-segmented, long cylindrical; labrum deeply incised at anterior margin; palpiger-stipes wholly dechitinized; mandible 6-dentate. Pronotum with 1st and 2nd lateral projections fused basally; meso- and metathorax each with 2 transverse rows of setae on dorsum; relative length of lateral projections: 4th = 6th = 16th > 2nd = 3rd = 8th = 9th = 15th > 1st = 10th > 14th > 11th > 5th = 7th = 12th = 13th; 4th 1.4 times as long as 5th; supra-anal processes slender, slightly longer than twice the 13th lateral projection; 9th slightly shorter than half the width of 1st abdominal segment; anal process long.

Pupa. Body cream yellow, and narrowed posteriorly, about 6 mm in length and 3 mm in breadth; dorsum densely covered with stout setae except for last 3 segments glabrous; pronotum with about 80 marginal spinules of irregular length: 2 pairs on the anterior margin distinctly longer than others; dorsum with about 50 setae; elytral portion with setae arranged in 4 longitudinal striae; 1st to 5th

abdominal segments with a leaflike lateral projection, which is slender and acutely produced into a long apical spinule; 1st spiracle strongly produced, higher than twice the width; 2nd to 5th each higher than wide; 6th to 8th segments each with a short spinule-like process ventromarginally; 9th segment with a pair of small tuberculations at apex.

Host plants. *Achyranthes* sp. (Amaranthaceae).

Specimens examined. 1 larva & 1 pupa, Velloire, Tamil Nadu, 16-xii-1978.

Notes. The last instar larvae bear an irregularly shaped mass of feces together with all the cast skins. The pupa retains the mass of feces and the cast skins of 1st 4 instars on the cast skin of the 5th instar. An adult was collected together on one and the same host, but has not yet been determined as to the specific name.

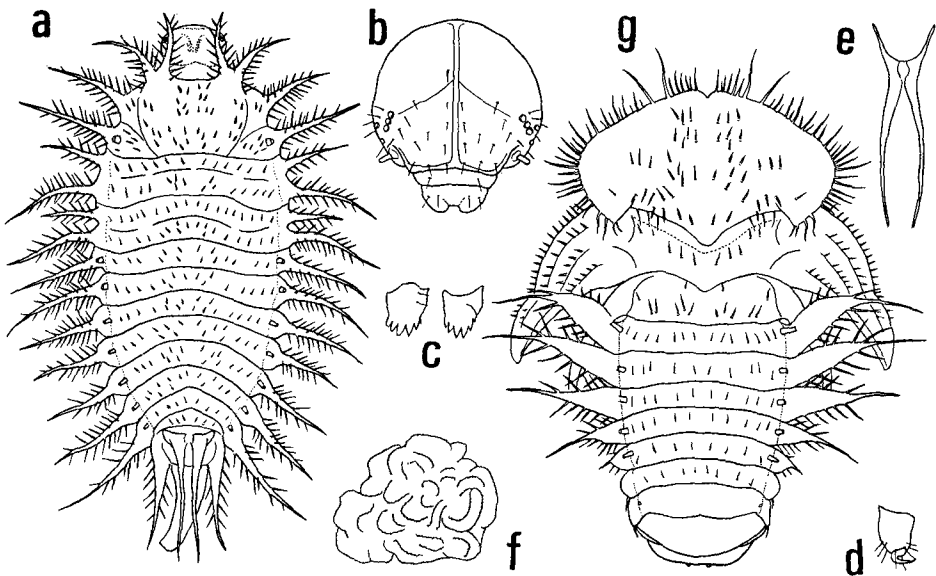


Fig. 12. *Cassida (Taiwania)* sp. 1

Full grown larva. a, dorsal view; b, head-capsule; c, mandible (as in Fig. 1); d, meso-thoracic tarsus; e, supra-anal processes; f, fecal mass. -g, pupa.

Cassida (Taiwania) sp. 2.

Last instar larva. Body oblong, narrowed posteriorly, about 6 mm in length and 2.5 mm in breadth; cream yellow with supra-anal processes light brownish; dorsum covered with short setae; lateral projections slender, 9th longer than half the width of 1st abdominal segment; spiracles as high as wide; mesothoracic one 1.5 times as high as wide. Head narrowed posteriorly; cordal suture connected with endo-carina; frontal suture almost lacking; vertex with a few setae on each side; frons with about 11 short setae on each side; antenna 2-segmented, with basal one weakly chitinized; labrum deeply emarginate at anterior margin; mandible 5-dentate. Pronotum with 1st and 2nd lateral projections fused basally; meso- and metathorax each with 2 transverse rows of setae on dorsum; relative length of lateral projections as: $2nd \approx 3rd \approx 4th \approx 6th > 1st \approx 8th > 9th \approx 15th > 10th \approx 16th > 5th \approx 7th \approx 11th \approx 12th \approx 13th \approx 14th$; 2nd 1.7 times as long as 5th; supra-anal processes slender, slightly shorter than 2nd lateral projection.

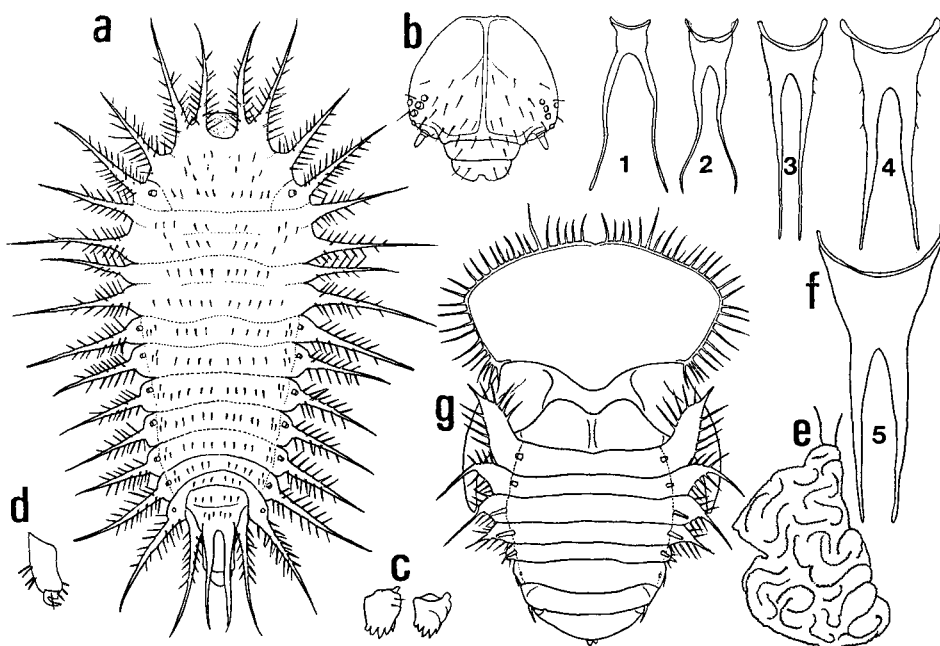


Fig. 13. *Cassida (Taiwania)* sp. 2.

Full grown larva. a, dorsal view; b, head-capsule; c, mandible (as in Fig. 1); d, mesothoracic tarsus; e, fecal mass (lateral view). f, supra-anal processes (as in Fig. 4). - g, pupa.

Pupa. Body oblong, narrowed posteriorly, about 5.3 mm in length and 3.2 mm in breadth; cream yellow and glabrous; pronotum with about 60 long marginal spinules, of which 2 pairs on the anterior margin are more or less stouter and 4 at posterior angle are fused basally; 1st 4 abdominal segments each with a leaflike lateral projection; 5th only slightly produced laterally; spiracles elevated, 1st and 2nd each as high as wide, 3rd and 4th extremely produced, each fully 3 times as high as wide, 5th twice as high as wide; 6th to 8th abdominal segments each with a short spinulelike process ventromarginally; 9th with a pair of small conical tubercles apically.

Host plants. *Leucas lanata* Benth. (Labiatae).

Specimens examined. 3 larvae & 1 pupa, Mettupalayam View (ca. 1000 m), Nilgiri Hills, Tamil Nadu, 10-xii-1978.

Notes. The larvae bear an irregularly shaped mass of feces completely covering the cast skins. The pupa retains this large mass of feces. One adult was reared from the larvae collected, but has not yet been determined.

Silana farinosa (Boheman)

Pupa. Body oval, 6.5 mm in length and 4 mm in breadth; pronotum slightly angulate laterally, with about 36 marginal spinules, of which mesal 4 pairs are stout; abdomen with a leaflike lateral projection on each of 1st 5 segments; 1st abdominal spiracle large and produced obliquely, higher than wide, 2nd smaller than 1st, as high as wide, but distinctly larger than each of 3rd to 5th, 3rd and 4th as high as wide, 5th almost flat; 6th and 7th segments each with distinct spinule-

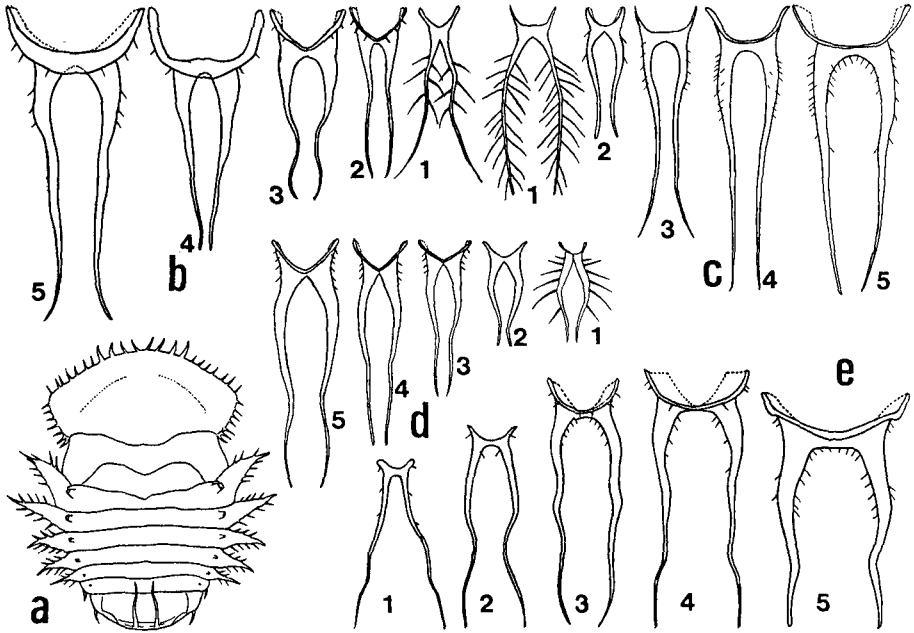


Fig. 14. a, *Silana farinosa* (Boheman), pupa. – Supra-anal processes (as in Fig. 4). b, *Aspidomorpha sanctaecrucis*; c, *A. spaethi*; d, *A. furcata*; e, *A. miliaris*.

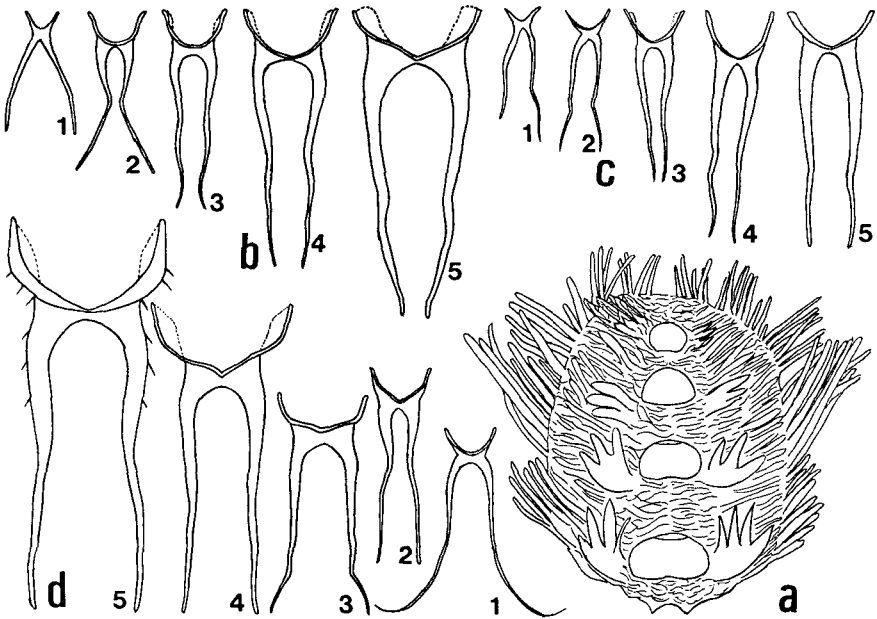


Fig. 15. a, *Thlaspidia cribrosa* (Boheman), cast skins and fecal mass of pupa. – Supra-anal processes (as in Fig. 4). b, *Laccoptera quatuordecimnotata*; c, *Chiridopsis bipunctata*; d, *Thlaspidia cribrosa*.

like process ventromarginally; 8th with a short process on venter; 9th segment with a pair of slender apical processes.

Host plants. *Ziziphus* sp. (Rhamnaceae).

Specimens examined. 1 mummified pupa, Thambaram, Tamil Nadu, 18-xii-1978.

Notes. The pupa bears at least the cast skin of the 5th instar larva. The specific determination was based on the association of adults and this pupa on one and the same host tree.

CHARACTERS OF THE IMMATURE STAGES OF TRIBES OF CASSIDINAE

The larvae of Cassidinae are well known for their peculiar habits and shapes. Accordingly there are a considerable amount of works on their biology and morphology. Most of these works are rather fragmental and deal with a few species except for the works by Muir and Sharp, Fiebrig, Gressitt and Ohno. To afford a basis for further discussion, some biological characters are summarized in Table 1 for 28 species which were observed by myself in India, Japan, Taiwan and Korea.

Egg. Eggs are generally laid in a semi-transparent egg-case, which consists of 2 layers of membranes. The egg-case may be bare or streaked with feces. In *Cassida* (*Taiwania*) *versicolora*, eggs are laid singly without egg-case on the leaf-surface and are streaked with feces. The number of eggs per egg-case is specific to each species and ranges from 1 to 15. In *Aspidomorpha* the pan-shaped egg-case is peculiarly furnished with an extra layer of membrane on the lower surface. Also in the genus elaborate oothecae composed of multiple egg-cases are known. For example, in *A. miliaris* 4 eggs are enclosed in an egg-case, and 10 to 20 egg-cases are piled up to make an ootheca. Thus 4 types of oviposition are recognized. 1. Eggs are laid bare. 2. Eggs are laid in an egg-case which is composed of 2 layers of membranes. 3. The egg-case is composed of 3 layers of membranes as in *Aspidomorpha*. 4. Multiple egg-cases are piled up into an ootheca.

Larva. The larva passes through 5 instars without exception and bears the cast skins one after another on the supra-anal processes. In *Aspidomorpha miliaris*, the 5th instar larva casts off the skins of 4 preceding instars before pupation. The cassidine larvae generally cover the cast skins with feces. The usage of feces, however, varies among species. 1. The feces are not utilized – a part of *Aspidomorpha*, and *Cassida* (*Cassida*) *nebulosa*. 2. Only the younger instar larvae utilize the feces – a part of *Cassida* (*Taiwania*) and *C. (Cassida) piperata*. 3. Feces are fully utilized during the whole larval stage – a part of *Aspidomorpha*, *Laccoptera*, a part of *Cassida* (*Taiwania*) and *C. (Cassida)*, *C. (Alledoya)*, *C. (Odontionycha)*, *Chiridopsis*, *Oocassida* and *Thlaspidia*. The above divisions are obviously not necessarily in accordance with systematic groups. However, once the shape of the fecal mass is considered, the 3rd group falls into 4 sub-groups which fairly agree with systematic groups, except for *Cassida*.

1. Filament type – a part of *Aspidomorpha*, and *Thlaspidia*.

Feces are long arcuate filamentous, protruding posteriorly from the cast skin of each instar. *Thlaspidia* (Fig. 15) has short and straight fecal filaments, which protrude from a rather flat fecal mass covering the cast skins. Except for the presence of these rod-like filaments, the fecal mass of *Thlaspidia* is suggestive of its relation to the 3rd type. In *T. lewisi* feces tend to cover the cast skin of each instar separately.

Table 1. Biological characters of observed larvae

Species	Host	Type of oviposition ^{a)}	Egg ^{b)}	5th instar larva		Pupa		Locality
				cast skins ^{c)}	feces	cast skins ^{c)}	feces	
<i>Aspidomorpha furcata</i>	<i>Ipomoea</i>	III	2-3	4	—	5	—	India
<i>A. dorsata</i>	<i>Ipomoea</i>			4	—	5	—	India
<i>A. spaethi</i>	<i>Ipomoea</i>	III	1-2	4	filaments	5	+	India
<i>A. sanctaerucis</i>	<i>Ipomoea</i>	IV (6-7)	5-6	4	filaments	5	+	India
<i>A. transparipennis</i>	<i>Calystegia</i>	III	4-5	4	—	5	—	Japan
<i>A. indica</i>	<i>Calystegia</i>	III	10-12	4	—	5	—	Japan, Korea
<i>A. miliaris</i>	<i>Ipomoea</i>	IV (10-20)	4	4 ^{d)}	—	1	—	India
<i>Lacoptera quadrimaculata</i>	<i>Ipomoea</i>	+II	1-2	4	shield	5	+	India, Taiwan
<i>L. quatuordecimnotata</i>	<i>Ipomoea</i>	+II	1-2	4	shield	5	+	India
<i>Cassida (Taiwania) sp. 1</i>	<i>Achyranthes</i>			4	mass	5	+	India
<i>C. (Taiwania) sp. 2</i>	<i>Leucas</i>			4	mass	1 ^{d)}	—	India
<i>C. (Taiwania) obtusata</i>	<i>Alternanthera</i>	II	1	4	mass	5	+	India
<i>C. (Taiwania) sauteri</i>	<i>Achyranthes</i>	II	3-4	4	mass	1	—	Taiwan
<i>C. (Taiwania) versicolora</i>	<i>Prunus</i>	+I	1	4	+(1, 2) ^{e)}	5	+(1, 2)	Taiwan, Japan
<i>C. (Taiwania) circumdata</i>	<i>Ipomoea</i>	II	1	4	+(1) ^{e)}	5	+(1)	Taiwan
<i>C. (Odontionycha) erudita</i>	<i>Isodon</i>	II	6-8	4	mass	1	—	Japan
<i>C. (Alledoya) vespertina</i>	<i>Clematis</i>			4	shield	5	+	Taiwan, Japan
<i>C. (Cassida) vibex</i>	<i>Cirsium</i>			4	mass	5	+	Japan
<i>C. (Cassida) fusciorufa</i>	<i>Artemisia</i>			4	mass	5	+	Japan, Korea
<i>C. (Cassida) rubiginosa</i>	<i>Cirsium</i>			4	mass	5	+	Japan
<i>C. (Cassida) piperata</i>	<i>Achyranthes</i>	II	1	4	+(1)	5	+(1)	Japan
<i>C. (Cassida) pallidicollis</i>	<i>Chenopodium</i>	II	5-7	4	mass	5	+	Korea
<i>C. (Cassida) nebulosa</i>	<i>Chenopodium</i>	II	12-15	4	—	1	—	Japan
<i>Chiridopsis bipunctata</i>	<i>Ipomoea</i>			4	spade	5	+	India
<i>C. promiscua</i>	<i>Ipomoea</i>			4	spade	5	+	India
<i>Oocassida cruenta</i>	<i>Ziziphus</i>	+II	1	4	mass	1	—	India
<i>Thlaspidia cribrata</i>	<i>Callicarpa</i>	II	1	4	filaments	5	+	Taiwan, Korea, Japan
<i>T. lewisi</i>	<i>Fraxinus</i>	II	1	4	filaments	5	+	Japan

a, See text; in type IV, numerals mean the number of egg-cases per ootheca; + indicates the presence of fecal streak.

b, Number of eggs per egg-case.

c, Number of cast skins retained by the 5th instar larva or pupa.

d, In *A. miliaris* the full grown larva casts off all the skins of younger larvae before pupation; in *Cassida* sp. 2, the pupa with at least the cast skin of the 5th instar larva.

e, 1st (and 2nd) instar larva(e) with feces.

2. Schield type – *Laccoptera* and *Cassida* (*Alledoya*) *vespertina*.

Feces are accumulated to form a thick, triangular to rectangular or pentagonal mass and almost wholly cover the cast skins. This type may be linked with the next type through *Laccoptera excavata* described by Muir and Sharp.

3. Spade type – *Chiridopsis* and a part of *Cassida* (*Taiwania*).

Feces are laid in a thin, flat, spadelike mass, surrounding cast skins and leaving open spaces in the mass (Fig. 8), or sometimes laid on the marginal areas of cast skins and forming small separate masses (Fig. 9). The fecal mass of the younger larvae in the subgenus *Taiwania* may be included in the next type.

4. Mass type – *Oocassida*, *Cassida* (*Odontionycha*), a part of *Cassida* (*Cassida*) and *Cassida* (*Taiwania*).

Feces form an irregular thick mass and cover the cast skins wholly.

Pupa. In most species the cast skins and feces are retained at the pupation, if kept during the larval stage. In some species (*Aspidomorpha miliaris*, *C. (Taiwania) sauteri*, *C. (Odontionycha) erudita*, *C. (Cassida) nebulosa*, *Cassida (Taiwania) sp. 2* and *Oocassida cruenta*), the full grown larva casts off the skins of preceding instars and pupates with only the cast skin of the 5th instar. There are, however, some variations concerning this habit among individuals of *C. nebulosa*: full grown larvae pupate mostly with all the cast skins retained, yet some cast off the skins of the 1st to 4th larval instars before pupation.

Considering all these traits and others, the observed genera are characterized in the immature stages as follows:

1. The genus *Aspidomorpha* is distinguished by the shape of the egg-case; fecal cover absent or of the filament type; lateral projections long in comparison with body width; 1st instar larva with 6 to 8 pairs of long stiff setae (in *A. spaethi*, with some 20 long setae) on supra-anal processes. *A. miliaris* is related to *A. puncticosta* and *A. confinis* described by Muir and Sharp, lacking such setae in the 1st instar. Host plants are *Ipomoea* and *Calystegia* (Convolvulaceae).

2. *Laccoptera* is characterized by the shield type feces and type 2 egg-case covered with feces. Host plants are *Ipomoea* (Convolvulaceae).

3. *Chiridopsis* is characterized by the spade type feces and type 2 egg-case. Host plants are *Ipomoea* (Convolvulaceae).

4. *Oocassida* is characterized by the mass type feces; pupation without cast skins of younger larvae; supra-anal processes peculiarly shaped, being united in a long common stalk, then diverging distally. Host plants are *Ziziphus* (Rhamnaceae).

5. *Thlaspida* is characterized by the short filament type feces, which is suggestive of its relation to the spade type; spiracles flat. Host plants are *Fraxinus* (Oleaceae) in *T. lewisi* and *Callicarpa* (Verbenaceae) in *T. cribrosa*.

6. *Cassida* is rather heterogeneous; fecal cover of the mass type, or of the shield type in *C. (Alledoya) vespertina*, absent in *C. (Cassida) nebulosa*; in *C. (Taiwania) versicolora* and *C. (Taiwania) circumdata* only the 1st and 2nd instar larvae bear the feces which may be of the spade type. Host plants are diverse: Labiatae, Convolvulaceae, Rosaceae, Compositae, Amaranthaceae and Ranunculaceae.

7. *Silana* is only known of the pupal exuviae. Host plants are *Ziziphus* (Rhamnaceae).

Among the 7 examined genera the genus *Aspidomorpha* is well defined by the characters of the immature stages, whereas the other 6 genera are not so

distinct from each other. In the systematics of adults (Hincks), *Aspidomorpha* and *Laccoptera* belong to the tribe Aspidomorphini and the rest to Cassidini. The former tribe is distinguished from the latter by the presence of a comb-like structure at the base of tarsal claws. In the larval characters, *Laccoptera* seems to be closer to *Chiridopsis* than to *Aspidomorpha*. The 7 examined genera belong to the above 2 tribes and are rather homogeneous in the morphological traits of the larvae.

Hincks classified the subfamily into 19 tribes, of which 26 genera belonging to 12 tribes are known of their immature stages. These genera are listed in Appendix with brief notes on their characters of the immature stages. In the following lines I give a summary of the known characters for each stage and then try to define each tribe.

Egg. Eggs are laid upright or obliquely (types 1 to 3 in Table 2), or transversely (types 4 to 7) on the leaf-surface. 1. Eggs are laid bare on the leaf-surface, or sometimes fixed with strings or hung down by strings from the leaf like a bunch of grapes; in any cases a few to some 30 eggs are clustered. 2. Eggs are clustered in a group and covered with frothy material and/or small scalelike structures of papery material. 3. Eggs are clustered in an elaborate ootheca which looks like a honey-comb or ant-hill. 4. Eggs are laid singly on the leaf-surface without egg-case or with a membranous layer on the upper side, and sometimes streaked with feces. 5. One to some 15 eggs are clustered in a simple egg-case which is composed of 2 layers of membranes. 6. The type 4 egg-cases are furnished with an extra layer of membrane on the lower surface as in *Aspidomorpha*. 7. Thirty to eighty eggs are clustered in an elaborate ootheca which is basically an accumulation of the type 5 egg-cases.

Larva. The lateral projections widely vary in shape from extremely short, spinule-like ones in *Physonota* to slender ones longer than half the body width as in some species of *Aspidomorpha* through short, stout hornlike ones in *Acromis*. They occur in 10, 14, 16 or 17 pairs: 0 (on prothorax) - 1 (on mesothorax) - 1 (on metathorax) - 8 (on abdomen) in *Acromis*; 2-1-1-0-6 (abdomen with projections on 2nd to 7th segments) in *Physonota*; 3-2-1-8 in *Epistictina*, *Polycalca* (part), *Stolas*, *Chelymorpha*, *Coptocycla* (part), *Charidotella* and *Cteisella*; 3-3-2-8, in many species of Cassidini and Aspidomorphini; 4-3-2-8 in *Omocerus*, *Polycalca* (part) and *Dorynota*. The supra-anal processes also show a wide variety in shape: paired and short hornlike in *Acromis*; paired and of common type as in *Cassida*; with a long common stalk in *Oocassida*; in *Polycalca* (*Desmonota*) *denticulata* (Boheman) or *Coptocycla* (*Psalidinota*) *contempta* (Boheman) the processes evolve into a very grotesque form as illustrated by Fiebrig. The habit of bearing the cast skins and fecal mass is also diverse as previously discussed. In addition to the 4 types, there is another type, the spiral type, shown by *Polycalca* (*Polycalca*) *metallica* Klark and *P. (P.) laticollis* Boheman: feces are piled up conically and look like a spiral shell. In the genus *Charidotis* both the shield type (*C. clypeolata* Boheman, *C. mansueta* Boheman, and *C. gibbipennis* Spaeth), and the spade type (*C. auroguttata* Boheman) are observed. This also may suggest a close relation between these types.

Pupa. The abdomen has 5 pairs of lateral projections in many species, but 4 pairs in *Epistictina*, and 3 pairs in *Basiprionota*, *Dorynota* (part) and *Charidotis* (part). *Dorynota monoceros* (Germer) entirely lacks these projections. With or without cast skins of younger instars; with or without marginal spinules on pronotum, which is sometimes deeply incised at middle on the anterior margin. In *Basiprionota bimaculata* (Thunberg) the pronotum is distinctly tuberculate.

Table 2. Characters of the immature stages for some tribes of Cassidinae

Tribe		Oviposition type ^{b)}							5th instar larva			Pupa		
		1	2	3	4	5	6	7	lateral projections	cast skins ^{c)}	feces	lateral projections	cast skins ^{c)}	feces
Epistictinini	(1) ^{a)}								14 pairs	+	filaments	4 pairs	1	—
Basiprionotini	(4)		+			+			14, 16	+	filaments	3, 5	1	—
Hemisphaerotini	(2)				+					+	filaments		5?	+
Omocerini	(5)		+			+			14, 17	—, 4	—, spiral	5	1	—
Dorynotini	(3)					+			17	+	filaments	0, 3, 5	1	—
Stolaini	(7)	+							10, 14	+	mass	5	1	—
Ischyrosomychini	(2)			+					16	4	—	5	5	—
Physonotini	(2)								10, 14					
Aspidomorphini	(17)					+	+	+	16	4	—, filaments, shield	5	5	—, +
Basiptini	(1)			+					16	—	—	5	1	—
Cassidini	(25)				+	+			16, 17	4	filaments, mass, shield, spade	5	1, 5	—, +
Charidotini	(5)					+			16, 17	4	shield, spade	3, 5	5	+

a, Number of species which are considered here.

b, See text.

c, Number of cast skins retained by the 5th instar larva or pupa; +, exact number of cast skins is unknown.

Table 2 summarizes these characters for each tribe. With a limited number of known larvae, it is very difficult to discuss about the phylogenetic relations among these tribes. The mode of oviposition, number of lateral projections and shape of fecal cover are useful for this purpose as already stated by authors. The subfamilies Cassidinae and Hispinae together constitute the group Cryptostomata of Chapuis. They are characterized by the tarsi 4-segmented, the head which is directed downward, and the abdomen with 8 visible tergites, and occupy a rather distinct position in the family Chrysomelidae. There is, however, no clear distinction between these 2 subfamilies. They are connected by an almost perfect series of transitional forms in adult structure. The cassidine larvae are generally defined as free-living with a pair of supra-anal processes in contrast to the leaf-mining hispine larvae without such processes. This distinction is not clear, for at least some larvae of the hispine genera, *Callispa* Baly and *Leptispa* Baly are ectophagous on leaves with well-developed supra-anal processes, thus are not distinguishable from the typical cassidine larvae (Chen). On the other hand the genus *Notosachantha* Chevrolat is said to 'have apparently a leaf-mining larva' (Gressitt and Kimoto). The cassidine larvae, which are well known of their peculiar shape and habit, may have evolved from a leaf-mining type or another type living concealed between the closely appressed leaf-bases and thus seem to be connected with the hispine leaf-miners as in the case of the adults. Although Cassidinae and Hispinae are commonly accepted as distinct subfamilies, it is reasonable to treat them as a single subfamily. Chen regarded the group as a superfamily and divided it into 4 families, Cassididae, Hispidae, Anisoderidae and Callispidae. His system seems less contradictory to our knowledge on the immature stages apart from the problem in the ranking of the groups.

ACKNOWLEDGEMENTS

First of all I wish to express my hearty thanks to Prof. D. N. Raychaudhuri, University of Calcutta, for the realization of this project and also to his staff and students: Dr. N. B. Chatterjee, Mr. J. L. Ganguly, Mr. S. Sarkar, Dr. M. R. Ghosh, Dr. P. K. Mandal, Dr. Dinendra N. Raychaudhuri and all other persons of his laboratory.

Dr. T. N. Ananthkrishnan, the Director of the Zoological Survey of India, Calcutta, also gave a great help to the project. I am also thankful to the following members of the Zoological Survey of India for their help: Dr. R. K. Varshney, Dr. R. C. Basu, Dr. G. S. Arora, Dr. N. Muraleedharan, Dr. B. C. Das, Dr. S. K. Mandal and Dr. C. R. Basu; Dr. B. S. Lamba, the Director of the Northern Regional Station of the Zoological Survey of India, Dehra Dun, and Dr. Arun Kumar and Dr. S. C. Verma of the station; Dr. J. M. Julka, High Altitude Zoology Field Station, Zoological Survey of India, Solan.

My hearty thanks are also due to Prof. V. K. Gupta, University of Delhi; Dr. P. K. Sen-Sarma, Forest Research Institute and College, Dehra Dun; Dr. A. Ramen and Dr. C. Kandasamy, Loyola College, Madras; Prof. K. Yasumatsu and Dr. A. Lewvanich for their kind help and hospitality in Bangkok. I am particularly grateful to Dr. N. C. Nair, Dr. A. N. Henry, Dr. M. S. Swaminathan and other members of the Southern Circle, Botanical Survey of India, Coimbatore, for their help in identifying host plants.

Last I wish to express my cordial thanks to the Authorities of the Indian Government for their permission and support for the project.

REFERENCES

- Artigas, J. N. 1973. Estados preimaginales de *Chelymorpha varians* Blanch. (Coleoptera, Chrysomelidae). Bol. Cos. Biol. de Concepcion 46: 163-168.
- Böving, A. G. and F. C. Craighead. 1930. An illustrated synopsis of the principal larval forms of the order Coleoptera. Entomol. Amer. n.s. 11: 1-86, pls. 125.
- Chen, S. 1964. Evolution and classification of the chrysomelid beetles (in Chinese). Acta Entomol. Sinica 13: 469-483.
- Chen, S. 1973. The classification of leaf-beetles (in Chinese). Acta Entomol. Sinica 16: 47-56.
- Dubeshko, L. and L. N. Medvedev. 1975. On the knowledge of the larvae of Chrysomelidae (Coleoptera) of the fauna of Mongolia (in Russian). Insects of Mongolia 3: 234-242.
- Fiebrig, K. 1910. Cassiden und Cyprtocephaliden Paraguays. Zool. Jahrb. suppl. 12(2): 161-264, pls. 4-9.
- Gressitt, J. L. 1952. The tortoise-beetles of China (Chrysomelidae: Cassidinae). Proc. Calif. Acad. Sci. 27: 433-592, pls. 10.
- Greeitt, J. L. and S. Kimoto. 1963. The Chrysomelidae (Coleopt.) of China and Korea, part 2. Pacif. Ins. Mon. IB: 301-1026.
- Hincks, W. D. 1952. The genera of the Cassidinae (Coleoptera: Chrysomelidae). Trans. Roy. Entomol. Soc. Lond. 103: 327-358.
- Hoffman, W. E. 1933. The biology and control of *Laccoptera chinensis* F. Lingnan Sci. Jour. 12: 259-260, pl. 16.
- Kershaw, J. C. and F. Miur. 1907. On the egg-cases and early stages of some South China Cassididae. Trans. Entomol. Soc. Lond. 1907: 249-252.
- Lefroy, M. and F. M. Fowlett. 1909. Indian Insect Life, 786 pp. Agric. Inst., Pusa, New Dehli.
- Maulik, S. 1910. Fauna of British India, Chrysomelidae (Hispiinae and Cassidinae). 439 pp. Today and Tomorrow's (reprint ed.), Faridabad.
- Maulik, S. 1948. Early stages and habits of *Sindia clathrata* Fabr. Ann. Mag. nat. Hist. 12: 368-371.
- Maulik, S. 1949. Immature stages of the British chrysomelid I. *Pilestoma fastuosa* (Schaller) (Casid.). Ann. Mag. nat. Hist. 12: 633-638.
- Medvedev, L. N. and E. G. Matys. 1975. Neue paläarktische Schildkäferlarven der Gattung *Cassida* L. (Coleoptera, Chrysomelidae). Dtsch. Ent. Z. N. F. 22: 137-143.
- Muir, F. and D. Sharp. 1904. On the egg-cases and early stages of some Cassididae. Trans. Entomol. Soc. Lond. 1904: 1-21, pls. 1-5.
- Ohno, M. 1956. On the Japanese tortoise beetles belonging to the genus *Thlaspida* Weise, with special reference to the morphology and biology of their early stages (in Japanese). Bull. Toyo Univ. 9: 138-129, pls. 3.
- Peterson, A. 1951. Larvae of Insects II. 416 pp, Columbus, Ohio.

Appendix

A LIST OF CASSIDINE GENERA OF WHICH THE IMMATURE STAGES ARE KNOWN,
WITH BRIEF NOTES ON THEIR CHARACTERS

Tribe Epistictinini

Epistictinia Hincks (after Gressitt, 1952) - *Larva*. Lateral projections in 14 pairs (3-2-1-8); 1st and 2nd lateral projections stout and short; feces in long stringy filaments. *Pupa*. Pronotum feebly emarginate at middle on anterior margin; abdomen with stout, triangular lateral projections on 1st 4 segments.

Tribe Basiprionotini

Basiprionota Chevrolat (after Gressitt, 1952) – *Egg*. Laid singly in a simple egg-case, sometimes with a bit of feces. *Larva*. Lateral projections stout and with granule-like spinules, in 16 pairs (3–3–2–8); feces in long curved filaments arranged in concentric arcs. *Pupa*. Pronotum distinctly emarginate on anterior margin and tuberculate on disc; abdomen with fleshy lateral projections on 2nd to 4th segments. *Hosts*. *Premna* sp. (Verbenaceae), *Liquidambar* sp. (Altingiaceae).

Craspedonta Chevrolat (after Gressitt, 1952 and Lefroy & Fawlett, 1909) – *Egg*. Many eggs laid in a large dense group and surrounded with a frothy material. *Larva*. Lateral projections in 14 pairs (3–2–1–8); 1st and 2nd projections as long as 15th or 16th; feces in long stringy filaments. *Pupa*. Pronotum feebly emarginate apically; abdomen with long curved lateral projections on 1st 5 segments; with cast skin of 5th instar larva and no feces. *Hosts*. *Gmelina* sp. (Verbenaceae).

Tribe Hemisphaerotini

Hemisphaerota Chevrolat (after Fiebrig, 1910, Böving & Craighead as *Porphyraspis**, 1930) – *Egg*. Laid singly and covered with yellowish substance and feces. *Larva*. Feces in long curved filaments which form a round nestlike shape. *Hosts*. *Cocos* sp. (Palmaceae).

Tribe Omocerini

Omocerus Chevrolat (after Fiebrig as *Tauroma*, 1910) – *Egg*. Laid singly in egg-case which bears spinules on margins. *Larva*. Round with 17 pairs (4–3–2–8) of lateral projections, which are short and curved backwardly; supra-anal processes extremely short, without cast skins and feces. *Hosts*. *Hyptis* sp. (Labiatae).

Polycalca (*Desmonota*) (Hope) (after Fiebrig, 1910) – *Larva*. Body markedly colored with red-orange, yellow, gray and black; lateral projections in 17 pairs (4–3–2–8); supra-anal processes robust with a common stalk. *Hosts*. *Ipomoea* sp. (Convolvulaceae)

Polycalca (*Polycalca*) Chevrolat (after Fiebrig, 1910) – *Egg*. About 7 to 30 eggs are piled up like scales and covered with brownish material. *Larva*. Lateral projections in 14 pairs (3–2–1–8); with cast skins and a large fecal mass of spiral type. *Pupa*. Lateral projections in 5 pairs; with cast skin of 5th instar larva. *Hosts*. *Hyptis* sp. (Labiatae) and *Cordia* sp. (Ehretiaceae).

Tribe Dorynotini

Dorynota Chevrolat (after Fiebrig as *Batonota*, 1910) – *Egg*. Laid singly in a simple egg-case, which is sometimes imbedded into a shoot of host. *Larva*. Lateral projections in 17 pairs (4–3–2–8); feces in long filaments. *Pupa*. Lateral projections in 3 or 5 pairs; in one case largely reduced into small tubercles. *Hosts*. *Tecoma* sp. (Bignoniaceae).

Tribe Stolaini

Stolas (*Batanochara*) Dejean (after Fiebrig as *Poecilaspis*, 1910) – *Egg*. Laid singly or some eggs in a group, sometimes hung down from host with a string. *Larva*. Lateral projections in 14 pairs (3–2–1–8); feces in a mass, or only with cast skins, but sometimes younger larvae with feces. *Pupa*. Lateral projections in 5 pairs; with cast skin of 5th instar larva. *Hosts*. *Mikania* sp. (Compositae) and *Ipomoea* sp. (Convolvulaceae).

* Generic name adopted according to Hincks.

Chelymorpha Chevrolat (after Peterson, 1951, and Artigas, 1973) – *Egg*. Some eggs laid bare in a group and placed upright. *Larva*. Lateral projections in 5 pairs. *Hosts*. *Convolvus* sp. (Convolvulaceae).

Acromis Chevrolat (after Fiebrig as *Selenis*, 1910) – *Egg*. About 30 eggs hung down like a bunch of grapes. The female stays on the egg-mass. *Larva*. Lateral projections short and in 10 pairs (0–1–1–8); supra-anal processes short; without cast skins and feces, sometimes with a part of cast skin. *Hosts*. – *Ipomoea* sp. (Convolvulaceae).

Tribe Ischyrosomychini

Cistudinella Champion (after Fiebrig, 1910) – *Egg*. An elaborate ootheca like a honey-comb contains upto 50 eggs. *Larva*. Lateral projections long and in 16 pairs (3–3–2–8), 4th, 5th and 7th ones very short; with all the cast skins but no feces; 1st instar larva with long setae on supra-anal processes. *Pupa*. Lateral projections in 5 pairs; with all the cast skins but no feces. *Hosts*. *Cordia* sp. (Ehretiaceae) and *Pentagonula* sp.

Tribe Physonotini

Physonota Boheman (after Peterson, 1951 and Böving & Craighead as *Eurypelpa*, 1930) – *Larva*. 10 pairs (2–1–1–0–6) of lateral projections extremely short and spinelike; in *Physonota* (*Eurypelpa*) Boheman in 14 pairs (3–2–2–7); the posterior projection on each of meso- and metathorax longer than the anterior one; supra-anal processes almost vestigial. *Hosts*. *Helianthus* sp. and *Heliopsis* sp. (both Compositae).

Tribe Aspidomorphini

Aspidomorpha Hope (after Muir & Sharp, 1904, Kershaw & Muir, 1907) – As shown in Table 1. *Hosts*. Convolvulaceae.

Laccoptera Boheman (after Muir & Sharp, 1904 and Gressitt, 1952) – As shown in Table 1. *Hosts*. Convolvulaceae.

Sindia Weise (after Maulik, 1948) – *Egg*. Laid singly in a simple egg-case which is fringed with short spinules. *Larva*. Lateral projections longer than 1/4 body width, in 16 pairs (3–3–2–8), 1st and 2nd distinctly joined at base; with all the cast skins and feces which form a triangular shield-type mass.

Tribe Basiptini

Basipta Chevrolat (after Muir & Sharp, 1904) – *Egg*. The ootheca is build around the stem of hosts, conical and somewhat like an ant-hill in shape. *Larva*. Lateral projections in 16 pairs (3–3–2–8); supra-anal processes greatly enlarged and curved apically; without cast skins and feces. *Pupa*. Lateral projections in 5 pairs; with cast skin of 5th instar larva. *Hosts*. *Brachylaena* sp. (Compositae).

Tribe Cassidini

Cassida Linne (after Muir & Sharp, 1904, Kershaw & Muir, 1907, Maulik, 1949, Medvedev & Matys, 1975, Dubeshko & Medvedev, 1975) – As shown in Table 1. *Hosts*. Amaranthaceae, Compositae, Convolvulaceae, Labiatae, Ranunculaceae, Rosaceae.

Coptocycla (*Coptocycla*) Chevrolat (after Fiebrig, 1910) – *Egg*. Laid singly in a simple egg-case, sometimes covered with feces. *Larva*. Lateral projections in 16 pairs (3–3–2–8); with cast skins; 1st instar larva with long straight filaments of

feces. In other species with lateral projections in 17 pairs (4-3-2-8); with fecal mass irregular in shape. *Hosts.* *Pithecoctenium* sp. (Bignoniaceae) and *Cordia* sp. (Ehretiaceae).

Coptocyclus (Psalidinota) (Boheman) (after Fiebrig, 1910) – *Egg.* Egg-case simple. *Larva.* Lateral projections extremely short, in 17 pairs (4-3-2-8); supra-anal processes with long stalk and peculiarly shaped; without feces and cast skins; 1st instar larva with a small fecal mass. *Pupa.* Pronotum incised at middle on anterior margin; lateral projections in 5 pairs; 9th abdominal processes similar to larval supra-anal processes. *Hosts.* *Cordia* sp. (Ehretiaceae).

Plagiometriona Spaeth (after Fiebrig, 1910) – *Egg.* Laid singly in a simple egg-case, covered with feces. Two cases are placed side by side. *Larva.* Lateral projections in 16 pairs (3-3-2-8); with irregular mass of feces but no cast skins; supra-anal processes very short. *Hosts.* *Acnistus* sp. (Solanaceae).

Charidotella Weise (after Fiebrig as *Cassida*, 1910) – *Egg.* Two eggs are laid side by side among the hairs of host leaves. *First instar larva.* Lateral projections extremely long and in 17 pairs (4-3-2-8); supra-anal processes with a long common stalk, diverge widely at middle and again approximate distally. *Hosts.* *Ipomoea* sp. (Convolvulaceae)

Tribe Charidotini

Charidotis Boheman (after Fiebrig, 1910) – *Egg.* Laid singly in somewhat specialized egg-case; in other species about 50 eggs are closely laid on a shoot and irregularly covered with membranous pieces and frothy material. *Larva.* Lateral projections in 16 pairs (3-3-2-8); with cast skins; with feces of triangular shield type or spade type. *Pupa.* Lateral projections in 3 or 5 pairs; with cast skins and feces. *Hosts.* *Tecoma* sp., *Pyrostegia* sp., *Bignonia* sp. (all Bignoniaceae), and *Anisomeris* sp. (Rubiaceae)

Cteisella Weise (after Fiebrig, 1910) – *Egg.* Laid singly in a simple egg-case. *Larva.* Lateral projections in 17 pairs (4-3-2-8); with feces of spade type.