

Description of Immature Stages of the Chinese Rose Beetle, *Adoretus sinicus* Burmeister (Coleoptera: Scarabaeidae)¹

DALE H. HABECK
HAWAII AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF HAWAII
HONOLULU, HAWAII

(Submitted for publication December, 1962)

INTRODUCTION

The Chinese rose beetle, *Adoretus sinicus* Burmeister, is an important pest of many crop and ornamental plants in Hawaii and other areas. Although several authors have published illustrations of diagnostic characteristics of the larva, no complete description exists in the literature. This lack of information on immature stages is due, no doubt, to the fact that it is the adult alone which does the economic damage. Timberlake (1919) illustrated the raster to show how it differs from those of *Popillia japonica* Newman and *Anomala orientalis* (Waterhouse). Ritcher (1948) used this species to characterize the tribe Adoretini in his key to the tribes of the Rutelinae. He illustrated the raster, the epipharynx, and the last antennal segment.

Though more than 250 species of *Adoretus* are listed by Ohaus (1915), the larvae of only a few species have been adequately described. Viado (1939) in the Philippines described and illustrated *A. luridus* Blanchard and *A. ranunculus* Burmeister in considerable detail. Friedrichs (1915) described and illustrated parts of *A. vestitus* Boheman (= *A. versutus* Harold) from Samoa, and Gravely (1919) briefly described and illustrated parts of *A. lacustris* Arrow, *A. versutus* Harold, and *A. caliginosus* Burmeister in India. This last species was also illustrated in all stages by Fletcher and Ghosh (1920). The larva of a fourth Indian species, *A. bimarginatus* Ohaus, was described and illustrated by Gardner (1935).

Since so few species of *Adoretus* larvae have been adequately described, the following description is necessarily detailed so that as other larvae of this genus become known, comparisons will be possible. The terminology used in this paper is generally that of Böving (1936). The specimens used in this study were mostly laboratory-reared, but some larvae and pupae were collected at various Oahu localities.

The generous assistance of Dr. Ryoji Namba who made numerous suggestions for improvement of this manuscript is gratefully acknowledged. Especial thanks go to my wife, Phyllis P. Habeck, who prepared the illustrations and assisted in numerous other ways.

¹Published with the approval of the Director as Technical Paper No. 610.

EGG

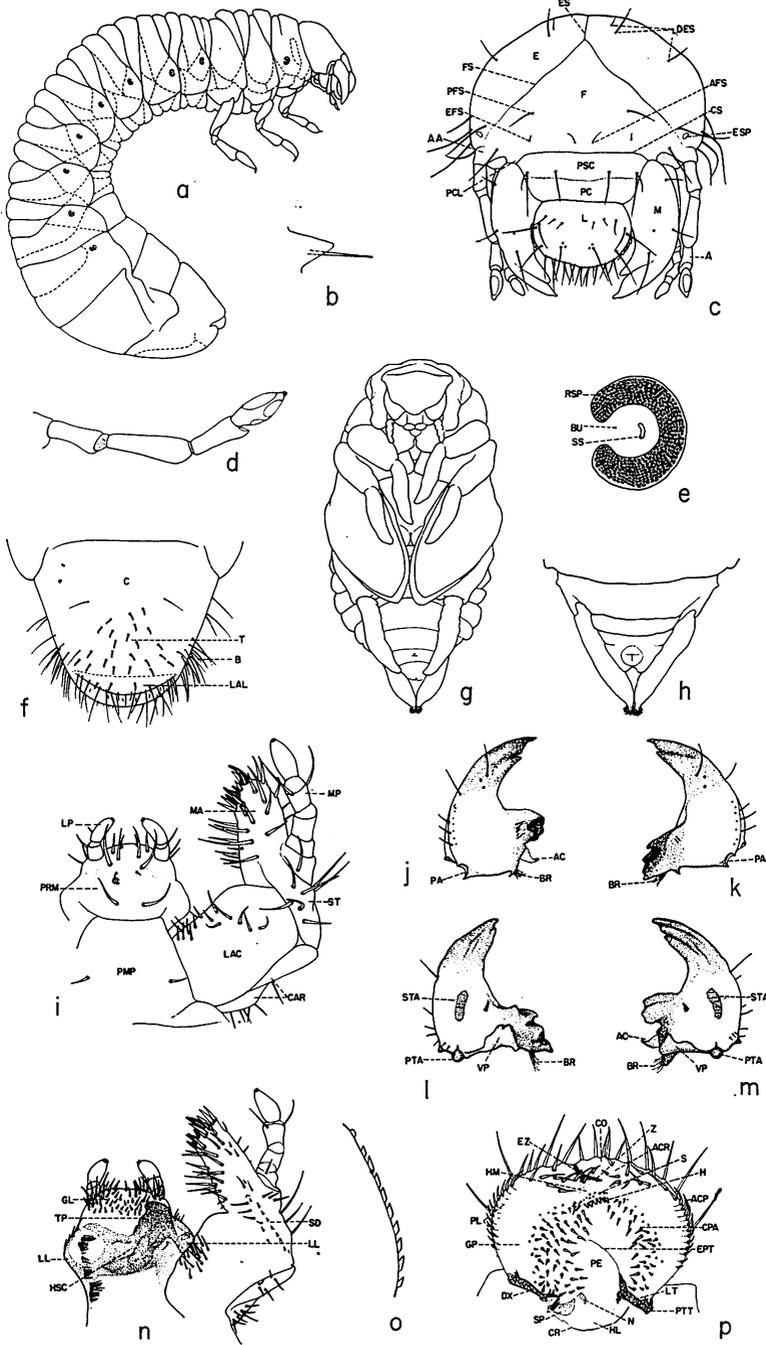
Shining white at oviposition, gradually becoming dull creamy white before hatching. Reddish-brown mandibles of first-instar larva clearly visible through chorion prior to hatching. Shape at oviposition oblong, about twice as long as broad; average dimensions 1.46 mm. long and 0.86 mm. wide. Shape before hatching broadly oval; average dimensions 1.67 mm. long and 1.37 mm. wide.

LARVA

The larvae of *A. sinicus* pass through three instars which can be separated by differences in size of head capsule. The average width in millimeters of the head capsule of three instars respectively, is 1.2, 1.9, and 3.1. No morphological differences were found to separate second and third instars. First instar is readily separated from older instars by presence of the hatching spine located on dorsolateral area of metathorax. The reddish-brown spine (fig. 1, b) is short, triangular, and extends outward and posteriorly. A short seta from inner side of spine near base extends outward between body and spine. An additional diagnostic characteristic of the first instar larva is the circular spiracular plate without bulla or spiracular slit which are characteristic of the older instars. The following description is based on mature third instar larvae; it is equally applicable to the first and second instar larvae except for the differences noted above. *Third Instar Larvae* (fig. 1, a): Typically scarabaeiform. Maximum length along mid-dorsal line about 34 mm. *Head Capsule* (fig. 1, c): Average width 3.1 mm., range 2.85–3.41 mm. Smooth, shining, yellowish brown; black pigmented eyespot (ESP) present. Epicranial suture (ES) distinct, blacker than, and about half as long as frontal sutures (FS). Frontal sutures represented by a fine white line extending toward antennal base but fading out near eyespot. Frons (F)

FIGURE 1.—*Adoretus sinicus* Burmeister: a, third instar larva, right lateral view; b, hatching spine, first instar, lateral view; c, head capsule, frontal aspect; d, antenna; e, abdominal spiracle; f, raster; g, female pupa, ventral view; h, male pupa, end of abdomen, ventral view; i, left maxilla and labium, ventral view; j, left mandible, dorsal view; k, right mandible, dorsal view; l, left mandible, ventral view; m, right mandible, ventral view; n, right maxilla, labium and hypopharyngeal sclerome, dorsal view; o, mandibular stridulating area, side view; p, epipharynx.

Abbreviations: A, antenna; AA, anterior angle; AC, acia; ACP, acanthoparia; ACR, acroparia; AFS, anterior frontal seta; B, barbula; BR, brustia; BU, bulla; C, campus; CAR, cardo; CO, corypha; CPA, chaetoparia; CF, crepis; CS, clypeofrontal suture; DES, dorsoepicranial suture; DX, dextotorma; E, epicranium; EFS, exterior frontal seta; EPT, epitorma; ES, epicranial suture; ESP, eyespot; EZ, epizygum; F, frons; FS, frontal suture; GL, glossa; GP, gymnoparia; H, helus; HL, haptolachus; HM, haptomeron; HSC, hypopharyngeal sclerome; L, labrum; LAC, labacoria; LAL, lower anal lip; LL, lateral lobe; LP, labial palpus; LT, laetotorma; M, mandible; MA, mala; MP, maxillary palpus; N, nesium; PA, preartus; PC, preclypeus; PCL, precoila; PE, pedium; PFS, posterior frontal seta; PL, plegma; PMP, postmentum; PRM, prementum; PSC, postclypeus; PTA, postartus; PTT, pternotorma; RSP, respiratory plate; S, sensilla; SP, sclerotized plate; SS, spiracular slit; ST, stipes; STA, stridulating area; T, teges; TP, truncate process; VP, ventral process; Z, zygum.



triangular, with three pair of setae: posterior frontal setae (PFS) located laterally near frontal suture closer to base of frons than to apex; anterior frontal setae (AFS) just above clypeo-frontal suture (CS) separated from each other by distance equal to their length; exterior frontal setae (EFS) located about midway between posterior frontal setae and precoila (PCL). Anterior angles (AA) with a seta midway between antennal base and precoila. Occasionally, a second smaller seta present in either or both angles. Epicranium with three conspicuous dorsal epicranial setae (DES) on each side, posterior-most pair no more and usually much less than half as long as other two. Three or four inconspicuous setae present in a line extending dorsal from most laterad of dorsal epicranial setae. Six conspicuous setae present laterally near antennal base on each side, one seta mesad of eyespot close to frontal suture, other laterad of eyespot. Genal area with five to nine small inconspicuous setae. Small pores scattered on surface of epicranium and frons.

Clypeus: Proximally 2.7 times wider than long and distally 2.3 times wider; divided into postclypeus (PSC) and preclypeus (PC) by apparent stronger sclerotization of the postclypeus. Postclypeus with three pairs of setae; two close together near lateral margin, one shorter and closer to lateral margin than others; third pair just proximal of preclypeus and more medial. Numerous pores on the postclypeus. Preclypeus asymmetrical, left anterior angle less obtuse than right anterior angle; without setae or pores.

Labrum: Asymmetrical, about 1.5 times as wide as long; lateral edges rounded. Basal half with three pairs (sometimes two or four and rarely as many as six) of setae in a line about equidistant from each other and slightly closer to lateral edge than midline. Distally, three pairs of long setae present on margin equidistant from each other, two lateral ones nearer to the edge. Five pairs of setae on apical edge, easily confused with setae protruding from epipharynx. Numerous pores scattered over the surface of the labrum; two pairs consistently dorsad and mesad near distal medial seta.

Antennae (fig. 1, *d*): Four-segmented, arising from projection of head capsule near mandibular base. Segment 2 longest, followed in decreasing order by segments 1, 3, and 4. Segment 3 with apical ventral projection with oval transverse sensory area on inner surface of projection. Segment 4 with three sensory areas, a single large oval one on dorsal side; two smaller ones on ventral sides; apical one oval and larger than circular proximal one. Antennae without setae except for a few minute ones at apex of segment 4.

Mandibles (fig. 1, *j-m*): Yellowish brown on posteriolateral aspect grading to reddish brown and finally black at scissorial and molar areas. Left mandible with outer scissorial tooth wider than inner tooth; right mandible with teeth equal in width although outer projects farther than inner. Furrow separating teeth deeper on left mandible than on right. Each mandible with a seta dorsally about one-third of way from apex.

and another seta midway between apex and base but more laterad. Basal half of mandible with three dorsolateral setae and three inconspicuous ventrolateral setae at base. Dorsal surface of distal portion of mola with few small setae clumped together. Differences in mandibles pronounced in molar area as illustrated (fig. 1, *j, k*). *Acia* (AC) present on medio-dorsal aspect of left mandible near base with setae along posterior margin and apex. *Brustia* or *penicillus* (BR) of right mandible consists of single tuft of setae at mola base; of left mandible, a semicircle of setae around base of molar heel. Each mandible with prominent ventral process (VP) projecting medially and ventrally near base mostly covered by microspines (visible under compound magnification) which extend nearly to condyles. Elongate, oval stridulating area (STA) present on ventral surface of each mandible. Two to six setae on dorsal surface near molar area. Anterior articulation by preartis (PA) on dorsolateral margin of each mandible and precoila at posterolateral margin of clypeus, posterior articulation by ventral postartis (PTA) and postcoila on genae.

Maxilla (fig. 1, *i, n*): Consists of fused galea and lacinia forming mala (MA), cardo (CAR), stipes (ST), and four-segmented maxillary palpus (MP). Cardo consists of two sclerites: basicardo with eight to twelve small setae; disticardo with four to seven small setae. Stipes with five to six setae; palpifer with one ventral and three or four dorsal setae located near end of stridulating spines. Labacoria (LAC) ventral surface with several setae in oblique line which extends mesad around to dorsal surface. Stipes dorsally with row of eight to ten stridulating spines (fig. 1, *o*) which rub against the stridulating area on ventral surface of mandibles. Mala with numerous spines and setae, the distal ones stronger than proximal ones; a strong spine (uncus of galea) apically; just proximal of it three smaller spines (unci of lacinia) united basally. Five to seven short setae present in a row parallel to stridulating spines. Maxillary palpus without setae except for one dorsal seta on segment 1; two on segment 3, ventral and lateral; group of small setae at apex of segment 4.

Labium (fig. 1, *i*): Consists of postmentum (PMP), prementum (PRM), labial palpus (LP), and glossa (GL). Postmentum trapezoidal, lightly sclerotized with seta near each basal angle. Prementum suboval with sclerotized band across basal portion bearing pair of setae, and two narrow sclerotized bands near base of labial palpi. Two pairs of setae between palpi bases, one on midline between them and other pair more proximal. Prementum with numerous fine setae distally; inner surface (glossa) with many setae; distal ones slender, proximal ones shorter and stouter. Labial palpi two-segmented, without setae except small inconspicuous setae apically on second segment.

Hypopharynx (fig. 1, *n*): Asymmetrical, hypopharyngeal sclerome (HSC) well developed, strongly sclerotized; truncate process (TP) on right, lateral semimembranous lobes (LL) present; right lobe with few setae on apical margin, left lobe with a row of setae longitudinally across middle of lobe extending to the base of the hypopharynx.

Epipharynx (fig. 1, *p*): Slightly wider than long, lateral edges rounded. Apical margin slightly indented right side of center by epizygom (EZ). Epizygom well developed, broadening somewhat at end to form zygum (Z). Zygum may be apparently absent, lightly sclerotized or distinctly visible as a curved elongate well-sclerotized structure parallel to heli (H) outlining haptomeron (HM). Corypha (CO) and acroparia (ACR) united; with a number of long setae. Clithrum absent. Acanthoparia (ACP) composed of 12 to 14 curved setae at each lateral margin, each setae located at end of a plegma (PL). About 12 to 14 plegmata in plegmatium. Proplegmata absent. Gymnoparia (GP) well developed on each side. Chaetoparia (CPA) well developed, right side larger than left, setae stronger near pedium (PE) than laterally near gymnoparia. Pedium oval, divided into upper three-fifths and lower two-fifths by epitorma (EPT). Dexiotorma (DX) well developed, transverse without apotorma or pternotorma. Laeotorma (LT) well developed with a pternotorma (PTT) laterally and epitorma mesally, the latter curving upward and transversely across pedium to inner margin of right chaetoparia. Epitorma gradually thinner toward apex, sometimes only a thin line through pedium. Haptomeron with five to eight (usually six) heli in a transverse row and a row of eight to eleven sensilla (S) between heli and zygum. Phobae absent. Crepis (CR) faintly indicated and outlining upper edge of haptolachus (HL) or absent in most specimens. Sclerotized plate (SP) present at inner end of dexiotorma and protruding entally at apex. Nesium (N) present just proximad of end of this plate; several setae on base of sclerotized plate near dexiotorma, three to seven setae in clump below laeotorma.

Thorax: With three pairs of well-developed legs, a spiracle on prothorax. Pro-, meso-, and metathorax each divided into three areas dorsally: prescutum, scutum, and scutellum. Prothorax: Fold between prescutum and scutum faint, sometimes missing. Prescutum and scutellum without setae dorsally. Scutum with long slender and short spinelike setae on an area extending well down onto pleural regions. Small lobe with three or four setae present posteroventrad of spiracle. Elongate, suboval, transverse sclerite just anterior of spiracles. Episternum and epimeron more heavily sclerotized than rest of segment; episternum with four setae, epimeron with two to three setae. Cervical sclerite extends from episternum to head near posterior tentorial pits. Sternum with numerous long and short setae forming a poorly defined transverse band. Meso- and metathorax: Scuti without setae dorsally. Prescutum and scutellum with two pairs of long slender setae in transverse row with about 24 pairs of short spinelike setae interspersed with or laterad of long setae. Lateral rounded lobes of scutum each with eight to twelve setae. Two smaller lobes: anteroventral with three to six setae of which two to four may occur on underside, posteroventral with three to six setae. Episterna with four setae and epimera with eight to nine setae. Sterna with setae in irregular transverse band.

Legs: Well developed, five-segmented. Prothoracic legs shortest, metathoracic legs longest with most of difference due to length of coxal segment. Coxa longest leg segment, followed in decreasing order by tibia, femur, and trochanter. Tarsunguli similar in length with reddish-brown curved apices, each with two setae. Setae uniformly distributed on leg segments except more sparsely dorsally on trochanter and femur; tibial setae heavier ventrally and distally.

Abdomen: Ten-segmented. Spiracles on first eight segments. Dorsum of first six abdominal segments divided into prescutum, scutum, and scutellum. Prescutum, scutum, and scutellum of first six segments with long slender and short spinelike setae in transverse patches. Long setae present on posterior margin of patch and shorter setae interspersed with or anterior of these setae. Setal patch on scutum extends laterad almost to spiracular sclerite; on prescutum and scutellum, only a short distance laterad. Prescutum of first segment with one to two pairs of long setae and two to three pairs of short setae, prescuti of segments two to six with 12 to 20 pairs of setae, scuti and scutelli of first six abdominal segments with 26 to 38 and 16 to 23 pairs of setae, respectively. Spiracular sclerite a poorly defined lobe surrounding spiracle with four to eight setae of various lengths, pleural lobe with about 10 setae. A small elongate-oval pleural lobe just posterior to lower edge of scutum with one to three (usually three) setae. Dorsum of segment 7 divided into two parts: anterior with two pairs of long slender setae, three to four pairs very fine short setae; posterior with four pairs of long setae and three pairs of fine short setae. Segment 8 with small incomplete dorsal fold about midway dividing segment into anterior half with two pairs of long setae and one to two pairs of short fine setae in a row, and posterior half with four to five pairs of long setae and seven to eight pairs of short fine setae. Segment 9 without dorsal fold; with two rows of setae; anterior with three pairs of long and two pairs of short setae, posterior row with five pairs each of long and short setae. Pleural lobe of segment 9 with 10 to 20 setae. Segment 10 with a dorsal subcircular furrow with many long slender setae scattered over entire surface. Dorsal or upper lip of anus with short, heavy spine-like setae. Sterna of abdominal segments one to nine each with eight to ten pairs of setae, somewhat sparser on segments 8 and 9.

Raster (fig. 1, f): Without palidia. Subtriangular teges (T) consists of about 22 short hamate setae. Lower anal lip (LAL) with about eight similar setae and 10 long and 10 short slender setae. Campus (C) occupying anterior half of raster with two long slender setae just anterior of teges. Numerous long slender setae found on each lateral edge forming a sparse barbula (B).

Spiracles (fig. 1, e): Nine pairs, one pair prothoracic and eight pairs abdominal. Prothoracic spiracle largest, opening posterior; openings in abdominal spiracles anterior. Respiratory plate (RSP) C-shaped with numerous oval to round openings surrounding a prominent oval bulla (BU). Bulla with a slightly curved spiracular slit (SS).

PUPA

Typically exarate (fig. 1, *g*, *h*): Pale yellowish white, gradually becoming brown before emergence of adult. Entire surface densely covered with minute setae. Average size: 13 mm. long by 6 to 7 mm. wide. Antennae appear indistinctly three-segmented. Eye between antenna and lateral edge of pronotum. Frons, clypeus, and labrum present. Mandibles between labrum, antenna, and maxilla. Distal portion of maxilla visible; maxillary palpus weakly divided into four segments. Labium distinct with labial palpus. Thoracic legs visible; front, middle, and hind legs extend, respectively, to middle of mesosternum, middle of hind coxa, and last abdominal segment. Pro- and mesothoracic coxae adjacent and covering all but a small portion of mesosternum; metathoracic coxae practically covered by wings and distant from mesothoracic coxae with much of metasternum visible between. Metathoracic femur laterad of and partially covered by wings. Tarsi weakly differentiated into segments. Forewings (elytra) covering most of hind wings; forewings with a few raised lines on surface. Prothorax prominent dorsally, well developed and shaped like that of adult. Mesothorax small extending further posteriorly along midline than laterally; metathorax larger. Abdomen dorsally with nine segments; a pair of transverse pockets, curved and with highly chitinized edges located intersegmentally between segments one and seven. Spiracles present on segments 1 to 8, the first pair covered by hind wing; those on segments 2 to 4 wide open, the others appearing nonfunctional. Segments 2 to 10 visible ventrally. Segments 2 to 8 similar in both sexes. Segment 2 barely visible between hind coxae; segments 3 to 6 subequal in length, 7 and 8 longer, 9 shorter. Female genital opening located on segment 9 (fig. 1, *g*). Male genital opening on segment 10 (fig. 1, *h*). Elongate lobes located laterally, arising near apex of eighth segment and extending posteriorly to unite at abdominal apex. Apex of each lobe covered with longer setae.

LITERATURE CITED

- BOVING, A. G. 1936. Description of the larva of *Plectris aliena* Chapin and explanation of new terms applied to the epipharynx and raster. PROC. ENT. SOC. WASHINGTON 38:169-185.
- FLETCHER, T. BAINBRIGGE and C. C. GHOSH. 1920. Borers in sugarcane, rice, etc. PROC. THIRD ENT. MEETING, PUSA, 1919. 1:354-417.
- FRIEDRICH, K. 1915. Ueber *Adoretus vestitus* Boh. als Schädling in Samoa und seine früheren Stande. ZEIT. WISS. INSEKTENBIOL. 10:41-47.
- GARDNER, J. C. M. 1935. Immature stages of Indian Coleoptera (16) (Scarabaeoidea). INDIAN FOR. REC. (n. s.) 1:1-33.
- GRAVELY, F. H. 1919. Descriptions of Indian beetle larvae—III. REC. INDIAN MUS. 16:263-270.
- OHAUS, F. VON. 1915. Scarabaeidae: Eucharinae, Phaenomerinae, Rutelinae. Schenkling, COLEOPT. CAT. 20 (66).
- RITCHER, P. O. 1948. Descriptions of the larvae of some ruteline beetles with keys to tribes and species (Scarabaeidae) ANN. ENT. SOC. AM. 41:206-212.
- TIMBERLAKE, P.H. 1919. *Popillia japonica*, a serious pest recently introduced into New Jersey from Japan. HAWAIIAN PLANT. REC. 21:106-109.
- VIADO, G. B. 1939. External anatomy and diagnostic characters of some common Philippine white grubs. PHILIPPINE AGR. 28:339-410.