LARVAE OF *COELOPHORA INAEQUALIS* (F.), *PHRYNOCARIA GRATIOSA* (MULSANT) AND *P. ASTROLABIANA* (WEISE) (COLEOPTERA: COCCINELLIDAE) WITH NOTES ON THEIR RELATIONSHIPS AND PREY RECORDS

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Abstract

All larval instars of *Coelophora inaequalis* (F.), *Phrynocaria gratiosa* (Mulsant) and *P. astrolabiana* (Weise) are described, their significant morphological characters illustrated and hosts noted. The larval morphology of these species is compared with those of *P. congener* (Billberg) and *Lemnia* spp., and the relationships between these 3 genera are discussed.

Introduction

The limits of *Coelophora* Mulsant and *Lemnia* Mulsant have been widely disputed since their erection by Mulsant (1850). Timberlake (1943) accepted both as separate genera but removed several species from *Coelophora* to create new genera, including *Phrynocaria* Timberlake. Recent opinion ranges from that of Pope (in press), who synonymised *Lemnia* with *Coelophora* and retained *Phrynocaria*, to that of Iablokoff-Khnzorian (1982, 1984), who restricted *Coelophora* to the type species *C. inaequalis* (F.) and placed all other species in 4 subgenera of *Lemnia* including *Phrynocaria* (= *Microlemnia* Iablokoff-Khnzorian 1982). However, others e.g. Sasaji (1982), still recognise all 3 genera, which are members of the predominantly aphidophagous tribe Coccinellini.

My own work (Houston 1979, 1983; Houston and Hales 1980) on the inheritance of adult colour patterns treated *Coelophora* and *Phrynocaria* as separate genera. These studies provided many preserved larvae of all instars of *C. inaequalis* and *P. gratiosa* (Mulsant), while larvae of *P. astrolabiana* (Weise) were also available. The opportunity was taken to describe these and compare them with published descriptions of the fourth instar larvae of *P. congener* (Billberg) (Sasaji and Tsubokawa 1983) and *Lemnia* spp. (Sasaji 1968) to determine if larval evidence elucidated the relationships between these 3 genera.

Materials and methods

Larvae were either field collected in association with adults or laboratory reared on aphids as in Houston (1979). *C. inaequalis* was reared on *Hysteroneura setariae* Thomas on *Panicum maximum* Jacq., *Hyperomyzus lactucae* (L.) and *H. carduellinus* (Theobald) on *Sonchus* spp., *Toxoptera aurantii* (Boyer de Fonscolombe) on *Murraya paniculata* Jack, and *T. citricidus* (Kirkaldy) on cultivated *Citrus* spp.. Both *Phrynocaria* spp. were reared on the 2 species of *Hyperomyzus* Börner.

Most larvae were fixed in KAA (Norris and Upton 1974) before preservation in 80 or 90% ethanol. For examination the mouthparts of some larvae were dissected out and the body slit along one side and soaked overnight in 10% KOH. The body tissue was then removed from the cuticle, which was washed in de-ionised water and placed on a slide in Hoyer's mounting medium. Figs 18-37 were prepared using a Philips 505 scanning electron microscope at 10 kV from specimens which had been critical-point dried and coated with gold.

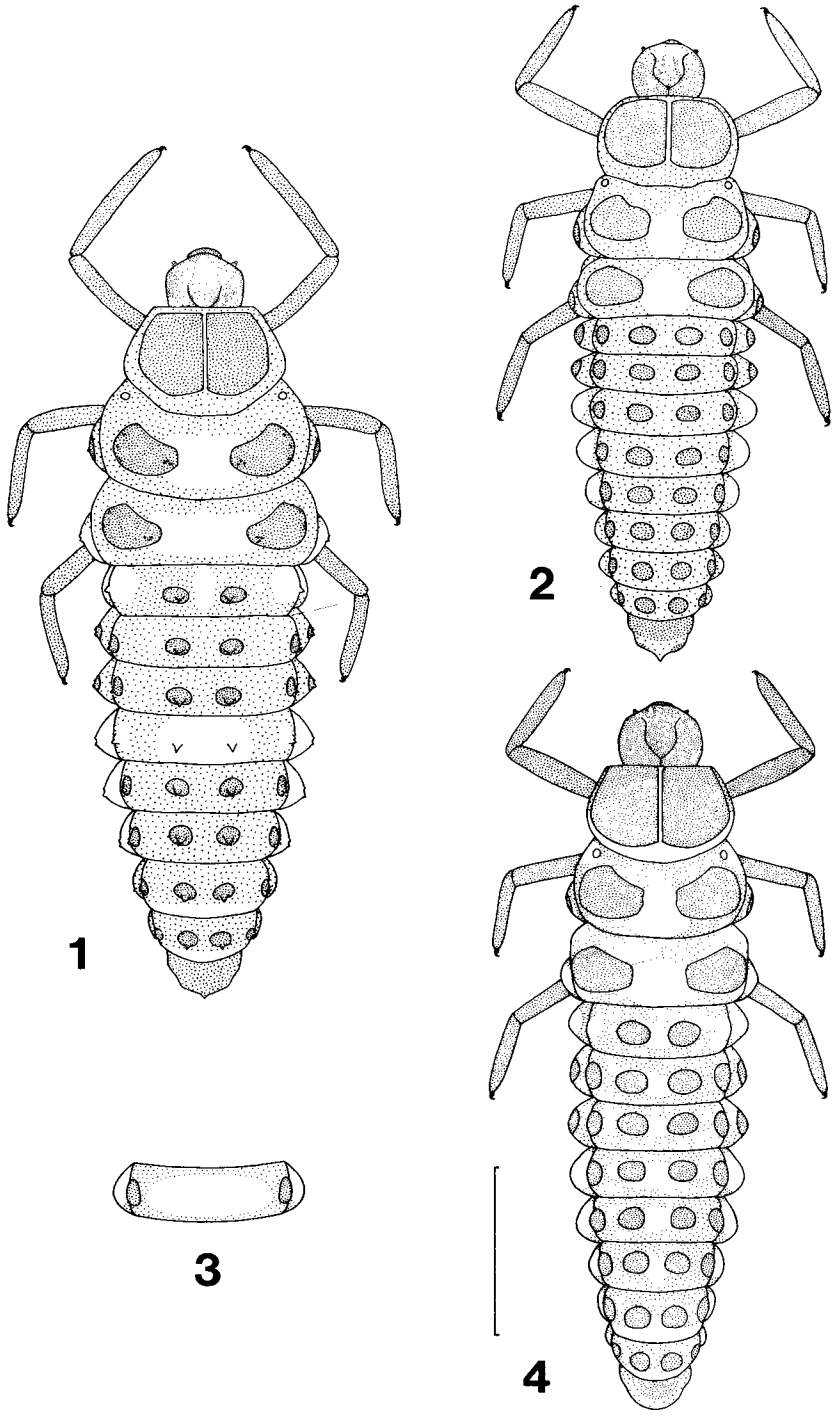
All specimens have been deposited in the Entomology Branch, Department of Primary Industries, Brisbane.

Abbreviations: *d*, *dl* and *l* for dorsal, dorsolateral and lateral tubercles respectively, with the numbers in front of the symbols referring to the abdominal segment on which they stand; L, S and M for long, short and minute setae respectively and any number in parentheses after a range of numbers is that most commonly found; P for sense pores; IV, III, II and I for the fourth, third, second and first larval instars respectively; and KJH for K. J. Houston.

Coelophora inaequalis (F.) (Figs 1, 5-6, 10, 12-13, 18-29)

Larval specimens examined—QUEENSLAND: 6IV and 19 exuviae (5III, 8II, 6I), bred from adult ♀ (20.xi.1973, predator of *T. aurantii* on *M. paniculata*); 8 (3IV, 5I), bred from adults ♂ x ♀ (27.xi.1973, on *Citrus limon* (L.) Burm. f.); 30 (16IV, 5III, 3II, 6I), bred from adult ♀ (31.iii.1974, on *Citrus*); 5IV, 15.iv.1974, predator of *H. setariae* on *P. maximum*; 22 (10IV, 3III, 2II, 7I), bred from adult ♀ (8.v.1974, on *C. limon*); 5 (3IV, 2I), bred from adult ♀ (19.v.1974); 19 (14IV, 5I), bred from 5 crosses of adults ♂ x ♀ (bred

adults ♂ x ♀, iv-viii.1974); 8 (4IV, 4I) bred from adults ♂ x ♀ (♀-21.ix.1974, on *Acacia*; ♂-bred from adults ♂ x ♀, viii.1974), 6 (4IV, 2I), bred from adult ♀ (9.xii.1974), 18 (11IV, 2III, 1II, 4I), 3.i.1975, J. F. Donaldson, predator of aphids on leaves of *Solanum tuberosum* L.; 2 (1IV, 1I), Toowoomba, 6.ii.1975, B. A. Franzmann, predator of *Rhopalosiphum maidis* (Fitch) on *Zea mays* L.; 3IV, Palen Creek 7 miles SW of Rathdowney, 3.iii.1974, I. D. Galloway, sweeping grass. [All collected in Brisbane by KJH except as indicated.]



FIGS 1-4—Instar IV larvae, dorsal view: **(1)** *Coelophora inaequalis*; **(2)** *Phrynocaria astrolabiana*; **(3-4)** *P. gratiosa*: **(3)** abdominal segment 4. Scale = 2.0 mm, all at same scale.

Fourth instar larva

Body length 5.5–9.0 mm; head width 0.75–0.90 mm (mean 0.84 mm, N = 65). Body fusiform, moderately convex.

Colouration (Fig. 1)—Dorsally head mostly dark brown, including most of vertex, a triangular anteromedian part of frontclypeus continued as a narrow median line posteriorly, and narrow border along inner side of frontal sutures; inner part of vertex anteriorly and outer part of frontoclypeus light brown, white area at end of frontal sutures. Body generally brown to light brown, legs, body armature and abdominal tergite 9 darker than ground colour except as follows: narrow longitudinal midline on pronotum white, areas around outer edges of pronotal plates often white or light brown; both meso-and metanotum with anterior longitudinal midline and area between plates white, area around *l* on metathorax white, some specimens with white patch posterolateral to each metanotal plate; abdomen with white patch between pair of l*d*, some larvae with white patches between some or all of 2-3, 5-7*d* pairs; white patches anterior to 2*dl* and 7*l*, may be present and include part of tubercles to all of 7*l*; 4*d*, 1 and 4*dl* and 1, 4-6*l* white; with white band along posterior margin of abdominal tergites 7 and 8, extending posterior to *dl*; tergite 9 with narrow light brown anterior margin.

Head—Frontal sutures incomplete, only posterior part visible; epicranial stem absent. Second antennal segment longer than first (Fig. 5); apex membranous with large conical sensillum length > 2.0 times width, some small sensilla and some sensory discs or pegs each enclosed by a narrow sclerotised ring with 2 often touching; segment 2 with anterodorsal and posteroventral seta on outer margin of sclerotised part, both shorter than large apical sensillum. Dorsal mandibular tooth with small, anteriorly directed denticle on dorsal edge and denticle closer to apex than prostheca (Fig. 6); ventral tooth shallowly V-shaped along ventral edge; prostheca membranous, covered with minute spicules and hairs. Width of apical segment of maxillary palps (Fig. 12) > 0.5 length; ventrally palpifer with lL; first segment with lS-M, 2P; second segment with lL, lS, lS-M, lP; third segment with scattered M, outer dorsal side with small sensillum in groove arising proximally and lP distally. Maxillary mala ventrally with inner sclerotised part usually widely joined to outer sclerotised part, no anterior notch in sclerotised area between inner sensillum and median L on anterior margin; inner sclerotisation extending to pigmented base of inner sensillum, with large notch in anterior margin and long narrow extension dorsomedially onto lateral edge of hypopharynx (Fig. 13); length of inner lobe of styli (Fig. 13) at least 0.75 length of outer lobe, inner seta longer than outer seta. Width of second segment of labial palps > 0.5 length which is *ca* 3.0 times length of first; sclerotised ring at base of labial palps (Fig. 10) incomplete, in some specimens posterior ends of ring joining median band but not each other. Mentum-submentum with 2L, 1-4(2)S and lM pairs which extend well posterior to level of unsclerotised notch on lateral margin of each cardostipes as in instar I (Fig. 24), notch further from anterior margin of cardostipes than width of notch along lateral margin of cardostipes. Hypopharyngeal bridge unsclerotised medially.

Thorax—Pronotal plates with larger setae arising from protuberances along margins. Meso- and metanotal plates with 3-5(3) strong setae arising from conical protuberances on inner edge and 5-6 similar structures on outer edge (Fig. 18); *l* is a group of setae on small bases (Fig. 19). Legs relatively long, fore tibiotarsi *ca* 2.0 times head width; tibiotarsi with many clavate, apical setae; claws with large basal dilation.

Abdomen—Tubercles with posterior inclination; *d* and *dl* (Figs 20-21) elongate processes, covered with setae on small protuberances, apical one largest, others generally becoming smaller towards base, *d* longer than *dl* on same segment; *l* (Fig. 22), low, wide, shallowly pointed mounds covered with setae on small bases. Tubercles in *d* position increasing in size from segments 1 to 4, decreasing from 6 to 8; l*d* about 0.33-0.5 length of largest *d* (i.e. on 4, 5, 6) and 8*d* even smaller. Longest *dl* usually on segment 4, subequal to 1*d*; 8*dl* reduced to a low mound, 7*dl* slightly larger. Tergites 3 and 4 with largest *l*, 1-3*l* increasing, 4-8*l* decreasing in size; size of setae on *l* increasing posteriorly. Medially sternites 1-4 with only thin simple setae; sternites 5 and 6 also with row of wide, flattened, blade-like setae, often slightly curved; sternites 7 and 8 with row of longer large simple setae (Fig. 23). Tergite 9 with posterior triangular appendix (Fig. 1).

Third instar larva

Body length 3.7-6.0 mm; head width 0.63-0.70 mm (mean 0.67 mm, N = 7). Same as instar IV except: head all dark brown; no white spots anterior to 2*dl* and 7*l*; 5 and 6*l* light brown in some specimens but area around them still white; frontal sutures lyriform but not reaching antennal insertions; denticle on dorsal tooth often not anteriorly directed; setal bases on plates and processes slightly more elongate.

Second instar larva

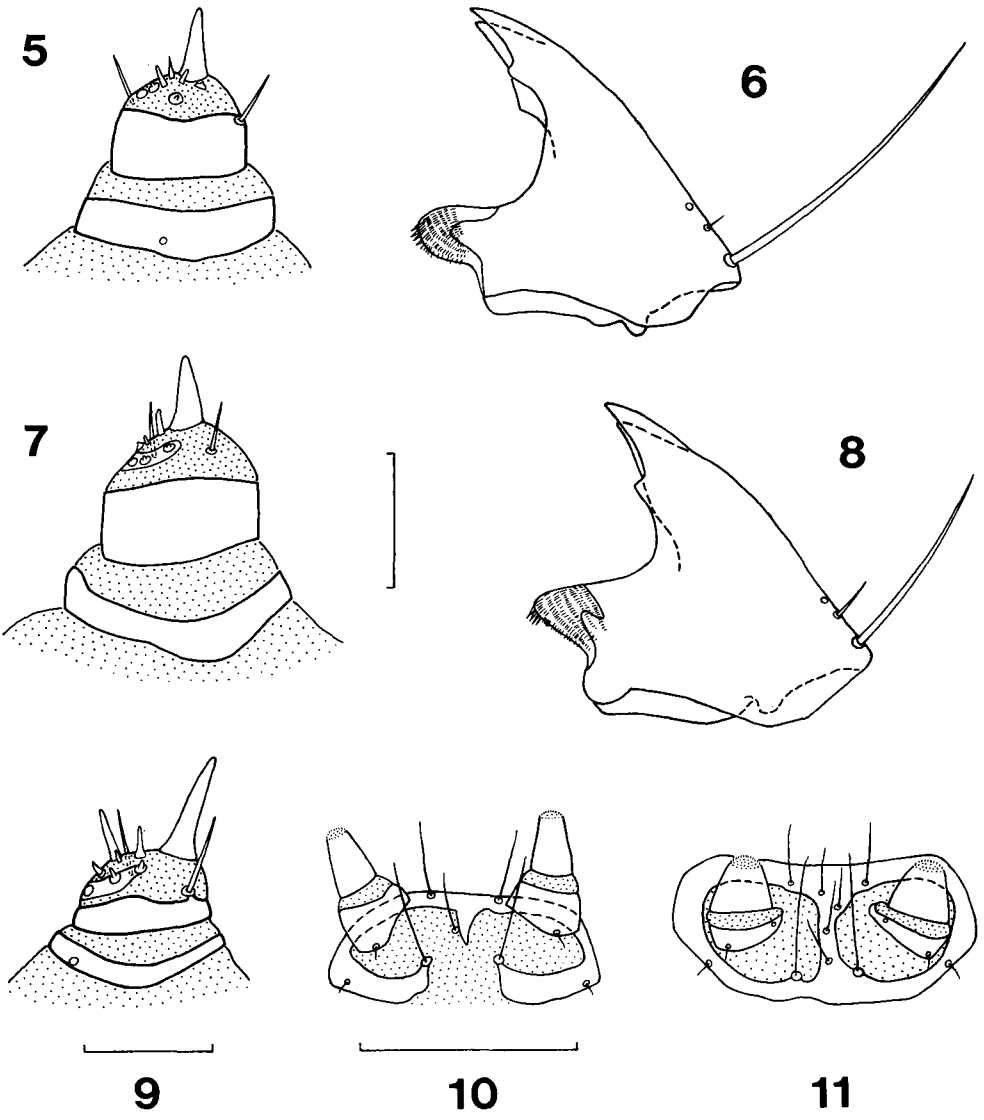
Body length 2.3-4.0 mm; head width 0.47-0.53 mm (mean 0.49 mm, N = 5). Similar to instar III.

First instar larva

Body length 1.3-2.8 mm; head width 0.37-0.42 mm (mean 0.39 mm, N = 25).

Colouration—As in instars III and II but only the following areas white: *l* on metathorax; abdominal 4*d*, 1 and 4*dl*, 1 and 4*l*; area between 4*d* pair; base of 5-7*l* brownish white.

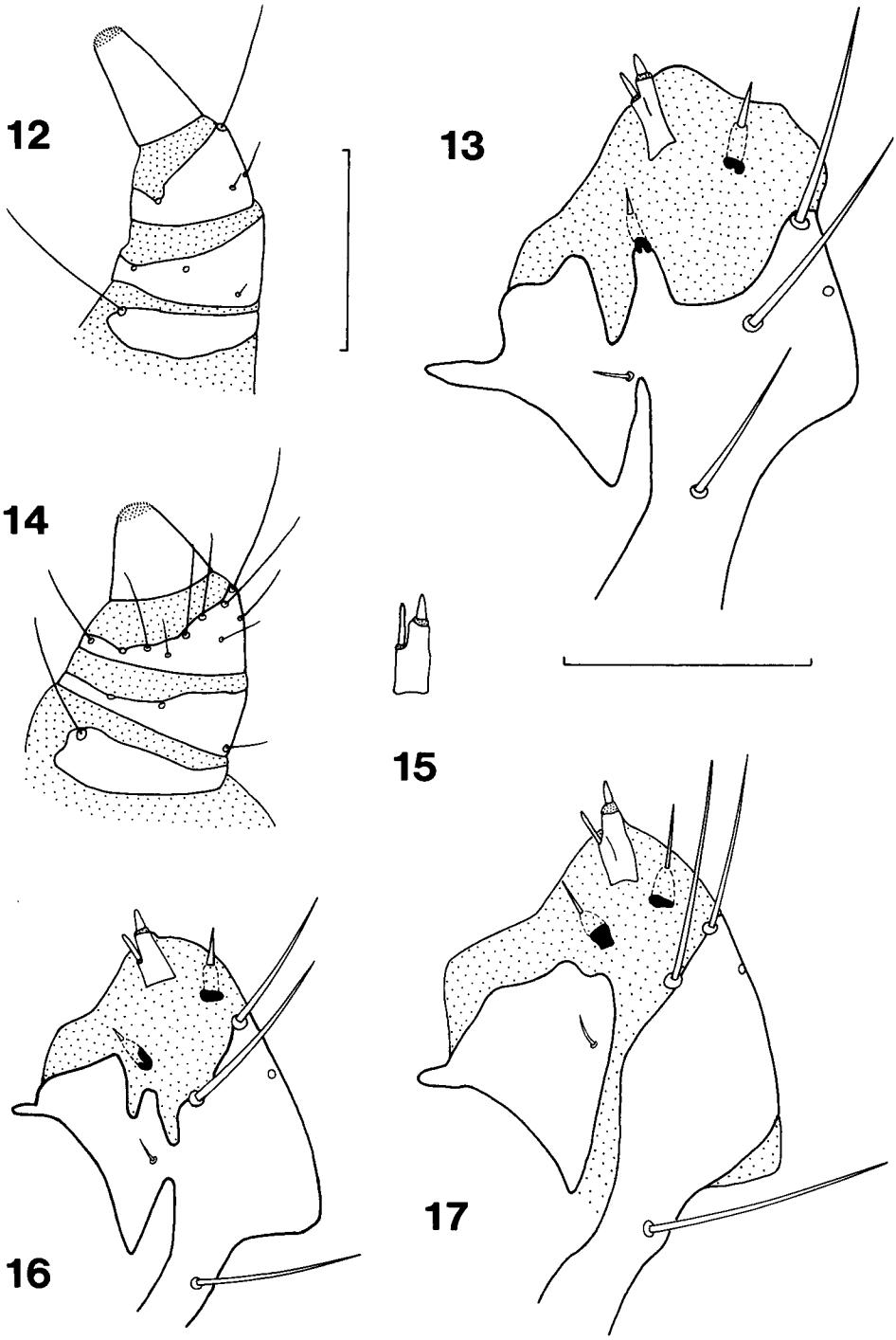
Head—Similar to that of instar III except: length of antennal segments, especially second, progressively reduced from instars IV and I, so that antennal segments *ca* equal in length in instar I; sensilla and setae relatively longer in instar I with large apical conical sensillum < 3.0 times as long as wide and longer than



FIGS 5-11—Larvae: **(5-6)** *Coelophora inaequalis*, instar IV: **(5)** left antenna, dorsal view; **(6)** right mandible, dorsal view; **(7-9)** *Phrynocaria gratiosa*: **(7)** instar IV, left antenna, dorsal view; **(8)** instar IV, right mandible, dorsal view; **(9)** instar I, left antenna, dorsal view; **(10-11)** instar IV, labial palps, ventral view: **(10)** *C. inaequalis*; **(11)** *P. gratiosa*. Scale = 0.05 mm for Figs 5, 7; = 0.2 mm for Figs 6, 8, 10-11; = 0.03 mm for Fig. 9.

sclerotised parts of first and second segments; denticle on dorsal tooth reduced to small convexity in some larvae; styli often shorter and wider; posterior halves of sclerotised rings at base of labial palps strongly joined to median band in some specimens; number of setae on mouthparts progressively reduced from instars IV to I, so that instar I with 3L on each cardostipes, posterolateral L on posterior margin of unsclerotised notch being smallest (Fig. 24), 2L, 1M pairs on mentum—submentum with 1M pair anterior to both L pairs, and ventral side of maxillary palps with 1L on palpifer, 1M, 2P on first segment, 1L, 1P on second segment, while apical segment with OM ventrally but dorsally with proximal 1S near inner edge as well as small sensillum in groove proximally and 1P distally on outer margin.

Thorax—All setae on thoracic plates arising from protuberances. Each pronotal plate (Fig. 25) with 3-5(4) setae including 0-1S on anterior margin, 5-7(6) setae including 0-1S on lateral margin, 2-3 setae on posterior margin, 1 seta on inner margin medially, 2 small setae across middle of plate, and small seta behind egg-tooth; pair of pronotal egg-teeth, sharkfin-shaped (Fig. 26). Each meso- and metanotal plate with 5-7(5) setae including 0-1S on outer margin plus 1 small submarginal seta, 3-4(3) setae on inner part with setal bases of only inner 2 setae usually joined on mesonotal plates (Fig. 27) but setal bases of all 3 setae often joined on



FIGS **12-17**—Larvae: **(12-13)** *Coelophora inaequalis*, instar IV, left ventral view: **(12)** maxillary palp; **(13)** mala; **(14-16)** *Phrynocaria gratiosa*, left ventral view: **(14)** instar IV, maxillary palp; **(15)** instar IV, stylus; **(16)** instar III, mala; **(17)** *P. astrolabiana*, instar IV, left ventral view, mala. (Figs 13, 16-17 show mala somewhat flattened on slide to bring inner sclerotised part closer to horizontal plane). Scale = 0.2 mm for Figs 12, 14; 0.1 mm for Figs 13, 15-17.

metanotal plates, and 1-2(2) setae on median part, usually both small on metanotal plates and 1 large and 1 small on mesonotal plates. Meso- and metathoracic *l* elongate with 2 setae.

Abdomen—Tubercles with posterior inclination, size of setae and protuberances from which setae arise decreasing from apex of process to base; *d*, *dl* (Figs 28, 29 respectively) elongate processes with 3-4(3) setae, *l* (Fig. 29) low mounds with 2-3(2) posteriorly inclined setae. Size differences between *d* or *dl* on different segments not as marked as instar IV, 1 and 8*d* smallest > 0.5 length of largest *d*; on any segment *d* larger than *dl*, *dl ca* same length as 8*d* or shorter, 8*dl* low and is smallest *dl*; 1 and 8*l* with smallest setal bases, size of setae on *l* increases posteriorly. Size of setae on plates and tubercles increasing from instars IV to I relative to size of plates or tubercles, but number of setae on them decreasing; largest change between instars II and I. Abdominal tergite 9 sclerotised, with small posterior appendix. Medially sternites 1-4 with row of thin, simple setae; sternites 5-7 with row of slightly longer, curved, flattened, narrowly blade-like setae; sternite 8 with row of much longer, large, simple setae.

Note

Swezey (1905) gave a short description of the egg, fourth instar larva, pupa and adult of *C. inaequalis* (as *Coccinella repanda* Thunberg). His illustrations were reproduced in Williams (1931, Fig. 74) and Swezey (1936, Fig. 16), under the correct name.

Phrynocaria gratiosa (Mulsant) (Figs 3-4, 7-9, 11, 14-16, 30-37)

Larval specimens examined—QUEENSLAND: IIV, Brisbane, 16.xi.1973, KJH, associated with *Coccus viridis* (Green) on *Citrus sinensis* Osbeck; 71 (26IV, 11III, 16II, 18I), bred from adult ♀ (Brisbane, ix.1978, B. K. Cantrell, on *Citrus*), Brisbane, x.1978, KJH; 21 (14IV, 3III, 4I), bred ex adult ♀ (Mt. Tamborine, 18.x.1978, KJH, associated with psyllids on *Acacia*), Brisbane, xi.1978, KJH.

Fourth instar larva

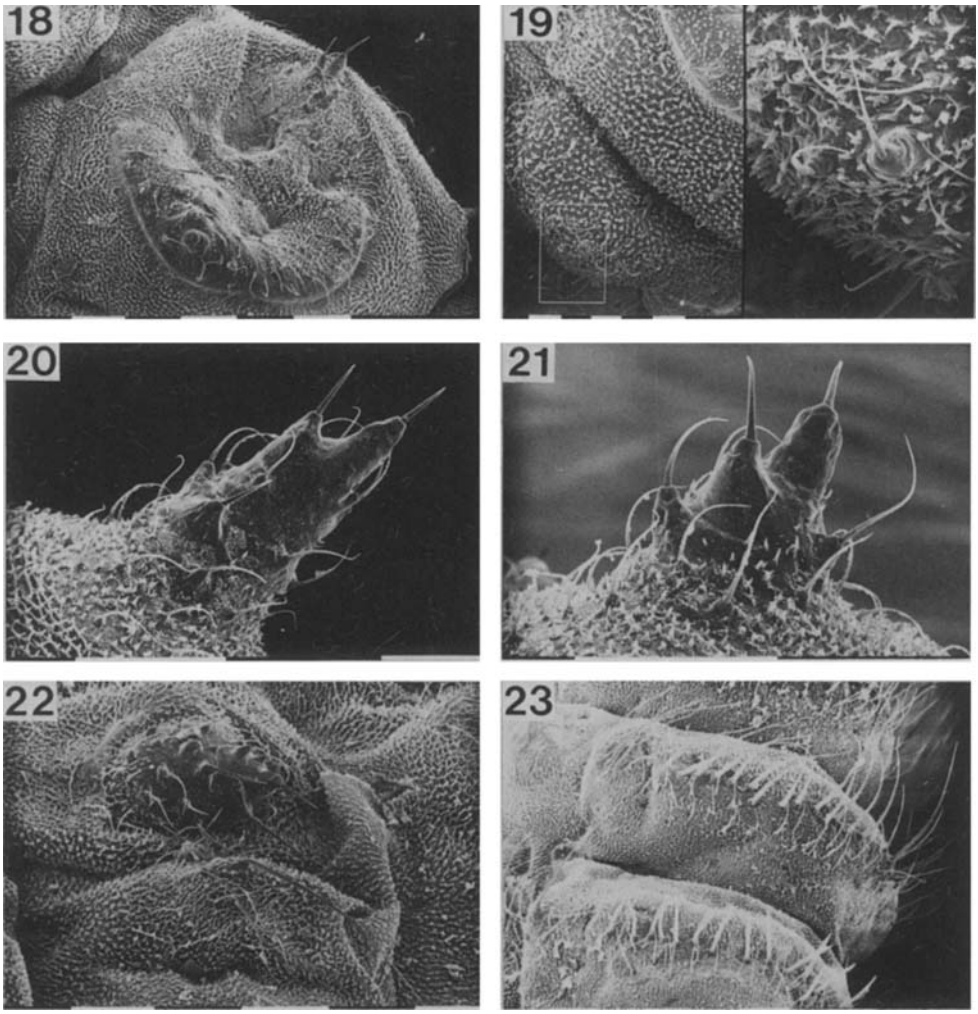
Body length 5.5-9.6 mm; head width 0.85-0.98 mm (mean 0.91 mm, N = 40). Body fusiform, moderately convex.

Colouration (Figs 3-4)—Dorsally head dark brown, anterior area along frontal sutures of head light brown. Ground colour of body grey-brown, legs, body armature and anteromedian part of abdominal tergite 9 brown to dark brown except: pronotum along posterior edges of plates white or yellow; both meso- and metanotum with anterior longitudinal midline and area between plates white, midline continued between *d* pair on abdominal tergite 1 in some specimens; many larvae with white patch at posterolateral edge of each meso- and metanotal plate which may coalesce with the median area; meso- and metathorax with white anterolateral spots enclosing spiracles on former segment, metathoracic *l* and area around it white, mesothoracic *l* brown but area around it often white; abdomen with white patches between 1-7*d* pairs, white patches between *d* and *dl* on segments 2-7 present or absent, white patches between 4*d* pair and between 4*d* and 4*dl* often joined posteriorly or completely (Fig. 3); 2 and 3*l* partly to mostly surrounded by white area; 1*dl* and 1,4-8*l* white but 1*dl* may be partly brown; 2*dl* and 2*l* partly white in some larvae; 4*d* usually brown (Fig. 4) but often 4*d* partly to completely white (Fig. 3); white band along posterior margin of abdominal tergites 7 and 8 often extending posterior to *dl*; abdominal tergite 9 with narrow light grey-brown anterior margin.

Head—Epicranial sutural stem short, frontal arms lyriform, not reaching antennal insertions. Second antennal segment (Figs 7,30) much longer than first; apex membranous with large conical sensillum length < 2.0 times width, some small sensilla and sensory discs or pegs with pigmented band enclosing 2-4(3) discs and probably representing remnants of third antennal segment; anterodorsal and posteroventral setae arising on membranous apex, dorsal seta smaller than apical sensillum but longer than ventral seta. Mandibles (Fig. 8) similar to those of *C. inaequalis* but denticle on apical dorsal tooth *ca* equidistant between prostheca and apex or closer to former. Apical segment of maxillary palps (Fig. 14) as wide as long; ventrally palpifer with 1L but some specimens with additional 1S, first segment with 1S, 2P and second segment with 7-10 setae and 1P; third segment with many M and outer dorsal side with small sensillum in groove arising proximally and 1P distally. Maxillary mala ventrally with anterior notch in sclerotised area between inner sensillum and median L on anterior margin which may join posterior notch so that inner sclerotised part separated from outer sclerotised part as in mala of *P. astrolabiana* (Fig. 17) or narrowly joined to it (Fig. 16); inner sclerotisation not reaching pigmented base of inner sensilla, inner sclerotised part dorsally with small extension towards hypopharynx; inner lobe of styli (Figs 15-16) *ca* 0.5 length of outer lobe, inner seta much longer than outer seta. Second segment of labial palps as wide as long and *ca* 3.0 × length of first; sclerotised ring at base of labial palps complete and palps separated by median band (Fig. 11). Cardostipes and mentum-submentum shorter and wider than those of *C. inaequalis*; sclerotised part of mentum-submentum with many L, 1S, 1M pairs, very short and strongly convex, not extending to level of posterior margin of lateral notch on each cardostipes, notch closer to anterior margin of cardostipes than width of notch as in instar I (Fig. 34). Hypopharyngeal bridge complete.

Thorax—Pro-, meso- and metanotal plates without processes (Fig. 32); *l* on meso- and metathorax low, elongate mounds. Legs short, fore tibiotarsi *ca* 0.33 longer than head width; tibiotarsi with many clavate, apical setae; claws with large basal dilation.

Abdomen—Most setae on tubercles inclined posteriorly; *d*, *dl* and *l* (Fig. 33) low rounded mounds with length *ca* equal to width except for *d* on anterior segments wider than long and elliptical. Medially sternites



FIGS **18-23**—*Coelophora inaequalis*, instar IV larva: **(18)** left mesonotal plate, dorsolateral view; **(19)** right metathorax, lateral view showing part of dorsal plate and with *l* enlarged; **(20-22)** left abdominal processes: **(20)** 3*d*, lateral view; **(21)** 5 *dl*, dorsolateral view; **(22)** 4*l*, ventrolateral view; **(23)** abdominal segments 6 and 7, ventral view. White scale = 0.1 mm for Figs 18, 20-23; = 50 μm for Fig. 19.

1-5 with small setae, sternites 6-8 also with row of much larger, normal setae. Tergite 9 with or without small triangular appendix.

Third instar larva

Body length 4.5-6.2 mm; head width 0.65-0.78 (mean 0.72 mm, N = 11).

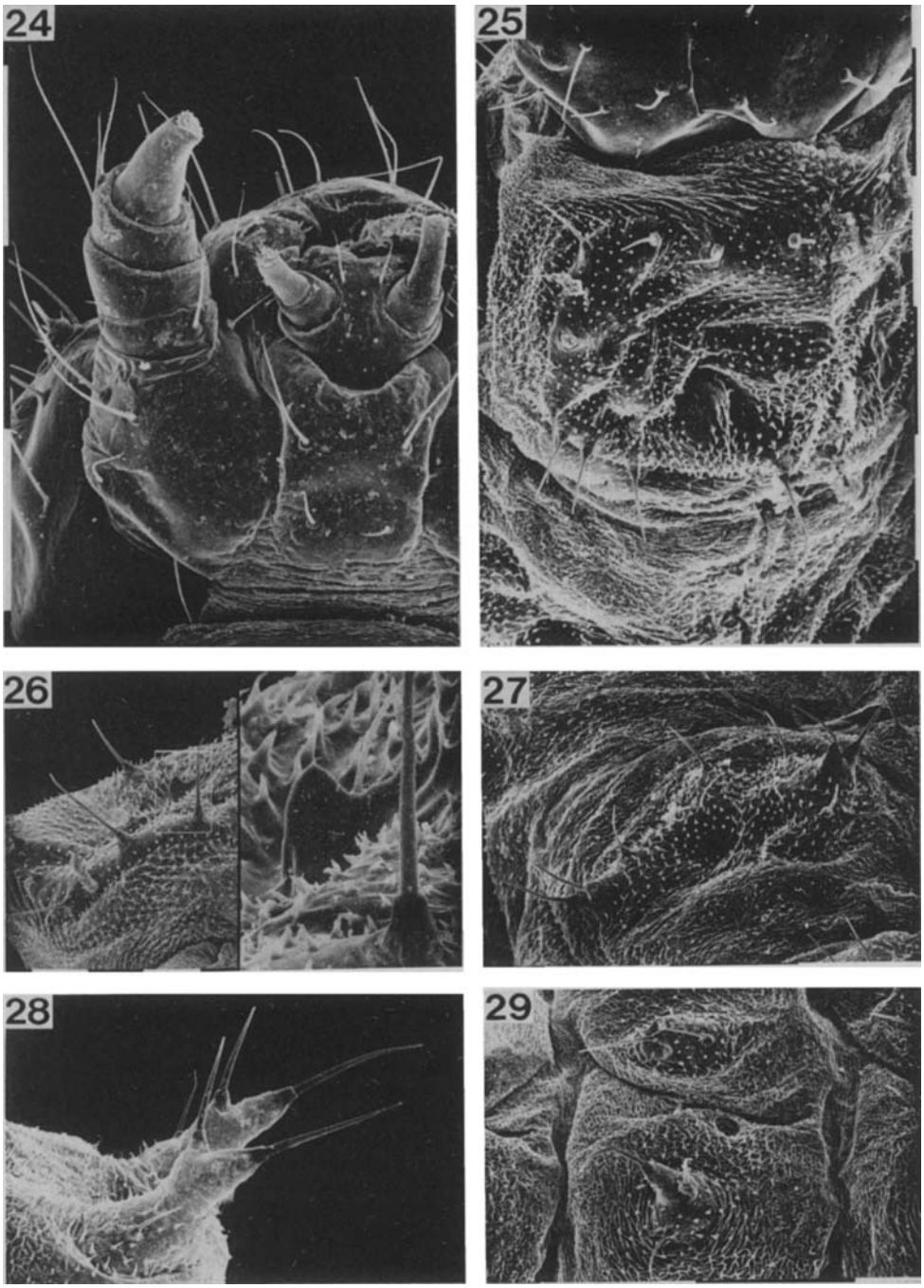
Colouration—As in instar IV except: head completely brown or dark brown; white areas posterior to thoracic plates usually absent; *l* on metathorax, 1*dl* and 1*l* on abdomen ranging from white to mostly brown; white areas around *l* on mesothorax, 2 and 3*l* small or absent; 5-8*l* often partly to mostly brown, with area of brown pigmentation increasing from 5 to 8*l*; white areas between 1-3, 5-7*d* pairs absent in some specimens; white areas around 4*d* pair reduced to white patch between them in many larvae; most of abdominal tergite 9 unicolourous brown except narrow anterior margin light grey-brown.

Head, thorax, abdomen—Similar to those of instar IV but frontal arms almost reaching antennal insertions, denticle on dorsal tooth of mandible not anteriorly directed.

Second instar larva

Body length 2.5-4.0 mm; head width 0.53-0.56 mm (mean 0.54 mm, N = 13).

Colouration—Dorsally head dark brown; legs, most tubercles, plates and abdominal tergite 9 (except for



FIGS **24-29**—*Coelophora inaequalis*, instar I larva: **(24)** labium and right maxilla, ventral view; **(25-26)** left pronotal plate: **(25)** dorsal view; **(26)** anterolateral view with egg-tooth enlarged; **(27)** left mesothoracic plate, dorsal view; **(28-29)** abdominal tubercles, left lateral view: **(28)** 3*d* pair; **(29)** 3*dl* and 3*l*. White scale = 0.1 mm for Figs 24-25, 27-29; = 5 μm for Fig. 26.

light grey-brown anterior margin) brown; ground colour grey-brown; some specimens with white areas posterior to pronotal plates and between meso- and metanotal plates; white longitudinal midline between pronotal plates and anteriorly on meso- and metanotum; 4*l* white, 5-8*l* often partly white, 4*d* usually mostly or completely brown but sometimes white; white patch between 4*d* pair.

Head, thorax, abdomen—Similar to those of instar III except abdominal tergite 9 usually slightly angled at apex but appendix absent.

First instar larva

Body length 1.4-3.0 mm; head width 0.40-0.42 mm (mean 0.41 mm, N = 20).

Colouration—Dorsally head dark brown; legs, plates, most tubercles and much of abdominal tergite 9 brown; ground colour grey-brown but mature larvae with paler areas around pronotal plates, between meso- and metanotal plates and along posterior margin of abdominal tergite 8; thoracic tergites and abdominal tergite 1 with white longitudinal midline, variably continued in pale ground colour to tergite 6; *d*, *dl* and *l* on tergite 4 white and area between 4*d* pair and 4*d* and 4*dl* white; anterior part of 5*l* white in some larvae.

Head—Similar to instar IV except: second antennal segment only slightly longer than first, sensilla and setae relatively longer with large apical conical sensillum *ca* 2.5 times width, dorsal and ventral setae arising just outside or on edge of sclerotised part of second segment (Fig. 9); mandible often with only small convexity at position of denticle on dorsal tooth; with same number of setae and pores on cardostipes, mentum-submentum and maxillary palps (Fig. 34) as instar I of *C. inaequalis*, but third segment of maxillary palp with 1S displaced medially; sclerotised part of mentum-submentum less concave and longer than in instar IV, often extending to slightly below level of lateral seta on posterior margin of unsclerotised notch on each cardostipes (Fig. 34).

Thorax—Each pronotal plate (Fig. 35) with 6-8(6) setae on anterior margin, 8-12 setae including 1 submarginal on lateral margin, 2-4(2) setae on posterior margin, 2 setae across middle of plate including 1 on inner margin, and 1 seta behind egg-tooth; egg-tooth (Fig. 35) smaller than that of *C. inaequalis*. Each mesonotal plate with 3-4(3) setae on inner part, 8-12(10) setae on outer part, and 2-3(3) setae in middle of plate (Fig. 35). Each metanotal plate with 3 setae on inner part, 9-13(10) on outer part, and 2-3(2) in middle of plate (Fig. 35). Egg-teeth lacking on both meso- and metanotal plates. Meso- and metathoracic *l* elongate with 2-4(3) setae. Size of protuberances on which setae stand correlated with setal size, small setae having very small bases. Thorax ventrally and legs similar to those of instar IV.

Abdomen—Most setae on tubercles inclined posteriorly; *d*, *dl* and *l* (Figs 36-37) low round mounds with setae on small protuberances; *d* on anterior segments wider than long and elliptical, others about as long as wide; *d* with 3-5(3) (Fig. 37), *dl* with 2-5(3 or 4) (Fig. 37) and *l* with 2-4(3) setae (Fig. 36); posterior seta on *d* with largest base. Abdominal tergite 9 sclerotised with some setae on bases (Fig. 36); no white patches between 4*d* pair and 4*d* and 4*dl*.

Phrynocaria astrolabiana (Weise) (Figs 2, 17)

Larval specimens examined—QUEENSLAND: 14 (12IV, IIII, III), Home Hill, 7.iv.1976, KJH, predator of *Pulvinaria* on *Ficus*; 12 (3IV, 3III, 2II, 4I) and 12 exuviae (6III, 2II, 4I), bred from adults (same data as above), Brisbane, iv.1976, KJH.

Fourth instar larva

Body length 6.2-8.5 mm; head width 0.80-0.90 mm (mean 0.85 mm, N = 14).

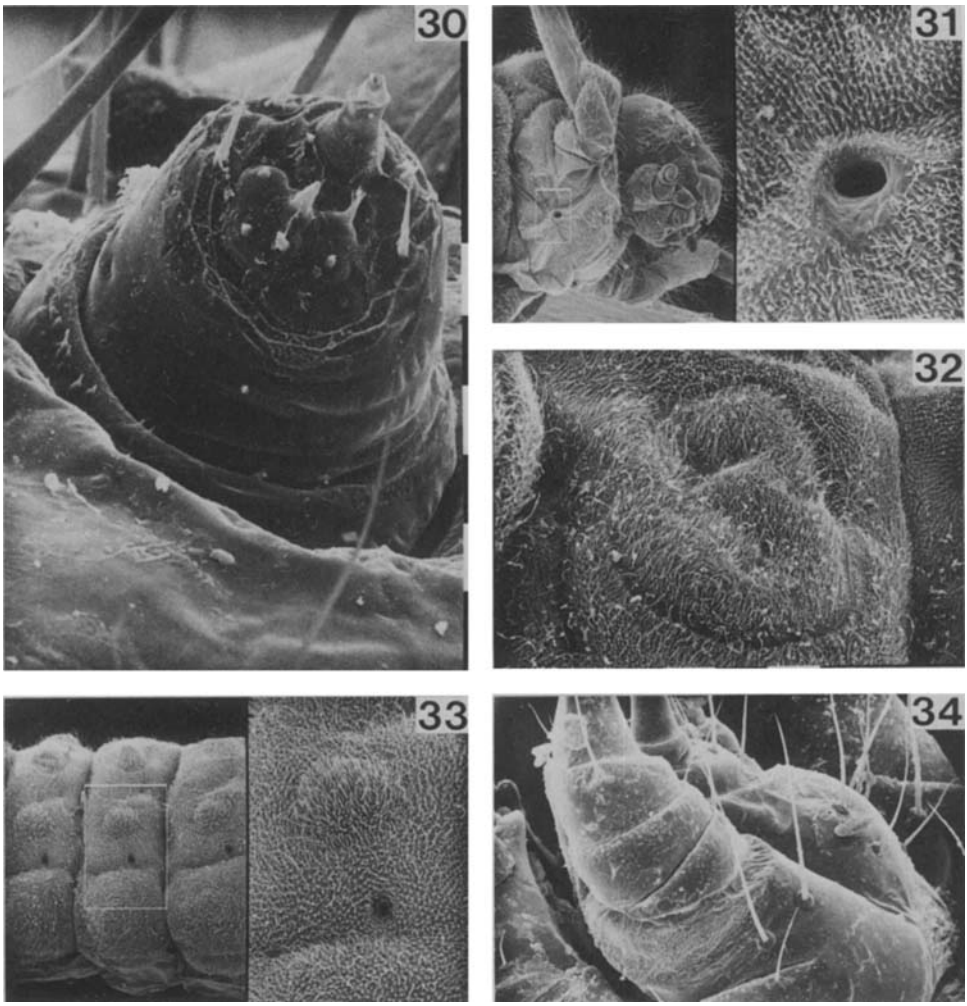
Colouration (Fig. 2)—Dorsally head mostly dark brown but anterior margin along frontal sutures light brown; frontoclypeus mostly light brown, but with 3 brown to dark brown longitudinal lines posteriorly i.e. a small straight median line and a pair of curved lines on either side, these may coalesce making posterior part of frontoclypeus brown to dark brown. Ground colour light grey-brown with legs and body armature brown to dark brown except as follows: narrow white midline on pronotum between plates and often extending posteriorly; meso- and metanotum with narrow white midline anteriorly, area between plates white but size variable and may occupy most of median area or rarely absent; some specimens with white patches between 4*d* and some with white patch posterior to 2*l*; 3-7*l* white but sometimes 5-7*l* partly to mostly brown; 8*l* partly to mostly brown; abdominal tergite 9 with large anterior band and on each side of posterior margin a small spot brown to dark brown, remaining area grey-brown including median margin anterior to dark band.

Head, thorax, abdomen—Similar to those of instar IV of *P. gratiosa* except: membranous apex of second antennal segment with conical sensillum length *ca* 2.0 times width, narrow pigmented band enclosing 2-3(2) discs or pegs, and anterodorsal and posteroventral setae sometimes arising on sclerotised part of second segment; apical segment of maxillary palps slightly longer than wide, second segment with 6-9 setae and 1P, maxillary mala ventrally (Fig. 17) with inner sclerotised part separated from outer sclerotised part, median L sometimes situated just off outer sclerotised area, extension of inner part towards pigmented base of inner sensillum short or absent so that inner part with or without a shallow notch on its anterior margin; large triangular appendix always present on abdominal tergite 9.

Third instar larva

Body length 5.5-5.7 mm; head width 0.70 mm (mean 0.70 mm, N = 2).

Colouration—Head dark brown to brown with lighter colour on anterior part of frontoclypeus; thoracic colouration as in instar IV, except median white areas between meso- and metathoracic plates small or



FIGS **30-34**—*Phrynocaria gratiosa*, larva: **(30-33)** instar IV: **(30)** right antenna, posterodorsal view; **(31)** head and prothorax, ventrolateral view; **(32)** left mesonotal plate, dorsolateral view; **(33)** abdominal segments 2-4, right lateral view with 3*dl* and spiracle enlarged; **(34)** instar I, right maxilla and labium, lateral view. White scale = 10 μm for Fig. 30; = 0.5 mm for Figs 31, 33; = 0.1 mm for Figs 32, 34.

absent; all abdominal tubercles brown to dark brown and ground colour grey-brown, except 3*l* mostly white to completely brown, 4*l* white to mostly white, 5-8*l* partly white, white spot posterior to 3*l* sometimes present. Tergite 9 dark to light brown with lighter colour on posterior part, but with anterior light grey-brown margin.

Head, thorax, abdomen—Similar to those of instar IV but frontal arms almost reaching antennal insertions and denticle on dorsal tooth of mandible not anteriorly directed.

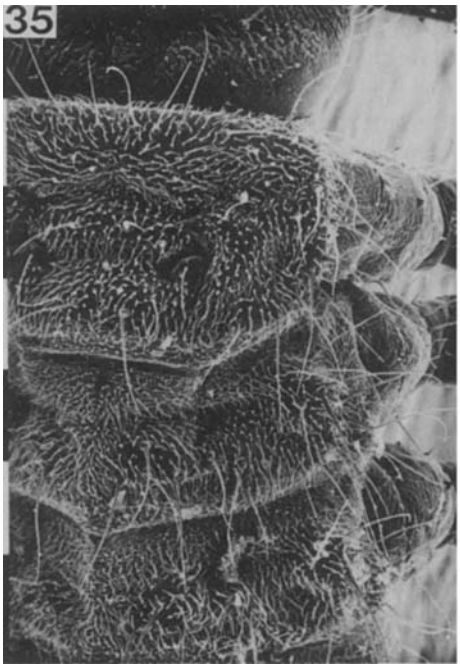
Second instar larva

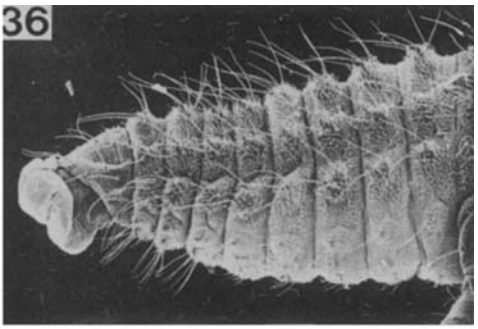
Body length 3.6-4.0 mm; head width 0.51-0.57 mm (mean 0.54 mm, N = 3). Similar to instar III but membranous apex of second antennal segment with pigmented band enclosing 2 discs or pegs or all discs separated, white spots between meso- and metathoracic plates always absent and with continuous pale longitudinal line running between each pair of plates, all abdominal tubercles brown except 4*l* mostly to partly white, appendix on abdominal tergite 9 less distinct.

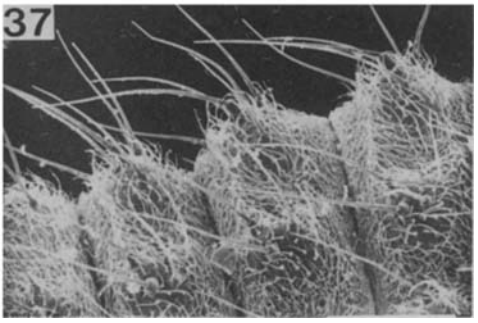
First instar larva

Body length 1.9-2.2 mm; head width 0.42 (mean 0.42 mm, N = 2).

Colouration—Dorsally head dark brown; legs, plates, all tubercles and most of abdominal tergite 9 (except light grey-brown anterior margin) brown; ground colour grey-brown; thoracic tergites with pale longitudinal midline extending to anterior part of abdominal tergite 1.







FIGS **35-37**—*Phrynocaria gratiosa*, instar 1 larva, right side: **(35)** thorax, dorsal view; **(36)** abdomen, lateral view; **(37)** 1-3*d* and 1-3*dl*, lateral view. White scale = 0.1 mm for all Figs.

Head, thorax, abdomen—As in instar I of *P. gratiosa* except: membranous apex of second antennal segment with conical sensillum length 2.0-2.5 times width and pigmented band enclosing 2 discs or all discs separated; mala similar to that of instar IV of *P. astrolabiana*; each pronotal plate with 3-5 setae on anterior margin, 7-9 setae including submarginals on lateral margin and 2-3 setae on posterior margin; each meso- and metanotal plate with 3 setae on inner part, 7-9 setae on outer part and 2 setae in middle of plate; each meso- and metathoracic *l* with 3 setae; abdominal *d* and *dl* with 3 setae, and *l* with 2-3 setae; and abdominal tergite 9 without appendix but angled posteriorly.

Discussion

Phrynocaria was erected for *P. congener*, the type species, and *P. gratiosa*. *P. astrolabiana* was originally described from New Guinea in *Coelophora*, where it remained until Pope (in press) transferred it to *Phrynocaria* and recorded it from northern Australia. Most of the characters of the fourth instar larva of *P. congener* agree with those of *P. gratiosa* and *P. astrolabiana*, particularly the apparent presence of a short epicranial stem and a preapical denticle on the dorsal tooth of the mandibles about equidistant between the prostheca and apex (Sasaji and Tsubokawa 1983, Figs 10A and 10C respectively), the short wide maxillary palps with many setae on the second segment, the short legs, and the body plates and tubercles without projections or obvious setal bases. The similarity of the larvae of these 3 species indicates that they are congeneric, although they can be separated by differences in colouration.

There are many distinct differences between the larvae (all instars) of the 2 Australian species of *Phrynocaria* and those of *C. inaequalis*, particularly in the position of the preapical denticle on the dorsal tooth of the mandibles, the shape of the inner sclerotisation of the mala and the sclerotisation at the base of the labial palps, the shape of the maxillary palps and mentum-submentum, the number of setae on the second segment of the maxillary palps, the presence or absence of an epicranial stem and projections and/or obvious setal bases on the body plates and tubercles, and the length of the legs.

The following characters of the fourth instar larvae of *L. biplagiata* (Swartz) (= *L. fraudulenta* Mulsant, the type species of *Lemnia*) and *L. saucia calypso* (Mulsant) distinguish them from those of *Phrynocaria*: maxillary palps more elongate and

narrower with fewer setae on the second segment (Sasaji 1968, Fig. 13, I, L); long legs with the fore tibiotarsi about twice the head width; and pointed abdominal tubercles with obvious setal bases. However, they share these characters as well as similar colour patterns and body armature with the fourth instar larva of *C. inaequalis.*

The above evidence, particularly the different body armature, indicates that *Phrynocaria* is a good genus distinct from *Coelophora* and *Lemnia.* Although the larvae of *C. inaequalis* and the 2 species of *Lemnia* are similar and could be regarded as congeneric, a more detailed study of *L. biplagiata*, particularly the first instar, is needed to confirm this.

Prey of C. inaequalis *and* Phrynocaria *spp.*

C. inaequalis is primarily a predator of a wide range of aphids but there are also some records of it feeding on young leafhoppers (Delphacidae) and psyllids (Psyllidae). In addition to the prey recorded here and in Thompson and Simmonds (1965), Leeper (1976), Houston and Hales (1980) and Pope (in press), it has recently been noted feeding on the introduced psyllid *Heteropsylla cubana* (Crawford) on *Leucaena* (R. J. Elder, pers. comm.).

Table 1 lists observed prey of *Phrynocaria* spp. and suggests that they are primarily predators of Coccidae but may also feed on some aphid and/or psyllid species.

Table 1. Prey of *Phrynocaria* spp.

Predator	Prey	Reference	Notes
P. congener	*Lecanium* sp. (Coccidae)	Timberlake (1943)	Specimens collected together and predator prey relationship assumed. (*Lecanium* is usually considered to be a junior synonym of *Coccus* but species originally described in *Lecanium* have been transferred to a wide variety of coccid genera.)
	Pulvinaria sp. (Coccidae)		
	aphids (Aphidoidea)		
P. gratiosa	*Lecanium depressum* Targioni-Tozzetti	Timberlake (1943)	Field observation. (*L. depressum* is a junior synonym of *Parasaissetia nigra* (Nietner), Coccidae.)
	Coccus viridis (Coccidae)	———	Specimens collected together and predator prey relationship assumed. One instar IV larva reared to adult on *C. viridis* (pers. obs.)
	Hyperomyzus spp.* (Aphididae)	———	Reared in laboratory.
	psyllids (Psyllidae)	———	Specimens collected together and predator prey relationship assumed.
P. astrolabiana	*Pulvinaria* sp.	———	Field observation (many adults and larvae present feeding on scales).
	Hyperomyzus spp.*	———	Reared in laboratory.
P. quadrivittata (Fauvel) (as *Coelophora)*	*Coccus viridis*	Chazeau (1981)	Field observation and reared in laboratory.

* *H. lactucae* and *H. carduellinus.*

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