Ann. Naturhist. Mus. Wien	96 B	153 - 168	Wien, Dezember 1994

A revision of the *Chelonus scrobiculatus* species-group of Cheloninae

(Insecta: Hymenoptera: Braconidae)

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Abstract

A group of six species of *Chelonus* is defined as the *scrobiculatus* species-group. Four species in this group are described as new (*C. fischeri* sp.n., *C. ismayi* sp.n., *C. gauldi* sp.n., *C. watti* sp.n.), three names (*C. striatigena* CAMERON, *C. celebesiensis* SZEPLIGETI, *C. areolellus* BAKER) are newly placed in synonymy with *C. scrobiculatus* SZEPLIGETI, and a key to the species of the group is given and their host records listed. *C. noyesi* sp.n. is newly described for comparative purposes, but not placed in this complex. A putative glandular structure on the male gaster of some species of the *scrobiculatus*-group is illustrated for the first time.

Zusammenfassung

Sechs Arten der Gattung *Chelonus* werden als *scrobiculatus*-Gruppe zusammengefaßt. Vier Arten dieser Gruppe werden neu beschrieben: *Chelonus fischeri* sp.n., *C. ismayi* sp.n., *C. gauldi* sp.n. und *C. watti* sp.n. Drei Namen (*C. striatigena* CAMERON, *C. celebesiensis* SZEPLIGETI, *C. areolellus* BAKER) werden zu *C. scrobiculatus* SZEPLIGETI synonym gesetzt. Ein Bestimmungschlüssel führt zu den Arten der Gruppe. Die bekannten Wirte der Arten werden angegeben. *Chelonus noyesi* sp.n. wird aus Vergleichsgründen neu beschrieben, jedoch nicht in diesen Artenkomplex gesetzt. Eine mutmaßliche Drüsenstruktur an der Gaster des Männchens einiger Arten der *scrobiculatus*-Gruppe wird zum ersten Mal abgebildet.

Introduction

The Cheloninae is a moderately large subfamily of braconid wasps with more than 700 described species worldwide. The group is characterized by the possession of a gastral carapace (formed by the fusion of tergites 1 - 3) that covers the rest of the gaster (all braconid groups with this characteristic are reviewed by DUDARENKO 1974), a complete posterior transverse carina on the mesosternum and three submarginal cells in the forewing. The ovipositor is usually short and more or less concealed beneath the carapace although some Australian species of *Ascogaster* WESMAEL, for instance, have a long filamentous ovipositor. The chelonine ovipositor is always very narrow at the tip - presumably to facilitate its insertion into the host egg.

Chelonine braconid wasps are solitary internal koinobiont parasitoids of Lepidoptera. They lay their eggs into the eggs of the host but their larval development is delayed until the host larva is mature. The final instar parasitoid larva emerges from the moribund host and consumes the remains of the host except for the skin and head capsule; BROODRYK

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(1969) gave a photographic record of this. The biology of the group has been reviewed by SHAW & HUDDLESTON (1991). WALKER & HUDDLESTON (1988) give characteristics for the discrimination of the principal genera of chelonines in S.E. Asia.

Chelonus scrobiculatus SZÉPLIGETI is widespread in Asia. It has been recorded many times (as *C. striatigena* CAMERON) as a parasite of the banana scab-worm. The banana scab-worm, *Nacoleia octasema* (MEYRICK), has been recorded as causing an average 30% loss of yield in banana crops in South East Asia and the South Pacific Islands (PAINE 1964) and has been cited as a major pest of bananas in Queensland (FRANZMANN 1975). Even when the pith is not attacked by the pest and the edibility of the banana is therefore not affected, the scabbing of the skin of the fruit often reduces its market value and makes the crop unfit for export. PAINE (1964) gave an in-depth account of the scab-moth, and WATERHOUSE & NORRIS (1987) an up-to-date review of the pest and its natural enemies.

Chelonus scrobiculatus has become successfully established in Fiji, to where it was introduced in an attempt to control the scab-worm (PAINE 1964). Parasitisation rates of up to 70% have been recorded for *C. scrobiculatus* since its establishment there (WATERHOUSE & NORRIS 1987) but the rate is generally lower, however, and only partial control is exerted. Because of this partial success and because the parasitoid oviposits into the host egg - the only stage at which the scab-worm is easily accessible to natural enemies or, indeed, to pesticides - the use of *C. scrobiculatus* in the management of the pest, perhaps as part of an integrated control approach, merits further attention.

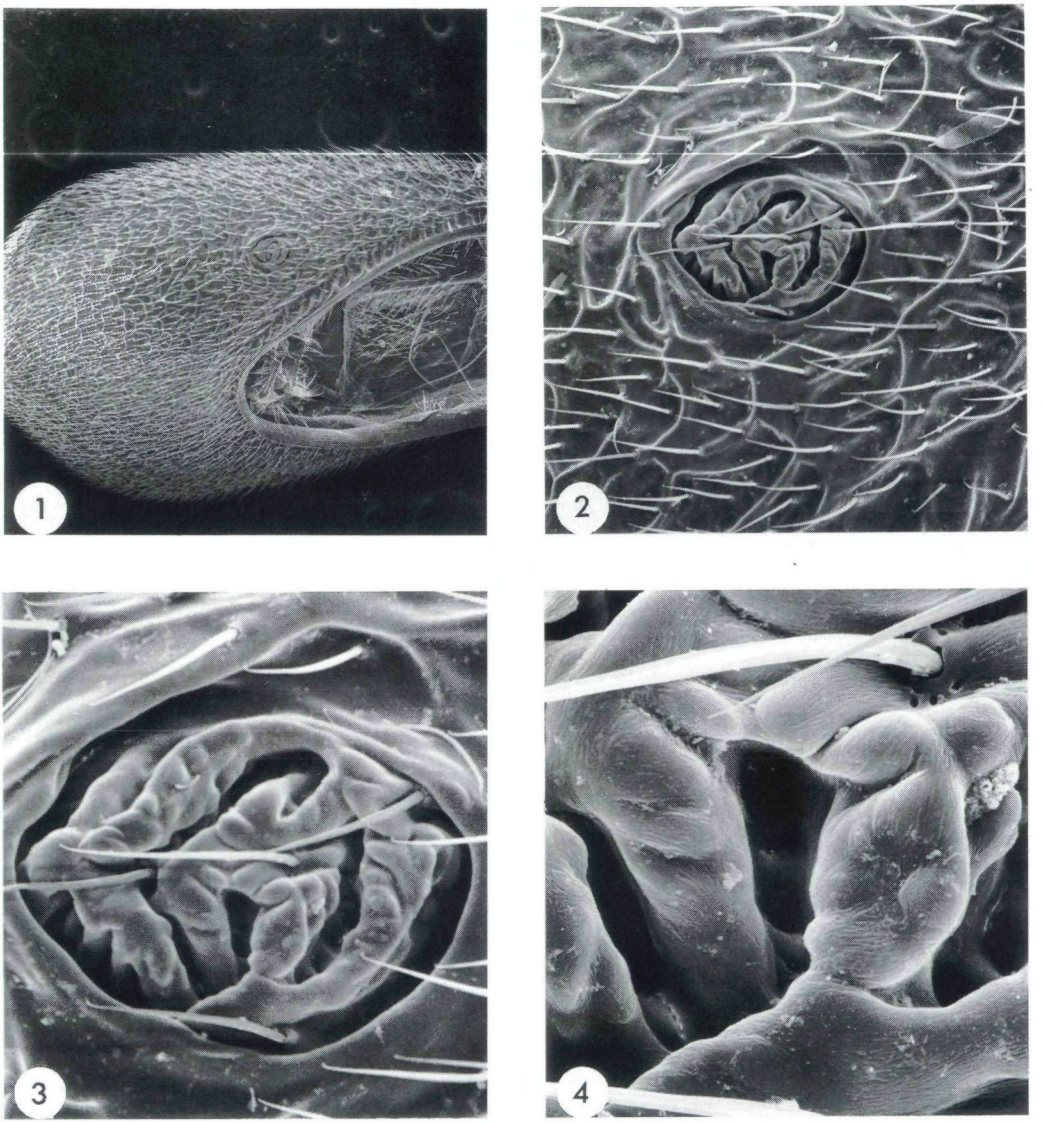
Neither the description of *C. scrobiculatus* nor that of *C. striatigena* is adequate to recognise the species - as attested by the previously unrecognised synonymy of these names. Moreover there are several closely-related species that are very similar in appearance, most of which have not been described and none of which have been differentiated either from each other or from the many other species of *Chelonus*. This paper is designed to enable these distinctions to be made and *C. scrobiculatus* to be recognised and, further, to illustrate an undescribed, apparently glandular structure on the abdomen of the males of some species of *Chelonus*.

Acknowledgements

Geoff Holloway (Australian Museum, Sydney, New South Wales), Trevor Crosby (New Zealand Arthropod Collection, Auckland) kindly lent specimens for this study. M. Shaffer and J.D. Holloway are thanked for checking the host data and Ken Hudson (Librarian, International Institute of Biological Control) for searching the literature. Abbreviations of depositories: Australian Museum (AM); Australian National Insect Collection (ANIC); British Museum (Natural History) (BMNH); Canadian National Collection (CNC); Hungarian Natural History Museum (HNHM); Museum Zoologicum Bogoriense (MZB); New Zealand Arthropod Collection (NZAC); National Museum of Natural History (USNM).

Glandular structure in male braconids

It has long been known that some male braconids are capable of producing odours. HAGEN (1953) described large tergal glands in male *Opius* (s.l.) and suggested these to be the source of the odours associated with various species of the group. BUCKINGHAM & SHARKEY (1988) gave a review of the abdominal glands of Braconidae, particularly those of the male. They described glands of males belonging to ten braconid subfamilies but



Figs 1 - 4. *Chelonus scrobiculatus*, apex of male carapace: (1) x 60; (2) x 300; (3) x 700; (4) x 2000.

found none in the two chelonine species they examined. Four species in the *C. scrobiculatus* group have paired posterolateral structures which we think are probably glandular in function although, because no live or freshly killed specimens were available, neither internal examination or histological studies were possible. Thus only the external appearance of these structures is illustrated (figs 1 - 8).

That the tergal glands in the *C. scrobiculatus* group are present only in the males implies that they have a sexual function and, indeed, MATTHEWS (1974) suggested that sweet odours emanating from many braconids may be important in mating. This suggestion was

also put forward by BUCKINGHAM & SHARKEY (1988) but their main hypothesis was that the glands produce a defensive secretion - an idea given more force perhaps in that not all males are so equipped, but they can still derive protection from defensive odours by participating in mimicry complexes with males of species that do have them.

It would be interesting to know whether the glandular structures present in four species of the *C. scrobiculatus* group are analogous in function to the much commoner apical foramen present in males of the *Microchelonus* group. The latter structure is very different in appearance but, despite it having been used extensively as a taxonomic character particularly at the species level, as far as we are aware no explanation of its function has ever been given.

The *Chelonus scrobiculatus* species-group

This group is proposed here for the species of *Chelonus* that exhibit the following combination of characteristics.

1. Carapace narrow, more or less straight-sided in dorsal view (figs 11, 19), flattened dorsally and clavate in lateral view; posteroventral rim always more or less strongly in front of apex (figs 10, 14 - 18).

2. Male never with a supragenital aperture at the apex of the carapace (fig. 9) but sometimes with a pair of ventrolateral glands at about the level of the apex of the ventral opening (figs 1, 5).

3. Antenna of female long, 16 segmented.

4. Frons more or less deeply depressed, bordered laterally by distinct carinae (fig. 12).

There are a few species of *Chelonus* that possess one or two of these characteristics but their males all have a supragenital foramen in the apex of the carapace and so they are excluded from this species-group. These species (*C. noyesi* sp.n., *C. rufipes* SZÉPLIGETI, *C. vitiensis* TURNER) are described or discussed below for comparative purposes but they are not included in the key.

Key to species

1. Distal part of carapace, between ventral opening and apex, matt and rugulose, at least dorsally 2

- Distal part of carapace, between ventral opening and apex, shining and punctured both dorsally and ventrally 4

2. Frons deeply excavate and bordered by strong carinae running from the antennal sockets to the lateral ocelli (fig. 12); legs always predominantly dark, at most fore leg pale marked and, rarely, a pale band on hind tibia ..... ***C. scrobiculatus* SZÉPLIGETI**

- Frons only weakly excavate and bordered by weak carinae (figs 20 - 21); legs mostly pale but if hind leg dark-marked then tibia always pale-banded 3

3. Hind leg dark except band at base of tibia, trochanter and tarsus pale; ventral opening of carapace three times as long as apical ventral part, carapace more rounded in lateral view (fig. 14) ..... ***C. tricoloratus* CAMERON**

- Hind leg completely brownish-yellow except apex of tibia and tarsus often infuscate; ventral opening of carapace about twice as long as apical ventral part, carapace less rounded in lateral view (fig. 15) ..... ***C. fischeri* sp.n.**

4. Ventral opening of carapace about four times as long as apical ventral part (fig. 16); head strongly contracted behind eyes (fig. 21); antenna of female shorter thicker, segments 11 - 15 at most 1.5 times as long as broad ..... ***C. watti* sp.n.**

- Ventral opening of carapace at most three times as long as apical ventral part (figs 17 - 18); head roundly, less strongly contracted behind eyes (fig. 20); antennae of female longer, thinner, segments 11 - 15 clearly at least twice as long as broad..... 5

5. Legs black, banded with white at the trochanter, base of tibia, and tarsi; gaster black, in females with a yellowish-white band anteromedially, head in lateral view with 7 - 10 coarse vertical striae between eye and occipital carina..... ***C. ismayi* sp.n.**

- Legs completely pale, mostly yellow; gaster always completely golden yellow; head in lateral view with much weaker striae. ..... ***C. gauldi* sp.n.**

Chelonus fischeri sp.n.

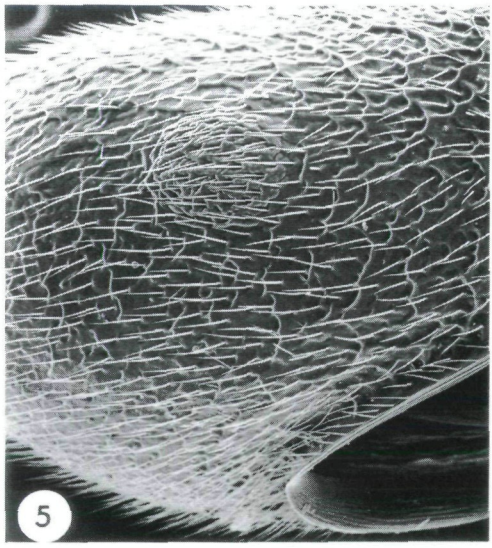
(figs 5 - 8, 15)

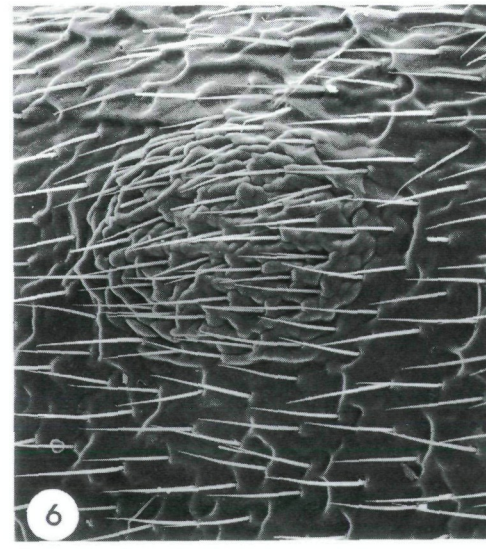
Material examined. Holotype ♀, Australia: A.C.T., Canberra, Black Mountain, xi. 1981 (Gauld) (ANIC). Paratypes. 2 ♂♂, 3 ♀♀, same data as holotype (BMNH, ANIC); 1 ♀, Canberra, 31.iii.1981 (Short) (BMNH); 3 ♂♂, 5 ♀♀, Queensland, Stanhope, 15.i.1983 (Bouček) (BMNH, ANIC); 1 ♀, Brisbane, 28.i-9.ii.1980 (Galloway) (BMNH); 1 ♀, Brisbane, Long Pocket, 1977 (Galloway) (BMNH); 6 ♂♂, 1 ♀, Gympie, Cooloola, iv.1978 (Galloway) (BMNH); 1 ♀, 1 ♂, Cooloola National Park, 7.iii.1984 (Masner) (CNC); 2 ♂♂, Mt. Glorious, ii-iii.1983 (Bouček) (BMNH); 1 ♂, Glasshouse Mountains, Tibrogargan 27.xii.1976 (Bouček) (BMNH); 2 ♂♂, N.S.W., Royal National Park, ii.1983 (Gauld) (BMNH); 1 ♂, 20 km S. of Gosford, ii.1983 (Gauld) (BMNH); 1 ♂, Clyde Mountains, Cabbage Tree Creek, ii. 1983 (Gauld) (BMNH); 3 ♂♂, 2 ♀♀, Victoria, Melbourne, Kinglake National Park, 31.i.1977 (Bouček) (BMNH).

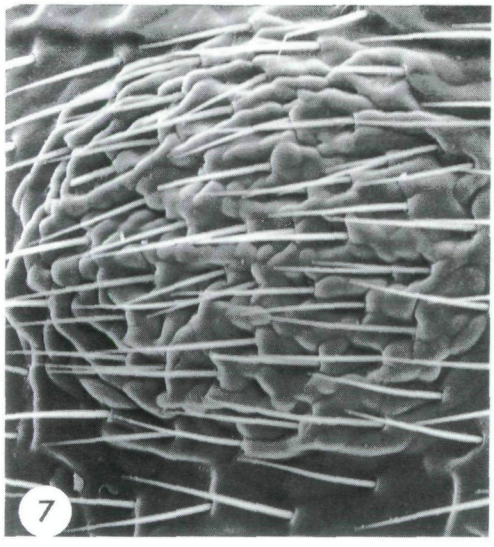
Female. - Antennae 16 segmented; flagellum weakly dilated medially, basal segments four to five times as long as broad, rest of segments each at least twice as long as broad. Head contracted behind eyes, temple shorter than eye in dorsal view. Vertex finely transversely striate. Frons shallowly depressed, bordered laterally by a carina and scrobes completely surrounded by concentric costulae; medial longitudinal carina between antennae. Ocelli on line, OO (distance between eye and lateral ocellus) = 4 OD (diameter of lateral ocellus). Face about twice as broad as high, completely rugose though with a predominant striate element vertically at the sides. Clypeus weakly convex, apical border produced, convex but medially truncate; punctate medially, weakly rugose laterally. Gena finely striate-rugose. Malar space slightly longer than basal breadth of mandible.

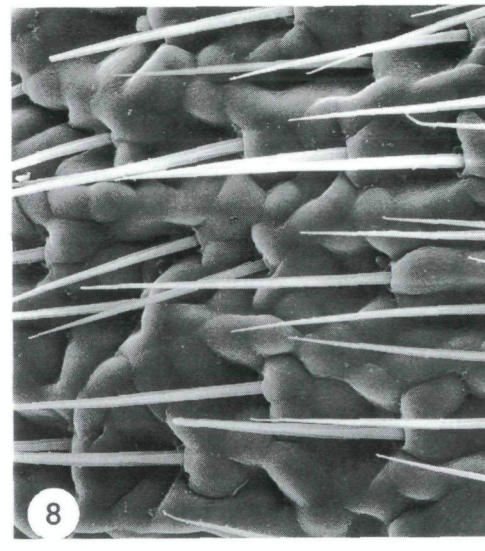
Pronotum: projecting little in front of mesonotum laterally reticulate-foveolate and rugose. Notaulices scarcely distinct from the coarse rugose sculpture of the mesoscutum. Precoxal suture reticulate-foveolate, indistinguishable from the fine reticulate sculpture of the mesopleuron. Propodeum divided by a medial transverse carina which is usually only weakly raised into medial dentate projections; coarsely reticulate-rugose dorsally, finely reticulate-rugose posteriorly.

Carapace: oval in dorsal view, predominantly coarsely longitudinally costulate proximally, densely reticulate-rugose medially, finely reticulate-rugose distally; ventral opening about two-thirds length of carapace.









Figs 5 - 8. *Chelonus fischeri*, apex of male carapace: (1) x 170; (2) x 350; (3) x 600; (4) x 1300.

Colour: black except base of antenna, basal third to half of carapace, and legs yellow; hind tibia at apex and tarsus sometimes infuscate.

Male. - Same as female except antenna 24 - 27 segmented, flagellum not dilated medially; carapace sometimes completely black and always with large callus-like ventrolateral glands.

Hosts: unknown.

Remarks. *Chelonus fischeri* sp.n. closely resembles another Australian species, *C. gauldi* sp.n.; the latter species, however, has a different colour pattern, the carapace smooth

punctate apically and no ventrolateral glands in the male. *Chelonus fischeri* is paired in the key to species with *C. tricoloratus* CAMERON, the relative coarseness of the sculpture in the latter species is a useful ancillary character for their discrimination.

Chelonus gauldi sp.n.

(fig. 17)

Material examined. Holotype ♀, Australia: NSW, Mt. Keira, 600m, ii.1983 (Gauld) (ANIC). Paratypes. 1 ♀, 11 ♂♂, same data as holotype (BMNH, ANIC); 6 ♂♂, Royal National Park, ii. 1983 (Gauld) (BMNH); 1 ♂, 4 ♀♀, Clarence R., Iluka rain forest, 22-23.ii.1965 (McAlpine) (AM); 1 ♀, Minnamorra falls near Kiama, 9.ii.1962 (McAlpine) (AM); 1 ♀, Wilson river reserve via Bellangry, 26.xi.1966 (McAlpine) (AM), 1 ♀, Hoonbrook, near Mullumbrizzby, 4.xii.1961 (McAlpine) (AM), 2 ♂♂ Queensland, Coolola National Park, 4-20.x.1979 (Galloway) (BMNH); 1 ♀, same data except 7.iii.1984 (Masner) (CNC); 3 ♂♂, Eungella National Park, 30.xi.1976 (Bouček) (BMNH); 1 ♀, Crediton creek, 12.xii.1961 (McAlpine & Lossin) (AM).

Female. - Antenna 16 segmented; flagellum long, basal segments at least four times as long as broad, remaining segments each at least twice as long as broad. Head contracted behind eyes; temple slightly shorter than eye in dorsal view. Vertex transversely striate. Frons weakly depressed with several concentric costulae around scrobes and a medial longitudinal carina between antennae. Ocelli on line, OO = 3.5 OD. Face about 1.5 times as broad as high, finely costate laterally, finely rugose medially. Clypeus weakly convex, apical border convex but truncate medially; punctate medially, weakly rugose laterally. Gena finely striate-rugose. Malar space about equal in length to basal breadth of mandible.

Pronotum: projecting little in front of mesonotum; reticulate-punctate laterally. Notaulices shallow, foveolate, coalescing posteriorly in a reticulate-foveolate area; medial lobe of mesoscutum with a longitudinal foveolate band medially, otherwise punctate with obsolescent rugae. Precoxal suture shallow, punctate-foveolate, merging with large punctures on mesopleuron.

Propodeum: short, divided by a medial transverse carina, completely reticulate-rugose.

Carapace: only weakly clavate in dorsal view, costulate proximally, polished, punctate distally; ventral opening about two thirds length of carapace.

Colour: black except antennae brown but pale yellow at base, legs pale yellow or ivory; carapace completely golden yellow.

Male. - Same as female except antenna 25 - 27 segmented, flagellar segments shorter.

Hosts: unknown.

Remarks. *Chelonus gauldi* sp.n. is closely related to *C. fischeri* sp.n. but the latter species is more heavily sculptured, has a different colour pattern and ventrolateral glands in the male. The males of *C. gauldi* sp.n. have no ventrolateral glands; the only other species in this group without them (*C. watti* sp.n.) is very different from *C. gauldi* sp.n. in many characteristics. The beautiful sunshine-yellow carapace makes *C. gauldi* sp.n. a very distinctive species not only in the *C. scrobiculatus* species-group but in the genus as a whole.

Chelonus ismayi sp.n.

(figs 18 - 20)

Material examined. Holotype ♀, Papua New Guinea: Central P., 20 km SE of Port Moresby, 9.ii.1985 (Ismay)(BMNH). Paratypes, 2 ♀♀, same data as holotype except 30.xii.1984 (BMNH) 16.iii.1985 (ANIC); 3 ♂♂, same data as holotype except 6.i.1985, 9.ii.1985 (ANIC, BMNH); 1 ♀, Eilogo Cr. Forest, 500m, 17.iii.1985 (Ismay) (BMNH).

Female. - Antenna 16 segmented; flagellum long, basal two or three segments about six times as long as broad, remainder at least twice as long as broad most conspicuously more than this. Head contracted behind eyes, temple distinctly shorter than eye in dorsal view. Vertex transversely striate. Frons shallowly depressed with several strong percurrent costulae laterally, inside these polished and with a medial longitudinal carina. Ocelli on line OO = 3 OD. Face about 1.5 times as broad as high with strong vertical costulae except beneath antennal sockets where they are transverse. Clypeus weakly convex with a deeply convex apical border; finely densely punctate. Gena with seven to ten strong vertical costulae.

Pronotum: short, projecting only weakly in front of mesonotum; reticulate - punctate laterally. Notaulices shallow, foveolate, coalescing posteriorly in a reticulate-foveolate area sometimes with a few rugae, rest of mesoscutum with coarse punctures and scattered rugae. Precoxal suture shallow, reticulate-foveolate merging with the reticulate sculpture on the mesopleuron.

Propodeum: short, divided into dorsal and posterior faces by a weak transverse carina which is raised medially into two blunt dentate projections; completely reticulate-rugose.

Carapace: clavate in dorsal view, costulate proximally reticulate-rugose medially, shining, punctate distally; ventral opening slightly more than two thirds length of carapace.

Colour: black except antenna brown but yellowish at base, carapace with a submedial, transverse pale band. Legs ivory except infuscate bands on all femora, mid and hind tibiae and hind coxa.

Male. - Same as female except antenna 24 - 27 segmented, all flagellar segments shorter; hind tibia sometimes completely infuscate; carapace completely black without a submedial transverse pale band and with small ventrolateral glands.

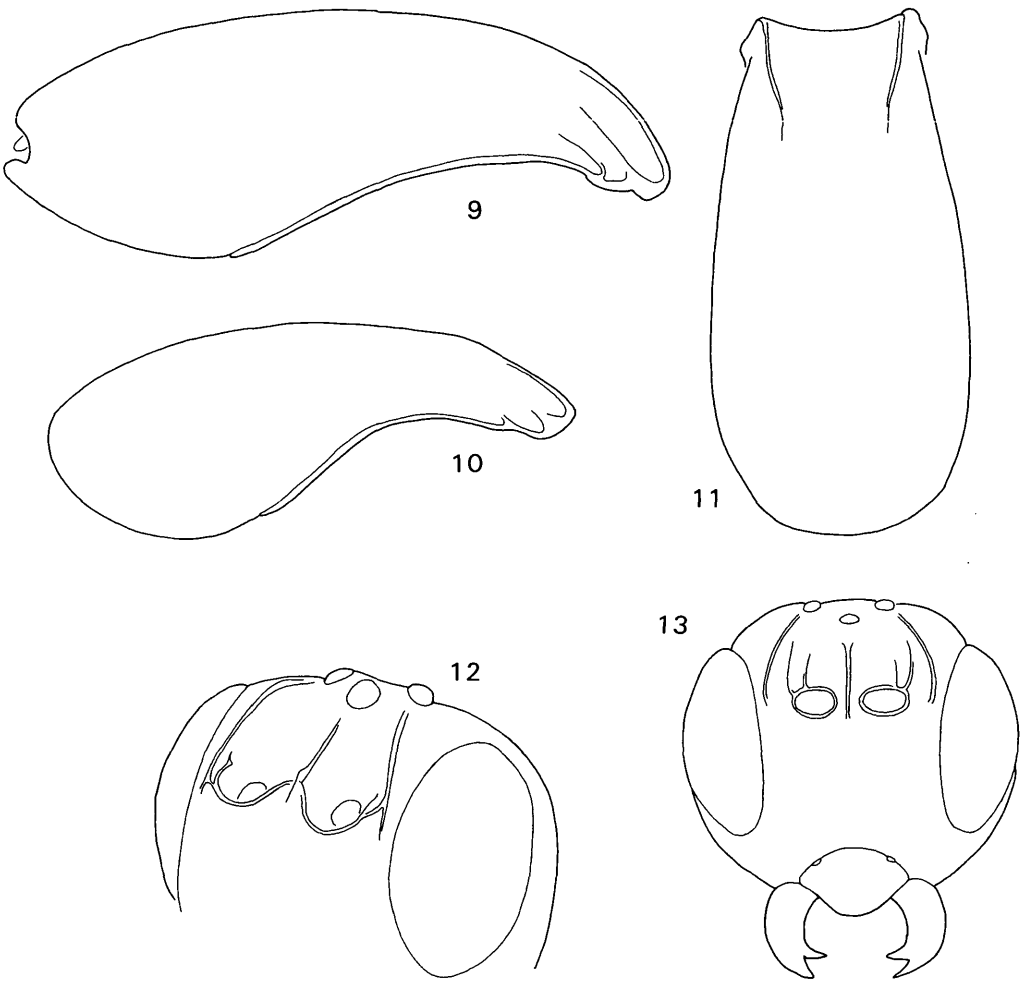
Hosts: unknown.

Remarks. With the exception of *C. scrobiculatus* itself, this species is the most distinctive member of the *C. scrobiculatus* group. The elongate malar space and coarse striate sculpture of the head are features found in no other species of the group.

Chelonus noyesi sp.n.

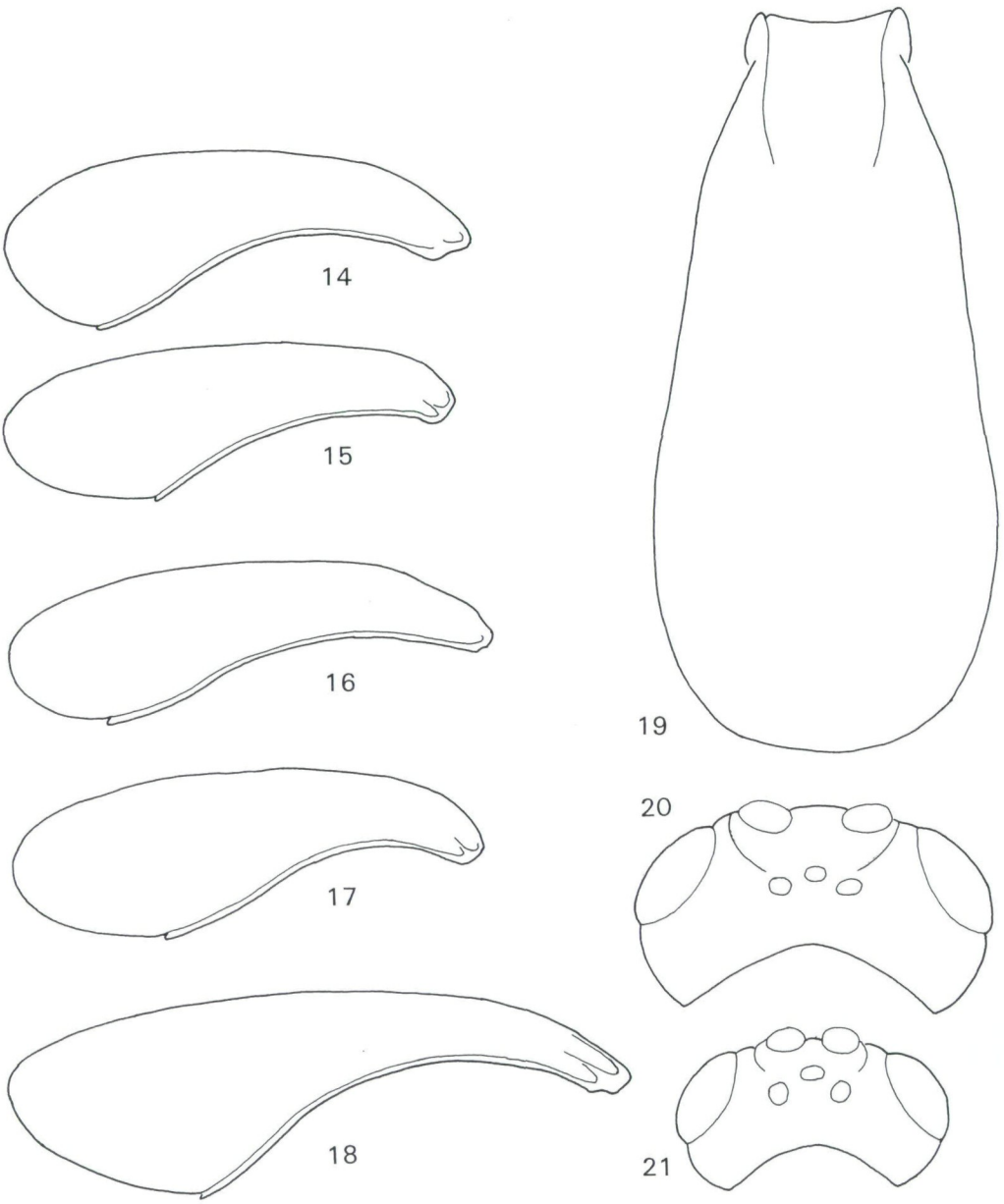
(figs 9, 13)

Material examined. Holotype ♀, Indonesia: Java, Tjipetir, 1928 (Franssen) [ex Rhodoneura myrtaea Drury] (BMNH). Paratypes, Indonesia: 1 ♂, 2 ♀♀, Sulawesi, Toraut, 1180 m, 14.iv.-14.v.1985 (Noyes)(BMNH, MZB); 5 ♂♂, Sulawesi, Utara, Dumoga-Lecone NP, iv.1985 (Noyes)(BMNH, MZB), Java; 3 ♀♀, 6 ♂♂, same data as holotype (BMNH). N. Borneo; 1 ♂, Kudat, 7.ix.1927 (BMNH). Brunei: 1 ♀, Vlu Temburong, 16-22.ii.1982 (Day)(BMNH). India: 1 ♀, Malabar, Walayar Forests, 13.ix.1938 (Nathan) (BMNH).



Figs 9 - 13. (9) *Chelonus noyesi*, carapace lateral; 10 - 12 *Chelonus scrobiculatus*: (10) carapace lateral; (11) carapace dorsal; (12) frons anterolateral; (13) *Chelonus noyesi*, head anterior.

Female. - Antenna 27 - 31 segmented; flagellum slightly dilated medially then tapered to apex, proximal segments distinctly longer than broad, the distal segments beyond segment 7 or 8 more or less quadrate. Head strongly rounded behind eyes. Eyes about equal in length to temple in dorsal view. Frons strongly depressed behind antennae the depression bordered laterally by a carina and with a medial longitudinal carina running to the fore ocellus. Ocelli on line. Occiput flat falling sharply away behind ocelli. Face about 1.5 times as broad as high, weakly convex, finely rugose, sometimes reticulate at least laterally. Clypeus rather flat, densely finely punctate, apical border rounded, protruding ventrally. Gena smooth, densely punctate, occasionally with weak, oblique striation.



Figs 14 - 21. (14) *Chelonus tricoloratus*, carapace lateral; (15) *C. fischeri*, carapace lateral; (16) *C. watti*, carapace lateral; (17) *C. gauldi*, carapace lateral; (18 - 20) *C. ismayi*: (18) carapace lateral; (19) carapace, dorsal: (20) head dorsal; (21) *C. watti*, head dorsal.

Pronotum: short not projecting beyond mesonotum, high, the anterior surface long and vertical in lateral view; coarsely reticulate. Notaulices coarsely foveolate, merging

laterally and posteriorly with the reticulate sculpture on the mesoscutum which is medially punctate with a medial longitudinal line of pits.

Mesonotum: rather flat dorsally, the anterior densely punctate part is at a sharp angle with the dorsal surface and in line with the dorsal surface of the pronotum. Precoxal suture indistinguishable from the coarse reticulate sculpture of the mesopleuron.

Propodeum: short, broad, divided into dorsal and posterior surfaces by a transverse carina which is elevated into prominent dentate flanges medially and laterally; completely reticulate-rugose, more coarsely reticulate dorsally and laterally than posteriorly.

Carapace: rather narrow, straight-sided and apically truncate in dorsal view; strongly arched dorsally and more or less bluntly pointed at apex in lateral view; ventral opening at most two thirds of length of carapace.

Colour: black except palps in part yellow, fore and mid tibiae and all tarsi sometimes pale.

Hosts: *Banisia* (as *Rhodoneura*) *myrtaea* DRURY (Lepidoptera; Thyrididae). *Banisia myrtaea* has not been recorded from Java but *B. fenestrifera* WALKER has often been identified as *B. myrtaea* and it seems most probable that the host species is one of the *fenestrifera* group (J.D. Holloway, personal communication).

Remarks. *Chelonus noyesi* sp.n. bears a close but superficial resemblance to *C. scrobiculatus*; their differentiation is discussed in the remarks on the latter species. *Chelonus noyesi* sp.n. is widely distributed in Asia, though it is not possible to form a precise estimate of its distribution when only so small a sample is available.

Chelonus scrobiculatus SZÉPLIGETI

(figs 1 - 4, 10 - 12)

Chelonus scrobiculatus SZÉPLIGETI, 1900: 58, Holotype ♀, New Guinea; Lemian, Berlinka fen (Biro) (HNHM) [examined].
Chelonus striatigena CAMERON, 1908: 688, LECTOTYPE ♂, Borneo: Kuching (BMNH) here designated [examined], n. syn.
Chelonus celebesiensis SZÉPLIGETI, 1908; 408. Holotype ♂, North Celebes; Toli Toli, xi-xii, 1895 (Fruhstorfer) (HNHM) [examined], n. syn.
Megachelonus areolellus BAKER, 1926; 459, Holotype ♀, Malaysia: Penang Island (Baker) (USNM) [examined], n. syn.

Material examined. 133 ♀♀, 89 ♂♂ from India, Thailand, China, Indonesia, Malaysia, Singapore, Papua New Guinea, Sulawesi, Brunei, Australia, Philippines, Solomon Islands, Western Samoa, Fiji.

Female.- Antennae 16 segmented, basal segments of flagellum elongate about three times as long as broad, segments 8 - 13 dorsoventrally flattened so that these segments in ventral view less than 1.5 times as long as broad. Head roundly contracted in dorsal view; temple about equal to, or slightly longer than eye in dorsal view. Vertex coarsely rugose, often striate. Frons strongly depressed, the depressed area bordered by a strong carina running from in front of the lateral ocelli around underneath the antennal sockets and then medially almost to the anterior ocellus. Ocelli not on line, OO = 3.0 - 4.0 OD. Face weakly convex, about twice as broad as high, completely finely reticulate-rugose, dorsally produced between the antennal sockets as a broad triangular projection. Clypeus weakly convex, shining, punctate; apical margin produced, truncate. Gena finely transversely striate.

Pronotum: dorsally rugose, often reticulate laterally. Notaulices broad foveolate rest of mesonotum coarsely sculptured except anteromedially with a smooth punctate area on each side of the midline. Precoxal suture more or less indistinguishable, the whole of the mesopleuron coarsely reticulate.

Propodeum: with a strong medial transverse carina produced into large medial and lateral dentate projections; coarsely reticulate-rugose dorsally.

Carapace: straight sided and weakly expanded posteriorly in dorsal view; strongly clavate in lateral view, the ventral opening at most two thirds the length of the carapace, sometimes less; completely finely rugose.

Colour: black carapace sometimes with pale patches distally; forelegs always with at least the tarsus pale-marked sometimes almost the whole leg pale; midlegs generally dark but sometimes trochanter and tarsus pale; hindlegs dark except trochanters yellow and tibiae with a pale patch on inside at base rarely a complete pale band.

Male. - Same as female except antennae with 24 - 27 segments, flagellum not dilated; carapace with ventrolateral glands (figs 1 - 4).

Hosts: **Pyralidae**: *Crocidolomia paronana* (FABRICIUS) (as *binotalis*), *Cydalina* (as *Glyphodes*) *laticostalis* (GUENEÉ), *Diaphania* (as *Pelpita*) *indica* (SAUNDERS), *Dichocrocis clytusalis* (WALKER) (as *Notarcha clytalis* & *Sylepta clytusalis*), *Eutectona* (as *Hapalia*) *machaeralis* (WALKER), *Glyphodes* (as *Margaronia*) *pulverulentalis* HAMPSON, *Glyphodes pyloalis* (WALKER), *Herpetogramma* (as *Psara*) *submarginalis* (SWINHOE), *Lygropia* sp., *Nacoleia* sp. (as *Nacoleia lamprosema*), *Nacoleia octasema* (MEYRICK), *Omiodes* (as *Lamprosema* & *Nacoleia*) *diemenalis* (GUENEÉ), *Omoides indicata* (FABRICIUS), *Palpita* (as *Margaronia*) sp., *Parotis marginata* (HAMPSON), *Psara stultalis* (WALKER), *Pycnarmon cribrata* (FABRICIUS), *Spoladea* (as *Hymenia*) *recurvalis* (FABRICIUS). **Tortricidae**: *Adoxophyes aurantiana* BRADLEY.

Remarks. The type specimen of *Megachelonus areolellus* is almost indistinguishable structurally from *C. scrobiculatus* but its legs are paler, its interantennal crest more prominent and its face slightly wider than any other specimen of *C. scrobiculatus* that we have examined. We do not consider these differences to have more than intraspecific significance. We have not been able to examine type material of *Chelonus tabonus* SONAN. WATANABE (1937) keyed *C. tabonus* and his characterisation of the species indicates to us that it is synonymous with *C. scrobiculatus*. We have not, however, placed *C. tabonus* in synonymy, having seen neither the type material nor Watanabe's material.

Chelonus scrobiculatus is a widely distributed species, occurring from the Oriental region to Australia and on a number of islands in the Pacific. The exceptionally deep excavation of the frons, the characteristic ventrolateral glands in the male and the robustness of the insect make this species distinctive within its group. *Chelonus scrobiculatus* is superficially very similar to *C. noyesi* sp.n. but the latter species can be distinguished by its 27 - 31 segmented female antennae and the terminal foramen in the carapace of the male. Thus *C. noyesi* sp.n. is clearly not closely related either to *C. scrobiculatus* or to the *C. scrobiculatus* group.

In laboratory-reared material, PAINE (1964) found behavioural differences between populations of this species. He postulated the existence of five 'strains' and gave it as his

belief (supported by R.D. Eady's recognition of slight morphological differences between the strains) that *C. scrobiculatus* may be more than one species. However, we have been able to examine Paine's material together with much material that was not available to Eady and we consider that the morphological variation in this material is no more than what is to be expected in so widely distributed a species. Furthermore, all specimens are the same in colour pattern of legs and in structure of antennae and male ventrolateral glands, all of which show consistent differences from other species in the group (compare, for instance, figures 1 - 4 with figures 5 - 8); indeed, these characteristics appear to be consistent within all species of the group. Thus, the division of *C. scrobiculatus* into several species, as suggested by PAINE (1964), is not justifiable on the morphological evidence at present available.

Chelonus tricoloratus CAMERON

(fig. 14)

Chelonus tricoloratus CAMERON, 1905: 79. Holotype ♂, Ceylon: Trincomalee (Yerbury) (BMNH) [examined].

Material examined. SRI LANKA, 1 ♂ (holotype of *C. tricoloratus*). INDIA: 3 ♀♀, Karnataka, Mudigere, 26.x- 4.xi.1979 (Noyes) (BMNH). BRUNEI: 1 ♀, Ulu Temburong 16- 22.ii.1982 (Day) (BMNH).

Female. - Antennae 16 segmented; flagellum long, all segments at least twice as long as broad most conspicuously more than this. Head moderately contracted behind eyes, temple about equal to eye in dorsal view. Vertex weakly striate. Frons shallowly depressed. Ocelli on line, OO = 2.5 - 3.0 OD. Face about 1.5 times as broad as high, reticulate-rugose but with a vertical striate element at the sides and transversely striate dorsally beneath antennal sockets. Clypeus distinctly narrower than face, more or less flat, apical border produced but truncate medially; predominantly punctate but sometimes with a few weak rugae. Gena with many fine, oblique striae. Malar space about equal to basal breadth of mandible.

Pronotum: coarsely reticulate-rugose. Notaulices distinct, wide foveolate grooves coalescing posteriorly where the mesoscutum is almost completely coarsely reticulate; medial lobe coarsely rugose. Mesopleuron coarsely reticulate, precoxal suture more or less indistinguishable.

Propodeum: divided by a weak transverse medial carina which is raised into weak medial and lateral dentate projections; coarsely reticulate-rugose.

Carapace: oval in dorsal view, rather rounded distally in lateral view; costulate proximally, finely reticulate-rugose distally. Ventral opening about three quarters length of carapace.

Colour: black except antennae yellowish-brown, base of carapace, forelegs, basal half of midlegs and hind trochanters pale yellow; tibiae of mid and hind legs banded with ivory and tarsi ivory at base.

Male. - Same as female except antennae 23 segmented [taken from description], carapace more or less parallel-sided in dorsal view and with small, spiracle-like ventrolateral glands. The male is generally rather darker, the carapace has only two pale spots on the

lateral rim at the base and the hind leg is dark except for the trochanter and a pale band on the tibia.

Hosts: unknown.

Remarks. CAMERON (1905), in his description, mistook the sex of his specimen; it is a male and in poor condition: its antennae and most of its legs are missing, its wings are crumpled and torn and its thorax broken by the pin. In addition to all of this it is covered in dirt and mould.

Chelonus tricoloratus is similar in colour pattern to *C. scrobiculatus*, but *C. tricoloratus* has longer, more slender antennal segments, more shallowly depressed frons and a more rounded carapace with a longer ventral opening than *C. scrobiculatus*; it is also much smaller and less robust than *C. scrobiculatus*. *Chelonus fischeri*, on the other hand, has much finer sculpture than *C. tricoloratus* and the colour patterns and male ventrolateral glands of the two species are markedly different.

Chelonus watti sp.n.

(figs 16, 21)

Material examined. Holotype ♀, Tonga: Futu, Niuafo'au I., 28.i-1,ii.1977 (Watt) (NZAC). Paratypes, 6 ♂♂, same data as holotype (BMNH, NZAC); 1 ♂, same data except 27.i.1977 (NZAC).

Female. - Antenna 16 segmented; flagellum stout, weakly dilated medially, distal segments only a little longer than broad in ventral view. Head strongly contracted behind eyes. Temple distinctly shorter than eye in dorsal view. Vertex weakly striate. Frons shallowly depressed with circumferential costulae. Ocelli on line, OO = 3 OD. Face about 1.5 times as broad as high, vertically costulate laterally, rugose medially with a transverse striate element. Clypeus moderately convex, with a convex apical border which is truncate medially; densely punctate. Gena finely obliquely striate, contracted ventrally so that head is rather triangular in face view. Malar space about equal to basal breadth of mandible.

Pronotum: projecting in front of mesonotum; dorsally smooth, laterally reticulate-punctate. Notaulices shallow foveolate, coalescing posteriorly in a reticulate-foveolate area.

Mesoscutum: with a medial longitudinal foveolate band, otherwise punctate. Precoxal suture coarsely reticulate- foveolate, indistinguishable from sculpture of mesopleuron.

Propodeum: divided by a medial transverse carina that is produced into two prominent dentate flanges medially and two weak flanges laterally; coarsely reticulate-rugose dorsally, more finely reticulate-rugose posteriorly.

Carapace: only weakly clavate in dorsal view, proximally striate-rugose with coarse longitudinal elements predominating, distally shining punctate; ventral opening about four fifths length of carapace.

Colour: black, except antenna brown distally, basal half yellowish; legs yellow but hind tibia infuscate dorsally.

Male. - Same as female except antenna 25 - 27 segmented, flagellum slender.

Hosts: unknown.

Remarks. This species is the least characteristic member of the *C. scrobiculatus* group; although, in common with *C. gauldi* sp.n., it lacks ventrolateral glands in the male, it does not appear to be closely related to that species. *Chelonus watti* sp.n. is very similar morphologically to *C. vitiensis* TURNER (described from Fiji) and the two forms would certainly be considered to be the same species were it not that the carapace of male *C. vitiensis* has a distinct apical foramen. The possibility exists that there is only a single species with dimorphic males, but breeding experiments are needed to establish this as more than a possibility. The possession of an apical foramen in male chelonines has hitherto been regarded as a stable characteristic of considerable significance taxonomically - the subdivision of *Chelonus* into subgenera, for instance, has been based on its presence or absence. Thus these two forms are here retained as distinct species pending contrary evidence.

Chelonus rufipes SZÉPLIGETI is also similar in colour pattern and size to *C. watti* sp.n. and *C. vitiensis* and, like *C. vitiensis*, possesses an apical foramen. The holotype of *C. rufipes* is a male and the only other material that we have had available is a small number of males from Papua New Guinea.

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