Bull. ent. Res. **76**, 701–717
Published 1986

A review of the genus *Cryptolaemus* (Coleoptera: Coccinellidae) with particular reference to the species resembling *C. montrouzieri* Mulsant

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Abstract

Cryptolaemus montrouzieri Mulsant is a well-known and historically important predator of mealybugs. It is indigenous to eastern Australia, and has been introduced throughout the world for biological control. In contrast, the other members of the genus, including those which resemble *C. montrouzieri*, remain poorly known. The genus *Cryptolaemus*, with seven previously described species, is redefined and two species-groups are recognized. The first, the *montrouzieri* group, comprising *C. montrouzieri*, *C. affinis* Crotch (Indonesia and Papua New Guinea and northern Queensland, Australia), *C. wallacei* Crotch (Indonesia) and *C. simplex* Blackburn (northern Australia), is revised; *C. crotchi* sp. n. (Indonesia) and *C. sinestria* sp. n. (Indonesia, Papua New Guinea and Solomon Islands) are described as new, and *C. simplex* is reduced to a subspecies of *C. montrouzieri*. A key to these species is provided. The second group comprises two of the remaining species, *C. subviolaceus* Crotch and *C. concinnus* Weise, but lack of sufficient material precludes a revision of this group at present. The final species, *C. engelhardi* Gorham, is transferred to the chilocorine genus *Brumoides* Chapin. Lectotypes are selected where appropriate.

Introduction

Cryptolaemus Mulsant is a small genus with seven previously described species Korschefsky, 1931) indigenous to the Australasian Zoogeographic Region. One species, *C. montrouzieri* Mulsant, was among the first species to be used as a predator to control an agricultural insect pest, and it now assumes a classical status of great importance in biological control literature. Since its first introduction into California in 1891 from Sydney, New South Wales, Australia, by Albert Koebele, and subsequent introduction in 1893 to Hawaii, it has been imported into over 40 countries throughout the warm temperate and tropical regions of the world to combat mealybug pests (Clausen, 1978). Table I shows a selection of these countries, together with their approximate date of first introduction and the source of supply. The majority of introductions this century have originated from these Californian or Hawaiian stocks, which is fortunate, given the economic importance of the species, since only a single species has been involved.

TABLE I. *Approximate dates and sources for the introduction of* Cryptolaemus montrouzieri *throughout the world*[*]

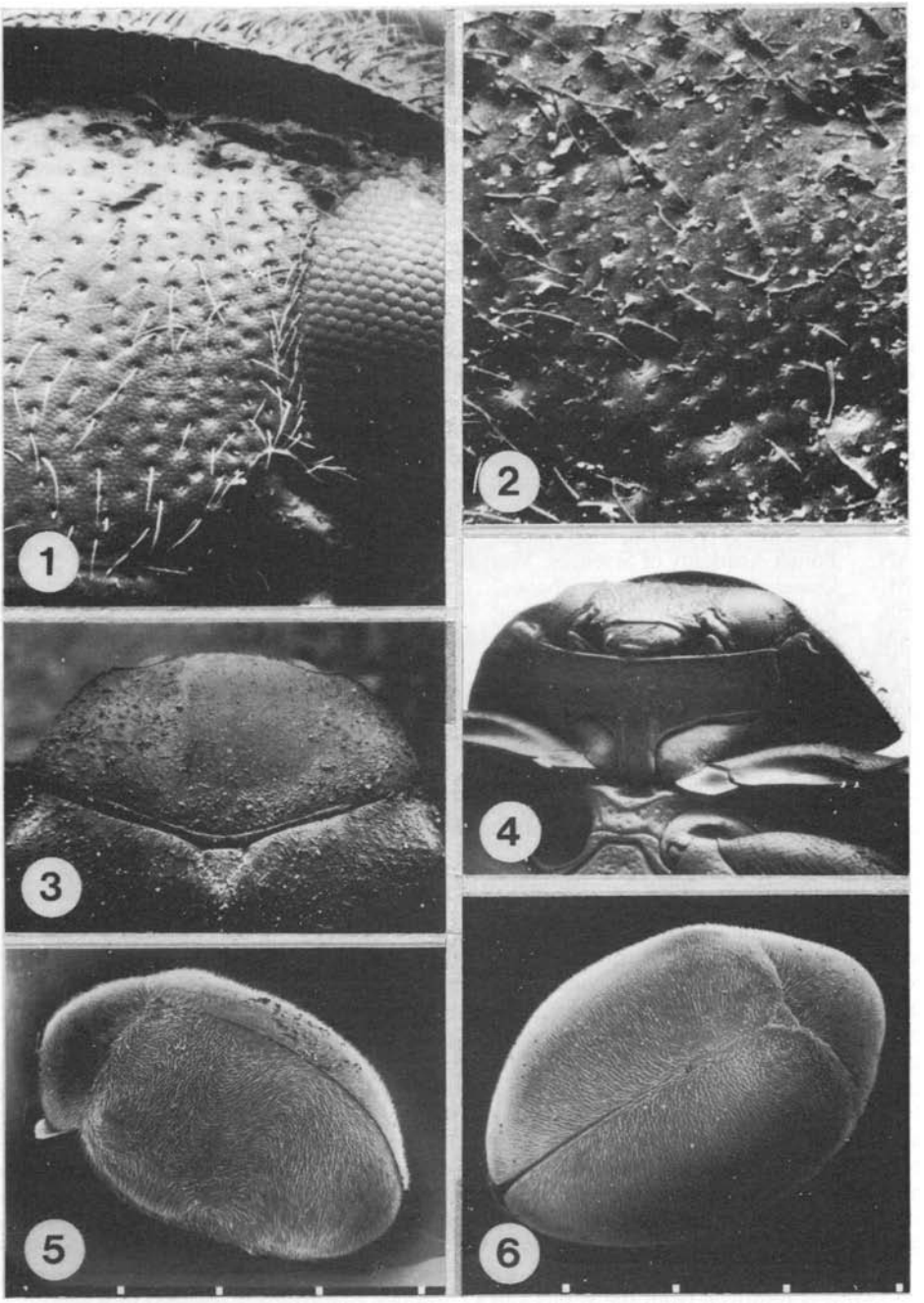
Locality	Date	Source
USA, California	1891	New South Wales, Australia
Florida	1931	
Hawaii	1893	Australia
Bermuda	1926	California
Puerto Rico	1911–13	
Cuba	*ca.* 1918	
Costa Rica	*ca.* 1912	California
British Guiana	pre 1913	
Chile	1931	
France	1918	California
Spain	*ca.* 1926	California
Italy	1907–08	
Israel	1924	France and Egypt
USSR, Georgian SSR	1933	Egypt
Algeria	*ca.* 1918	California
Morocco	*ca.* 1921	France
Egypt	1922	France
Kenya	1924	South Africa
Tanzania	pre 1935	
South Africa	1900	California and Australia
Mauritius	1938–39	South Africa
Seychelles	1959	California
India	1898	Australia
China		
Taiwan		
Bonin Islands	*ca.* 1935	
Guam, Micronesia	1926	Hawaii
West Malaysia	pre 1916	
Indonesia, Java	1918	Hawaii
Sulawesi	1928	Java
Fiji	*ca.* 1923	Australia
New Hebrides	pre 1915	Australia
Western Australia	1902	New South Wales, Australia
New Zealand	1897–99	Australia

[*] Data from Clausen (1978), Schilder & Schilder (1928), Wilson (1960) and various abstracts in the *Review of Applied Entomology, Series A*.

Perhaps it is because of the success of *C. montrouzieri* in many (but not all) of its introductions that virtually no attention has been paid to the possible beneficial effects of other members of the genus. Szent-Ivany (1963) alone describes the success of *C. affinis* Crotch in controlling populations of coffee mealybugs (*Planococcus citri* (Risso)) in an upland valley in Papua New Guinea. Most species also remain poorly known taxonomically, there having been virtually nothing published on them since their original descriptions, apart from a short paper by Cockerell (1929). He provided a key to species based mainly on the literature, but it is of very little help since it relies on a variable colour character.

Recently, specimens of *Cryptolaemus* from the Solomon Islands were submitted for identification to the CAB International Institute of Entomology, London, and a preliminary examination showed that they probably represented an undescribed species. A thorough investigation was initiated when it was learnt that biological studies were being undertaken on the Papua New Guinean species and that problems of identification were being encountered (J. W. Ismay & Elaine Brough, pers. comm.). The aim of this paper is to redefine the genus *Cryptolaemus* based on a review of all its previously known species. Two species groups, the *montrouzieri* group and the *subviolaceus* group, are recognized, and one species, *C. engelhardi* Gorham, is removed from the genus. The species of the *montrouzieri* group are revised, and two new species are described. A key to this group of species is provided.

The photographs of uncoated specimens (Figs. 1–4) were taken on an ISI 60A scanning electron microscope, and those of coated specimens (Figs. 5 & 6) were taken on a Cambridge Instruments S. 180 scanning electron microscope.



Figs. 1, 4 & 6.—*Cryptolaemus sinestria* sp. n.; 1, sculpture on head (×96); 4, prosternum (×25); 6, whole body (scale dots 1 mm). Figs. 2 & 3.—*C. wallacei* Crotch; 2, elytral punctures (×180); 3, pronotum (×21). Fig. 5.—*C. montrouzieri simplex* Blackburn, whole body (scale dots = 1 mm).

Genitalia in a dried state proved unsuitable for microscopic study, so the following preparation technique was used to reveal their fine structure. Whole specimens were softened in water and their abdomens removed. These were treated with cold or warm 10% KOH until the genitalia could be dissected out (usually 4 h or less). Once removed from the abdomen, the genitalia were briefly rinsed in distilled water, transferred to a cavity slide with a drop of 30% lactic acid and covered with a coverslip. The specimen was left at least overnight to allow the apex of the sipho to become fully distended to reveal its fine structure. Once examined or drawn, the genitalia were rinsed in distilled water and stored in a drop of glycerine in a microvial pinned below the specimen.

The following abbreviations are used in the text for specimen depositories:

AM The Australian Museum, Sydney;
ANIC Australian National Insect Collection, C.S.I.R.O., Canberra;
BMNH British Museum (Natural History), London;
DASA Department of Agriculture South Australia, Northfields, Adelaide;
DM Darwin Museum, Darwin;
DPI Department of Primary Industry, Konedobu;
DPII Department of Primary Industries, Indooroopilly, Brisbane;
DPIM Department of Primary Industries, Mareeba;
DPPD Department of Primary Products, Berrimah, Darwin;
MNHN Museum National d'Histoire Naturelle, Paris;
MVM Museum of Victoria, Melbourne;
PAN Polish Academy of Sciences, Warsaw;
QM Queensland Museum, Brisbane;
RPK Rex Pitkethley private collection;
SAM South Australian Museum, Adelaide;
UCCC University of Cambridge Crotch Collection, Cambridge;
WADA Western Australia Department of Agriculture, Perth;
W.-H. Walford-Huggins private collection.

Cryptolaemus Mulsant

Cryptolaemus Mulsant, 1853: 268; Korschefsky, 1931: 169; Chapin, 1965: 193, 198; Sasaji, 1971: 91, 93; Gordon, 1985: 100, 105. Type-species: *Cryptolaemus montrousieri* [*montrouzieri*] Mulsant, 1853, by monotypy.

This genus may be defined as a group of relatively large (length 3·5–4·6 mm) Scymninae, readily distinguished from all other genera in the subfamily by a forwardly extended prosternum (Fig. 4) concealing the mouthparts if the head is retracted and the following combination of characters: ten-segmented antennae, in length, more or less equal to the width of the head between the eyes; truly trimerous tarsi with sexually dimorphic claws (bifid in male, appendiculate in female); finely faceted eyes; an abdomen with six visible ventral segments in both sexes and entire, more or less semicircular postcoxal plates (Fig. 8) on the first; and elytral epipleurae with an oblique ridge (Fig. 7) toward base. With the exception of the prosternal extension, all these characteristics may be found among other scymnine genera. Certain *Scymnodes* species and some undescribed species from the Indo-Australasian Region are similar in general appearance to *Cryptolaemus*, but they have either pseudotrimerous tarsi or 11-segmented antennae, or both these characters combined.

Seven species were listed in the genus by Korschefsky (1931). In this paper, *C. engelhardi* is removed from the genus and *C. simplex* Blackburn is reduced to a subspecies of *C. montrouzieri*, but two new species are described, restoring the number to seven.

Two groups of species are apparent within the genus: those which resemble *C. montrouzieri*, and those resembling *C. subviolaceus* Crotch. Species of the *montrouzieri* group have a short-oval form (Figs. 5 & 6), head and pronotum (base in front of scutellum often infuscated) reddish yellow, elytra black with a broad reddish yellow apical patch but

without a metallic sheen, male genitalia with broad, paddle-shaped parameres covered with setae on their inner surface, and female coxites more elongate (Fig. 27) and more strongly sclerotized.

The *subviolaceus* group contains species which are subquadrate, of more variable coloration, elytra dark with a weak to strong metallic sheen, but with only a very narrow pale apical patch, male genitalia with parameres either narrow or strap-like with setae restricted to the apex and margins, and female coxites shorter and less strongly sclerotized.

Cryptolaemus engelhardi Gorham

Gorham (1883) described this species from two specimens from Saleyer [Indonesia, Kabia, Salajar]. We have examined a female from the Museum van Natuurlijke Historie, Leiden, labelled 'type', but accepted by us as a syntype; it is not a scymnine but clearly belongs in the Chilocorinae. On the basis of its seven-segmented antennae, presence of apical tibial spurs and simple tarsal claws, we transfer it to the genus *Brumoides* Chapin (**comb. n.**).

subviolaceus group

Two previously described species, *C. subviolaceus* and *C. concinnus* Weise, are referable to this group. Crotch (1874) described *C. subviolaceus* from an unrecorded number of specimens from Macassar [Indonesia, Sulawesi, Makasar] collected by A. R. Wallace. There is a single female specimen in the Crotch collection in Cambridge bearing the following labels "TYPE [blue printed label]/ TYPE [printed] subviolaceu[s] Mac. Wall. [Crotch's handwriting]". We designate this specimen as the **lectotype.** There is some doubt about the reliability of the locality data. Makasar is far to the west of the known distribution of the other members of the genus, and the only other specimen of the species which we have seen is a female (in BMNH) labelled Mysol [Indonesia, Misoöl], also from Wallace's material.

Weise (1902) described *C. concinnus* from an unrecorded number of specimens from Erima, Astrolabe Bay, Papua New Guinea. We have examined a single female from the Hungarian Natural History Museum bearing the following labels "N. Guinea Biró 97. [printed]/ Erima Astrolabe B. [printed]/ Holotypus [printed in red on a red-bordered rectangular label] 1902 Cryptolaemus concinnus Weise [Kaszab's handwriting]". We designate this specimen as the **lectotype.** If there was a Weise determination label originally, this has presumably been lost, since the data labels have been removed at least once. There is no doubt that this specimen fits the original description. There are two female specimens of this species in the BMNH, from Damanti, Finisterre Mountains and from Kokoda, both in Papua New Guinea.

In addition to these specimens, we have seen a further nine specimens of the group from the Molluccan–New Guinean region, apparently representing five different species. Add to this relative paucity of specimens the apparent colour differences between the sexes, and a revision of this part of the genus must clearly wait for further material to become available.

montrouzieri group

KEY TO SPECIES

1 Head with frons smooth and shining between punctures, without microsculpture except on vertex behind eyes 2

— Frons with reticulate microsculpture, dull (Fig. 1) 3

2 At least meso- and metasterna, meso- and metafemora and tibiae black; scutellum black, concolorous with elytra. Distribution: native of eastern Australia, Queensland to Victoria; New Caledonia; other South Pacific islands; imported widely throughout the world for biological control ..... *montrouzieri montrouzieri* Mulsant

— Underside entirely reddish yellow; scutellum partly red, at least paler than elytra. Distribution: Northern Territory of Australia (to west of Gulf of Carpentaria), north-east Western Australia ..... *montrouzieri simplex* Blackburn

3 Pronotum with a fine, narrow, sub-basal groove in front of scutellum, extending toward side margins (Fig. 3) 4

— Pronotum without a sub-basal groove, rarely with punctures confluent and appearing as a weak coarser groove. Distribution: Indonesia, Irian Jaya; Papua New Guinea, New Britain, New Ireland; Solomon Islands ..... *sinestria* sp. n.

4 Disc of pronotum shining, without microsculpture; elytral disc densely punctured with a mixture of larger and smaller, deeply pitted punctures, separated by *ca.* 1–2 diameters; larger punctures *ca.* 2–3 times diameter of smaller. Distribution: Indonesia, Irian Jaya; Papua New Guinea, New Britain, Woodlark Island; Australia, islands of Torres Straits and northern Queensland ..... *affinis* Crotch

— Disc of pronotum with evident microsculpture in basal half; elytral punctures shallower, not as above 5

5 Elytral disc very diffusely punctured with punctures of two very distinct sizes, separated by *ca.* 5 diameters (Fig. 2). Small punctures very fine, larger punctures crater-like', more than 5 times diameter of smaller. Distribution: Indonesia, Halmahera, known only from lectotype ..... *wallacei* Crotch

— Elytral disc more densely covered with very shallow punctures, larger punctures only 2–3 times diameter of smaller. Distribution: Indonesia, Batjan, known only from holotype ..... *crotchi* sp. n.

Cryptolaemus montrouzieri montrouzieri Mulsant

Cryptolaemus montrousieri Mulsant, 1853: 268. **Lectotype** ♀, Australia (MNHN), here designated [examined].

Cryptolaemus montrouzieri Mulsant; Crotch, 1874: 204 (nom. emend.); Korschefsky, 1931: 169; Wilson, 1960; Chapin, 1965: 199; Sasaji, 1971: 94; Gourreau, 1974: 21; Leeper, 1976: 289; Clausen, 1978; Gordon, 1985: 105.

Head, antennae and mouthparts reddish yellow; punctures on head relatively large, deep and close, separated by about two-thirds their diameter in centre of frons, and by half their diameter or less nearer eyes and clypeus. Intervals between punctures appearing convex, shining and without microsculpture. Punctures becoming finer on vertex behind eyes, where intervals have weak transverse microsculpture.

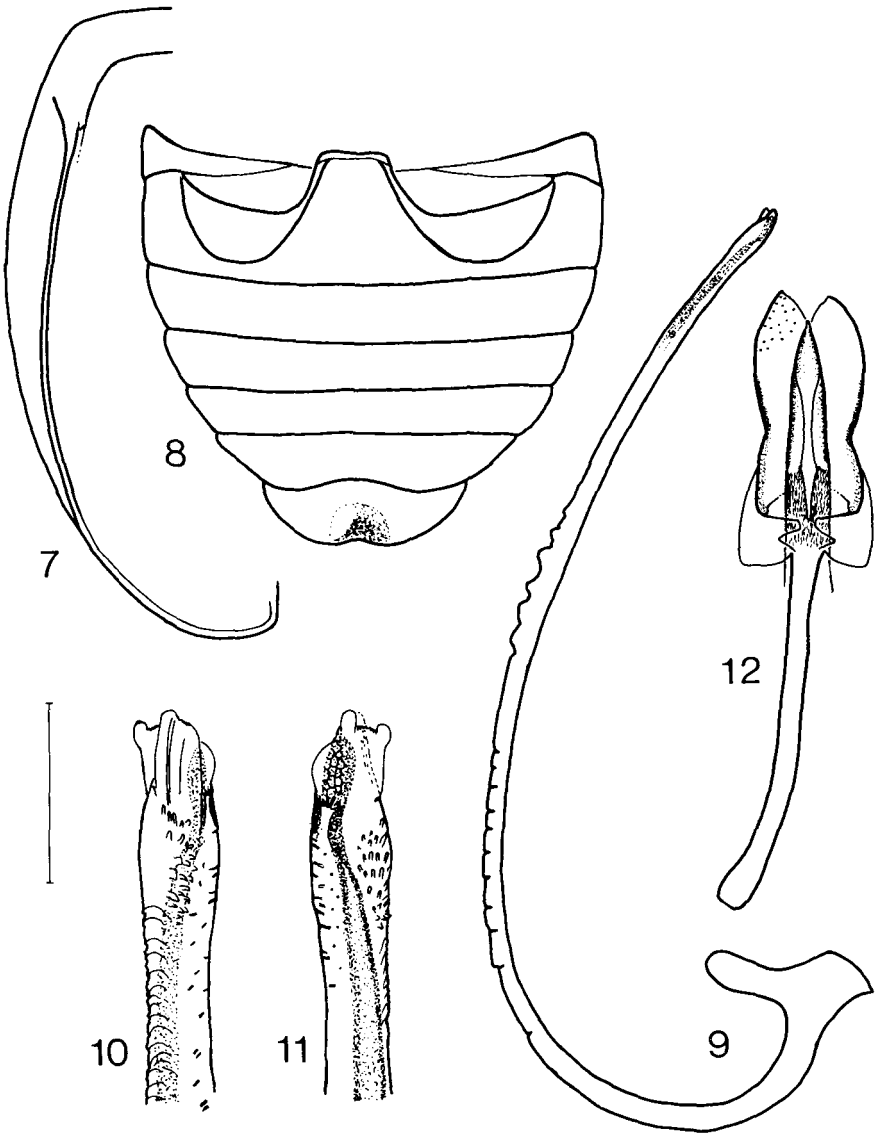
Pronotum reddish yellow, sometimes with poorly defined basal infuscation anterior to scutellum. Punctures on disc fine and diffuse, separated by *ca.* 2–3 diameters, becoming larger, deeper and more closely packed towards side margins. Puncturation at front angles almost as dense as on head. Intervals shining, without microsculpture. Pronotum with fine sub-basal groove (as in Fig. 3).

Scutellum black, closely punctured. Elytra shining black with apices reddish yellow; strongly punctured. Punctures of more or less equal size, separated by approximately 1–1·5 diameters. Pubescence pale yellowish, individual hair varying greatly in length, giving a rather shaggy appearance to elytra, and forming S-shaped pattern on disc (as in Fig. 5).

Prosternum reddish yellow or infuscated basally; meso- and metasterna more or less black. Forelegs variable, in males usually reddish yellow with outer edge of tibiae broadly infuscated, in females generally much darker to almost completely black. Middle and hind legs more or less pitchy to black, with paler tarsi. Abdomen reddish yellow, often with first visible segment infuscated medially. Postcoxal plates approximately evenly rounded, and fifth abdominal segment in male strongly emarginate medially (Fig. 8).

Length 3·8–4·6 mm, breadth 2·7–3·2 mm.

Male genitalia (Figs. 9–12) with parameres relatively short and broad. Apex of sipho truncated, with three small prominences, subapical papillae small, rounded and somewhat sparing. Dorsal surface of median lobe with two rows of two or three small setae basally.



Figs. 7–12.—*Cryptolaemus montrouzieri montrouzieri* Mulsant: 7, elytral epipleuron; 8, abdomen of male; 9, sipho; 10, siphonal apex, left view; 11, same, right view; 12, median lobe, parameres (setae omitted), trabes. (Scale marker = 1 mm, Figs. 7 & 8; 0·5 mm, Figs. 9 & 12; 125 μm, Figs. 10 & 11.)

Distribution. Eastern Australia, New Caledonia, South Pacific Islands. Imported throughout the world (Table I).

Type material examined. Cryptolaemus montrousieri Mulsant, lectotype ♀, "1139 Cryptolaemus montrousieri Mulsant Woodlark [typical Perroud collection label with the word 'Woodlark' a later, incorrect addition in different handwriting]/ type/ Cryptolaemus montrousieri [Mulsant's handwriting]", MNHN, Paris. Paralectotype ♀, "Type [blue printed label]/ Type montrouzieri Deyr [off-white label, 'Type' printed, the rest in Crotch's handwriting]", UCCC, Cambridge.

Mulsant (1853) described the species from an unrecorded number of specimens from Australia (collections of Deyrolle and Perroud), but only the two above specimens have been found.

Other material examined from: AUSTRALIA: widely distributed from Northern Queensland, Kuranda, Redlynch; southwards through New South Wales; Victoria, Melbourne; Western Australia, Perth region. NEW ZEALAND: Kerikeri, Whangarei, Warkworth Auckland. NEW CALEDONIA: Nouméa. COOK IS.: Aitukaki, Rarotonga. AUSTRAL IS.: Tubuai, Mahu. TONGA: 'Uta Vava'u, Neiafu. PHILIPPINES: Lais Malita. KENYA: Ahero, Muguga. SPAIN: Majorca. SOUTH AFRICA: Transvaal. EGYPT: Cairo. BAHAMAS: Abaco. BERMUDA. PUERTO RICO: Aguirre. HAWAII.

Total number of specimens examined: *ca.* 900.

Comments. The nominate form of *C. montrouzieri* can be separated from all other known species of the group by coloration; it is the only species with dark tibiae. Most previous descriptions of *C. montrouzieri* undoubtedly refer to this species, although that of Alves & Raimundo (1971) does not.

Cryptolaemus montrouzieri simplex Blackburn **stat. n.**

Cryptolaemus simplex Blackburn, 1889: 1506. **Lectotype** ♂, Australia (BMNH), here designated [examined].

Cryptolaemus simplex Blackburn; Korschefsky, 1931: 170.

Head, antennae and mouthparts, pronotum, elytral apices, underside (excluding elytral epipleurae) reddish yellow. Scutellum reddish, elytra black.

Distribution. Australia: Northern Territories, Western Australia.

Type material examined. Cryptolaemus simplex Blackburn, lectotype ♂, "T [black ink], 2324 NT [both in red ink on the mounting card]/ type/ Cryptolaemus simplex, Blackb. [Blackburn's handwriting]", BMNH, London.

Blackburn (1889) described *C. simplex* from material sent to him by Dr Bovill from the Northern Territories. Only a single specimen was found amongst Blackburn's material, and this is selected as lectotype.

Other material examined from: AUSTRALIA: Northern Territory, 3, Black Point, Coburg Peninsula 11°09'S 132°09'E, 15–23.ii.1977 (ANIC & BMNH); 2, Elcho Id, 1, 30.iv.1976 (ANIC), 1, 25.iv–6.v.1976 (W.-H.); 2, W Alligator River mouth 12°11'S 132°16'E, 20–22.vii.1979 (QM); 2, Coopers Ck, 11 km SW Nimbuwah Rock 12°17'S 133°20'E, 1.xi.1972 (ANIC & BMNH); 2, Lee Point, 15 km NNE Darwin 12°20'S 130°54'E, 17.xi.1979 (ANIC); 1, Casuarina Beach, 10 km NNE Darwin, 22.x.1972 (ANIC); 1, 5 km NNW Cahills Crossing, E Alligator River 12°23'S 132°57'E, 5.xi.1972 (ANIC); 1, 1 km N Cahills Crossing, E Alligator River, 3.x.1972 (BMNH); 14, Darwin, 2, 11.xi.1979 (DM), 1, 5.x.1980 (DM), 2, Rapid Ck, 23.xi.1976 (RPK), 1, 22.ix.1913 (BMNH), 8, undated (AM, SAM, MVM & ANIC); 10, East Arm, Darwin, 20.xi.1980 (DM); 10, Port Darwin, undated (BMNH, DASA & SAM); 2, Jabaluka Lagoon, 14 km N Mudginberry HS, 14.xi.1972 (ANIC & BMNH); 8, Fogg Dam, 54 km ESE Darwin 12°34'S 131°18'E, 14.x.1980 (DM & BMNH); 1, E Alligator River Crossing 12°25'S 132°58'E, 16–18.vii.1979 (ANIC); 1, Howard Springs, 15.x.1980 (DM); 1, Sorcery Rock nr Cannon Hill, Kakadu NP, 28.iii.1980 (DM); 1, Holmes Jungle, 15.x.1980 (DM); 2, Magela Ck, 2 km N Mudginberry HS, 14.xi.1972 (ANIC & BMNH); 3, 19 km ENE Mt Cahill 12°47'S 132°51'E, 16.xi.1972 (ANIC & DPPD); 1, Stapleton, 1.i.1913 (MVM); 2, Adelaide River, undated (BMNH); 1, Brock[sic] Ck, Burnside, 27.i.1929 (ANIC); 1, Adelaide River Crossing, on Daly Rd 13°29'S 131°04'E, 10.viii.1980 (DM); 1, 3 km SSW Katherine 14°30'S 132°15'E, 12.xi.1979 (ANIC); 6, Roper River, undated (SAM); 1, Auvergne HS 15°41'S 130°00'E, 10.vi.1968 (ANIC); 1, Bessie Spring, 8 km ESE Cape Crawford 16°40'S 135°51'E, 26.x.1975 (ANIC). Western Australia: 2, Carson Escarpment 14°49'S 126°49'E,

9–15.viii.1975 (ANIC & BMNH); 1, Kimberley Res. Stn, Wyndham, 4.xii.1953 (WADA); 1, Kununurra, 25.x.1972 (WADA).

Total number of specimens examined: 86.

Comments. Blackburn originally separated *C. simplex* from *C. montrouzieri* by the pale underside. We have been unable to find any good structural characters to separate individuals into two species, except that specimens with pale undersides appear to be on average more finely punctured, especially on the disc of the pronotum and on the elytra. The male genitalia however seem to fall within the overall range of variation shown by typical specimens of *C. montrouzieri*, in particular, the extent to which the parameres are broadly rounded apically rather than weakly angled (as Fig. 12), and in the strength of papillation near to the apex of the sipho. In view of the constant differences in coloration and the separate geographical distributions, we shall regard *simplex* as a subspecies of *C. montrouzieri* and hope that breeding experiments will be conducted by others to show whether or not our conclusions are correct.

Cryptolaemus affinis Crotch

Cryptolaemus affinis Crotch, 1874: 204. **Lectotype** ♀, Indonesia (UCCC), here designated [examined].

Cryptolaemus affinis Crotch; Korschefsky, 1931: 169.

Head, antennae and mouthparts reddish yellow; punctures on head finer and shallower than in *C. montrouzieri*, separated by 1–1·5 diameters in centre of frons, more closely packed adjacent to eyes. Intervals between punctures appearing flat on disc, with fine, almost reticulate microsculpture which becomes obsolete towards vertex. Eyes rather variable in size.

Pronotum reddish yellow, with black basal patch (all mainland New Guinea and New Britain specimens) or weakly infuscated area (*ca.* 50% of Australian specimens) in front of scutellum, or unicolorous (others). Puncturation moderately fine but deep, punctures separated by one to two diameters on disc, denser at front angles. Fine transverse sub-basal groove present (as in Fig. 3).

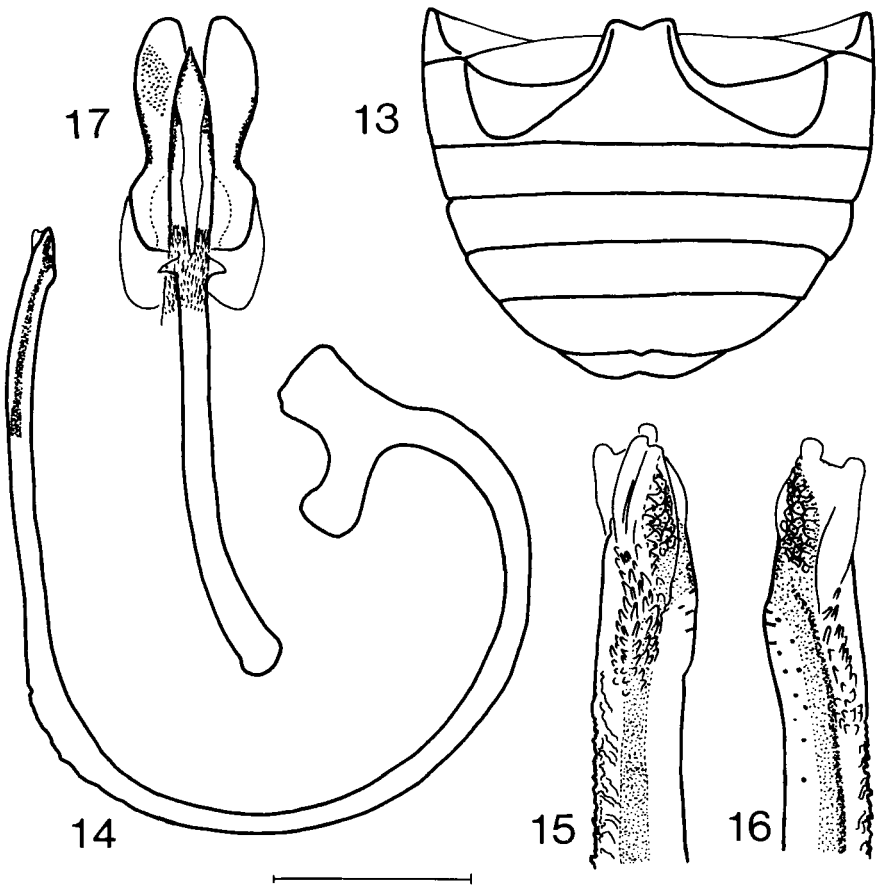
Scutellum variable in colour, black to reddish, punctured. Elytra shining black with apices reddish yellow, strongly punctured. Punctures on elytral disc clearly of two different sizes, larger punctures (2–3 times diameter of smaller) diffusely spaced, their interstices filled with smaller, finer punctures separated by 1–2 diameters. Larger punctures becoming less numerous towards side margins and posteriorly, more or less absent from apical third. Pubescence ashy-white, individual hairs varying in length, but overall appearance neater than in *C. montrouzieri*. Pubescence forming S-shaped pattern on disc.

Underside reddish yellow in Australian specimens, with meso- and metasterna infuscated laterally to entirely black in northern Torres Straits and mainland New Guinean specimens. Legs variable, reddish yellow in specimens from Australia, New Britain and Woodlark Island, or with meta-femora weakly infuscated (*ca.* 15% of males and 50% of females from mainland New Guinea). Abdomen reddish yellow, sometimes weakly infuscated basally. Postcoxal plates not evenly rounded, inner part of line weakly curved or sometimes slightly concave, external part of line near apical margin strongly curved (Fig. 13). Fifth visible abdominal segment in male with apical margin straight or weakly emarginate, with small median protuberance (Fig. 13).

Length 3·9–4·6 mm, breadth 2·9–3·5 mm.

Male genitalia (Figs 14–17), sipho very similar to that of *C. montrouzieri* except papillation near apex stronger. Parameres relatively short and broad, as *C. montrouzieri*, but much more strongly constricted basally. Dorsal surface of median lobe with six or more pairs of setae clustered basally.

Distribution. Indonesia (Irian Jaya), Papua New Guinea, Australia.



Figs. 13–17.—*Cryptolaemus affinis* Crotch; 13, abdomen of male; 14, sipho; 15, siphonal apex, left view; 16, same, right view; 17, median lobe, parameres (setae omitted), trabes. (Scale marker = 1 mm, Fig. 13; 0·5 mm, Figs. 14 & 17; 125 μm, Figs. 15 & 16.)

Type material examined. *Cryptolaemus affinis* Crotch, lectotype ♀, [specimen without data], UCCC, Cambridge.

Crotch (1874) originally described *C. affinis* from an unrecorded number of specimens collected by A. R. Wallace from two separate localities: Batchian [Indonesia, Batjan] and Dorey [Indonesia, Irian Jaya, near Manokwari]. The Crotch collection in Cambridge contains two specimens, one labelled "TYPE affinis Batch. Wall.", the second without locality labels, but presumed to be the Dorey specimen. These two specimens are not conspecific. We hereby designate as lectotype of *Cryptolaemus affinis*, the second specimen, a female, for the following reasons. First, both specimens have equal syntype status. Second, Crotch refers to the elytral puncturation being "tolerably close, unequal . . ." and this only really applies to the Dorey specimen, and not to the Batjan specimen. Third, we wish to preserve Crotch's name for the widespread species, rather than relegate it to obscurity. The Batjan specimen is described below as *C. crotchi* sp. n.

Other material examined from: PHILIPPINES: 2, Lais Malita, ix.1984, with mealybugs on *Theobroma cacao* (BMNH) [introduced]. PAPUA NEW GUINEA: East Sepik District: Maprik subdistrict, 3, Bainyik Agricultural Station, 2, 21.vi.1960 (DPI & BMNH), 1,

2.iii.1960 on *Planococcus* and *Pulvinaria* sp. on *Coffea canephora* (BMNH). Madang District: 1, Karkar I., Kulili Plantation, 19.ix.1958, on *T. cacao* flush (DPI); 3, Madang, 1, xi.1964 on *Hibiscus* (BMNH), 2, 8.x.1959 on coffee (DPI); 4, Madang Agricultural Station, 3, 14.x.1959 on coffee (DPI & BMNH), 1, 16.x.1964 ex *T. cacao* (DPI); 1, Madang Town area, 18.xi.1964, with *Maconellicoccus hirsutus* (Green) on *Hibiscus* (DPI). East Highland District: 3, Goroka, 1, 6.vi.1974 (ANIC), 1, ix.1964 on coffee (BMNH), 1, 13.i.1965 on *Hibiscus* (DPI). Morobe District: 1, Wau, Plantation of New Guinea Goldfield Company, 3400 ft [1030 m], 16.ii.1958, on coffee bushes (DPI); 1, Bubia, Lae, 5.vi.1957, on *T. cacao* (DPI); 1, Orori, 3000 ft [930 m], vii.1933 (BMNH). Northern District: 1, Sangara, 21.vii.1970, predator on common pseudococcids (DPI); 1, Kokoda, 1200 ft [370 m], vi.1933 (BMNH). West New Britain: 1, Nahavio oil palm area, 1.v.1967 (DPI). Milne Bay District: Woodlark I., 2, Murua, Kulumadau Hill, 16.iii.1957 (PAN & BMNH). Central District: 1, Saphai Ck, 17 miles [27 km] NE of Port Moresby, 11.xi.1959, on *Ipomoea carnea* (DPI); 8, Port Moresby, 2, Home Garden 28.i.1956, 5, Konedobu, 4, 17.iii.1957 preying on *M. hirsutus* on *Hibiscus rosa-sinensis* (DPI & BMNH), 1, 8.x.1965 (DPI), 1, Moitaka iii.1962 (ANIC); 6, Laloki, 4, Plant Introduction and Quarantine Station 7.xii.1965 on *Flemingia strobilifera* (DPI & BMNH), 1, same data but on *Bixa orellana* (DPI), 1, [no detailed locality] 3.x.1981 on citrus (BMNH); 1, Waigani, 10.xi.1981, ex citrus (BMNH); 1, Kapogere Agricultural Training Centre near Rigo, 1–4.v.1965, on *Dolichos lablab* [now *Lablab purpureus*] (DPI); 1, Subitana Estate, 1.iv.1958, on coffee (DPI); 2, Days Plantation, 16 miles [26 km] from Port Moresby, 19.iv.1966 (DPI); 1, D.A.S.F. Experimental Block, Brown River, 4.iii.1959, on *Cocos nucifera* (DPI); 5, Bereina, 21.xii.1959, on cotton (BMNH & DPI); 1, Mana Mana village, 8.ii.1955, on coconut palm (DPI); 6, Tapina, *ca.* 3200 ft [1000 m], 12.vi.1960, on *Hibiscus rosa-sinensis* (DPI & BMNH). Western District: 4, Rouka, Morehead River, 19.iii–28.v.1962 (ANIC & BMNH). AUSTRALIA: Queensland: 34, Torres Straits, 6, Saibai Id, 1, 26.iii.1985 (DPII), 5, 5–6.ii.1986 (DPII & BMNH), 7, Moa Id, 1, 22–23.ii.1975 (AM), 1, 31.iii.1985 (DPII), 4, 10–12.ii.1986 (DPII & BMNH), 1, undated (SAM), 2, Hammond Id, 4–8.vii.1974 (AM & BMNH), 1, Goode Id, 11.iii.1909 (BMNH), 14, Thursday Id, 3, 10.iii.1909 (BMNH), 1, 15.xii.1976 (DPII), 1, 21.x.1976 (DPII), 5, 5–6.ix.1983 (DPII), 4, 29.i.1986 (DPII), 1, Albany Id, undated (SAM), 2, Reed Id, undated (SAM), 1, Palm I., undated (SAM); 4, Somerset, undated (SAM); 2, Bamaga, 9–12.ix.1983 (DPII); 1, Weipa, xii.1980 (DPIM); 1, Iron Range 12°42′S 143°18′E, 17.viii.1972 (ANIC); 1, Aurukun, 1.ix.1983 (DPII); 1, Cooktown, undated (SAM); 1, Endeavour River, undated (MVM); 1, Annan River, 3 km SW Black Mountain 15°41′S 145°12′E, 27.xi.1980 (ANIC); 1, Leichardt Ck, 18.iv.1975 (DPIM); 6, Kuranda, 1, ii.1909 (BMNH), 5, undated (AM); 2, Barron River, 4.xii.1977 (AM); 3, Redlynch, 1, 12.xi.1970 (ANIC), 1, 12–20.viii.1938, 1, 21.viii.1938 (BMNH); 3, Kamerunga, Cairns, 5.xii.1977 (AM); 5, Cairns, 2, 9.v.1972 (W.-H.), 1, 18.xi.1934 (ANIC), 2, undated (ANIC); 5, Mungana *via* Chillagoe, 24.v.1981 (BMNH & DPIM); 9, South Johnstone, 15.x.1963, feeding on mealybugs on Peuro (DPIM & DPII); 7, Mission Beach, 5.iv.1976, ex *Pulvinaria* sp. on frangipani (DPII); 2, nr Kennedy, 5.iv.1976, bred ex larvae (DPII); 2, Under John Row Bridge, Ingham, 21.iii.1976 (DPII).

Total number of specimens examined: 154.

Cryptolaemus wallacei Crotch

Cryptolaemus wallacii Crotch, 1874: 204. **Lectotype** ♀, Indonesia (UCCC), here designated [examined].

Cryptolaemus wallacei Crotch; Korschefsky, 1931: 170 (nom. emend.).

Dorsal coloration as *C. affinis*, pronotum with small infuscate area anterior to scutellum. Meso- and metasterna, including mesocoxae, dark pitchy to black; prosternum, legs and abdomen reddish yellow. Puncturation of head strong and close, intervals microreticulate. Pronotum with punctures very shallow and fine almost everywhere, stronger and closer adjacent to anterior angles. At least basal half of pronotal disc with fine microsculpture. Transverse sub-basal groove well-defined (Fig. 3).

Puncturation of elytra clearly of two distinct sizes, larger punctures on disc about five times diameter of smaller (annulus excluded), diffusely scattered over anterior two-thirds of elytra, but more or less absent from apical third, their interstices filled with small, fine, evenly-spaced punctures (Fig. 2), which appear annulated as in *C. crotchi* sp. n. (see below) when viewed with very shallow angle of illumination. Pubescence very short, unidirectional.

Length 4·4 mm, breadth 3·3 mm.

Genitalia not studied.

Distribution. Indonesia: Halmahera.

Type material examined. Cryptolaemus wallacii Crotch, lectotype ♀, "TYPE [blue printed label]/ Gilolo [handwritten on white disc]/ TYPE [printed] wallacii [Crotch's handwriting]/ HOLOTYPE [printed] Cryptolaemus wallacii Crotch 1874 [Gordon's handwriting on blue label]", UCCC, Cambridge.

Crotch described this species based on an unrecorded number of specimens from Gilolo [Indonesia, Halmahera], collected by A. R. Wallace.

Total number of specimens examined: 1.

Comments. This species differs from all others by the great contrast in size between the large and small elytral punctures. It shares with *C. crotchi* alone, the microsculpture on the pronotal disc.

***Cryptolaemus crotchi* sp. n.**

Cryptolaemus affinis Crotch, 1874: 204 (partim)

Head, antennae and mouthparts reddish yellow; punctures on head strong and close, separated by their diameter or less near midline of disc, but very closely packed towards eyes. Intervals with strong reticulate microsculpture.

Pronotum reddish yellow with base near scutellum diffusely and weakly infuscated. Punctures on disc close and very shallow, a mixture of larger and smaller sizes, becoming slightly coarser and closer towards side margins. Intervals with reticulate microsculpture, very strong in front of scutellum, but becoming evanescent on front half of disc (the specimen has an imperfection on the right side of the disc). Transverse sub-basal groove well-defined (as in Fig. 3).

Scutellum black, elytra black with apices broadly reddish yellow. Punctures close, very shallow and when viewed in direct lighting, appearing annulated, separated by their diameter (annulus included). Elytral disc, especially adjacent to suture with a few scattered larger punctures, about three times diameter of smaller punctures (annulus excluded). Pubescence pale yellow, very short, appearing unidirectional (although disc badly rubbed).

Meso- and metasterna black, prosternum and legs (including mesocoxae) reddish yellow. Abdomen reddish yellow, first visible segment weakly infuscated medially, finely punctured and with weak microsculpture. Postcoxal plates fairly evenly rounded. Fifth visible abdominal segment of male weakly emarginate apically, with weak median protuberance.

Length 3·8 mm, breadth 2·9 mm.

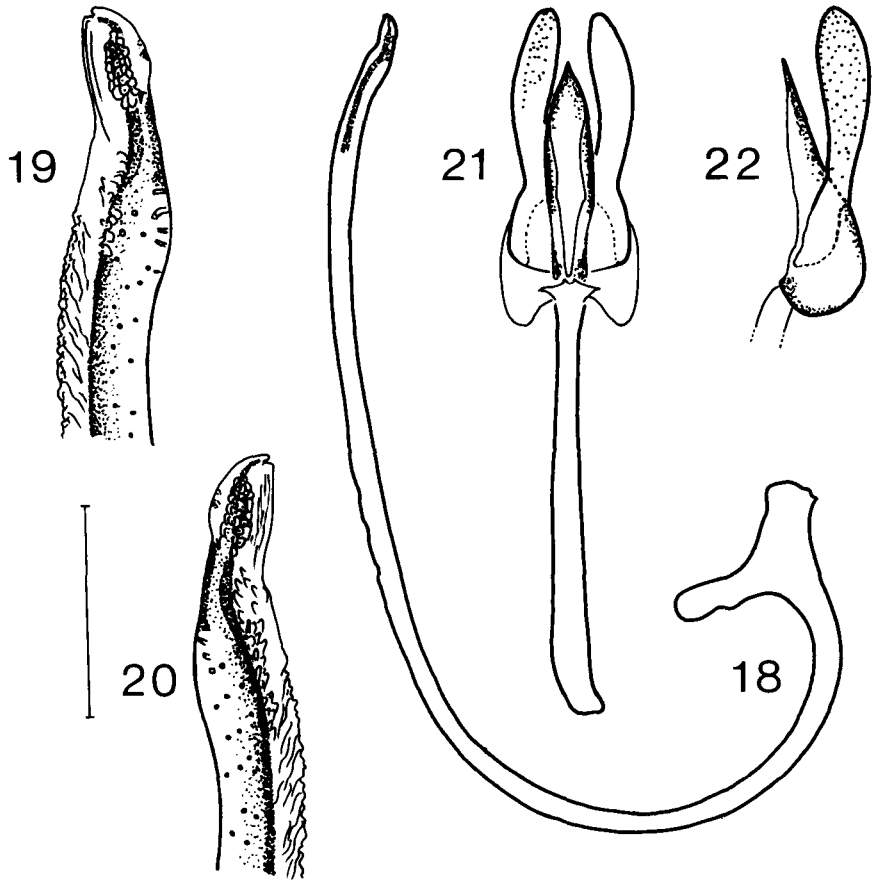
Male genitalia (Figs. 18–22), parameres elongate, narrower than other *montrouzieri* group species, and strongly curved when viewed dorsally. Sipho with apex blunt, gently curved, dorsal edge with only indistinct wavy outline at base of apical half.

Distribution. Indonesia: Batjan.

Material examined. Holotype ♂, INDONESIA: Batch. [Batjan] (Wall.[ace]) (UCCC).

Total number of specimens examined: 1.

Comments. This species, together with *C. wallacei*, differs from other members of the group by having the pronotal disc microsculptured. It is very similar to *C. wallacei*, but differs in size and elytral puncturation, lacking the very large punctures characteristic of *C. wallacei*. On the basis of only two specimens (one of each sex) we do not know what the



Figs. 18–22.—*Cryptolaemus crotchi* sp. n., holotype; 18, sipho; 19, siphonal apex, left view; 20, same, right view; 21, median lobe, parameres (setae omitted), trabes, ventral view; 22, same, lateral view. (Scale marker = 0·5 mm, Figs. 18, 21 & 22; 125 μm, Figs. 19 & 20.)

variation in puncturation is, and it is possible that future collecting will show that we have only described extremes of variation of a variable species. However, until further material becomes available, we regard the two specimens as representing different species.

***Cryptolaemus sinestria* sp. n.**

Head, antennae and mouthparts reddish yellow. Punctures on frons strong, of variable density, separated by 1–2 diameters on disc, more closely packed laterally; interstices with strong microsculpture, reticulate to weakly transverse (Fig. 1).

Pronotum reddish yellow, with infuscated to black basal patch in front of scutellum (all mainland New Guinea specimens, the one New Ireland male and in one of eleven New Britain females), or unicolorous (others). Pronotum moderately strongly punctured, punctures separated by *ca.* 2–3 diameters near front of disc, becoming more closely packed toward base and side margins. Intervals mostly smooth and shining except for very weak transverse microsculpture in front of scutellum and weak reticulate microsculpture near front angles. Sub-basal groove absent from in front of scutellum.

Scutellum mostly black, sometimes reddish in Solomon Islands and New Britain populations. Elytra shining, black, with apices reddish yellow. Punctures strong, separated by one to one and a half diameters, somewhat variable in size, though not so obviously of two distinct sizes as in *C. affinis*. Pubescence mostly pale yellowish, rather variable in length and direction; mainland New Guinea specimens mostly with pubescence longer and more variable in length and direction than in New Britain and Solomon Islands specimens (Fig. 6), where pubescence is much shorter and neater in appearance.

Prosternum reddish yellow to infuscate medially, meso- and metasterna infuscated to black, sometimes reddish medially in New Britain and New Guinea specimens. Forelegs reddish yellow. Meso- and metafemora variable in coloration, reddish to strongly infuscated. In mainland New Guinea, *ca.* 7% of population with pale femora, others dark; in New Britain and New Ireland, all specimens with pale femora; in Solomon Islands, all males with pale femora but 50–60% of females with dark meso- and metafemora. Abdomen reddish yellow, sometimes first visible segment infuscated medially. Postcoxal plates and fifth visible segment of male similar to those of *C. affinis* (Fig. 13).

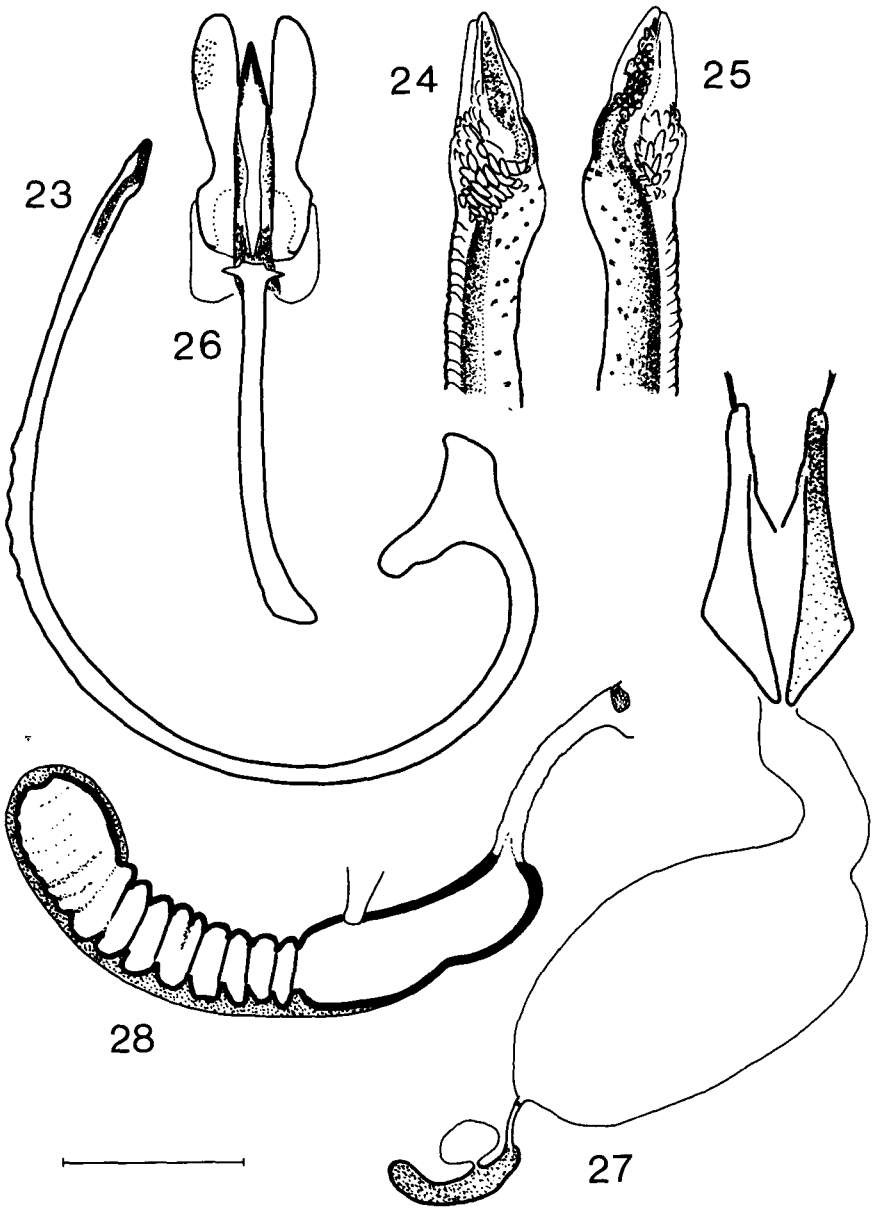
Length 3·7–4·4 mm, breadth 2·8–3·3 mm.

Male genitalia (Figs. 23–26), differ substantially from those of *C. montrouzieri* and *C. affinis* in having parameres proportionally much longer and siphonal apex more pointed. Dorsal surface of median lobe with two tight clusters of setae basally, usually containing more setae than in *C. affinis*. Subapical papillation of sipho strong.

Female genitalia (Figs. 27 & 28) typical of the genus. Coxites elongate, relatively well sclerotized; spermatheca weakly curved, sperm duct short with small sclerotized fleck at junction with bursa copulatrix; sclerotized infundibulum absent.

Distribution. Indonesia (Irian Jaya), Papua New Guinea, New Britain, New Ireland, Solomon Islands.

Material examined. Holotype ♂, PAPUA NEW GUINEA: Morobe District, Wau, Moale Plantation, 3800 ft, xii.68–v.1969 (*Mrs J. E. Benson*) (BMNH). Paratypes 54 ♂, 45 ♀, 3 unsexed as follows: INDONESIA: Dutch New Guinea [Irian Jaya] 1 ♂, Humboldt Bay, Hollandia, iv.1936 (*L. E. Cheesman*) (BMNH); 1 ♂, Humboldt Bay District, 1937 (*W. Stüber*) (BMNH). PAPUA NEW GUINEA: East Sepik District: 1 ♂, Bainyik Agr. Sta, Maprik Subdistrict, 2.iii.1960, feeding on *Planococcus* and *Pulvinaria* sp. on *Coffea canephora* (*J. J. H. Szent-Ivany*) (DPI); 1 ♀, Naramgo Vill., Maprik Subdistrict, 19.vi.1959, resting on taro leaves (*J. J. H. Szent-Ivany*) (DPI); 1 ♀, Amatiop (sic) [? Awatiu] Village Garden, nr Maprik, 22.vi.1959, resting on yam vine [no collector] (BMNH). Madang District: 4 ♂, 2 ♀, Kulili Ptn, Karkar I., 19.ix.1958, on aphids on *Theobroma cacao* flush (*J. H. Ardley*) (DPI & BMNH); 1 ♀, Town Area, Madang, 18.xi.1964, assoc. with *Maconellicoccus hirsutus* on *Hibiscus* (*J. J. H. Szent-Ivany*) (DPI); 1 ♂, 1 ♀, 1 unsexed, Madang, 8.x.1959, on coffee (*J. Healy*) (DPI & BMNH). Morobe District: 1 ♂, 1 ♀, Bubia, Lae, 5.ii.1957, on *T. cacao* (*J. H. Ardley*) (DPI & BMNH); 2 ♂, Bubia, Lae, 5.vi.1957, on *T. cacao* (*J. H. Ardley*) (BMNH); 2 ♂, Bubia, Lae, 9.i.1959, on *T. cacao* (*J. H. Ardley*) (DPI); 1 ♀, Bubia, Plant Industry Centre, 26.vii.1966, ex *Saccharum officinarum* (*T. Fenner & M. Hunter*) (DPI); 1 ♀, Bubia *via* Lae, 29.iii.1955 (*J. J. H. Szent-Ivany*) (BMNH); 2 ♂, 2 ♀, Bubia *via* Lae, 5.vi.1957, on *T. cacao* (*J. H. Ardley*) (DPI & BMNH); 1 ♀, Lae, New Guinea (NE), 27.v.1956 (*E. J. Ford*) (PAN); 1 ♀, Wau, Cameron's House, 29.xii.1957 (*J. H. Ardley*) (DPI); 1 ♀, Village garden, Gurakoa Area, 9.xi.1966, ex *C. arabica* (*T. L. Fenner*) (DPI). Central District: 1 ♂, 1 ♀, Bereina, viii.1961 (*P. L. Stallwood*) (DPI & BMNH); 2 ♂, Laloki, Plant Int. & Quar. Sta., 6.ii.1960, on *Canavalia ensiformis* Sword Bean (*J. J. H. Szent-Ivany*) (DPI & BMNH); 1 ♀, Port Moresby District, 24.iii.1956 (*E. S. Brown*) (BMNH); 1 ♂, Port Moresby, 28.ii.1962 (*K. R. Norris*) (ANIC); 1 ♀, Lawes Rd Hill, Port Moresby, 29.xi.1955 (*Mrs E. Anderson*) (DPI); 4 ♂, 1 unsexed, Konedobu, Port Moresby, 17.iii.1957, reared on *Tamari* (sic) assoc. with pseudococcid *M. hirsutus* (*J. H. Barrett*) (DPI & BMNH); 1 ♂, Konedobu, Port Moresby, 7.xi.1960, feeding on *M. hirsutus* on *Hibiscus* sp. (*E. Kanjiri*) (DPI). East New Britain: Gazelle Peninsula: 1 ♀, Kerawat (*sic*), 60 m, 2.ix.1955,



Figs. 23–28.—*Cryptolaemus sinestria* sp. n., holotype ♂ and paratype ♀; 23, sipho; 24, siphonal apex, left view; 25, same, right view; 26, median lobe, parameres (setae omitted), trabes; 27, female genitalia; 28, spermatheca. (Scale marker = 0·5 mm, Figs. 23, 26 & 27; 125 μm, Figs. 24, 25 & 28.)

secondary growth clearing (*J. L. Gressitt*) (PAN); 1 ♀, Keravat, Lowl. Agr. Exp. Sta. 13.vi.1957, on young coconut palm (*J. H. Barrett*) (DPI); 1 ♂, Keravat, Lowl. Agr. Exp Sta., viii.1964, ex *T. cacao* mealybugs (*G. S. Dun*) (BMNH); 6 ♂, 2 ♀, same data, except 9.x.1964 (*T. L. Fenner*) (DPI & BMNH); 1 ♂, Keravat, No. 2 Ptn, 22.iv.1965, on *T. cacao* (*T. L. Fenner*) (DPI); 2 ♂, 1 ♀, Gela Gela Pltn, vii.1964 (*T. L. Fenner*) (DPI & BMNH); 2 ♀, Gela Gela Pltn, 13.vii.1966, on *T. cacao* (*M. Wanario*) (DPI); 1 ♂, 1 ♀, Gela Gela Pltn 24.ii.1967 (*R. A. Carver*) (BMNH); 1 ♀, Kokopo, Baniora Ptn, 10.v.1966 (*G. S. Dunn*) (DPI); 1 ♂, 1 ♀, Vunabalbal (*sic*) [Vanubalbal], 1.iv.1968, on *T. cacao* flush (*J. Andrews*) (DPI & BMNH); 1 ♀, Rabaul, ii.1969, on *Hibiscus* (*D. F. O'Sullivan*); 2 ♂, Rabaul, 27.v.1969, with *M. hirsutus* on *Hibiscus* (*D. F. O'Sullivan*) (DPI & BMNH). New Ireland: 1 ♂, New Ireland (SW), "Camp Bishop", 12 km up Kait R., 240 m, 10.vii.1956 (*E. J. Ford*) (BMNH). Bougainville District: 3 ♂, 1 ♀, Buka, Ag. Stn, 23.x.1964, *T. cacao* (*T.L.F.*) (DPI & BMNH) [specimens of Solomon Islands form]. NEW GUINEA: 1 ♂, [no detailed locality] (*J. L. Froggat*) (BMNH). SOLOMON ISLANDS: 1 ♀, Kulambangra [Kolombangara], 5.vi.1922 (*E. A. Armytage*) (BMNH); 1 ♂, New Georgia, Wanawara [Vona Vona] I., 19.viii.1963 (*P. Greenslade*) (BMNH); 1 ♀, Russell I., Tenaru, 30.xii.1935 (*R. A. Lever*) (BMNH); 1 ♀, Savo, 6.iv.1962 (*P. J. M. Greenslade*) (BMNH); 8 ♂, 8 ♀, 1 unsexed, Guadalcanal, 1 ♂, Lunga plantn, 22.viii.1928 (*R. W. Paine*) (BMNH), 1 ♂, Betimatu, 31.xii.1964 (*P. J. M. Greenslade*) (BMNH), 1 ♂, Tadhimboko, 0–100 m, 28.xii.1973 (*N. L. H. Krauss*) (BMNH), 1 ♂, Honiara Dist, Kukum, 2.x.1956 (*E. S. Brown*) (BMNH), 1 ♀, Kukum, 18.ii.1963 (*P. Greenslade*) (BMNH), 1 ♂, Kukum, 15.vi.1963 (*P. Greenslade*) (BMNH), 1 ♂, 1 ♀, Kukum 18.xi.1963 (*P. Greenslade*) (BMNH), 1 unsexed, Kukum 26.viii.1964 (*M. McQuillan*) (BMNH), 1 ♂, 2 ♀, Kukum 30.x.1964 (*M. McQuillan*) (BMNH), 1 ♂, 1 ♀, Kukum 31.x.1964 (*M. McQuillan*) (BMNH), 1 ♀, Honiara, 0–200 m, i.1974 (*N. H. L. Krauss*) (BMNH), 1 ♀, Tenaru, 31.viii.1984, ex sapodilla (*R. Macfarlane*) (BMNH), 1 ♀, Black post, 4.x.1984, resting on cocoa pod (*R. Macfarlane*) (BMNH); 1 ♂, 3 ♀, Gavutu, 17.viii.1928, on mealybug on coconut (*R. W. Paine*) (BMNH); 2 ♀, Malaita, Auki, 11.vi.1962 (*P. Greenslade*) (BMNH). TRINIDAD: 1 ♂, Stocks from New Guinea, bred in Trinidad on *Planococcus citri*, ii.1960 (*F. D. Bennett*) (BMNH).

Total number of specimens examined: 103.

Comments. This species is rather variable, and different populations differ in their coloration and relative length and direction of elytral pubescence. The differences between mainland New Guinea and Solomon Islands (including Buka Island) specimens are quite marked, and one could describe two subspecies were it not for the New Britain populations which show some intermediate characters. The male genitalia also appear to be more variable than in the other species, in particular, the extent of sub-apical curvature of the sipho, the degree of basal constriction of the parameres and the relative length of the median lobe. However, these appear to vary individually and are not correlated with external appearance or distribution.

This species has been confused with *C. montrouzieri* in the past, judging from the determination labels on specimens we have examined, but it is clearly separable by the characters used in the key. We have evidence from a single specimen (BMNH), bearing the data "Stocks from New Guinea, Bred in Trinidad", that it has been exported at least once, although the current status of the species in Trinidad is unknown.

Etymology: *sinestria*, a noun in apposition, from Latin *sine*—without, and *stria*—a furrow.

Acknowledgements

We must express our gratitude to the following for the loan of type materials: Mlle N. Berti (MNHN), Dr W. Foster (UCCC), Dr J. Krikken (Museum van Natuurlijke Historie, Leiden, Netherlands) and Dr Z. Kaszab (Hungarian Natural History Museum, Budapest). We are indebted to the following for the loan of many other specimens, without whose aid the taxonomic problems might not have been resolved: Dr C. N. Smithers (AM), Dr J. F.

Lawrence (ANIC), Mr P. Allan (DASA), Dr M. Malipatil (DM), Dr J. Ismay (DPI), Mr K. Houston (DPII), Mr R. Storey (DPIM), Mr J. Gillett (DPPD), Dr A. Neboiss (MVM), Dr S. A. Slipinski (PAN), Dr G. Monteith (QM), Mr R. Pitkethley (DPPD), Dr E. Matthews (SAM), Mr K. Richards (WADA), Mr A. Walford-Huggins (Julatten, Queensland, Australia). In addition, our thanks must go to Dr R. B. Madge for reading through the manuscript and offering valuable advice, and to the staff of the electron microscope unit and photographic sections of the BMNH for assistance and the production of Figs. 1–6.

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(*Received 21 April 1986*)