

A review of the species resembling *Chilocorus nigrita* (Coleoptera: Coccinellidae): potential agents for biological control

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Abstract

Chilocorus nigrita (Fabricius) is a well-known predator of scale insects. It has been widely used for biological control and has spread naturally beyond its previous native range over the last three decades or so. Three other Oriental species closely resembling *C. nigrita* can now be separated. *Chilocorus melas* Weise is redescribed and a lectotype designated. *Chilocorus gressitti* Miyatake is a junior synonym of *C. melas*. *Chilocorus subindicus* from the southern parts of the Indian subcontinent and *C. gracilior* from eastern Indonesia are described as new.

Introduction

Chilocorus nigrita (Fabricius) (Coleoptera: Coccinellidae), more generally known in the literature as *Chilocorus nigritus*, is now a widespread and well-known predator of scale insects. Its biology, host range (mostly scale insects, Homoptera, in the families Coccidae and Diaspididae) and economic importance were reviewed by Samways (1984). It was known as a predator of various scale insects in India (Woglum, 1913) and was introduced deliberately from Coimbatore, India, to several localities in East Mahé, Seychelles, where it proved to be a successful control agent of scale insects on coconut. Vesey-FitzGerald (1953) described its successful introduction from material which was received from India at the end of 1938, reared for a generation, then released into the field in East Mahé in early 1939.

From about 1966, the range of the species expanded rapidly from its Indian and South East Asian origin into Africa, the Pacific islands and to South America (Samways, 1989). While some of this range expansion was due to the deliberate introduction of the species for biological control, it appears to have reached other regions by natural dispersal (Greathead & Pope, 1977; Chazeau, 1981). Samways (1989) discussed the distribution of *C. nigrita* (in a broad sense) in relation to climate diagrams. The results of

the present taxonomic study do not affect his conclusions because only the true *C. nigrita* appears, from material examined to date, to have spread beyond its present natural indigenous range. This is indeed fortunate given the uncertainty that can arise if more than one biological species is confused under the same name. For example, Pope (1981) showed that previous references to *Rhyzobius ventralis* (Erichson) (Coleoptera: Coccinellidae) had confused two separate species, and this finding helped to explain some biological control successes and failures attributed to the one species. Since Samways (1989), *C. nigrita* has been recorded from Fiji and Tuvalu in the Pacific, and previously unidentified material shows that it reached Brazil at least as early as 1975.

A critical examination of older museum and other material, especially from the Indian subcontinent and Africa submitted to the International Institute of Entomology for identification over the last decade or so, showed that more than one species could have been confused under the name *Chilocorus nigrita* in the past. The present study aims to clarify the identification of this important species and to enable its separation from other closely related species.

Key to species of *Chilocorus* resembling *C. nigrita*

This key is based on characters of the male genitalia, because reliable external characters have not been found to separate all species.

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1. Median lobe of aedeagus more slender and elongate, about four times as long as broad (fig. 21). Species only known from Flores and Sumbawa, Indonesia *gracilior* sp.n.
 – Median lobe of aedeagus shorter and broader, about two and one half times as long as broad or less (figs 2, 12, 16). Species distribution otherwise, not from Flores or Sumbawa..... 2
2. Median lobe of aedeagus abruptly contracted basally (fig. 2). Parameres strongly and abruptly narrowed in basal half (fig. 3). Sclerotized part of siphon angulated on dorsal surface near apex (fig. 5). Species very widely distributed..... *nigrita* (Fabricius)
 – Median lobe of aedeagus gradually and evenly contracted basally (figs 12, 16). Parameres weakly or more evenly narrowed in basal half (figs 13, 17). Sclerotized part of siphon with smoother outline of dorsal surface near apex (figs 15, 19). Species distributed in southern parts of Indian subcontinent, South East Asia, China 3
3. Parameres more slender, more pointed apically (fig. 17). Apex of median lobe curved dorsad (fig. 17). Species distributed in southern parts of Indian subcontinent..... *subindicus* sp.n.
 – Parameres broader, more rounded apically (fig. 13). Apex of median lobe curved ventrad (fig. 13). Species distributed in South East Asia and China ... *melas* Weise

***Chilocorus nigrita* (Fabricius)**

(figs 1–11)

Coccinella nigrita Fabricius, 1798: 79

Chilocorus nigritus: Mulsant, 1850: 463; Crotch, 1874: 184; Korschefsky, 1932: 240; Bielawski, 1957: 86; Kapur, 1967: 171; Nagaraja & Hussainy, 1967: 252; Miyatake, 1970: 318, 333; Chazeau *et al.*, 1974: 278; Greathead & Pope, 1977: 264; Chazeau, 1981: 17.

Chilocorus nigrita: Booth *et al.*, 1990: 90.

Description. Length 3.2–4.0 mm, breadth 2.9–3.9 mm, subcircular in body outline (fig. 1), typical coloration with elytra, pronotum (excepting side parts) and outer margins of elytral epipleura very dark pitchy to black, and with head, sideparts of pronotum, legs, underside and elytral epipleura (except outer margins) yellowish-brown; lateral margins of elytra often paler than disc, vertex of head and side parts of pronotum darker brown to black in some individuals, especially females. Head with fine pubescence, frons broader than eye width, variably punctured from fine to moderately coarse, interstices flat to convex, dull with reticulate microsculpture, canthus in front of eye rather narrow. Pronotum finely punctured, punctures separated by about 2–5 diameters, interstices flat, shining on disc, at most with rather obsolete microsculpture, side parts adjacent to eyes more closely and coarsely punctured and pubescent with interstices strongly reticulate. Elytra shiny, without microsculpture, finely punctured, punctures separated by about 3–6 diameters on disc, slightly coarser and closer adjacent to side margins. Male genitalia characteristic, median lobe (fig. 2) with basal half broad, abruptly contracted at base and bulging subbasally; apex of median lobe in side view (fig. 3) turned ventrally; parameres blade-shaped,

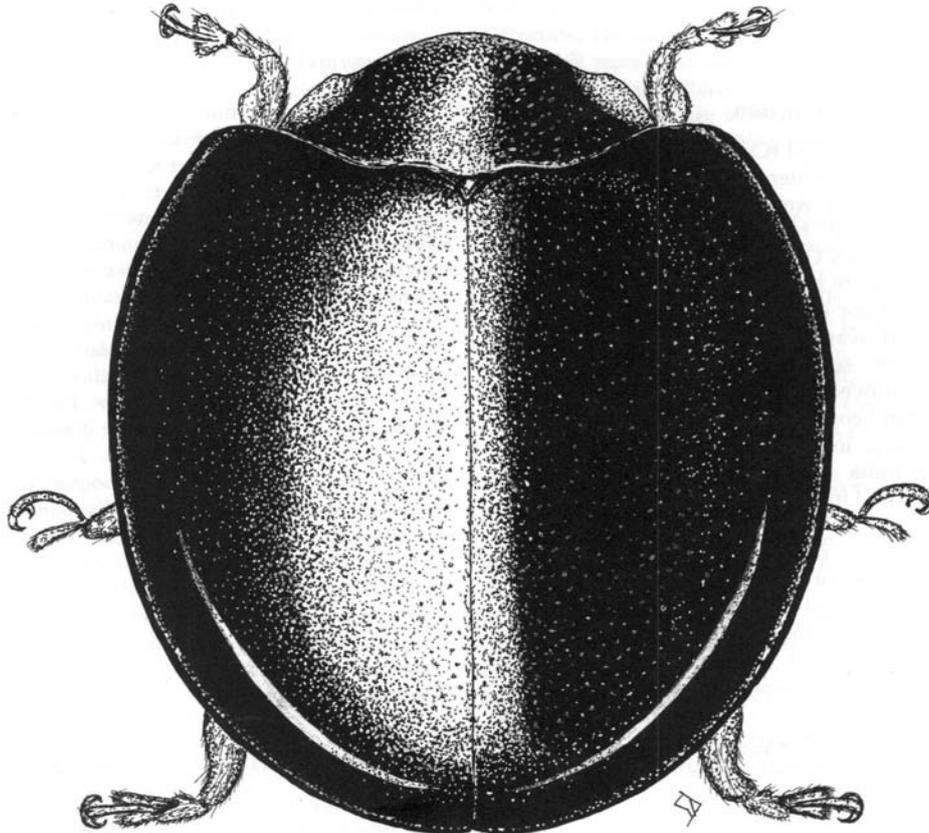


Fig. 1. *Chilocorus nigrita*, habitus. Body length 3.5 mm.

abruptly angled and constricted in basal half (fig. 3); sipho with dorsal angulation subapically (fig. 5), outer arm of siphonal capsule with long, high ridge (fig. 4). Female genitalia with coxites little longer than broad (figs 6–8), spermatheca somewhat variable in shape (figs 9–11), with curved apical appendix.

Type material. Fabricius (1798) described this species from an unrecorded number of specimens collected from 'Tranquebariae' by Daldorff, in Lund's collection, now in the Zoological Museum, Copenhagen. Mulsant (1850) examined a single Fabrician type 'conservé au Muséum de Copenhague', but the material now appears to be lost. Zimsen (1964) listed the species name, but did not note any specimens and O. Martin (personal communication) stated that Fabricius' type was no longer in the collection of the Zoological Museum, Copenhagen.

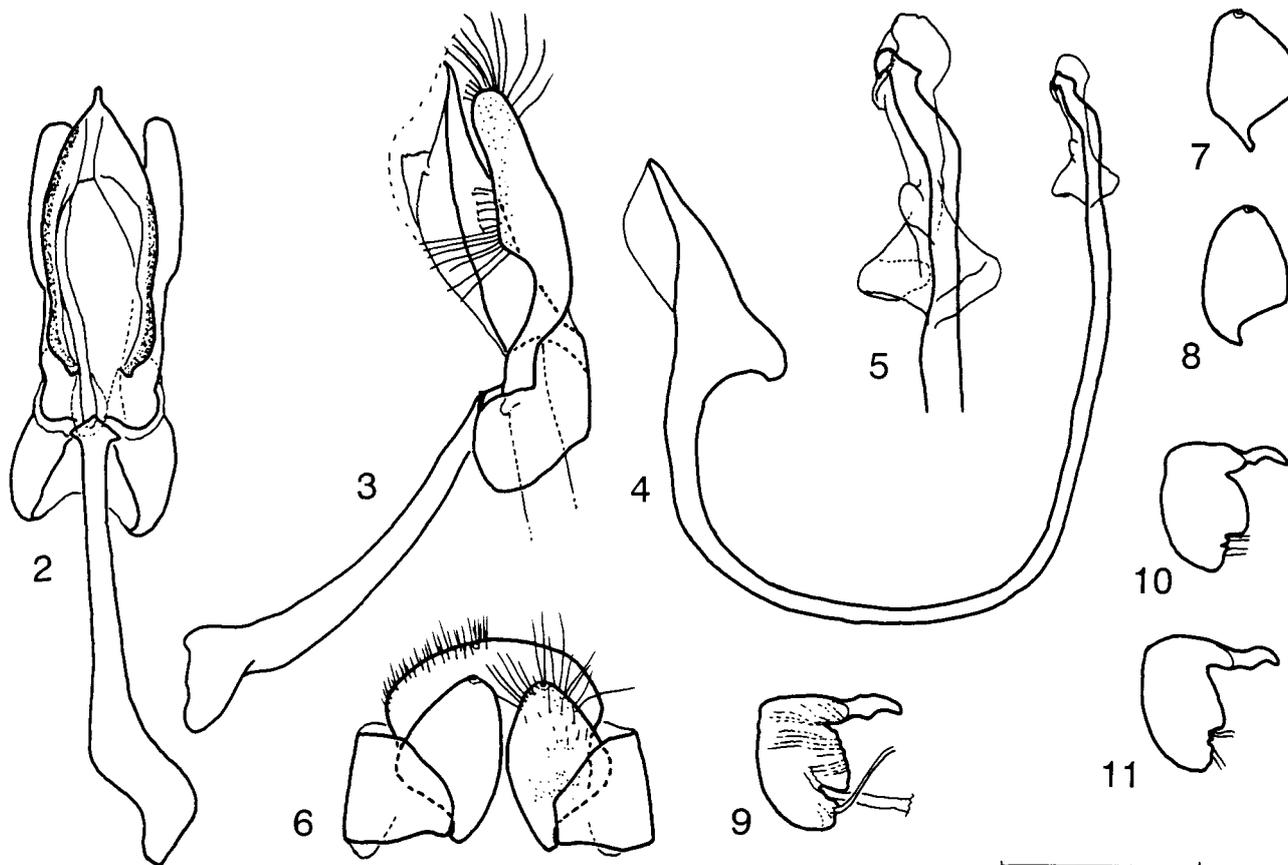
In the apparent absence of any surviving type material, the name *nigrata* is here retained for the more widespread Indian species which has spread as a result of biological control and natural introductions over the last 60 years. Where the male genitalia have been illustrated previously, all the figures can be identified as referring to the present species.

Material examined. 281 specimens. INDIA: no other data (1910/11) R.S. Woglum; Himachal Pradesh, Kalka 1984; Uttar Pradesh, Saharanpur 1956, Kumaon c.1920, Faizabad 1923, Dehra Dun 1945; West Bengal, Shrirampur 1982, Kurseong 1904; Gujarat, Mahuva c.1980; Bihar, Kundri 1951, Pusa 1905; Maharashtra, Pune 1908; Karnataka, Bangalore 1957, 1956, Belgaum pre-1922; Tamil Nadu, Coimbatore 1946, Trichinopoly 1905, Kurumbagarum 1947, Madura pre-1922, Madras, Chetpat-Polur. 1931; Andaman Islands, Port Blair

19th century, 1989. SRI LANKA: near Chilaw 1958; Sab. Ratnapura 1953. BANGLADESH: Chittagong Ragamati c.1982. BURMA: Tharrawddy pre-1922. MADAGASCAR: Fenerive East 1989. RÉUNION: Saint-Philippe 1955. MAURITIUS: Bel Etang 1960, Mt Pouce 1959, Tamarin 1975, 1978, Round Island 1978. SEYCHELLES: Poivre Island 1980, Praslin 1952, 1996, Bird Island 1952, N. Mahé 1952, 1996, Astove Atoll 1968, Curieuse 1996, Silhouette 1996. CHAGOS ARCHIPELAGO: Diego Garcia 1971. MALAYSIA: Penang 19th century; Selangor, Kuala Lumpur 1927; Sabah, Tuaran 1988. INDONESIA: West Sumatra, Siberut Island 1924; Sumatra, Kuala Tenajan, Siak, 1959. FIJI: Viti Levu 1994. VANUATU: Espiritu Santo 1983. TUVALU: Funafuti 1995. KIRIBATI: 1985. WESTERN SAMOA: Upolu Island 1971, 1975, 1986. OMAN: 1987. KENYA: Miwapa 1969, Ramisi 1968, Ruiru 1985. TANZANIA: near Tanga 1966, Arusha Chini 1969. SOUTH AFRICA: Transvaal, Malelane 1972. GHANA: Cape Coast 1986. TOGO: Anacho 1984, Lomé-Cacaveli 1987. BRAZIL: Recife 1975, Alagoas, Maceió 1994. (BMNH, CAS, IZPAN, MNHUB, ZMK).

Comments. The etymology of the name *nigrata* is uncertain, but its treatment as a noun, rather than as an adjective, is consistent with its original use by the early taxonomic authors (Grenstead, 1951). Thus as Fabricius originally used the combination *Coccinella nigrata*, *nigrata* being a noun, does not change its ending when combined with a generic name of different gender from the original.

The first recorded occasion when *C. nigrata* was used in a biological control attempt was its introduction from India into California and Florida (Woglum, 1913). It did not become established. The specimens examined above from 'India', collected by R.S. Woglum (in California Academy of Sciences) probably date



Figs 2–11. *Chilocorus nigrata*, male and female genitalia. 2, median lobe, parameres (setae omitted for clarity), trapes, ventral view; 3, same, lateral view (some setae omitted or cut down for clarity); 4, siphon; 5, apex of siphon; 6–8, female coxites; 9–11, spermatheca. Scale marker = 0.5 mm, figs 2–4, 6–11; 0.25 mm, fig. 5.

from this original introduction and their identity as *C. nigrita* is therefore confirmed.

Chilocorus melas Weise

(figs 12–15)

Chilocorus melas Weise, 1898: 229, Lectotype, here designated [examined]

Chilocorus melas: Korschefsky, 1932: 243

Chilocorus gressitti Miyatake, 1970: 330, Holotype ♂, [not examined] syn. nov.

Chilocorus gressitti: Pang & Mao, 1979: 84

Description. Length 3.1–3.8 mm, breadth 2.9–3.7 mm, subcircular in body outline, elytra and pronotum (excepting a fine border around anterior angles) jet black, head yellowish-brown in males, black to pitchy fading anteriorly in females, legs, episterna and epimera yellowish-brown, pro-, meso- and metasterna pitchy to black, fading laterally in most populations from mainland South East Asia, but sterna yellowish-brown to slightly pitchy in populations from Johore, southern Malaysia, Sarawak and Java. Head with fine pubescence, frons broader than eye width, coarsely punctured, interstices varying from almost flat to convex, with reticulate microsculpture to shining and smooth, canthus in front of eye rather narrow. Pronotum finely punctured, punctures separated by about 2–5 diameters, interstices flat, shining on disc, at most with rather obsolete microsculpture, side parts adjacent to eyes more closely and coarsely punctured and pubescent with interstices strongly to weakly reticulate. Elytra shiny, without microsculpture, finely punctured, punctures separated by about 3–6 diameters on disc, punctures much larger and deeper adjacent to side margins. Male genitalia characteristic, median lobe somewhat parallel-sided medially to gradually narrowing basally (fig. 12) but without abrupt prebasal bulge, apex in side view turned ventrally (fig. 13); parameres (fig. 13) broadly rounded in apical half, constricted in basal half but without abrupt angle at constriction; siphon with sclerotized part more evenly produced at tip (fig. 15), without dorsal angulation subapically, outer arm of siphonal capsule (fig. 14) with

weaker dorsal ridge. Female genitalia very similar to those of *C. nigrita*.

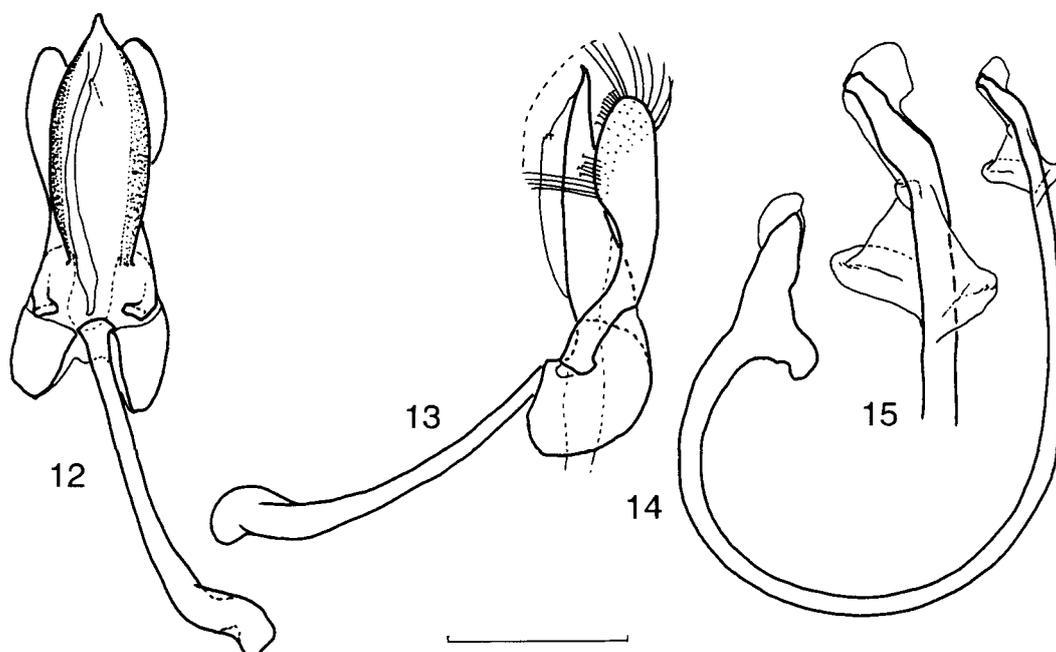
Type material. Weise (1898) described *C. melas* from an unrecorded number of specimens from Java from the collections of Fruhstorfer and Smka. The female specimen from Weise's collection in the Museum für Naturkunde der Humboldt-Universität, Berlin, labelled 'Fruhstorfer Java [printed]/Typus [printed on red paper]/Chilocorus melas m. [Weise's handwriting]/Zool. Mus. Berlin [printed]' is hereby designated as the Lectotype of *Chilocorus melas*, and is labelled accordingly.

The original description of *C. gressitti* (listed above as a new synonym of *C. melas*) was based on material from 'Changchow, Fukien, S. China', and the author indicated that the type material was derived from the collection in the California Academy of Sciences. However, all attempts to borrow this material have so far been unsuccessful and the material is not currently deposited in the California Academy of Sciences (R. Brett, personal communication).

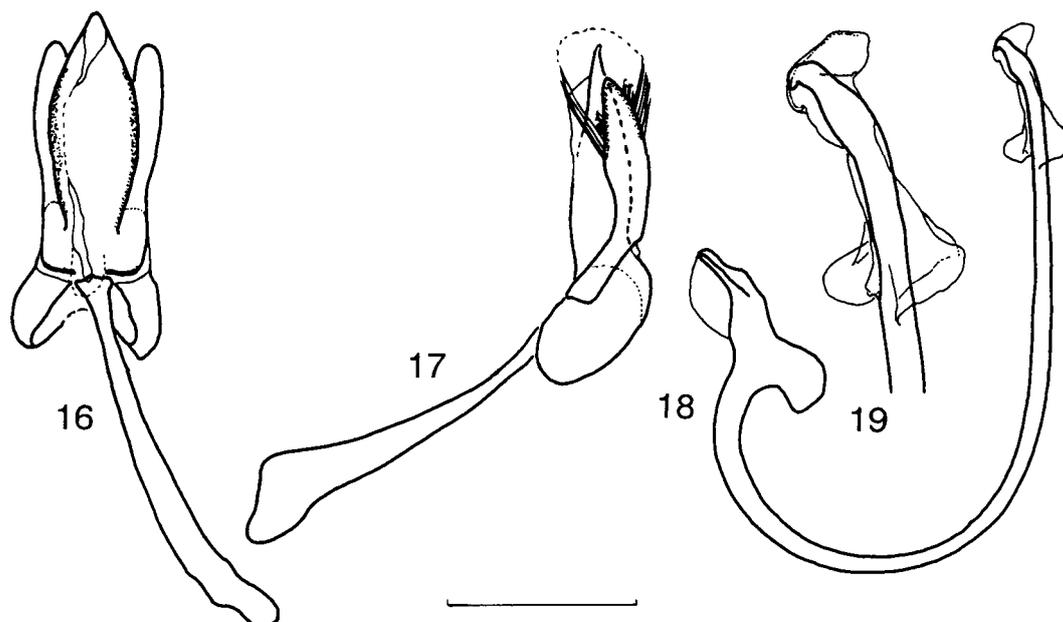
Material examined. 22 specimens. BHUTAN: Tatap. [rest of data illegible], 26.ii.1988 M. Bigger CIE A20015. INDIA: Sikkim, Gopaldhara, 1916 H. Stevens. BURMA: no other data, Bowring. CHINA: no locality data, 1849, 1853 Bowring. THAILAND: Bangkok, H. Hillman; Bangkok Meksongsee. VIETNAM: Hanoi, ii.1917 R.V. de Salvaza; Hadong, 1.ii.1917 R.V. de Salvaza. MALAYSIA: Johore, xi.1962 B.J. Wood, in oil palms CIE 18951; Kuala Lumpur, 20.xi.1940; Sarawak, Kuching, 2–14.v.1909 J.E.A. Lewis. INDONESIA: Lectotype of *C. melas*, Java, no other data, Fruhstorfer. (BMNH, IZPAN, MNHUB)

Comments. When comparative material is available, this species can be separated externally from *C. nigrita* by the stronger punctation of the sides of the elytra. The original description of *C. gressitti*, especially the figures of the male genitalia, leave no doubt about its identity and it is therefore synonymized under Weise's earlier name, *C. melas*.

The native range of *C. melas* appears to be South East Asia. It does not appear to have been used in any deliberate biological control introductions to new localities so far, nor has it spread naturally beyond its native range.



Figs 12–15. *Chilocorus melas*, male genitalia. 12, median lobe, parameres, trapes, ventral view; 13, same, lateral view; 14, siphon; 15, apex of siphon. Scale marker = 0.5 mm, figs 12–14; 0.25 mm, fig. 15.



Figs 16–19. *Chilocorus subindicus*, male genitalia. 16, median lobe, parameres, traves, ventral view; 17, same, lateral view; 18, siphon; 19, apex of siphon. Scale marker = 0.5 mm, figs 16–18; 0.25 mm, fig. 19.

Chilocorus subindicus sp.n.

(figs 16–19)

Description. Length 2.7–3.8 mm, breadth 2.4–3.4 mm, subcircular in body outline, with elytra pitchy to almost black, pronotum pitchy on disc, gradually becoming paler yellowish-brown on side parts. Head and underside yellowish-brown in both sexes. Head with fine pubescence, frons broader than eye width, moderately punctured, interstices weakly convex with moderate to weak reticulate microsculpture, canthus in front of eye rather narrow. Pronotum and elytra punctured and sculptured as *C. nigrita*. Male genitalia characteristic, median lobe broadest about middle (fig. 16), narrowing basally and apically, apex rather broadly rounded in ventral view compared with other species and turned dorsally in side view (fig. 17); parameres more weakly constricted basally (fig. 17). Siphon with apex (fig. 19) similar to that of *C. melas*, but outer arm of siphonal capsule with a stronger ridge (fig. 18). Female genitalia very similar to those of *C. nigrita*.

Type material. Holotype ♂, INDIA: Lakshadweep Islands, Kadmat Island 20.v.1990 T.K. Jacob/pred. of scales on brinjal CIE A21231/Pres by Comm Inst Ent B.M. 1990–1 (BMNH). Paratypes 19♂, 18♀, 2 unsexed, in total. 5♂, 5♀, 2 unsexed, INDIA: same data as holotype; 2♂, 1♀, Lakshadweep Islands, 1988, pred. on mealybug, sp 7, CIE A19645; 1♂, 3♀, Maharashtra, Pune [as Poonah], v.1908 G.E. Bryant; 1♂, Madras, G.E. Bryant; 1♂, Madras, Ind. Mus. 79.64; 1♂, Malabar, Fry Coll. MALDIVIVE ISLANDS: 2♂, Male, 23.xii.1956, 1♀, Male, 14.ii.1957, 1♀, 1957, 1♂, Gan-Addu Atoll, 4.x.1958, all W.W.A. Phillips; 1♂, Addu Atoll, Feydhoo, 12.xi.1993, P.A.C. Ooi & G.W. Watson, on bamboo scale IIE 22974; 3♂, 2♀, Addu Atoll, Hithadhoo, 11.xi.1993, P.A.C. Ooi, pred. on ?*Saissetia* sp IIE 22974; 1♀, Addu Atoll, Meadhoo, 8.xi.1993, P.A.C. Ooi & G.W. Watson, pred. on diaspids IIE 22974; 2♀, Thoddoo, 6.xii.1995, M. Naseem, sp. T30 on banana leaf IIE 23409. (BMNH). SRI LANKA: 3♂, Ceylon (no other data), Compere, Armitage Collection. (CAS)

Comments. This species is found in the southern parts of mainland India and the islands just to the south. Apart from the male genitalia, I can find no reliable means of separating the species from *C. nigrita*. *Chilocorus subindicus* is often slightly more convex than *C. nigrita*, with the sides of the elytra more steeply descending, but there is too

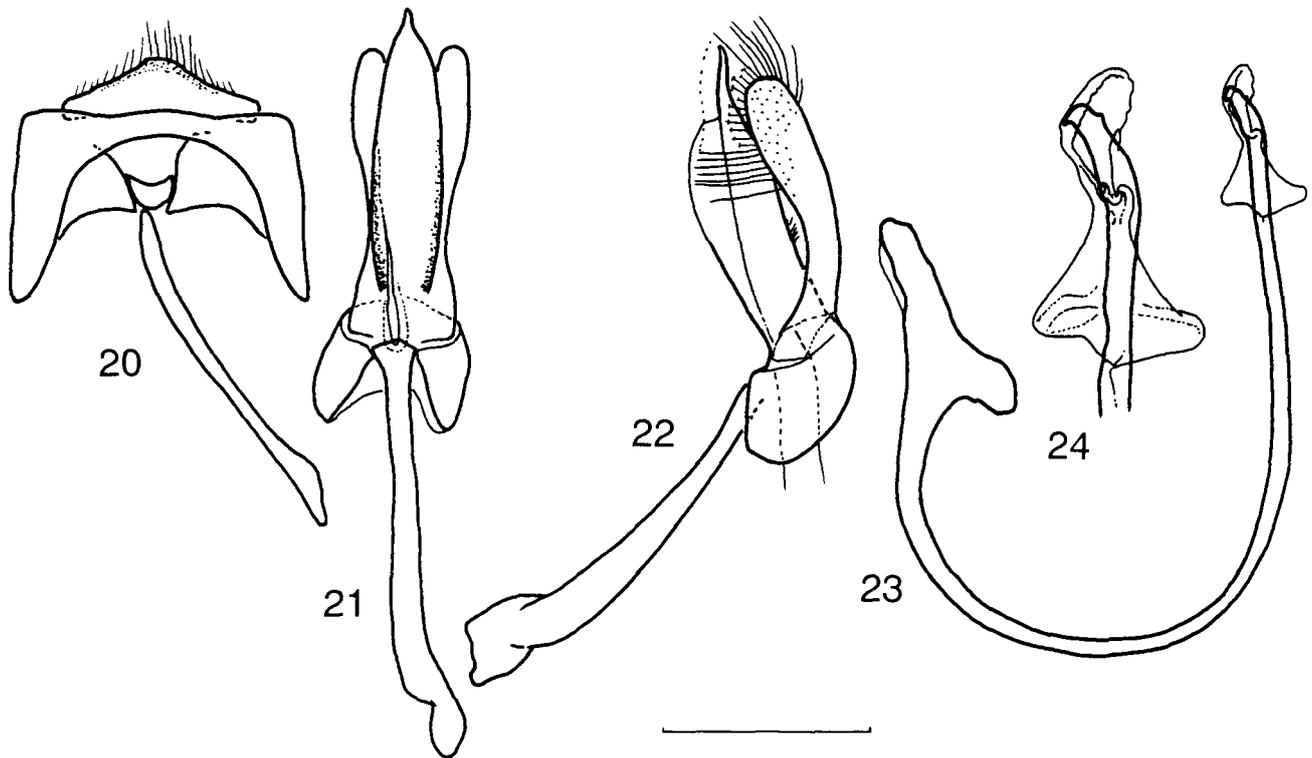
much individual variation in shape for this to be a reliable means of identification for individuals. Both species have been found in Sri Lanka and material from this island has been used for biological control introductions to Mauritius and Hawaii (Samways, 1984). However, *C. subindicus* does not appear to have been used successfully in any deliberate biological control introduction, because successful exports of *Chilocorus* in the past from Sri Lanka have involved only *C. nigrita*.

Chilocorus gracilior sp.n.

(figs 20–24)

Description. Length 3.0–3.2 mm, breadth 2.8–3.1 mm, subcircular in outline, coloration of Flores specimens, including holotype, as typical *C. nigrita*, Sumbawa specimens generally darker with side parts of pronotum entirely pitchy. Head with fine pubescence, frons broader than eye width, finely punctured on disc of frons, more coarsely punctured anteriorly, interstices more or less flat, dull with reticulate microsculpture on disc, more convex and shining anteriorly, canthus in front of eye rather narrow. Pronotum finely punctured, punctures separated by about 1–4 diameters, becoming more widely spaced at sides of disc just above side parts, interstices flat, shining on disc, at most with rather obsolete microsculpture at base, side parts pubescent with coarser, closer punctures and strong reticulate microsculpture. Elytra shiny, without microsculpture, finely punctured, punctures separated by about 3–6 diameters on disc, slightly coarser and closer towards side margins. In males, abdomen with sixth visible sternite concave medially, without median tooth and apex of genital tergite produced medially (fig. 20). Male genitalia characteristic, median lobe much more slender than other species, gently contracted basally (fig. 21), apex in side view turned ventrally, parameres weakly narrowed in basal half (fig. 22), siphon with apex (fig. 24) similar to that of *C. melas*, outer arm of siphonal capsule with low, weak ridge (fig. 23). Female genitalia very similar to those of *C. nigrita*.

Type material. Holotype ♂, INDONESIA: Flores, Ende, 25.ix.1981/sp. A1, pred. of Aleurodicus on coconut CIE A13569 (BMNH). Paratypes 3♂, 3♀, in total. 2♂, 2♀, INDONESIA: same data as holotype except



Figs 20–24. *Chilocorus gracilior*, male genitalia. 20, ninth, tenth tergites; 21, median lobe, parameres, trapeses, ventral view; 22, same, lateral view; 23, siphus; 24, apex of siphus. Scale marker = 0.5 mm, figs 20–23; 0.25 mm, fig. 24.

numbered A5, A6, A8, A9; 1♂, 1♀, Sumbawa, B. Aroe Hassa 2-5000', IX.X Doherty. (BMNH)

Comments. This species is readily distinguished from all the preceding species by the more slender male genitalia, hence the specific name chosen for it. It is just possible that *C. subaenescens*, described by Weise (1898) but not apparently recognized subsequently, is the same as *C. gracilior*. Weise's species was described from Sumbawa (from Staudinger's collection) and was separated from *C. nigrita* by its very dark, metallic green colour. At 3.5 mm long, it was within the size range of *C. nigrita*, but was slightly larger than the specimens above described here as *C. gracilior*. Attempts to locate the type material of *C. subaenescens* in order to confirm its identity have been unsuccessful; it was not in the Museum für Naturkunde der Humboldt-Universität, Berlin (M. Uhlig, personal communication), nor in the Staatliches Museum für Tierkunde, Dresden (O. Jäger, personal communication). At present, I prefer to describe the above Indonesian specimens under a new name, *C. gracilior*, rather than risk misidentifying Weise's earlier species, *C. subaenescens*, especially because there are metallic coloured chilocorines known from the eastern parts of Indonesia to which Weise's species name might also apply.

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