First Record of Ant-loving Crickets (Orthoptera: Myrmecophilidae: Myrmecophilinae) in New Caledonia

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ABSTRACT *Myrmecophilus quadrispina* (Perkins 1899) has been described from Hawaii and found in the Samoan Islands. In both places it has been considered an introduced species. It is reported here from the Loyalty Islands (Lifou). This is the first occurrence of a myrmecophiline cricket in the New Caledonian area. The species is redescribed, and its male and female genitalia examined. Its biology and behaviour at Lifou Island are briefly documented. A key to *Myrmecophilus* spp. from the Australian region is given.

Introduction

Myrmecophilinae are small crickets which are known to live only in ant nests. Their morphology is very distinctive (Schimmer 1909), especially their wingless ovoid body, their small head with reduced eyes and thick antennae, their large hindfemora which completely cover the hindtibiae, their pseudosegmented erect cerci and their enveloping ovipositor valves. Other distinctive, usually overlooked, characters are the structure of male genitalia (Desutter 1987 and Fig. 3-4) and, in some genera, apically trifid cercal hairs (Desutter-Grandcolas unpub. data).

Nearly 50 species of Myrmecophilinae have been described, most of them belonging to the genus *Myrmecophilus* Berthold, 1827 (Chopard 1968; Baccetti 1975; Gorochov 1986; Ingrisch 1987, 1995; Otte and Alexander 1983; Otte 1994). Eight species are known from the Australian region, of which seven originate from Australia (Chopard 1925a,b, 1951, 1968; Baccetti 1975; Otte and Alexander 1983) and one from the Fiji and Solomon Islands (and perhaps also the Society Islands according to Hebard (1935)). Up to now, no Myrmecophilinae have been encountered in the New Caledonian area, and their occurrence in this territory is acknowledged here for the first time.

In this paper, *M. quadrispina* (Perkins 1899) is recorded from the Loyalty Islands (Lifou). This species has been described from Hawaii where it was considered an introduced species, as it was found in Honolulu gardens and among plants on transit boats (Zimmerman 1948). Chopard (1929) mentioned *M. quadrispina* from the Samoan Islands (the specimens studied by Chopard in this last paper fit the description of *M. quadrispina*, in particular for hindtibial spurs; it was misidentified as *M. hebardi* (Mann 1920) by Hebard (1935). Otte (1993: 334) also mentioned *M. quadrispina* from Hong Kong, although no reference was cited.

In the present paper *M. quadrispina* is redescribed; among other characters, male and female genitalia are examined and figured for the first time. A key to species of *Myrmecophilus* from the Australian region is proposed. Data on the life habits and behaviour of *M. quadrispina* on Lifou Island are presented.

Materials and methods

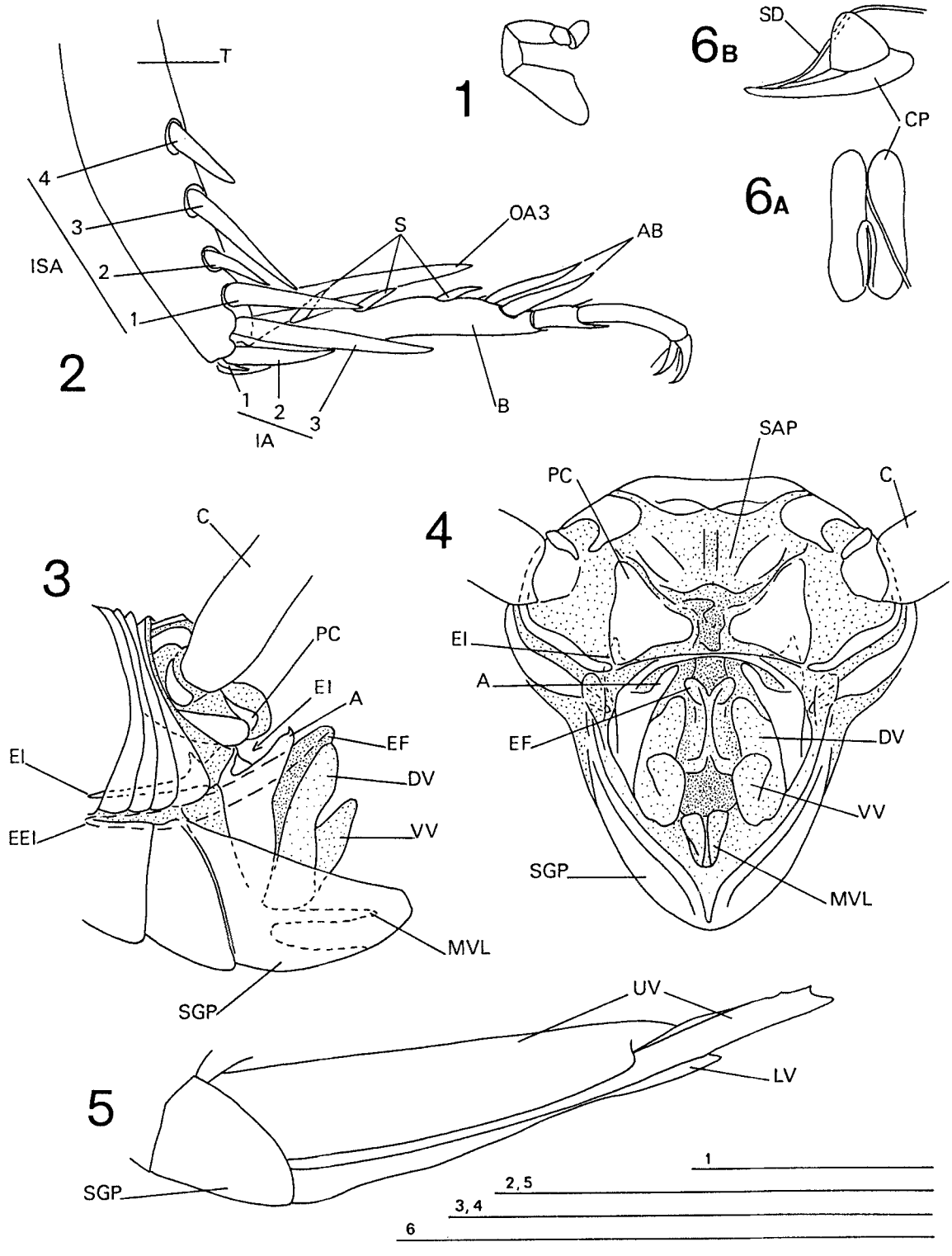
Crickets were found with ant colonies under calcareous stones in a trail embankment; the trail was located at the edge of a mixed *Araucaria* and deciduous forest on the top of calcareous cliffs, in a human-disturbed site of the Cap des Pins (Loyalty Islands, Lifou). The presence or absence of crickets and ants under each stone was noted, and their behaviour observed. Crickets were collected when possible.

Specimens were kept dry. Male and female genitalia were examined with a stereomicroscope at a $\times 100$ magnification and preserved in glycerine; to preserve their three-dimensional structure, they were not put on slides.

Abbreviations: Institutions: MNHN, Muséum National d'Histoire naturelle, Paris; NHM, Natural History Museum, London.

Tibial spurs (Fig. 2): AB, apical spurs of basitarsus; B, basitarsus; IA, inner apical spur; ISA, inner subapical spurs; OA3, third outer apical spur; S, spines of basitarsus; T, hindtibia. Spurs are numbered from ventral to dorsal for apical spurs, and from the apex to the base (and not the reverse) of hindtibia for subapical spurs; this allows homologising the apical spurs and the first subapical spurs between species, following the position criterion, even when some apical spurs are lacking.

Terminalia: A, epiphallic ancorae; C, cerci; CP, copulatory papilla; DV, ectophallic dorsal valves; EF, dorsal ectophallic fold; EI, epiphallic invagination; EEI, epi-ectophallic invagination; LV, lower valve of ovipositor; MVL, median ventral lobe; PC, paraproct; SAP, susanal plate; SD, female spermathecal duct; SGP, subgenital plate; UV, upper valve of ovipositor; VV, ectophallic ventral valves. Terminology for male genitalia according to Desutter (1987, 1990). Membranous parts are figured with dots.



Figs 1-6. *Myrmecophilus quadrispina*: **(1)** left maxillary palp; **(2)** inner spurs of hindtibia and basitarsus; **(3-4)** male terminalia in apical **(3)** and lateral **(4)** view; **(5)** female ovipositor; **(6)** female copulatory papilla, in dorsal (A) and lateral (B) view. Scales: 1 mm. Abbreviations: see text.

Myrmecophilus quadrispina (Perkins) (Figs 1-6)

Myrmecophila quadrispina Perkins, 1899: 14.
Myrmecophilus quadrispina: Chopard, 1929: 35; Zimmerman, 1948: 131; Chopard, 1968: 247; Otte, 1993: 334.

Material examined. Hawaii: 1 ♂ and 1 ♀ syntypes, Oahu, Honolulu (NHM). **Samoa:** 1 ♀, Tutuila, Fagasa, 9.ix.1923, nutmeg tree, Swezey and Wilder, identified by Chopard (MNHN). **New Caledonia:** 5 ♂♂, 4 ♀♀, 7 juveniles, Loyauté Islands, Lifou, Cap des Pins, 14.iii.1994; 1 ♂, 2 ♀♀, 1 juvenile, same locality, 9.iii.1994, L. Desutter-Grandcolas and P. Grandcolas (MNHN).
Ant host: Hawaii (from Zimmermann 1948): *Pheidole megacephala* (Fabricius), *Solenopsis geminata rufa* (Jerdon), *Paratrechina* sp. **Lifou Island:** *Pheidole* probably *megacephala* (J. Casevitz-Weulersse det.).

Description. Small. Body dark brown; antennae and femora pale brown; tibiae, tarsi, cerci and antennal bases yellow. Ventral margin of lateral lobe of pronotum brown. Maxillary palpi with segment 5 elongate, more than twice as long as segment 4, and evenly and greatly enlarged toward apex (Fig. 1). Tibiae III (Fig. 2) with 4 inner subapical spurs (first and third the longest), 1 outer subapical spur, 3 inner and 3 outer apical spurs (third the longest on both sides). Basitarsus III (Fig. 2) with 3 large dorsal spines and 2 very long apical spurs.
Male: Subgenital plate larger than long, indented at apex. Genitalia (Figs 3, 4): epiphalle with large transverse dorsal plate and 2 hook-like ancorae. Epiphallic invagination well formed, evenly narrowed; two small lateral hooks near its base. Epi-ectophallic invagination long and narrow. Dorsal and ventral valves slightly sclerotised. Ectophallic fold indented at apex. Ventral lobe long and narrow.
Female: Ovipositor longer than hindtibiae; its colour yellow. Apex of dorsal valves with indented crest near upper margin (Fig. 5). Genitalia (Fig. 6): copulatory papilla extremely flat, having form of large long sclerotised plate, apex slightly bilobate; median line of this plate invaginated over entire length, but deeply so only over the posterior half. Spermathecal duct aperture in anterior half of this invagination.
Juveniles: Similar to adults, but of much paler colour.
Measurements (in mm, mean value in parentheses). *Males* (n = 3): pronotum length: 0.74-0.87 (0.81); pronotum width: 1.07-1.34 (1.25); hindfemora length: 1.43-1.47 (1.45); hindtibiae length: 1.13-1.23 (1.19). *Females* (n = 3): pronotum length: 0.82-0.88 (0.84); pronotum width: 1.31-1.41 (1.35); hindfemora length: 1.47-1.52 (n = 2); hindtibiae length: 1.13-1.22 (1.17); ovipositor length: 1.28-1.32 (1.30).

Key to species of *Myrmecophilus* from the Australian region

The keys proposed by Baccetti (1975) and Otte and Alexander (1983) can be modified as follow to include the nine species now recognised in the Australian region:

1. Hindtibiae with 2 inner subapical spurs. Distribution: Australia, South Australia ..... ***M. australis*** (Tepper)
   Hindtibiae with more than 2 subapical spurs 2
2(1). Hindtibiae with 3 inner subapical spurs 3
   Hindtibiae with 4 inner subapical spurs 7
3(2). Basitarsus with one dorsal spine. Distribution: Fiji and Solomon Islands ..... ***M. hebardi*** (Mann)
   Basitarsus with 3 dorsal spines 4
4(3). Subapical spurs of tibiae III: 1 less than twice as long as 2 5
   Subapical spurs of tibiae III: 1 twice as long as 2 6
5(4). Body length 3 mm. Distribution: Australia, New South Wales ... ***M. keyi*** Baccetti
   Body length 2.3-2.5 mm. Distribution: Australia, Queensland, South Australia, New South Wales ..... ***M. parachilnus*** Otte and Alexander
6(4). Colour very pale. Size very large (body length 4 mm). Distribution: Australia, Queensland... ***M. testaceus*** (Chopard)
   Colour blackish with 2 or 3 transverse whitish bands on abdomen and whitish hindfemora. Species very small (body length 1.6-1.7 mm). Distribution: Australia, Western Australia ..... ***M. tindalei*** Otte and Alexander
7(2). Basitarsus with 4 dorsal spines 8
   Basitarsus with 3 dorsal spines. Distribution: Hawaii, Samoan and Loyalty Islands ..... ***M. quadrispina*** (Perkins)
8(7). Hindtibiae with 2 outer subapical spurs. Distribution: Australia, Northern Territory.... ***M. longitarsis*** (Chopard)
   Hindtibiae with 1 outer subapical spur. Distribution: Australia, Queensland ..... ***M. mjoebergi*** (Chopard)

Distribution and biology of *M. quadrispina*

M. quadrispina has a very wide distribution. It has now been reported from Hawaii, the Samoan Islands, Lifou, and perhaps Hong Kong. In Hawaii, it was found in gardens and boats and considered an immigrant species (Perkins 1899; Zimmermann 1948; Otte 1993). In the Loyalty Islands, it was found under stones in a trail embankment in a human-disturbed site. No data are available for the Samoan specimens. As for several other *Myrmecophilus* spp., several ant species are known to host *M. quadrispina*, namely *Pheidole megacephala*, *Solenopsis geminata rufa* and one species of the genus *Paratrechina*

Motschoulsky. All these ant taxa are widely distributed in the tropics (J. Casevitz-Weulersse pers. comm.). These data, although still scarce, could indicate that *M. quadrispina* has been imported into various places with its ant hosts. Its place of origin cannot yet be hypothesised.

The life habits of Myrmecophilinae and in particular their commensalism with ants have been studied extensively (see Hölldobler and Wilson 1990 and references therein).

I observed *M. quadrispina* under stones with *Pheidole* ants. Both males and females were found, showing that this species is not parthenogenetic which is the case in some other species of *Myrmecophilus* (Chopard 1938; Hölldobler and Wilson 1990). Juvenile crickets were mixed with adults in ant colonies. The host ants are quite small, the workers being of the size or slightly longer than the adult crickets.

A total of 41 stones was examined. Their lower side was always in contact with the soil, and ant galleries were frequently observed. Nineteen stones were colonised by ants, only six of them also housing crickets. Crickets were never found under stones not occupied by ants. Table 1 indicates the mean size of the colonised stones.

Table 1. Size of the stones under which *Pheidole* ants with and without *Myrmecophilus quadrispina* crickets have been found at the Cap des Pins (Loyalty Islands, Lifou). The mean value is indicated (mm) for their length (L), width (W) and height (H), their minimal and maximal values are in parentheses.

	n (n = 41)	L	W	H
Stones with ants	15	24	21	14
	(15-50)	(10-60)	(5-60)	
Stones with ants without crickets	9	20 (15-30)	18 (10-30)	9 (5-15)
Stones with ants with crickets	6	29 (15-60)	25 (10-60)	20 (5-60)

The number of crickets per stone was variable and ranged from 1 to 3 per stone; only 1 stone (40 cm long, 30 cm large, 20 cm thick) sheltered numerous crickets, of which nine were collected.

Previous behavioural studies (Hölldobler and Wilson 1990) have mentioned that myrmecophiline crickets probably evolved mimicry that allows them to live among ants without eliciting aggressive behaviour. Crickets benefit from living in ant nests by finding diverse food. However, when ant nests are disturbed, aggressive reactions of ants toward crickets have frequently been observed. In natural conditions, crickets escape the ants "through swift and nimble running" (Hölldobler and Wilson 1990). Wheeler (1900) also mentioned the "zig-zag path" of the crickets "made up of very short lines and abrupt angles" (see also Henderson and Akre 1986). I observed repeatedly an additional escape behaviour of *M. quadrispina*, not described from other crickets. When the ant colony was disturbed by removal of the stone, ants and crickets ran in every direction. If a cricket was then facing an ant, the ant moved its head rapidly and made several grasping movements with its mandibles. The cricket then rapidly turned out at 180° and ran away along a semi-circular route to finish about 5 mm to the side of the ant. In such interactions, the ant never pursued the cricket.

Ant-loving crickets are considered an example of tactile mimicry (Hölldobler and Wilson 1990), but they also show specialised escape behaviours. These two behavioural components are probably related to their ambivalent relationships with ants.

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