

Four New Species of *Myrmecophilus* (Orthoptera, Myrmecophilidae) from Japan

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Abstract Four new species of the genus *Myrmecophilus* (Myrmecophilidae, Myrmecophilinae, Myrmecophilini), *M. horii*, *M. kubotai*, *M. kinomurai* and *M. ishikawai*, are described from mainland Japan. Structures of body surface, configuration of microsculpture and shape of scales on the derm, have been found useful as taxonomic characters for classifying the members of the genus, and the descriptions are mainly based upon their peculiarities.

Key words: Myrmecophilidae, *Myrmecophilus*, myrmecophilous cricket, new species, mainland Japan, new taxonomic characters, structure of body surface

Introduction

The cricket genus *Myrmecophilus* is represented by 55 species and subspecies from the Palearctic, Nearctic, Australian and Oriental regions (see, Appendix), and all the species are considered to be myrmecophilous.

From Japan, six species have hitherto been known: *M. sapporensis* Matsumura, 1904, *M. teranishii* Teranishi, 1914, *M. formosanus* Shiraki, 1930, *M. albicinctus* Chopard, 1924, *M. tetramorii* Ichikawa, 2001 and *M. gigas* Ichikawa, 2001 (Ichikawa, 2001), though identifications of the two species (*M. formosanus* and *M. albicinctus*) occurring in the Nansei-shotō (the Ryūkyū archipelago) and originally described from other countries need more consideration. Although Sakai and Terayama (1995) cited one species of cricket, “*M. sapporensis*”, collected from various ant species (26 species) in mainland Japan, subsequent studies have shown that the material examined by them apparently includes other species. The known Japanese species, *M. sapporensis*, *M. teranishii*, *M. tetramorii* and *M. gigas* described from mainland Japan are very similar to each other, and can be assigned to a species group of their own, the *sapporensis* group.

Taxonomy of *Myrmecophilus* is usually very

difficult, and has been based on some ambiguous characters, e.g., coloration, shape and size of body and leg spurs, all of which are often unstable and variable within a species. Thus, discovery of certain diagnostic characters has been needed, though non-morphological information, e.g., molecular information and chromosome number, is considered to be also informative. In the course of morphological study of *Myrmecophilus*, I have found that the structure of body surface is useful for identifying the species of the genus.

Observation of the structure of body surface of the unidentified material from mainland Japan and the type specimens of all the species of the *sapporensis* group has revealed the existence of four undescribed species belonging to the *sapporensis* group. Although revisional study based on the material collected from all over Japan and her adjacent regions, e.g., China, Korea and the Russian Far East, is needed, these species can be described at present in view of their clear morphological features and also of their host ant preference.

Materials and Methods

Crickets were all collected from ant nests by using aspirator and directly, or after being killed

with ethyl acetate, put in 70–80% ethanol for preservation. For morphological observation, most specimens were dried in air or sometimes dried with Xylene-Cellosolve method, and then mounted on square paper cards with fish glue.

Classification of species in the present study is mainly based on the structure of body surface: configuration of microsculpture and shape of scales. General structure of the scales is composed of costae, apical angle and medial projection (Fig. 1). Allometric data, shape of ovipositor and colour are also used. Host ant species are very informative for preliminary sorting of species because host specificity is relatively strong in the *sapporensis* group. Terminology of the other body parts followed Maeyama and Terayama (1994).

Body surface, above all mesal area of the pronotum, and ovipositor were observed and photographed by using scanning electron microscope (SEM), all the material uncoated.

Species name of symbiotic hosts in Type material and body parts in Measurements are

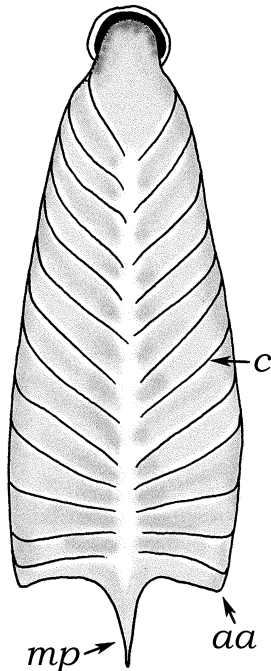


Fig. 1. General morphology of scale; *c*: costae; *aa*: apical angle; *mp*: medial projection.

abbreviated as follows: *Lasius* (*Lasius*) *japonicus* Santschi, 1941 (LLJ); *L.* (*Chthonolasius*) sp. (LC); *L.* (*Dendrolasius*) *nipponensis* Forel, 1912 (LDN); *L.* (*D.*) *spathepus* Wheeler, 1910 (LDS); *L.* (*D.*) *capitatus* (Kuznetsov-Ugamsky, 1927) (LDC); *L.* (*D.*) *teranishii* Wheeler, 1928 (LDT); *L.* (*D.*) *morisitai* Yamauchi, 1979 (LDM); *Formica truncorum* Fabricius, 1804 (FT); *F. yessensis* Wheeler, 1913 (FY); *F. japonica* Motschulsky, 1866 (FJ); *F. lemani* Bondroit, 1917 (FL); *F. hayashi* Terayama & Hashimoto, 1997 (FH); *Camponotus* (*Camponotus*) *japonicus* Mayr, 1866 (CJ); body length (BL); body length of dried specimen (BLD); mid tibial length (MTL); hind tibial length (HTL). Measurements are indicated in millimetre.

The holotypes and some paratypes are deposited in the National Science Museum, Tôkyô (NSMT).

Genus *Myrmecophilus* Berthold, 1827

Myrmecophilus Berthold, 1827: 409 [original description]; Chopard, 1968: 243 [synonymy, list of species].

Remarks. Several subgenera, *Eumyrmecophilus* Gorochov, 1994, *Myrmecophilus* Berthold, 1827, *Myrmecophilina* Silvestri, 1912, and *Paramyrmecophilus* Gorochov, 1986, have been recognised before, but they are not satisfactorily defined and could not be determined in many cases. Thus, the present new species were not assigned to any of them. *Myrmecophilellus* Uvarov, 1940, and *Camponophilus* Ingrisch, 1995, are known as close relatives of *Myrmecophilus*, with which they are probably synonymous.

Group of *M. sapporensis*

Species included. *Myrmecophilus. sapporensis*, *M. teranishii*, *M. tetramorii*, *M. gigas*, *M. horii*, *M. kubotai*, *M. kinomurai*, *M. ishikawai*.

Diagnosis. Body (Fig. 2) almost unicolorous; yellowish brown to brown in ground colour; mouthparts, antenna and legs paler. Head with frons gently convex around apex; clypeus about twice as wide as long; surface covered with long



Fig. 2. *Myrmecophilus kinomurai*, facies.

recumbent setae, and with fusiform setae around vertex. Dorsal surface of thorax and abdomen densely covered with minute projections; scales on body surface fusiform, costate, lacking pore or ridge. Pronotum 1.5 times as long as combined length of meso- and metanota. Hind tibiae with 9 or 10 spurs. Ovipositor more or less parallel-sided, weakly bifid at apex.

Remarks. This species group is restricted to mainland Japan at present, but will probably be found to spread over wide areas of continental Asia, in particular, China, Korea and the Russian Far East. Since the fauna of myrmecophilous insects of these areas have been poorly known, future investigations are needed for determining its precise definition.

***Myrmecophilus horii* sp. nov.**

(Figs. 3, 7)

Type material. Holotype: female, Naka-jima, Tôya-ko, Abuta-chô, Hokkaidô, 5. IX. 1999, M. Maruyama. (FJ) (NSMT). Paratypes: [Hokkaidô]:

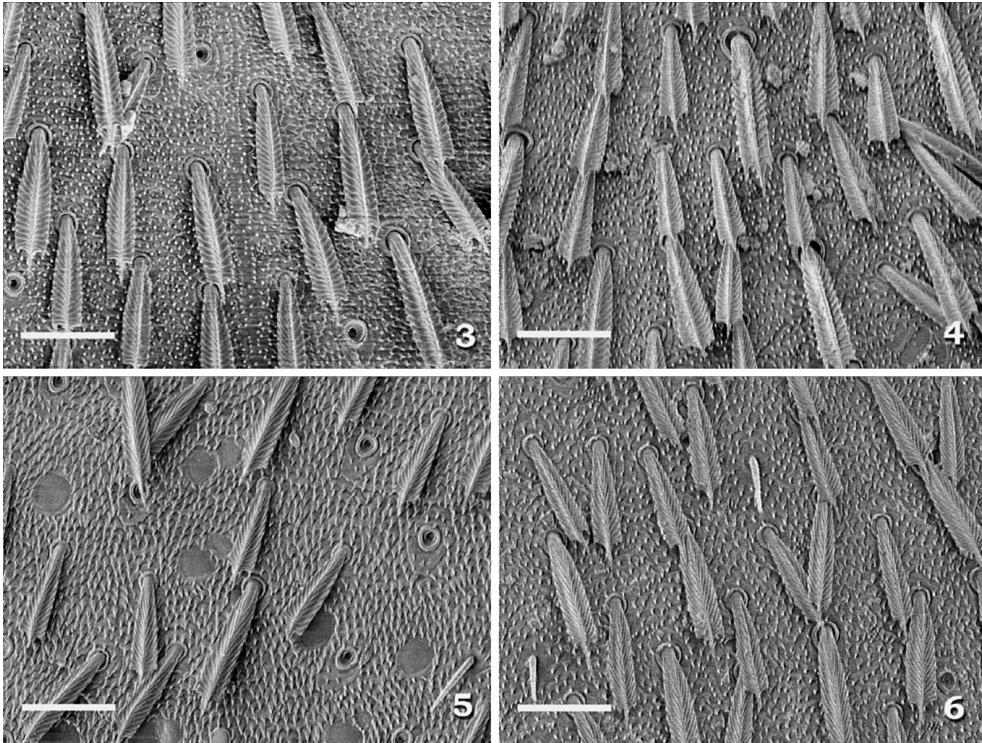
2 females, 1 male, 6 nymphs, same data as holotype; 1 male, 29. V.–26. VI. 1992, S. Hori. (pitfall trap); 1 female, 9 nymphs, Shin-machi, Maruseppu-chô, 12. VI. 2001, M. Maruyama. (FT); 1 nymph, Daiei, Shari-chô, 26. V. 2001, Y. Kida (FL); 1 female, Jôzankei, Minami-ku, Sapporo-shi, 24. VIII. 1990, H. Sakai (FY).

Distribution. Japan: Hokkaidô.

Symbiotic hosts. *Formica truncorum*, *F. yessensis*, *F. japonica*, *F. lemni*. (Probably, all the sympatric species of *Formica*.)

Etymology. Dedicated to Shigehisa Hori, a collector of the type series, for his invaluable contributions to the insect fauna of Hokkaidô.

Description. Colour brown; posterior margins of thorax and abdomen paler. Surface (Fig. 3) aculeate, fingerprint-patterned; projections small, forming a row. Scales (Fig. 3) slender, moderately dilated apicad, widest at middle, with 14–18 costae on each side; apical angle either rectangular or slightly produced; medial projection short, shorter than 1/6 of whole scale. Ovipositor (Fig. 7) slender, almost parallel-sided,



Figs. 3–6. Pronotal surfaces of the holotypes of *Myrmecophilus* spp., SEM photographs—1, *M. horii*; 2, *M. kubotai*; 3, *M. kinomurai*; 4, *M. ishikawai*. Scale bar=20 μ m.

widest at basal 2/5.

Measurements. BL: 3.8–5.0; BLD: 3.0–3.8; MTL: 0.95–1.25; HTL: 1.23–1.75.

Remarks. This species is similar to *M. gigas* Ichikawa in body size but distinguished from the latter by the more slender scales on the body surface. From the other sympatric species occurring in Hokkaidô, *M. sapporensis* Matsumura and *M. kinomurai* sp. nov., this species is easily distinguished by the larger body, and the hosts are clearly different: *M. sapporensis*—*Lasius* (*Lasius*) spp. and *L. (Cautolasius) flavus*., *M. kinomurai*—*L. (Dendrolasius)* spp.

***Myrmecophilus kubotai* sp. nov.**

(Figs. 4, 8)

Type material. Holotype: female, Koganei-kôen, Koganei-shi, Tôkyô-to, Honshû, Japan, 29. IV. 2003, M. Maruyama (FJ) (NSMT). Paratypes: [Tôkyô-to]: 21 females, 6 males, 5 nymphs, same

data as holotype; 11 nymphs, Midori-chô, Koganei-shi, 29. IV. 2003, M. Maruyama (LLJ); 2 females, 1 male, 2 nymphs, same locality, 29. IV. 2003, M. Maruyama (FJ); 1 female, same locality, 29. IV. 2003, M. Maruyama (CJ); 1 male, same locality, 10. V. 2003, M. Maruyama (FJ); 1 female, same locality, 8. VII. 2003, M. Maruyama (CJ); 4 nymphs, Sakai, Musashino-shi, 30. IV. 2003, M. Maruyama (LLJ); [Kanagawa-ken]: 7 female, 2 males, 1 nymph, Sagami-gawa, Zama-shi, 27. IV. 2003, M. Maruyama; [Gifu-ken]: 1 female, Akutami, Gifu-shi, 28. V. 2003, K. Kinomura (CJ); 1 nymph, Nôgô, Neo-mura, 12. VI. 2003, K. Kinomura (FJ); 7 nymphs, Kurisu, Yamato-chô, 22. VI. 2003, K. Kinomura (FJ); 1 nymph, Hirugano, Takatsu-mura, 6. VII. 2003, K. Kinomura (FJ); [Mie-ken]: 2 female, 1 male, 2 nymph, Hirakura, Misugi-mura, 8. VI. 1997, S. Nomura (FH).

Distribution. Japan: Honshû.

Symbiotic hosts. *Formica japonica*, *F. hayashi*,

Camponotus (*Camponotus*) *japonicus*, *Lasius* (*Lasius*) *japonicus* (probably temporal host).

Etymology. Dedicated to Masao Kubota, president of the Myrmecological Society of Japan, in honour of his invaluable contributions to the ants and myrmecophilous insects in Japan.

Description. Colour dark brown; posterior margins of thorax and abdomen paler. Surface (Fig. 4) aculeate, fingerprint-patterned; projections small, forming a row. Scales (Fig. 4) consisting of two kinds: longer and shorter ones; longer one slender, slightly dilated apicad, widest near apex, with 17–20 costae on each side; apical angle acutely produced, 1/2 as long as medial projection; medial projection short, shorter than 1/6 of whole scale. Shorter one slender, moderately dilated apicad, widest near apex, with 12–18 costae on each side; apical angle rounded, rectangular or slightly produced; medial projection short, shorter than 1/5 of whole scale. Ovipositor (Fig. 8) slightly tapered apicad, widest at basal 1/3.

Measurements. BL: 3.3–4.0; BLD: 2.5–3.5; MTL: 0.93–1.11; HTL: 1.25–1.41.

Remarks. This species is similar to *M. kinomurai* sp. nov. in coloration and body size but distinguished from the latter by having the scales not uniform but consisting of two different kinds. Though the type material was collected from the nests of three ant species, this species is likely to be collected from other species of *Formica* and *Camponotus*. Most specimens recorded by Sakai and Terayama (1995) as “*M. sapporensis*” seem to belong to this species.

Some material examined was collected from nests of *Lasius japonicus*. However, the ants may be a temporal host because only nymphs of the crickets were found from the nests of this ant.

***Myrmecophilus kinomurai* sp. nov.**

(Figs. 2, 5, 9)

Type material. Holotype: female, Fujio-jinja, Takamatsu-shi, Kagawa-ken, Shikoku, 1. VI. 2001, M. Maruyama (LDN) (NSMT). Paratypes: [Hokkaidô]: 1 nymph, Maruyama, Chûô-ku, Sap-

poro-shi, 2. V. 2001, M. Maruyama (LDN); 1 femle, 2 males, 3 nymphs, Minaminosawa, Minami-ku, Sapporo-shi, 7. IX. 2001, M. Maruyama (LDT); 1 female, Yûtoku, Ôtaki-mura, Hokkaidô, 24. VIII. 2001, M. Maruyama (LDN); [Miyagi-ken]: 1 female, Aoba-yama, Sendai-shi, 22. IX. 2001, M. Maruyama (LDC); [Saitama-ken]: 6 females, 1 male, Nakao, Shôwa-machi, Kitakatsushika-gun, 3. V. 2002, H. Kamezawa (LDN); [Tôkyô-to]: 1 femle, 3 nymphs, Takao-san, Hachiôji-shi, 4. VI. 2001, M. Maruyama (LDN); [Chiba-ken]: 1 female, 1 nymph, Azeta, Sakura-shi, 20–26. VI. 1998, M. Maruyama (LDS); [Nagano-ken]: 1 female, Otari-onsen, Otari-mura, Nagano-ken, 9. VI. 2003, M. Maruyama (LDN); [Gifu-ken]: 3 nymphs, Arisaka, Yamato-chô, 17. V. 2003, K. Kinomura (LDC); 1 female, 2 males, 1 nymph, Kurisu, Yamato-chô, 22. VI. 2003, K. Kinomura (LDN); 2 females, 3 males, 8 nymphs, Sembiki, Seki-shi, 11. V. 2003, K. Kinomura (LDS); 1 male, Kinka-zan, Gifu-shi, 1 VI. 2003, K. Kinomura (LDC); 1 nymph, same data, but 10. VII. 2003; 1 nymph, same data, but 11. VI. 2003 (LDS); 1 male, Iwase, Shôkawa-mura, 4. X. 2003, K. Kinomura (LDN); 2 females, 1 male, 1 nymph, Isshiki, Shôkawa-mura, 12. VII. 2003, K. Kinomura (LDM); 3 males, 2 nymphs, same data, but 10. VIII. 2003, K. Kinomura (LDT); 2 nymphs, same data, but 6. VIII. 2003; 2 males, same data, but (LDS); 2 females, 1 male, 1 nymph, same data, but 12. VII. 2003; 2 females, 1 male, 3 nymphs, Imamura, Neo-mura, 7. IX. 2003, K. Kinomura (LDS); 1 female, 5 males, 1 nymph, same data, but 17. IX. 2003; 2 females, Hachiman, Mugegawa-chô, 21. VII. 2003, K. Kinomura (LDS); 1 female, 3 males, 1 nymph, Bijo-kôgen, Kuguno-chô, 5. VIII. 2003, K. Kinomura (LDN); 6 males, 4 nymphs, same data, but 8. VIII. 2003; 1 female, 3 males, 2 nymphs, Morimo, Kamioka-chô, 27. VII. 2003, K. Kinomura (LDT); 1 nymph, Kentô-san, Takatsu-mura, 6. VII. 2003, K. Kinomura (LDN); 2 females, Nakao, Kamitakara-mura, 4. VIII. 2003, K. Kinomura (LDT); [Hyôgo-ken]: 1 female, Numa, Hikami-chô, Hikami-gun, 7. VI. 2003, M. Maruyama (LDS); [Kagawa-ken] 7 females, 2

males, same data as holotype; 1 female, same data as holotype, but 31. V. 2001; 1 female, 1 nymph, Ôtawâ, Nagao-chô, 31. VI. 2001, M. Maruyama (LDM).

Distribution. Japan: Hokkaidô, Honshû, Shikoku.

Symbiotic hosts. *Lasius* (*Dendrolasius*) *nipponensis*, *L. (D.) sphaetheus*, *L. (D.) capitatus*, *L. (D.) morisitai*, *L. (D.) teranishii*.

Etymology. Dedicated to Kyoichi Kinomura, a collector of the type series, for his invaluable contributions to ant ecology and devoted supports for young entomologists in Japan.

Description. Colour dark brown; posterior margins of thorax and abdomen paler. Surface (Fig. 5) aculeate; projections large. Scales (Fig. 5) slender, moderately dilated apicad, widest near apex, with 20–22 costae on each side; apical angle rounded or rectangular; medial projection short, shorter than 1/7–1/6 of whole scale. Ovipositor (Fig. 9) slightly narrowed apicad, widest at basal 1/3.

Measurements. BL: 4.0–4.2; BLD: 2.75–

3.25; MTL: 1.05–1.12; HTL: 1.25–1.41.

Remarks. This species is closely similar to *M. ishikawai* in structure of body surface but easily distinguished from the latter by evidently darker colour and sparser costae on scales. This species is also similar to *M. kubotai* in colour and body size but distinguished from the latter by the scales on the surface which do not comprise two kinds but are uniform.

***Myrmecophilus ishikawai* sp. nov.**

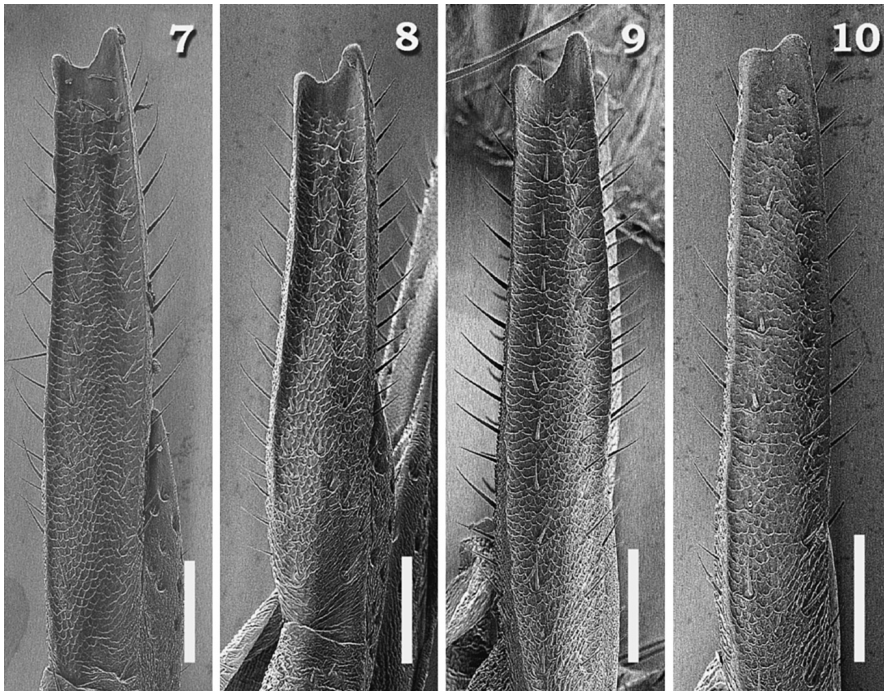
(Figs. 6, 10)

Type material. Holotype, female: Yada, Shizuoka-shi, Shizuoka-ken, Japan, 18. IV. 1994, H. Ishikawa. (LC) (NSMT). Paratypes: 1 female, 1 male, same data as holotype.

Distribution. Japan: Honshû.

Symbiotic hosts. *Lasius* (*Chthonolasius*) sp. (*L. umbratus* (Nylander, 1846) or *L. meridionalis* (Bondroit, 1920)).

Etymology. Dedicated to Hitoshi Ishikawa, an eager taxonomist of Orthoptera in Japan and



Figs. 7–10. Ovipositors of the holotypes of *Myrmecophilus* spp., SEM photographs—1, *M. horii*; 2, *M. kubotai*; 3, *M. kinomurai*; 4, *M. ishikawai*. Scale bar=100 μ m.

collector of the type series.

Description. Colour pale brown; posterior margins of thorax and abdomen paler. Surface (Fig. 6) aculeate; projections large. Scales (Fig. 6) slender, moderately dilated apicad, widest near apex, with 22–25 costae on each side; apical angle rounded or rectangular; medial projection short, shorter than 1/6–1/5 of whole scale. Ovipositor (Fig. 10) slender, slightly tapered apicad, widest at basal 1/5.

Measurements. BL: 3.8–4.0; BLD: 2.5–3.5; MTL: 0.91–0.99; HTL: 1.24–1.25.

Remarks. This species is closely similar to *M. kinomurai* in structure of body surface but easily distinguished from the latter by colour being conspicuously paler and costae on the scales denser. The host is a subterranean species, and the pale colour of this species may possibly be related to its habitat.

Acknowledgments

The author thanks S. Hori (Historical Museum of Hokkaidō), A. Ichikawa (Ōsaka), F. Ito (Kagawa University), G. Itō (Hokkaidō University), Y. Itoku (Tōkyō), H. Ishikawa (Shizuoka), H. Kamezawa (Tōkyō), Yasunari Kida (Hokkaidō), K. Kinomura (Gifu), S. Nomura (NSMT) and M. Terayama (Tōkyō) for material, especially A. Ichikawa for valuable information and literature. Thanks are also due to H. Sugaya (Hokkaidō University) for taking SEM photographs and J. Cooter (Hereford) and S.-I. Uéno (NSMT) for reading manuscript.

This study is supported by a grant to the author from the Research Fellowship of the Japan Society for the Promotion of Science for Young Scientists (PD).

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Appendix

A Checklist of the Known Species of the Genus *Myrmecophilus*

- Myrmecophilus* Berthold, 1827
- acervorum* (Panzer, 1799): Central Europe.
- aequispina* Chopard, 1923: Southern Europe.
- albicinctus* Chopard, 1924: India.
- subsp. *albicinctus* Chopard, 1924
- subsp. *concolor* Chopard, 1928
- americanus* Saussure, 1877: Columbia.
- arboreus* Maeyama & Terayama, 1994: Papua New Guinea.
- australis* Tepper, 1896: Australia.
- baronii* Baccetti, 1966: Europe (Malta).
- bifasciatus* Fischer von Waldheim, 1846: Russia.
- bituberculatus* Ingrisch, 2001: Nepal.
- brevipalpis* Chopard, 1948: Arabia.
- chocolatinus* Gorochov, 1992: Vietnam.
- cottami* Chopard, 1922: Egypt.
- crenatus* Gorochov, 1986: Mongolia.
- denticaudus* Bei-Bienko, 1967: Afghanistan.
- dubius* Saussure, 1877: Malaysia.
- escherichi* Schimmer, 1911: Sri Lanka.
- formosanus* Shiraki, 1930: Taiwan.
- gigas* Ichikawa, 2001: Japan.
- gracilipes* Chopard, 1924: India.
- haeckeli* Fernando, 1962: Sri Lanka.
- hebaridi* Mann, W., 1920: Fiji.
- hirticaudus* Fischer von Waldheim, 1846: Crimea.
- horii* Maruyama, sp. nov.: Japan.
- ishikawai* Maruyama, sp. nov.: Japan.

- keyi* Baccetti, 1975: Australia.
kinomurai Maruyama, sp. nov.: Japan.
kubotai Maruyama, sp. nov.: Japan.
longitarsis Chopard, 1925: Australia
manni Schimmer, 1911: North America (Washington).
meneliki (Reichensperger, 1913): Ethiopia.
mjobergi Chopard, 1925: Australia.
mauritanicus (Lucas, 1849): Algeria.
myrmecophilus (Savi, 1819): Europe.
nebrascensis Lugger, 1898: North America (Nebraska).
nigricornis Chopard, 1963: Israel.
ochraceus Fischer von Waldheim, 1853: Europe (Sicily), Turkey.
oculatus Miram, 1930: Turkmenistan.
oregonensis Bruner, 1884: North America.
pallidithorax Chopard, 1930: Malaysia (Borneo).
parachilnus (Otte & Alexander, 1983): Australia.
pilipes Chopard, 1928: Sri Lanka.
pergandei Bruner, 1884: North America (Washington).
polyrhachi Ingrisch, 1987: Peninsular Malaysia.
prenolepidis Wasmann, 1905: unknown.
quadrispina Perkins, 1899: Hawaii
salomonis Wesmael, 1890: Tunisia.
sanctae-helenae Chopard, 1970: St. Helena.
sapporensis Matsumura, 1904: Japan.
seychellensis Gorochof, 1994: Seychelles.
sinicus Bei-Bienko, 1956: China.
surcoufi Chopard, 1919: Algeria.
teranishii Teranishi, 1914: Japan.
termitophilus Maran, 1959: Greece.
testaceus Chopard, 1925: Australia.
tetramorii Ichikawa, 2001: Japan.
tindalei Otte & Alexander, 1983: Australia
wahrmani Chopard, 1963: Israel.
zorae Karaman, 1963: Macedonia.