

## Article

# Taxonomic studies of Japanese Formicidae part 3: genus *Vollenhovia* Mayr

Mamoru TERAYAMA\* & Kyoichi KINOMURA\*\*

### Abstract

Four new species of the genus *Vollenhovia* are described and figured; *V. benzai* from Kyushu, Shikoku, Yaku-shima and the Amami Is., *V. amamiana* from the Amami Is., *V. okinawana* from Okinawa-jima, and *V. sakishimana* from the Sakishima and the Ogasawara Isles.

*Vollenhovia benzai* is separated from the other East Asian congeners by the low subpetiolar process and the convex dorsal outline of the postpetiole, *V. amamiana* by the developed subpetiolar process and the absence of propodeal teeth, *V. okinawana* by the presence of the unsculptured longitudinal band on the dorsum of promesonotum and the shape of the dorsal outline of the postpetiole (highest at posterior 1/3 in profile), and *V. sakishimana* by the developed subpetiolar process, the absence of a large brown spot on frons, and the yellowish body.

A tentative key is given based on the worker and a distribution map to the species is also provided.

**Key Words:** Insecta, Hymenoptera, Formicidae, *Vollenhovia*, new species, Japan

### Introduction

The genus *Vollenhovia* Mayr, 1865, belonging to the subfamily Myrmicinae, is represented by 48 described species and is mostly distributed in the Oriental and the Indo-Australian Regions, and a few in the Palaearctic (2 species) and the Australasian (1 species) Regions (Bolton, 1995).

This genus is distinguished from the other genera of the subfamily Myrmicinae by the following characteristics: 1) frontal carinae and antennal scrobes absent; 2) clypeus more or less longitudinally bicarinate; 3) antennae with 12 segments, rarely 11 segments, the funicles ending in a 3-segmented club; 4) frontal lobes present; 5) maxillary palp with 1-3 segments, usually 2 segments; 6) eyes present, relatively large; 7) ventral processes distinct on meso- and metasternum; 8) middle and hind legs without tibial spur; 9) petiole sessile or subsessile; 10) subpetiolar process present, often blade-like; 11) petiole not particularly more voluminous than postpetiole in dorsal view.

Among 7 species mentioned by Terayama and Yamauchi (1992), 2 have scientific names: *V. emeryi* Wheeler, 1906, and *V. nipponica* Kinomura and Yamauchi, 1992. The latter is workerless and parasitic the former (Kinomura and Yamauchi, 1992). In *V.*

*emeryi*, two forms of the queen caste exist, macrogynes with normal wings and microgynes with aberrant short wings (Kubota, 1984; Kinomura and Yamauchi, 1994). *Vollenhovia emeryi* chosenica Wheeler, 1928, is removed from the Japanese fauna since no reliable recent record is available from Japan (Myrmecological Society of Japan, 1988; Terayama and Yamauchi, 1992).

In the course of the present study, we examined materials from various localities of East Asia including China, Korea, Hong Kong and Taiwan in addition to Japan. So far there are 4 described species from this area, the species number should indicate only a part of the whole East Asian fauna in this genus.

In the present paper we have described four of five unnamed Japanese species as being new to science. Regarding the remaining species, much information is needed to finally determine the exact taxonomic status. Among the East Asian congeners including unnamed species, *V. emeryi* from Japan and Korea, *V. pyrrothoria* from China and the four other species closely resemble each other according to the following characteristics: 1) mandible with 7 teeth, 2) promesonotal dorsum almost straight excluding anterior collar in profile, 3) metanotal groove not incised dorsally or very weakly incised, 4) petiole higher

\*Department of Biology, College of Arts and Sciences, The University of Tokyo, Komaba, Meguro-ku, Tokyo 153, Japan.

\*\*Gifu-Aikawa High School, Akutami-nanzan, Gifu-shi 501-31, Japan.

than long in profile (as long as it is high at least), 5) posterodorsal end of petiolar node carinate. These morphological similarities and geographical distributions suggest that they belong to the same phyletic group.

Measurements, indices and abbreviations used in this paper follow those in part 1 of this series.

### *Vollenhovia benzai* sp. nov.

(Figs. 2, 6)

**Holotype.** Worker. HL 0.53 mm; HW 0.48 mm; SL 0.29 mm; CI 90; SI 60; WL 0.60 mm; PL 0.23 mm; PH 0.21 mm; DPW 0.14 mm; TL 2.0 mm.

Head slightly longer than wide, with subparallel sides and weakly concave posterior margin in frontal view. Mandibles with 7 teeth; basalmost tooth minute. Clypeal carinae subparallel. Antennae with 12 segments; scape 0.55 x head length. Eyes 0.13 mm in diameter.

Dorsum of promesonotum straight in profile; metanotal groove not incised dorsally; posterodorsal corner of propodeum dully angulated, without a dorsal tooth in profile.

Petiole higher than long, with convex dorsal outline in profile; anterodorsal corner rounded, not forming distinct angle. Subpetiolar process low and small; its thin lamellar wall ca. 0.12 mm in height. Postpetiole as long as high and highest at midlength, with convex dorsal outline in profile; posterodorsal margin convex.

Head shagreened with large coarse punctures; space between punctures less than 0.5 x their own diameters; dorsum of alitrunk coarsely punctated with numerous longitudinal ruglae and without unsculptured longitudinal band medially; mesopleura, propodeum and petiole reticulate; sculpture on petiole weaker than that on propodeum; postpetiole smooth in most part; gaster and legs smooth and subopaque.

Color: reddish brown; mandibles, antennae, and legs yellowish brown; frons without dark brown spot.

**Paratype female.** HL 0.53 mm; HW 0.50 mm; SL 0.35 mm; CI 95; SI 70; WL 0.78 mm; PL 0.25 mm; PH 0.24 mm; DPW 0.35 mm; TL 2.5 mm (one measured).

Head slightly longer than wide, with weakly concave posterior margin in frontal view; eyes 0.13 mm in diameter; ocelli small, forming a right angled triangle.

Alitrunk 0.48 mm in maximum dorsal width; dorsum of metanotum coarsely punctated with longitudinal unsculptured band medially; interspaces among punctures smooth; posterodorsal corner of propodeum dully angulate, not forming a distinct tooth in profile.

Petiole almost as long as wide, with strongly convex dorsal margin in profile; subpetiolar process low and small. Postpetiole with convex dorsal margin highest at midlength in profile; posterodorsal margin convex.

Color: reddish brown; ocellar triangular area blackish brown; frons without dark brown spot.

**Variation.** Five paratype workers with the following measurements and indices: HL 0.50-0.53 mm; HW 0.43-0.48 mm; SL 0.29-0.31 mm; CI 93-95; SI 63-64; WL 0.60-0.63 mm; PL 0.20-0.24 mm; PH 0.19-0.21 mm; DPW 0.14-0.16 mm; TL 2.0-2.2 mm.

Eye diameter varied from 0.12 to 0.13 mm.

**Holotype.** Worker, Onoma, Yaku-shima, Kagoshima Pref., 16.VIII.1986, K. Kinomura leg.

**Paratypes.** 2 females, 4 workers, same data as holotype; 2 females 4 workers, same locality, 17.VIII.1986, K. Kinomura leg.; 1 female, 2 workers, Nagata, Yaku-shima, Kagoshima Pref., 14.VIII.1986, K. Kinomura leg.; 3 workers, Yaku-shima, Kagoshima Pref., 19.III.1991, T. Satoh leg.; 1 female, 3 workers, Yaku-shima, Kagoshima Pref., 25.III.1981, M. Terayama leg.

**Other material examined.** 6 workers, Fukuoka-shi, Fukuoka Pref., 20.VIII.1983, M. Terayama leg.; 3 workers, Misawa, Tokushima Pref., 5.VIII.1977, K. Kinomura leg.; 1 worker, Sukumo, Kochi Pref., 7.VIII.1977, K. Kinomura leg.; 3 workers, Amami-oshima, Kagoshima Pref., 24.III.1980, M. Terayama leg.; 5 workers, same locality, 29.VI.1983, M. Terayama leg.; 1 female, 3 workers, same locality, 19.III.1980, M. Terayama leg.; 3 workers, Tokuno-shima, Kagoshima Pref., 20.III.1980, M. Terayama leg.

**Type depository.** The holotype and some paratypes are deposited in the Museum of Nature and Human Activities, Hyogo, and the other paratypes are in the National Institute of Agro-Environmental Sciences, Tsukuba, and National Science Museum, Tokyo.

**Etymology.** One of the seven deities of good fortune in Japanese Folklore.

**Remarks.** Among the 4 described species from East Asia, this species is distinguishable as follows: differs *V. benzai* from *V. emeryi* Wheeler, 1906, of Japan and *V. pyrrhorhina* Wu and Xiao, 1989, of China by having a low and small subpetiolar process, dully angulate posterodorsal corner of propodeum, lacking large brown spot on frons, and smaller body size (HL 0.50-0.53 mm and HW 0.43-0.48 mm in *benzai* workers; HL 0.55-0.59 mm and HW 0.50-0.54 mm in *emeryi* workers (n = 10), and HL 0.60 mm and HW 0.55 mm in *pyrrhorhina* worker (one paratype is measured); *V. benzai* differs from *V. satoi* Santschi, 1937, from Taiwan by having less incised metanotal groove

(deeply incised dorsally in *satoi*); and *V. benzai* differs from *V. nipponica* Kinomura and Yamauchi, 1992, which is a workerless social parasitic species by having a low and small subpetiolar process and a dully angulate posterodorsal corner of the propodeum in female. It is also distinguished from the other Japanese congeners in workers by the following characteristics: 1) frons without large brown spot; 2) dorsum of promesonotum coarsely punctate, without unsculptured longitudinal band medially; 3) propodeal teeth absent; 4) subpetiolar process low, longer than high; 5) postpetiole highest at midlength in profile.

This species is polygenous, and nesting in the woodlands or woodland margins. Distribution is shown in Fig. 10. This species corresponds to *Vollenhovia* sp. 6 ("Tatenashi-umematsuari" in Japanese) in Terayama and Yamauchi (1992).

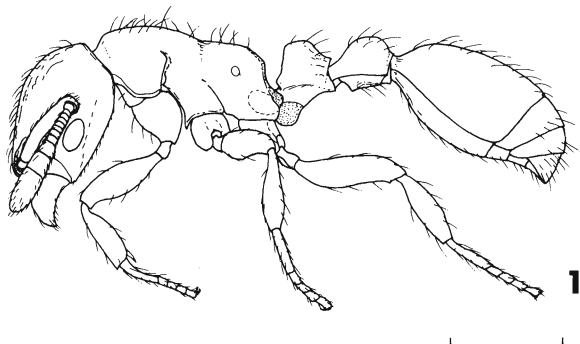


Fig. 1. *Vollenhovia amamiana* sp. nov., worker, profile. Scale bar = 0.5 mm.

### *Vollenhovia amamiana* sp. nov.

(Figs. 1, 3, 7)

**Holotype.** Worker. HL 0.65 mm; HW 0.60 mm; SL 0.40 mm; CI 92; SI 67; WL 0.83 mm; PL 0.30 mm; PH 0.33 mm; DPW 0.18 mm; TL 2.7 mm.

Head slightly longer than wide, with subparallel sides and concave posterior margin in frontal view. Mandibles with 7 teeth, basalmost tooth distinct. Clypeal carinae diverging toward the anterior end. Antennae with 12 segments; scape 0.61 x head length. Eyes 0.14 mm in diameter.

Dorsal outline of promesonotum almost straight in profile; metanotal groove very weakly incised dorsally; dorsal outline of propodeum straight; posterodorsal corner of propodeum dully angulate, not forming distinct tooth.

Petiole higher than long, with flat dorsal outline in profile; anterodorsal and posterodorsal margins weakly angulate. Subpetiolar process developed, with relatively strongly convex ventral margin; its thin lamellar wall 0.08 mm in height. Postpetiole slightly longer than high, highest at midlength, with broadly

convex dorsal outline in profile; posterodorsal margin convex except the posterior collar.

Head and dorsum of alitrunk shagreened with large coarse punctures; punctures separated less than 0.5 x their own diameters; promesonotal dorsum without unsculptured longitudinal band medially; mesopleura and lateral surfaces of propodeum coarsely punctated. Petiole and postpetiole reticulate; sculpture of postpetiole weaker than that of petiole. Gaster smooth and subopaque except the anterior half of 1st tergite scattered with very small punctures.

Color: reddish brown; mandibles, antennae, and legs yellowish brown; frons with a large brown spot.

**Paratype female.** HL 0.68 mm; HW 0.65 mm; SL 0.43 mm; CI 96; SI 65; WL 1.08 mm; PL 0.30 mm; PH 0.35 mm; DPW 0.20 mm; TL 3.0 mm (one measured).

Head slightly longer than wide, with shallow concave posterior margin; eyes 0.15 mm in diameter; ocelli forming obtuse triangle.

Alitrunk 0.58 mm in maximum dorsal width; dorsum of pro- and mesonotum shagreened with coarse punctures; unsculptured longitudinal band absent on dorsum of mesonotum; posterodorsal corner of propodeum dully angulate, not forming distinct tooth in profile.

Petiole higher than long, with angulate anterodorsal and posterodorsal corners in profile. Subpetiolar process large and high, with relatively strongly convex ventral margin. Postpetiole highest at midlength, with convex dorsal outline in profile.

Color: reddish brown; ocellar triangular area blackish brown; frons with a large brown spot.

**Variation.** Five paratype workers with the following measurements and indices: HL 0.58–0.64 mm; HW 0.55–0.59 mm; SL 0.38–0.40 mm; CI 88–92; SI 68–71; WL 0.80–0.83 mm; PL 0.28–0.30 mm; PH 0.31–0.33; DPW 0.18–0.20 mm; TL 2.6–2.7 mm.

Eye diameter varies from 0.12 to 0.13 mm.

**Holotype.** Worker, Tatsuno-gou, Amami-oshima, Kagoshima Pref., 25.XI.1994, K. Yamauchi leg.

**Paratypes.** 1 female, 23 workers, same data as holotype; 1 female, 4 workers, Kinsakubara, Amami-oshima, Kagoshima Pref., 6.VIII.1984, M. Morisita leg.; 1 worker, Tokuno-shima, Kagoshima Pref., 6.VIII.1984, M. Terayama leg.

**Type depository.** The holotype and some paratypes are deposited in the Museum of Nature and Human Activities, Hyogo, and the other paratypes are in the National Institute of Agro-Environmental Sciences, Tsukuba, and National Science Museum, Tokyo.

**Etymology.** The specific epithet refers to the type locality.

**Remarks.** This species closely resembles *V. emeryi* Wheeler, 1906, in having the larger size (HL > 0.55 mm, HW > 0.50 mm), presence of a large brown spot of frons, and a developed subpetiolar process. It is distinguished from the latter by the absence of propodeal spines, and having an angulate posterodorsal corner of petiolar node in profile.

*Vollenhovia emeryi* is distributed from Hokkaido to Yaku-shima in Japan, while this new species is restricted to the Amami Islands (Fig. 10).

This species corresponds to *Vollenhovia* sp. 3 ("Oh-umematsuari" in Japanese) in Terayama and Yamauchi (1992).

### *Vollenhovia okinawana* sp. nov.

(Figs. 4, 8)

**Holotype.** Worker. HL 0.53 mm; HW 0.45 mm; SL 0.31 mm; CI 85; SI 69; WL 0.63 mm; PL 0.24 mm; PH 0.21 mm; DPW 0.15 mm; TL 2.1 mm.

Head longer than wide, with subparallel sides and weakly concave posterior margin in frontal view. Mandibles with 7 teeth; basalmost tooth minute. Clypeal carinae subparallel. Antennae with 12 segments; scape 0.58 x head length. Eyes 0.13 mm in diameter.

Dorsum of promesonotum almost straight in profile; metanotal groove not incised dorsally; posterodorsal corner of propodeum dully angulate, without tooth in profile.

Petiole as long as high, with convex dorsal outline in profile; anterodorsal and posterodorsal corners not forming angle. Subpetiolar process low and small; its thin lamellar wall ca. 0.04 mm in height. Postpetiole slightly longer than high, highest at posterior 1/3 in profile; posterodorsal margin concave.

Head shagreened with relatively large coarse punctures; space between punctures less than 0.5 x their own diameters; dorsum of alitrunk punctated with unsculptured longitudinal band medially; mesosoma, propodeum and petiole reticulate; sculpture on petiole weaker than that on propodeum; postpetiole smooth in most part; gaster and legs smooth and subopaque.

Color: reddish brown; mandibles, antennae, and legs yellowish brown; frons without dark brown spot.

**Paratype female.** HL 0.60 mm; HW 0.56 mm; SL 0.35 mm; CI 94; SI 62; WL 0.88 mm; PL 0.25 mm; PH 0.29 mm; DPW 0.18 mm; TL 2.6 mm. (one measured).

Head slightly longer than wide, with slightly concave posterior margin in frontal view; eyes 0.15 mm in diameter; ocelli forming right triangle.

Alitrunk 0.45 mm in maximum dorsal width; dor-

sum of pro- and mesonotum coarsely punctated, with smooth interspaces; mesonotum with an unsculptured longitudinal band medially; propodeum without tooth.

Petiole higher than long, with convex dorsal outline in profile. Subpetiolar process low and small. Postpetiole highest at posterior 1/3, with concave posterodorsal margin in profile.

Forewings 0.60 mm in length.

Color: reddish brown; ocellar triangular area dark brown; frons without large brown spot.

**Variation.** Five paratype workers with the following measurements and indices: HL 0.48-0.49 mm; HW 0.45 mm; SL 0.29-0.30 mm; CI 92-95; SI 63-64; WL 0.60-0.63 mm; PL 0.20-0.24 mm; PH 0.19-0.20 mm; DPW 0.15-0.16 mm; TL 2.0-2.2 mm.

Eye diameter varies from 0.12 to 0.13 mm. In some specimens the basalmost tooth of mandibles is obscure.

**Holotype.** Worker, Gushiken, Notobu, Okinawa-jima, Okinawa Pref., 1.I.1985, K. Yamauchi leg.

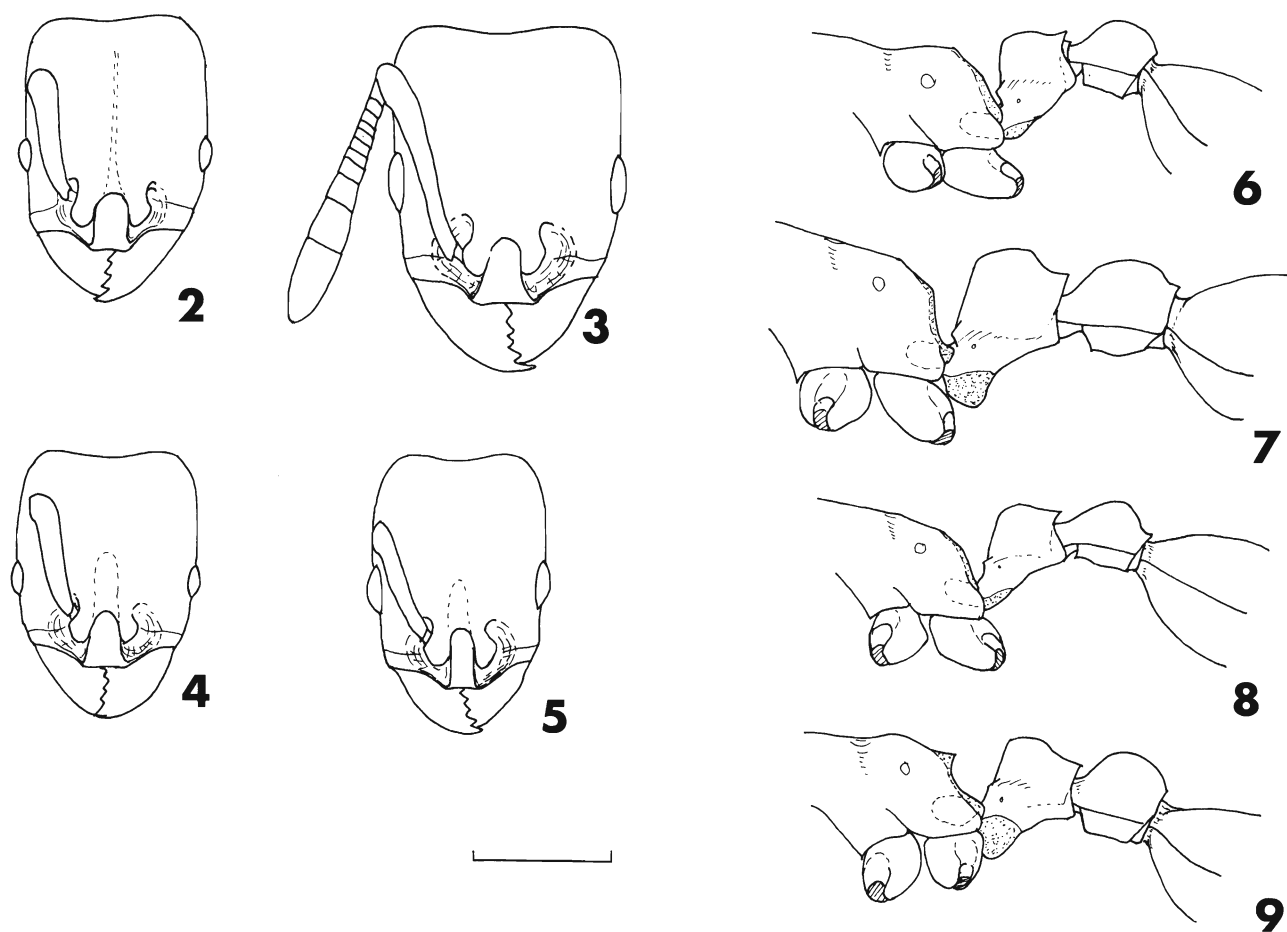
**Paratypes.** 1 female, 6 workers, same data as holotype; 1 female, 2 workers, Nakijin, Motobu, Okinawa-jima, Okinawa Pref., XII.1990, K. Yamauchi leg.; 8 females, 21 workers, Fuku-gawa, Okinawa-jima, Okinawa Pref., 31.XII.1984, K. Yamauchi leg.

**Type depository.** The holotype and some paratypes are deposited in the Museum of Nature and Human Activities, Hyogo, and the other paratypes are in the National Institute of Agro-Environmental Sciences, Tsukuba, and National Science Museum, Tokyo.

**Etymology.** The specific epithet refers to the type locality.

**Remarks.** This species is very similar to *V. benzai* sp. nov. However, it is distinguished from the latter by the shape of the postpetiole which is highest at posterior 1/3 and concave posterodorsal margin in the female and worker (highest at midlength and convex posterodorsal margin in *benzai*).

This species corresponds to *Vollenhovia* sp. 4 ("Okinawa-umematsuari" in Japanese) in Terayama and Yamauchi (1992). This new species produces usual alate females and is widely distributed from southern to northern regions of the Okinawa-jima island. However, an ecologically different population is also present in this island. It produces ergatoid females only as reproductive females and is restricted to the northern part of the island. This population corresponds to *Vollenhovia* sp. 7 ("Yanbaru-umematsuari" in Japanese) in Terayama and Yamauchi (1992). No consistent differences in worker and male external morphology have been identified between *V. okinawana* sp. nov. and *V. sp. 7*. We reserve the taxonomic status of those in this paper.



**Figs. 2-9.** *Vollenhovia* spp. ---- 2, 6, *V. benzai* sp. nov., worker; 3, 7, *V. amamiana* sp. nov., worker; 4, 8, *V. okinawana* sp. nov., worker; 4, 9, *V. sakishimana* sp. nov., worker. ---- 2-5, Head, frontal view; 6-9, propodeum, petiole, and postpetiole, lateral view. Scale bar = 0.5 mm.

Further study is needed for resolving the taxonomy.

### *Vollenhovia sakishimana* sp. nov.

(Figs. 5, 9)

**Holotype.** Worker. HL 0.54 mm; HW 0.45 mm; SL 0.33 mm; CI 83; SI 73; WL 0.66 mm; PL 0.24 mm; PH 0.28 mm; DPW 0.15 mm; TL 2.1 mm.

Head longer than wide, with subparallel sides and concave posterior margin in frontal view. Mandibles with 7 teeth; basalmost tooth minute. Clypeal carinae subparallel. Antennae with 12 segments; scape 0.61 x head length. Eyes 0.12 mm in diameter.

Alitrunk with largely straight dorsal margin of promesonotum in profile; metanotal groove not incised dorsally; dorsal margin of propodeum weakly convex; posterodorsal corner of propodeum with a small tooth and is as long as basal width in profile.

Petiole slightly higher than long, with convex

dorsal margin in profile; anterodorsal corner dully angulate; posterodorsal corner convex, not forming angle. Subpetiolar process large, with rounded ventral margin; its thin lamellar wall 0.06 mm in height. Postpetiole as long as high, highest at midlength, with relatively strongly convex dorsal outline in profile; posterodorsal margin convex.

Head and dorsum of promesonotum shagreened and moderately punctated; unsculptured longitudinal band absent on promesonotal dorsum; mesopleura and lateral surfaces of propodeum coarsely punctated; petiole and postpetiole reticulate; sculpture on postpetiole weaker than that on petiole, and much shinier; gaster and legs smooth and subopaque.

Color: yellowish brown including mandibles, antennae and legs; frons without large brown spot.

**Paratype female.** HL 0.60 mm; HW 0.55 mm; SL 0.38 mm; CI 92; SI 69; WL 0.90 mm; PL 0.28 mm; PH 0.33 mm; DPW 0.20 mm; TL 2.6 mm (one measured).

Head slightly longer than wide, with weakly

concave posterior margin; eyes 0.17 mm in diameter; ocelli forming obtuse triangle.

Alitrunk 0.53 mm in maximum dorsal width; mesonotal dorsum weakly shagreened and moderately punctated, without unsculptured longitudinal band medially; posterodorsal corner of propodeum with distinct tooth in profile.

Petiole higher than long, with convex dorsal outline in profile. Subpetiolar process large and high, with relatively strongly convex ventral margin. Postpetiole highest at midlength, with convex dorsal outline in profile; posterodorsal margin convex.

Color: yellowish brown; ocellar triangle blackish brown; frons without large brown spot.

**Variation.** Five paratype workers with the following measurements and indices: HL 0.50–0.53 mm; HW 0.46–0.48 mm; SL 0.31–0.33 mm; CI 88–93; SI 67–68; WL 0.68–0.70 mm; PL 0.24–0.25 mm; PH 0.28–0.30 mm; DPW 0.15–0.16 mm; TL 2.0–2.1 mm.

The subpetiolar process of the Ogasawara and Yonaguni specimens are somewhat smaller than that of the Iriomote and Ishigaki specimens. In some paratype specimens the basalmost tooth of the mandibles is obscure and the propodeal tooth is much shorter than that of the holotype.

**Holotype.** Worker, Iriomote-jima, Okinawa Pref., 28.III.1991, M. Terayama leg.

**Paratypes.** 8 workers, same data as holotype; 1 female, 1 worker, Ohtomi, Iriomote-jima, Okinawa Pref., 6.VIII.1985, K. Yamauchi leg., 1 female, 3 workers, Yoshino, Ishigaki-jima, Okinawa Pref., 16.VIII.1985, K. Yamauchi leg.

**Other material examined.** 5 workers, Haha-jima, Ogasawara Is., Tokyo, 7.II.1980, K. Masuko leg.; 2 workers, Yonaguni-jima, Okinawa Pref., VIII.1989, H. Takamine leg.

**Type depository.** The holotype and some paratypes are deposited in the Museum of Nature and Human Activities, Hyogo, and the other paratypes are in the National Institute of Agro-Environmental Sciences, Tsukuba, and National Science Museum, Tokyo.

**Etymology.** The specific epithet refers to the type locality.

**Remarks.** This species closely resembles *V. emeryi* Wheeler, 1906, but differs from the latter by the absence of a large brown spot on frons, having subparallel clypeal carinae, yellowish body color, and smaller body size (HL 0.52–0.55 mm and HW 0.43–0.45 mm in *sakishimana* workers; HL 0.55–0.59 mm and HW 0.50–0.54 mm in *emeryi* workers).

This new species corresponds to *Vollenhovia* sp. 5 ("Sakishima-umematsuari" in Japanese name) in Terayama and Yamauchi (1992) and *V.* sp. B in Onoyama (1976).

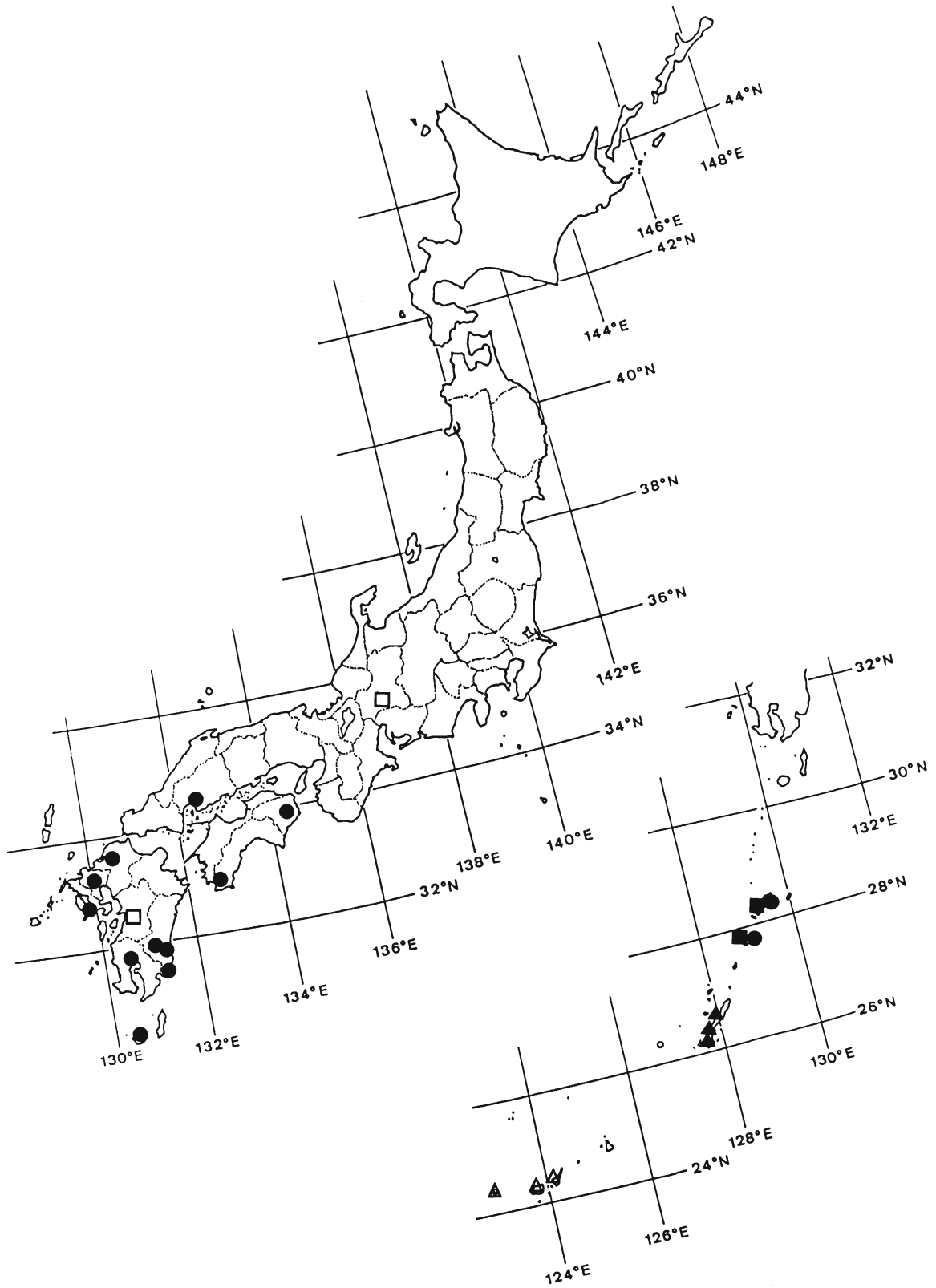
**A tentative key to the Japanese species of *Vollenhovia* (worker).**

A workerless social parasitic species, *V. nipponica* Kinomura and Yamauchi, is excluded in the following key. It should be noted *V. okinawana* sp. nov. (see the remarks of this species).

1. Subpetiolar process developed; its thin lamellar wall higher than long (Figs. 7, 9) ..... 2
- Subpetiolar process low; its thin lamellar wall distinctly longer than high (Figs. 6, 8) ..... 4
2. Frons with a large brown spot; larger species (HL > 0.55 mm, HW > 0.50 mm); clypeal carinae diverging anteriorly; body reddish brown ..... 3
- Frons without large brown spot; smaller species (HL < 0.54 mm, HW < 0.48 mm); clypeal carinae almost parallel; body yellowish brown ..... *sakishimana* sp. nov.
3. Propodeal teeth present; posterodorsal corner of petiolar node convex, not forming angle in profile ..... *emeryi* Wheeler
- Propodeal teeth absent (Fig. 1); posterodorsal corner of petiolar node forming angle in profile (Fig. 1) ..... *amamiana* sp. nov.
4. Dorsum of promesonotum with an unsculptural longitudinal band medially; postpetiole highest at posterior 1/3 in profile; posterodorsal margin of postpetiole concave in profile (Fig. 8) ..... *okinawana* sp. nov.
- Dorsum of promesonotum coarsely punctated in most part and without unsculptured longitudinal band medially; postpetiole highest at midlength in profile; posterodorsal margin of postpetiole broadly convex in profile (Fig. 6) ..... *benzai* sp. nov.

## Acknowledgments

We wish to thank Dr. K. Yamauchi (Gifu Univ.) for his constant guidance, and Drs. M. Morisita (Prof. Emer. of Kyoto Univ.), K. Masuko (Senshu Univ.), T. Satoh (Tokyo Univ. of Agr. and Tech.), and Mr. H. Takamine (Naha-shi) for their offers of the valuable materials. We also thank Drs. L.-Y. Cho (Taiwan Agri. Res. Inst.), M. Brancucci (Naturhistorisches Mus., Basel), B.-M. Choi (Cheong-ju Nat. Tea. Coll., Korea) and Mr. C.-L. Wang (Res. Inst. Forestry, Beijing) for their kindness in permitting us to examine Asian formicid collection including types. We also thank two anonymous reviewers for their helpful comments and suggestions.



**Fig. 10.** Geographical distributions of the five Japanese species of *Vollenhovia*. □, *V. nipponica* Kinomura and Yamauchi; ●, *V. benzai* sp. nov.; ■, *V. amamiana* sp. nov.; ▲, *V. okinawana* sp. nov.; △, *V. sakishimana* sp. nov. *Vollenhovia emeryi* Wheeler is commonly and widely distributed from Hokkaido to Yaku-shima of Kagoshima Prefecture.

## References

- Bolton, B. (1995) A taxonomic and zoogeographical census of the extant ant taxa (Hymenoptera: Formicidae). *J. Nat. Hist.* 29: 1037-1056.
- Kinomura, K. and Yamauchi, K. (1992) A new worker-less socially parasitic species of the genus *Vollenhovia* (Hymenoptera, Formicidae) from Japan. *Jpn. J. Ent.* 60: 203-206.
- Kinomura, K. and Yamauchi, K. (1994) Frequent occurrence of gynandromorphs in the natural population of the ant *Vollenhovia emeryi* (Hymenoptera: Formicidae). *Ins. Soc.* 41: 273-278.
- Kubota, M. (1984) Anomalous female wings in *Vollenhovia emeryi* Wheeler. *Ari* 12: 2. (in Japanese)
- Myrmecological Society of Japan (1988) A list of the ants of Japan with common Japanese names. The Myrmecological Society of Japan, Tokyo. (in Japanese)
- Onoyama, K. (1976) A preliminary study on the ant fauna of Okinawa-ken, with taxonomic notes (Japan; Hymenoptera: Formicidae). *Ecol. Stud. Nat. Cons. Ryukyu Is.* 2: 121-141.
- Santschi, F. (1937) Fourmis du Japon et de Formose. *Bull. Ann. Soc. Ent. Belg* 77: 361-388.
- Terayama, M. and Yamauchi, K. (1992) Genus *Vollenhovia*. In: Myrmecological Society of Japan (ed.), A guide for the identification of Japanese ants (III). Myrmicinae and supplement to Leptanillinae (Hymenoptera: Formicidae), pp. 48-50. (in Japanese)
- Wheeler, W.M. (1906) The ants of Japan. *Bull. Amer. Mus. Nat. Hist.* 22: 301-328.
- Wheeler, W.M. (1928) Ants collected by Professor F. Silvestri in Japan and Korea. *Boll. Lab. Zool. Gen. Agrar. Portici* 22: 3-38.
- Wu, J. and Xiao, G. (1989) A new species of the genus *Vollenhovia* from China (Hymenoptera: Formicidae). *Entomotaxonomia* 11: 239-241.

Received: December 4, 1996

Accepted: December 4, 1996