

The Genus *Reticulitermes* (Isoptera: Rhinotermitidae) in Japan, with Description of a New Species

Yoko TAKEMATSU

Institute of Tropical Agriculture, Kyushu University, Fukuoka, 812–8581 Japan

Abstract. Japanese species of *Reticulitermes* are revised. *Reticulitermes kanmonensis* n. sp. is described. *Reticulitermes okinawanus*, *R. yaeyamanus* and *R. amamianus* are treated as distinct species. *Reticulitermes flaviceps* is newly recorded from Japan. Keys to Japanese species of *Reticulitermes* for alate and soldier are given.

Key words: Isoptera, Rhinotermitidae, *Reticulitermes*, Japan.

Introduction

The genus *Reticulitermes* Holmgren, 1913 is widely distributed in the northern temperate zone, and everywhere in Japan from Hokkaido to the Ryukyus. It is one of the major genera which cause serious damage to woodwork in buildings. From Japan, the following three species of *Reticulitermes* have been recorded; *R. speratus* (Kolbe), *R. flaviceps amamianus* Morimoto, and *R. miyatakei* Morimoto. In addition, an undescribed species of this genus has been known in Fukuoka and Yamaguchi Prefectures, Japan. Morimoto (1968) subdivided *R. speratus* into five subspecies (*R. speratus speratus*, *R. s. leptolabralis*, *R. s. kyushuensis*, *R. s. okinawanus* and *R. s. yaeyamanus*) based on the morphological characters of soldiers and alates.

Morimoto (1968) made a revisional work on the taxonomy of Japanese *Reticulitermes*. He pointed out that there were some problematical species and subspecies in their systematics, and the key proposed by him does not work for identification of some species because of the existence of variations of characters. This prevents further development of control work and evolutionary study.

Conventionally, classification of termites has been made by morphological and morphometrical methods. However, there are many cases where a broad variation exists even in a given morphological key character. Because of this, there remains some ambiguity in the taxonomy and additional criteria for discrimination and identification of species is needed. It has been generally accepted that the cuticular hydrocarbon compositions of insects are different at specific level,

and there is little variation at intraspecific level (Howard, 1993). Takematsu & Yamaoka (1999) analyzed cuticular hydrocarbons, as well as the conventional morphological characters, of *Reticulitermes* in Japan and neighboring countries and demonstrated the usefulness of cuticular hydrocarbons as a criterion. They revealed that a total of nine cuticular hydrocarbon phenotypes are associated with six *Reticulitermes* species, including three undescribed species, distributed in Japan, Korea and Taiwan. The result of their analysis was coincident well with the conventional systematics of Japanese *Reticulitermes* species including previously undescribed species. The use of chemical analysis would facilitate evaluation of inter- and intraspecific variation of morphological characters and determination of key characters of species.

In this study, I observed the morphology of Japanese *Reticulitermes* incorporating results of cuticular hydrocarbon analysis, and revised the taxonomy of Japanese *Reticulitermes*.

Materials and Methods

Morphological observation. Dissection and measurement were done in 80% alcohol. The measurements, indices and their abbreviations are as follows:

1. Head length without mandibles (HL): straight length from the base of the mandibles to the posterior margin of the head. [S, A]
2. Maximum width of head (HW): maximum width including the compound eyes when present. [S, A]
3. Left mandible length (LML): straight cross length from the condyle to the tip of the left mandible. [S]

4. Labrum length (LL): maximum length of the labrum, including anterolateral processes when present. [S, A]

5. Labrum width (LW): maximum width of the labrum. [S, A]

6. Maximum height of head (HH): maximum height of the head, excluding postmentum, including ocelli when raised. [S, A]

7. Number of antennal segments (A): number of the segments with hairs. [S, A]

8. Maximum width of postmentum (PmW1). [S]

9. Minimum width of postmentum (PmW2). [S]

10. Maximum length of pronotum (PnL). [S, A]

11. Maximum width of pronotum (PnW). [S, A]

12. Compound eye diameter (CD): maximum diameter of the compound eye. [A]

13. Cephalic index: HL/HW. [S, A]

14. Mandibular index: LML/HL. [S]

15. Compound eye index: CD/HH. [A]

16. Labrum index: LL/LW. [S]

17. Postmentum index: PmW2/PmW1. [S]

The applications for castes of above measurements and indices are shown in square brackets.

Abbreviation. The abbreviations are as follows: A, alate; S, soldier.

Type depository. The type-series designated in this paper are preserved in the Entomological Laboratory, Faculty of Agriculture, Kyushu University, Japan.

Descriptions

Genus *Reticulitermes* Holmgren

Reticulitermes Holmgren, 1913, K. Svenska Vetensk. Akad.

Handl., 50: 60–61 [as subgenus of *Leucotermes*]. Type species: *Leucotermes* (*Reticulitermes*) *flavipes* (Kollar)

Reticulitermes Holmgren: Banks & Snyder, 1920, U.S. Natl. Mus. Bull., (108): 42–43 [raised to full genus and designated type].

Reticulitermes (*Frontotermes*) Tsai *et al.*, 1977, Acta Ent. Sin., 20: 465–475. syn. n.

Diagnosis.

Alate. Head capsule dark brown to blackish. Ocelli small, separated from eyes. Fontanelle minute. Left mandible with three marginal teeth; 2nd marginal tooth almost as long as 1st marginal tooth. Right mandible with subsidiary tooth, two marginal teeth and molar plate, slightly convex at anterior margin. Pronotum flat or less raised, narrower than head. Wings not covered with hairs. Fore wings with sub-

costa almost fused with costa at base; radius not branched; radial sector absent; media weak, with 1–3 branches distally; cubitus weak and unsclerotized. Arolium absent; tibial spurs 3 : 2 : 2, hairy.

Soldier. Head rectangular, almost straight at lateral sides; fontanelle minute; frons slightly raised; epicranial and frontal sutures absent. Mandibles long and saber-shaped. Left mandible with a few crenulations at basal half and a knob-like basal projection, without distinct tooth. Right mandible with a few crenulations at base, without distinct tooth. Postmentum long and club-shaped, narrower posteriorly. Pronotum flat or less raised, slightly notched at anterior margin. Femora not swollen; tibial spurs 3 : 2 : 2.

Remarks. Tsai *et al.* (1977) divided this genus into 2 subgenera, *Frontotermes* and *Planifrontotermes*, by the shape of frontal hump and the number of hairs on pronotum. According to the type-concept in the ICZN, the subgenus that contains the type species must bear the same name as the genus (ICZN 44(a)). As the type species of this genus, *R. flavipes*, belongs to the subgenus *Frontotermes*, this subgenus must be treated as a synonym of *Reticulitermes*.

Reticulitermes speratus (Kolbe)

(Figs. 1, 5–7)

Termes speratus Kolbe, 1885, 147.

Termes (*Leucotermes*) *speratus*: Desneux, 1904, 33.

Termes flavipes: Oshima, 1908, 515.

Termes (*Leucotermes*) *flavipes*: Oshima, 1909, 30; Oshima, 1910, 345.

Leucotermes flavipes: Shiraki, 1909, 231; Oshima, 1911b, 3; Nitobe, 1911, 20; Nawa, 1911, 14.

Leucotermes speratus: Nawa, 1910, 547; Oshima, 1910, 414; Holmgren, 1911, 69; Yano, 1910, 601; Yano, 1911, 364; Nawa, 1912, 17; Holmgren, 1912, 124; Oshima, 1912, 71; Oshima, 1913, 277; Yano, 1913, 109.

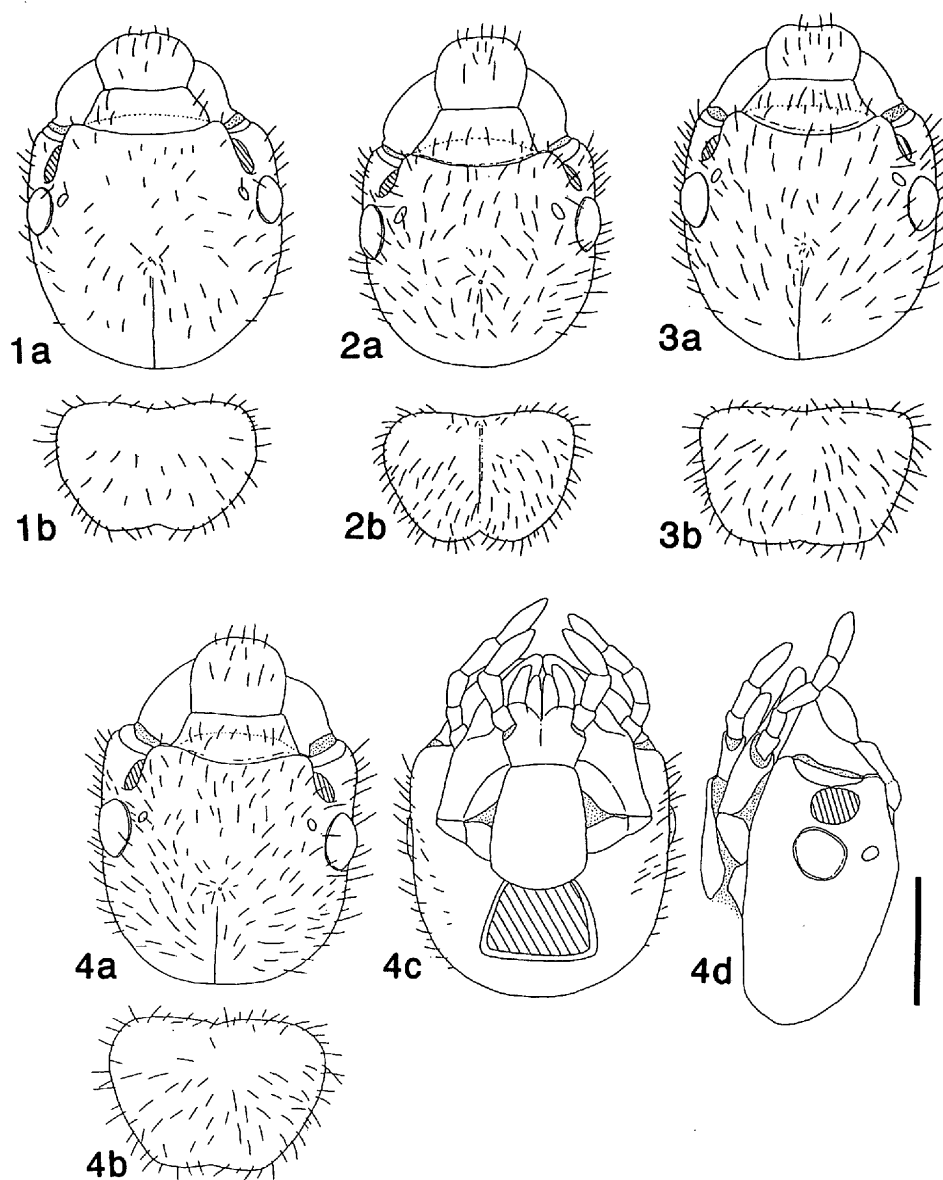
Leucotermes (*Reticulitermes*) *speratus*: Holmgren, 1912, 124–126; Holmgren, 1913, 61; Hozawa, 1915, 62–83.

Reticulitermes speratus: Light, 1929, 589; Snyder, 1949, 74; Ahmad, 1958, 71–72; Tsai & Chen, 1964, 60–61; Gay, 1967, 12, 29; Morimoto, 1968, 69–70.

Reticulitermes (*Frontotermes*) *speratus*: Tsai *et al.*, 1977, 468–469; Huang *et al.*, 1989, 350–352.

Reticulitermes flaviceps: Hsia & Fang, 1965, 363.

Alate. Head capsule brown; antennae pale brown; mandibles yellowish brown, teeth darker. Postmentum brown as head capsule. Pronotum whitish. The rest of body brownish. Wing membrane pale brown and hyaline, veins brownish. Femora and the base of tibiae brown, the rest of legs whitish yellow.



Figs. 1-4. Alates of *Reticulitermes* in Japan. — 1, *R. speratus*; 2, *R. miyatakei*; 3, *R. amamianus*; 4, *R. kanmonensis* sp. nov. a, head, dorsal view; b, pronotum, dorsal view; c, head, ventral view; d, head, lateral view. Scales; 0.5 mm.

Head capsule oval, widest at compound eyes, with many long and short hairs sparsely; cephalic index 0.98–1.05. Compound eyes 0.20–0.23 mm in diameter; compound eye index 0.39–0.43. Antennae with 16–17 segments. Clypeus trapezoidal; postclypeus with 3–4 hairs at posterior margin and lateral portions. Labrum with several long and short hairs on surface. Postmentum longer than wide, with many long hairs at lateral margins, a few long hairs on posterior half and several minute hairs on anterior half.

Pronotum semicircular, faintly concave at anterior margin but not notched in the middle, rounded at sides, weakly concave and notched at posterior margin, with many short and long hairs, less than 25

on disc, which are abundant on posterior portion, with many long hairs along marginal portion. Fore wings 7.90–8.40 mm long.

Measurements (mm). HL 0.93–1.03 (0.99); HW 0.95–1.00 (0.97); LL 0.33–0.34 (0.33); LW 0.37–0.38 (0.37); HH 0.50–0.53 (0.52); PnL 0.50–0.57 (0.54); PnW 0.82–0.90 (0.87) (n=25).

Soldier. Head capsule yellowish; labrum and antennae yellow; mandibles dark brown, paler basally.

Head capsule subrectangular, parallel sided or slightly broadest behind the middle, with long and short hairs sparsely; frontal area distinctly convex. Antennae with 14–17 segments. Clypeus trapezoidal; postclypeus with a few hairs at anterior margin or bald. Labrum subpentagonal, longer than wide, vary in

shape, rounded or triangularly at anterior margin, with two long hairs at apex and with a few minute or long hairs on surface, without paraterminal setae. Mandibular index 0.61–0.66. Right mandible with the inner margin gently curved. Postmentum widest at anterior one third, narrowest at posterior one third, with long and short hairs on surface but vary in the number; postmentum index 0.33–0.40.

Pronotum flat, subtrapezoidal, with small number of hairs abounding on posterior, less than 10 on disc, with many long short hairs at marginal portions.

Distribution. Japan (Hokkaido to Tokara Is.); Korea; China.

Remarks. This species usually nests in the rotten logs, trunks and buildings. It swarms at humid noon in April to May. This species was separated into 5 subspecies by Morimoto (1968).

It was found that two subspecies of this species, ssp. *okinawanus* and ssp. *yaeyamanus*, were different from the other three subspecies in hydrocarbon profiles (Takematsu & Yamaoka, 1999). A clear difference was also observed between these two subspecies. This result indicates that ssp. *okinawanus* and ssp. *yaeyamanus* are not members of *R. speratus*, but should be allocated to a separate species, respectively.

Kolbe (1885) described this species based on specimens from Hakodate and Tokyo, and the specimens of these two localities are somewhat different. The common features of these are broad labrum with rounded tip, which are characteristics for the nominal subspecies of *R. speratus*. Three subspecies of *R. speratus* are as described below.

***Reticulitermes speratus speratus* (Kolbe)**

(Fig. 5)

Reticulitermes speratus speratus (Kolbe): Morimoto, 1968, 69–70.

Soldier. Head capsule subrectangular, slightly tapering anteriorly, with long and short hairs sparsely; cephalic index 1.44–1.55. Labrum suboval with rounded tip, broad, with two long hairs at apex; labrum index 1.00–1.29. Clypeal setae absent or minute. Pronotum with a few hairs or bald on posterior surface.

Measurements (mm). HL 1.68–1.80 (1.76); HW 1.14–1.25 (1.18); LML 1.05–1.10 (1.08); LL 0.38–0.45 (0.42); LW 0.35–0.40 (0.38); HH 0.89–0.95 (0.92); PmL 1.20–1.30 (1.24); PmW1 0.44–0.50 (0.47); PmW2 0.18–0.19 (0.18); PnL 0.50–0.53 (0.52); PnW 0.85–0.90 (0.87) (n=25).

Materials examined. JAPAN: Hirosaki, Aomori

Pref., 22. ix. 1992 (Kitade) (S, W); Sado Is., Niigata Pref., 1. viii. 1992 (Yoshizawa) (S, W); Ojiya, Niigata Pref., 2. viii. 1992 (Yoshizawa) (S, W); Aizubandai, Fukushima Pref., 27. viii. 1992 (Ogata) (S, W); Takahamaotomi, Fukui Pref., 16. viii. 1992 (Ueno) (S, W); Minakami, Gunma Pref., 20. ix. 1992 (Sakano) (S, W); Matsudo, Chiba Pref., 19. vii. 1992 (Yahiro) (S, W); Hachijo Is., Izu Is., 5. vi. 1993 (Morimoto) (S, W); Hahajima Is., Ogasawara Is., 15. vii. 1991 (Ueno) (S, W); same locality, 27. xi. 1992 (Yoshino) (S, W); Chichijima Is., Ogasawara Is., 25. xi. 1992 (Yoshino) (S, W).

Distribution. Japan (Southern part of Hokkaido, Northern part of Honshu, Ogasawara Is.).

***Reticulitermes speratus leptolabralis* Morimoto**

(Fig. 6)

Reticulitermes speratus leptolabralis Morimoto, 1968, 69–70.

Soldier. Head capsule subrectangular, with long and short hairs sparsely; cephalic index 1.55–1.59. Labrum subpentagonal with more or less pointed tip, slender, with two long hairs at apex; labrum index 1.33–1.42. Clypeal setae absent or minute. Pronotum with several hairs or bald on posterior surface.

Measurements (mm). HL 1.60–1.70 (1.65); HW 1.03–1.10 (1.05); LML 1.03–1.06 (1.05); LL 0.43–0.47 (0.45); LW 0.30–0.35 (0.32); HH 0.80–0.85 (0.83); PmL 1.15–1.25 (1.20); PmW1 0.40–0.45 (0.43); PmW2 0.15 (0.15); PnL 0.47–0.50 (0.49); PnW 0.70–0.76 (0.73) (n=25).

Materials examined. JAPAN: Kariya, Aichi Pref., 1. xi. 1992 (Hoshino) (S, W); Kiinagashima, Mie Pref., 6. x. 1991 (Takematsu) (S, W); Nachikatsuura, Wakayama Pref., 8. x. 1996 (Takematsu) (S, W); Koza, Wakayama Pref., 8. x. 1991 (Takematsu) (S, W); Kushimoto, Wakayama Pref., 8. x. 1991 (Takematsu) (S, W); same locality, 2. iv. 1992 (Yoshino) (S, W); same locality, 5. ix. 1992 (Takematsu) (S, W); Nara, Nara Pref., 8. x. 1991 (Ueno) (S, W); Tenri, Nara Pref., 4. ix. 1992 (Takematsu) (S, W); Cape Ashizuri, Kochi Pref., 14. xi. 1992 (Takematsu) (S, W); same locality, 29. ix. 1990 (Takematsu) (S, W).

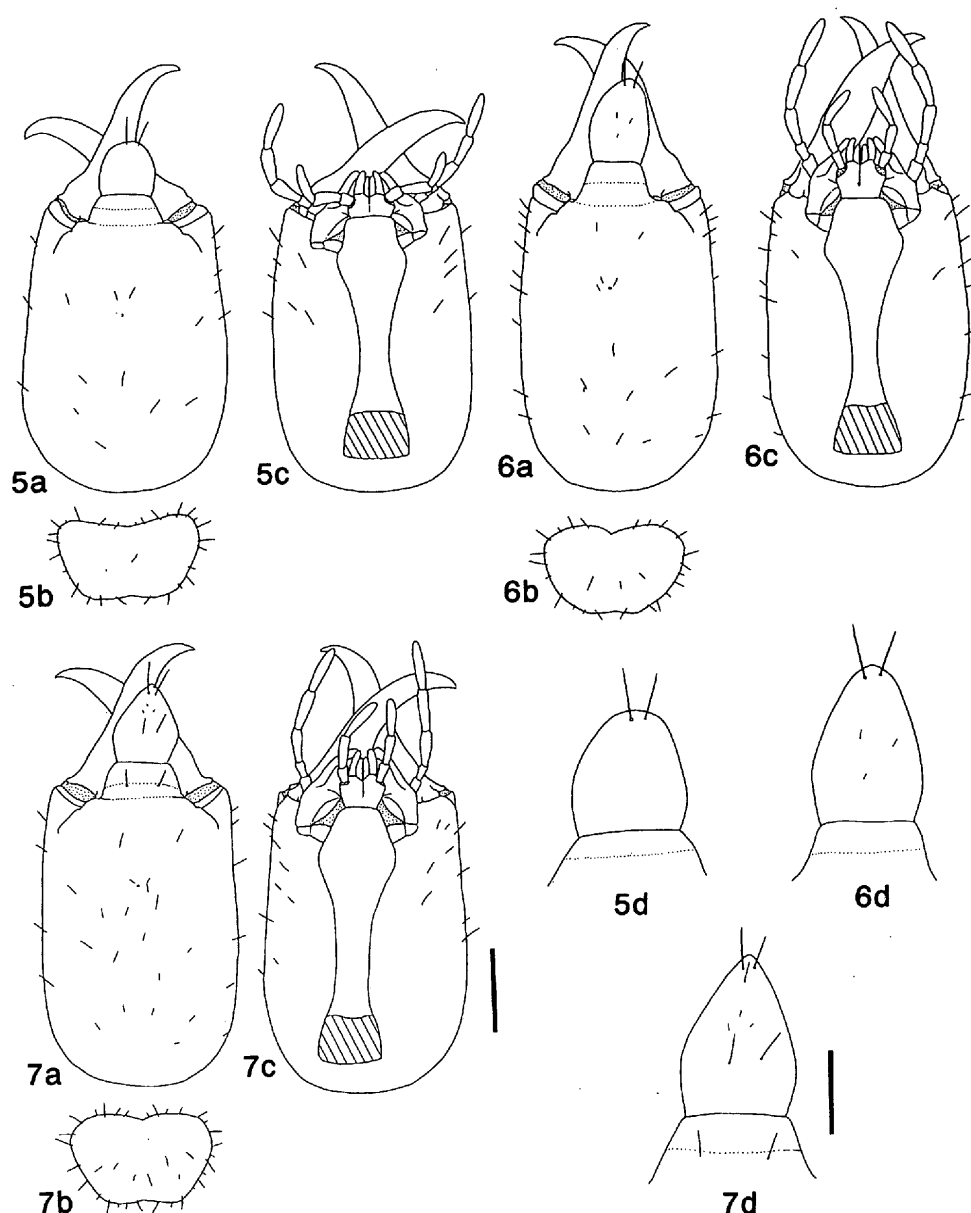
Distribution. Japan (Central part of Honshu, Shikoku).

***Reticulitermes speratus kyushuensis* Morimoto**

(Fig. 7)

Reticulitermes speratus kyushuensis Morimoto, 1968, 69–70.

Soldier. Head capsule subrectangular, with long and short hairs sparsely; cephalic index 1.42–1.48.



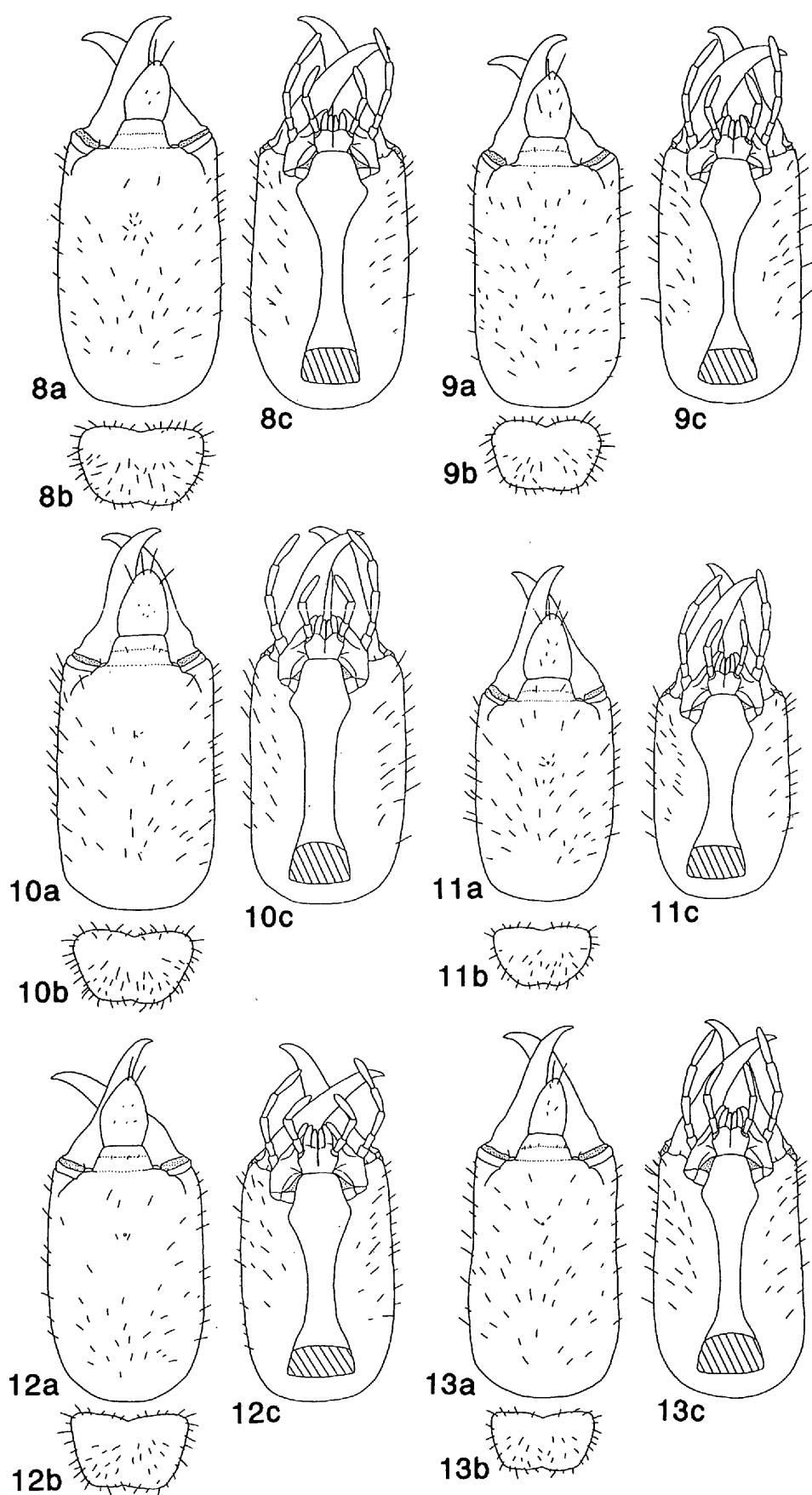
Figs. 5–7. Soldiers of *Reticulitermes speratus*. — 5, *R. s. speratus*; 6, *R. s. leptolabralis*; 7, *R. s. kyushuensis*. a, head, dorsal view; b, pronotum, dorsal view; c, head, ventral view; d, labrum. Scales; 0.5 mm for a–c; 0.25 mm for d.

Labrum subpentagonal with more or less pointed tip, slender, with two long hairs at apex and with a few long hairs on surface; labrum index 1.20–1.29. Clypeal setae long or short. Pronotum with 7–10 hairs on posterior surface.

Measurements (mm). HL 1.65–1.73 (1.69); HW 1.15–1.18 (1.17); LML 1.05–1.10 (1.07); LL 0.44–0.45 (0.45); LW 0.35–0.38 (0.36); HH 0.85–0.93 (0.90); PmL 1.25–1.27 (1.26); PmW1 0.45–0.48 (0.46); PmW2 0.16–0.18 (0.17); PnL 0.52–0.53 (0.53); PnW 0.82–0.88 (0.86) ($n=25$).

Materials examined. JAPAN: Hamamura, Tottori Pref., 3. ix. 1992 (Takematsu) (S, W); Tsuyama, Okayama Pref., 4. ix. 1992 (Takematsu) (S, W); Sandan-

kyo, Hiroshima Pref., 3. ix. 1992 (Takematsu) (S, W); Fukuoka, Fukuoka Pref., 12. xi. 1988 (Takematsu) (S, W); same locality, 22. iv. 1989 (Takematsu) (S, A); same locality, 23. iv. 1990 (Takematsu) (S, W, A); same locality, 11. vi. 1993 (Chujo) (S, W); same locality, 26. x. 1989 (Takematsu) (S); same locality, 17. v. 1995 (Takahashi) (A); Mt. Hikosan, Fukuoka Pref., 13. x. 1992 (Takematsu) (S, W); Tsushima Is., 11. v. 1991 (Takematsu) (S, W); same locality, 4. v. 1992 (Yoshizawa) (A); same locality, 28. iv. 1992 (Ogata) (S, W); Nagasaki, Nagasaki Pref., 21. iii. 1989 (Takematsu) (S, W); Shiiba, Miyazaki Pref., 9. vi. 1989 (Takematsu) (S, W); Aoshima, Miyazaki Pref., 26. iv. 1993 (Nomura) (S, W); Kagoshima,



Kagoshima Pref., 28. x. 1992 (Takematsu) (S, W); Cape Sata, Kagoshima Pref., 27. iv. 1991 (Takematsu) (S, W, A); Yakushima Is., 5. v. 1991 (Ueno) (S, W, A); Takarajima Is., Tokara Isls., 14. v. 1991 (Ueno) (S, W); same locality, 21. iii. 1992 (Nomura) (S, W); Nakanoshima Is., Tokara Isls., 28. iv. 1995 (Takahashi) (S, W, A). KOREA: Kuwang Nung, 13. v. 1991 (Nomura) (S, W); same locality, 26. ix. 1991 (Morimoto) (S, W); same locality, 15. v. 1992 (Nomura) (S, W, A, 5 series); same locality, 16. vii. 1992 (Nomura) (S, W); same locality, 19. vii. 1992 (Saigusa) (S, W).

Distribution. Japan (Southern part of Honshu, Kyushu, Tsushima Isls., Tanegashima Is., Yakushima Is., Tokara Isls.); Korea.

Reticulitermes kanmonensis sp. nov.

(Figs. 4, 8, 14)

Alate. Head capsule brown; antennae pale brown; mandibles yellowish brown, teeth darker. Postmentum distinctly paler than head capsule. Pronotum whitish. The rest of body brownish. Wing membrane pale brown and hyaline, veins brownish. Femora and the base of tibiae right brown; the rest of legs whitish yellow.

Head capsule squarish oval, widest at the base of mandibles, with many long and short hairs densely; cephalic index 1.00–1.07. Compound eyes sub-circular, 0.23–0.24 mm in diameter; compound eye index 0.43–0.45. Antennae with 16–17 segments. Clypeus trapezoidal; postclypeus with several hairs at posterior margin and lateral portions. Labrum dome-shaped, with more than 10 long and short hairs on surface. Postmentum longer than wide, weakly convex at anterior margin, narrowed anteriorly, rounded at posterior margin, with many long hairs at lateral margins and several long and short hairs on surface.

Pronotum reversely subtrapezoidal, faintly concave at anterior margin and notched in the middle, narrowed posteriorly and almost straight at sides, weakly concave and notched at posterior margin, with numerous short and long hairs, more than 30, which are abundant on posterior portion and with many long hairs along marginal portion. Fore wings 7.90–8.10 mm long. Hind wings slightly shorter than fore wings. Abdominal terga and sterna densely haired on surface.

Soldier. Head capsule yellowish; anteclypeus whitish; postclypeus yellow, slightly darker than head; labrum yellow as postclypeus; antennae yellow as postclypeus; mandibles dark brown, paler basally. Thorax and abdomen yellowish white.

Head capsule subrectangular, with sides slightly convex, widest at middle, with many long and short hairs; head capsule 1.75–1.85 mm in length; cephalic index 1.67–1.72; frontal area distinctly convex, bilobed. Antennae with 14–17 segments. Clypeus trapezoidal; clypeal setae absent or minute. Labrum subpentagonal or subtriangular, longer than wide, triangularly at anterior margin, convex at sides, with two long hairs at apex and with a few minute hairs or bald on surface, without paraterminal setae; labrum index 1.07–1.33. Mandibular index 0.53–0.57. Right mandible with inner margin straight and curved inward at tip. Postmentum widest at anterior one third, narrowest at posterior one third, with sides parallel at narrowest point, with long and short hairs on anterior surface and with minute hairs on posterior surface; postmentum index 0.33–0.39.

Pronotum flat, subtrapezoidal, greatly wider than long, slightly raised along anterior margin, faintly concave at anterior margin and notched in the middle, rounded at anterior and posterior corners, with many hairs abounding on posterior half, more than 15, with many long short hairs at marginal portions. Abdominal terga and sterna densely haired on surface.

Measurements (mm). Alate: HL 0.97–1.03 (1.01); HW 0.97–1.00 (0.99); LL 0.37–0.38 (0.37); LW 0.40–0.42 (0.41); HH 0.52–0.55 (0.53); PnL 0.55–0.57 (0.56); PnW 0.80–0.87 (0.83) (n=15). Soldier: HL 1.75–1.85 (1.82); HW 1.05–1.10 (1.08); LML 0.98–1.03 (1.01); LL 0.35–0.43 (0.39); LW 0.30–0.35 (0.32); HH 0.83–0.85 (0.84); PmL 1.25–1.30 (1.28); PmW1 0.45–0.49 (0.47); PmW2 0.15–0.18 (0.17); PnL 0.53–0.54 (0.54); PnW 0.79–0.83 (0.82) (n=25).

Type-material. Holotype, Soldier 1ex., JAPAN: Atsugi, Yamaguchi Prefecture (no. 485), 21. vi. 1993 (Takematsu) (KU). Paratypes, JAPAN: Shimonomaki, Yamaguchi Pref., 3. iv. 1993 (Yamamoto) (S, W, A, three series); Atsugi, Yamaguchi Pref., 12. vi. 1993 (Takematsu) (S, W, three series); same locality, 21. vi. 1993 (Takematsu) (S, W, type colony); Kitakyushu, Fukuoka, 6. iv. 1992 (Yoshino) (S, W).

Distribution. Japan (Fukuoka Pref., Yamaguchi

Figs. 8–13. Soldiers of *Reticulitermes* in Japan. — 8, *R. kanmonensis* sp. nov.; 9, *R. miyatakei*; 10, *R. flaviceps*; 11, *R. amamianus*; 12, *R. okinawanus*; 13, *R. yaeyamanus*. a, head, dorsal view; b, pronotum, dorsal view; c, head, ventral view. Scales; 0.5 mm.

Pref.)

Remarks. This species has the sympatric distribution with *R. speratus*, but it is easy to distinguish this species from *R. speratus* by the density of hairs on pronotum and head. Furthermore, the hydrocarbon compositions of this species proved significantly different from the other species in Japan and Taiwan as well (Takematsu & Yamaoka, 1999). It swarms at humid noon in March to April, about one month earlier than *R. speratus*. This species is distributed only on both sides of the Kanmon Strait and may be an introduced species.

***Reticulitermes miyatakei* Morimoto**

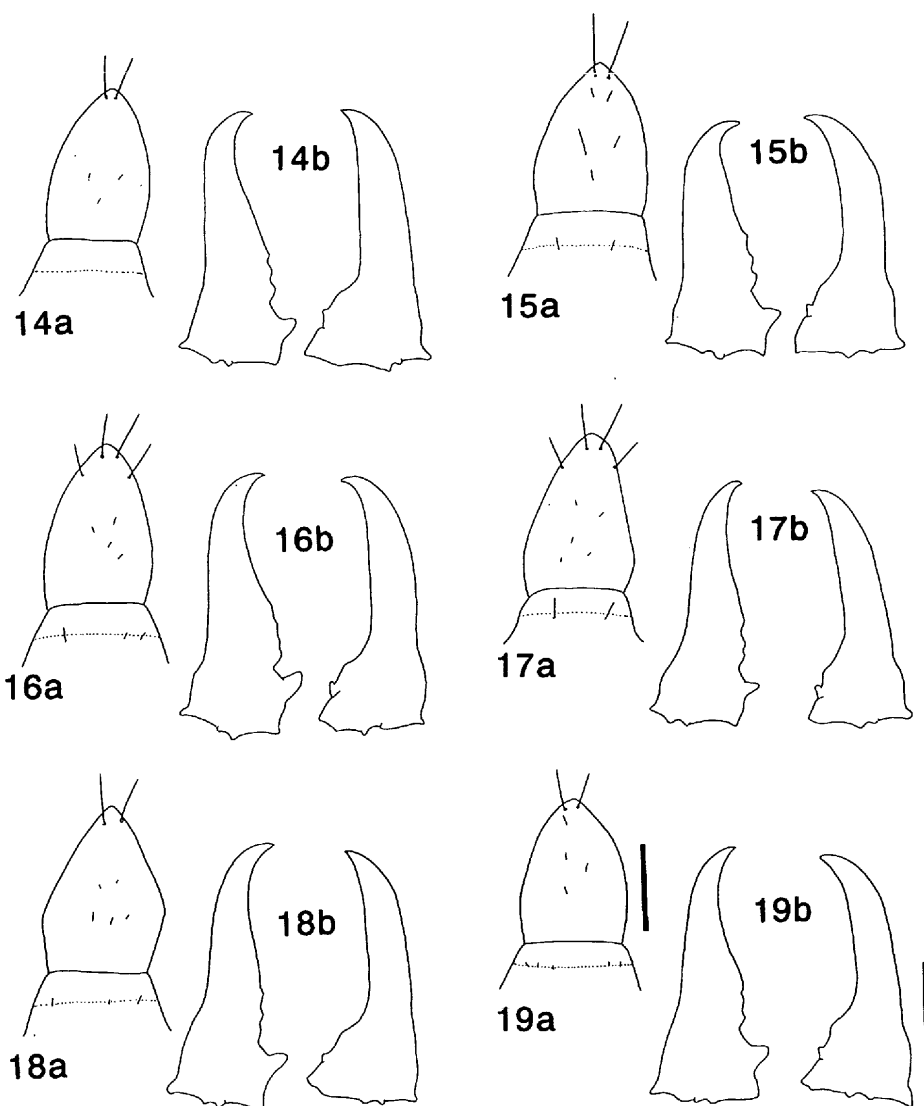
(Figs. 2, 9, 15)

Reticulitermes miyatakei Morimoto, 1968, 66–67; Takematsu, 1990, 1–4.

Alate. Head capsule brown; antennae pale brown; mandibles pale brown, teeth darker. Postmentum paler than head capsule. Pronotum brown as head capsule. The rest of body brownish. Wing membrane pale brown and hyaline, veins brownish. Legs pale brown.

Head capsule oval, widest at compound eyes, with many long and short hairs densely; cephalic index 1.02–1.06. Compound eyes 0.23–0.24 mm in diameter; compound eye index 0.45–0.47. Antennae with 16–17 segments. Clypeus trapezoidal; postclypeus with several hairs at posterior margin and lateral portions. Labrum with more than 10 long and short hairs on surface. Postmentum longer than wide, with many long hairs at lateral margins and several long and short hairs on surface.

Pronotum semicircular, faintly concave at anterior



Figs. 14–19. Soldiers of *Reticulitermes* in Japan. — 14, *R. kanmonensis* sp. nov.; 15, *R. miyatakei*; 16, *R. flaviceps*; 17, *R. amamianus*; 18, *R. okinawanus*; 19, *R. yaeyamanus*. a, labrum; b, mandibles. Scales; 0.25 mm.

margin but not notched in the middle, rounded laterally, concave and notched at posterior margin, with numerous short and long hairs, more than 30 on disc, which are abundant on posterior portion and with many long hairs around marginal portion. Fore wings 7.65–8.10 mm long.

Soldier. Head capsule yellowish; labrum and antennae yellow; mandibles dark brown, paler basally. Thorax and abdomen yellowish white.

Head capsule subrectangular, parallel sided, with many long and short hairs; cephalic index 1.71–1.85; frontal area weakly convex. Antennae with 14–17 segments. Clypeus trapezoidal; postclypeus with a few short or minute hairs on anterior margin or bald. Labrum subpentagonal, broader, triangularly pointed at apex, with two long hairs at apex and with a few minute hairs on surface, without paraterminal setae; labrum index 1.25–1.36. Mandibular index 0.52–0.60. Right mandible with inner margin curved. Postmentum widest at anterior one third, narrowest at posterior one third, with parallel sides at narrowest point, with several long and short hairs on surface; postmentum index 0.20–0.24.

Pronotum flat, subtrapezoidal, with many hairs abounding on posterior, more than 15, with many long and short hairs at marginal portions.

Measurements (mm). Alate: HL 0.87–0.97 (0.92); HW 0.87–0.92 (0.90); LL 0.31–0.33 (0.32); LW 0.33–0.35 (0.34); HH 0.50–0.52 (0.51); PnL 0.49–0.52 (0.51); PnW 0.72–0.77 (0.74) ($n=5$). Soldier: HL 1.75–1.83 (1.80); HW 0.98–1.03 (1.02); LML 0.95–1.05 (1.01); LL 0.43–0.48 (0.45); LW 0.34–0.35 (0.35); HH 0.83–0.85 (0.84); PmL 1.34–1.38 (1.36); PmW1 0.42–0.45 (0.44); PmW2 0.09–0.10 (0.10); PnL 0.48–0.50 (0.49); PnW 0.73–0.75 (0.75) ($n=25$).

Materials examined. JAPAN: Mt. Yuwandake, Amami-Oshima Is., 12. x. 1988 (Morimoto) (S, W, A, 7 series).

Distribution. Japan (Amami-Oshima Is., Tokunoshima Is.).

Remarks. This species swarms at humid noon in April to May. It is distributed only on the Amami group of the Ryukyus and has the sympatric distribution with *R. amamianus*. The coloration of the alate is different in these species and the soldier of this species is devoid of the paraterminal setae on the labrum.

Reticulitermes flaviceps (Oshima)

(Figs. 10, 16)

Termes flaviceps: Oshima, 1911b, 356.

Termes speratus: Oshima, 1908, 514.

Leucotermes speratus: Shiraki, 1909, 230; Hozawa, 1915, 62–63.

Termes (Leucotermes) flavipes: Oshima, 1909, 30; Oshima, 1910, 345.

Leucotermes flavipes: Oshima, 1911a, 3.

Leucotermes flaviceps: Oshima, 1912, 74; Oshima, 1913, 277–278; Oshima, 1914, 1.

Reticulitermes speratus: Ahmad, 1958, 71–72; Tsai & Chen, 1964, 60.

Reticulitermes flaviceps: Light, 1929, 589; Snyder, 1949, 72.

Reticulitermes flaviceps flaviceps: Morimoto, 1968, 68–69.

Reticulitermes (Frontotermes) flaviceps: Tsai *et al.*, 1977, 465–466; Tsai & Huang, 1980, 17; Huang *et al.*, 1989, 349–350.

Alate. Unknown to me.

Soldier. Head capsule yellowish; labrum and antennae yellow; mandibles dark brown, paler basally. Thorax and abdomen yellowish white.

Head capsule subrectangular, parallel sided or slightly tapering anteriorly, with many long and short hairs; cephalic index 1.65–1.76; frontal area distinctly convex. Antennae with 14–17 segments. Clypeus trapezoidal; postclypeus with a few short hairs on anterior margin or bald. Labrum subpentagonal, slender, triangularly pointed at apex, with two long terminal setae and a pair of paraterminal setae at apex, with a few minute or long hairs on surface; labrum index 1.29–1.48. Mandibular index 0.57–0.61. Right mandible with inner margin straight and curved at tip. Postmentum widest at anterior one third, narrowest at posterior one third, with sides parallel at narrowest portion, with several long and short hairs on anterior surface; postmentum index 0.41–0.45.

Pronotum flat, subtrapezoidal, with more than 15 hairs abounding on posterior half, with many long and short hairs at marginal portions.

Measurements (mm). Soldier: HL 1.65–1.80 (1.71); HW 1.00–1.03 (1.02); LML 1.00–1.03 (1.01); LL 0.40–0.45 (0.43); LW 0.31–0.32 (0.31); HH 0.75–0.83 (0.80); PmL 1.25–1.30 (1.26); PmW1 0.40–0.41 (0.40); PmW2 0.17–0.18 (0.18); PnL 0.50–0.54 (0.51); PnW 0.78–0.80 (0.80) ($n=25$).

Materials examined. JAPAN: Yonaguni Is., Ryukyus, 15. iii. 1981 (Kawamura) (S, W); same locality, 5. iv. 1991 (Kamitani) (S, W); same locality, 2. viii. 1992 (Takematsu) (S, W); Ishigaki Is., Ryukyus, 4. viii. 1992 (Takematsu) (S, W).

Distribution. Japan (new record: Ishigaki Is., Yonaguni Is.); China; Taiwan.

Remarks. Many discussions have been made on the identity and distribution of *R. flaviceps* and *R. speratus*, and there were some disagreements on the treatment of these species. Oshima (1911b) originally described *R. flaviceps* based on specimens from Taibei, Taiwan, and mentioned that this was a "common termite in Taibei".

Later Oshima (1912) redescribed the same species from Ranyu Is., Taiwan, but did not refer to his original description. Morimoto (1968) showed taxonomic characters of *R. flaviceps* referring to the original description of Oshima (1911b), whereas some Chinese taxonomists designated this specimens based on the redescription of Oshima (1912). In my recent examination on specimens from these two localities, it becomes clear that they are different species; specimens from Taibei should be true *R. flaviceps* and those from Ranyu Is. represent a different species.

This species is newly recorded from Japan. On Ishigaki Is., another species of this genus, *R. yaeyamanus*, is distributed sympatrically with this species, whereas on Yonaguni Is., only *R. flaviceps* is found.

Description of the alate was made by Oshima (1911b) (in Japanese) and Morimoto (1968).

***Reticulitermes amamianus* Morimoto, stat. nov.**

(Figs. 3, 11, 17)

Reticulitermes flaviceps amamianus Morimoto, 1968, 69.

Alate. Head capsule dark brown; antennae brown, paler than head; mandibles pale brown, teeth darker. Postmentum paler than head capsule. Pronotum whitish. The rest of body brownish. Wing membrane pale brown and hyaline, veins brownish. Femora and the base of tibiae brown, the rest of leg whitish yellow.

Head capsule oval, widest at compound eyes, with many long and short hairs densely; cephalic index 0.99–1.04. Compound eyes 0.22–0.23 mm in diameter; compound eye index 0.41–0.45. Antennae with 16–17 segments. Clypeus trapezoidal; postclypeus with 10 or more hairs at posterior margin and lateral portions. Labrum with 10 or more long and short hairs on surface. Postmentum longer than wide, with many long hairs at lateral margins and several long and short hairs on surface.

Pronotum reversely subtrapezoidal, faintly concave at anterior margin but not notched in the middle, narrowed posteriorly and almost straight at sides, weakly concave and notched at posterior margin, with more than 30 short and long hairs on disc, which are

abundant on posterior portion and with many long hairs along marginal portion. Fore wings 7.80–8.10 mm long.

Soldier. Head capsule yellowish; labrum and antennae yellow; mandibles dark brown, paler basally.

Head capsule subrectangular, parallel sided, with long and short hairs densely; cephalic index 1.50–1.63; frontal area distinctly convex. Antennae with 14–17 segments. Clypeus trapezoidal; postclypeus with a few short hairs on anterior margin or bald. Labrum subpentagonal, longer than wide, slender, triangularly pointed at apex, with two long terminal setae and a pair of paraterminal setae at apex, with a few minute or long hairs on surface; labrum index 1.31–1.43. Mandibular index 0.69–0.72. Right mandible with inner margin gently curved. Postmentum widest at anterior one third, narrowest at posterior one third, with sides concave at narrowest portion, with several long and short hairs on anterior surface; postmentum index 0.37–0.38.

Pronotum flat, subtrapezoidal, with more than 15 hairs abounding on posterior half, with many long and short hairs at marginal portions.

Measurements (mm). Alate: HL 0.93–0.97 (0.94); HW 0.93–0.94 (0.93); LL 0.32–0.33 (0.32); LW 0.36–0.37 (0.37); HH 0.50–0.53 (0.52); PnL 0.52–0.55 (0.53); PnW 0.74–0.78 (0.76) (n=25). Soldier: HL 1.41–1.45 (1.43); HW 0.85–0.95 (0.90); LML 0.95–1.03 (1.00); LL 0.43–0.45 (0.44); LW 0.32–0.33 (0.33); HH 0.70–0.78 (0.74); PmL 1.00–1.05 (1.03); PmW1 0.38–0.41 (0.40); PmW2 0.14–0.15 (0.15); PnL 0.43–0.48 (0.45); PnW 0.63–0.68 (0.66) (n=25).

Materials examined. JAPAN: Mt. Yuwandake, Amami-Oshima Is., 12. x. 1988 (Morimoto) (S, W, 3 series); same locality, 2. iv. 1989 (Takematsu) (S, W, A, 4 series); same locality, 23. iv. 1993 (Takematsu) (S, W, A); Mt. Yuidake, Amami-Oshima Is., 1. iv. 1989 (Takematsu) (S, W, A, 2 series); same locality, 23. iv. 1993 (Takematsu) (S, W); Kinsakubaru, Amami-Oshima Is., 24. iv. 1993 (Morimoto) (S, W, 3 series).

Distribution. Japan (Yoron Is., Amami-Oshima Is.).

Remarks. This species swarms at humid noon in April to May and is distributed only on the Amami group of the Ryukyus. It has the sympatric distribution with *R. miyatakei*, but it is easily recognizable by the coloration in alates and the possession of the paraterminal setae of the labrum.

This species was described as a subspecies of *R. flaviceps* by the possession of the paraterminal setae

(Morimoto, 1968). However, the hydrocarbon compositions of two subspecies of *R. flaviceps*, ssp. *flaviceps* and ssp. *amamianus*, proved to be significantly different from each other (Takematsu & Yamaoka, 1999). Differences were found in as many as 20 chemical substances. Chemical data clearly showed that these two "subspecies" belong to separate species, and the shape of the mandibles should be a key character for morphological discrimination of the two species.

This is the first record of the alate.

***Reticulitermes okinawanus* Morimoto, stat. nov.**

(Figs. 12, 18)

Reticulitermes speratus okinawanus Morimoto, 1968, 70.

Alate. Unknown.

Soldier. Head capsule yellowish; labrum and antennae yellow; mandibles dark brown, paler basally. Thorax and abdomen yellowish white.

Head capsule subrectangular, with sides slightly convex, widest at middle, with many long and short hairs; cephalic index 1.57–1.68; frontal area distinctly convex. Antennae with 14–17 segments. Clypeus trapezoidal; clypeal setae absent or minute. Labrum subpentagonal, longer than wide, slender, triangularly pointed at apex, convex at sides, with two long terminal setae at apex and with a few minute hairs or bald on surface, without paraterminal setae; labrum index 1.29–1.37. Mandibular index 0.60–0.62. Right mandible with inner margin gently curved. Postmentum widest at anterior one third, narrowed posteriorly at narrowest portion, with several long and short hairs on anterior surface and with a few hairs or without hairs on posterior surface; postmentum index 0.38–0.40.

Pronotum flat, subtrapezoidal, with more than 15 hairs abounding on posterior half, with many long and short hairs at marginal portions.

Measurements (mm). Soldier: HL 1.65–1.68 (1.67); HW 1.00–1.05 (1.03); LML 1.00–1.03 (1.02); LL 0.45–0.46 (0.45); LW 0.34–0.35 (0.34); HH 0.83–0.88 (0.85); PmL 1.15–1.20 (1.18); PmW1 0.43–0.45 (0.44); PmW2 0.17–0.18 (0.17); PnL 0.50–0.55 (0.52); PnW 0.75–0.78 (0.76) (n=25).

Materials examined. JAPAN: Kunigami, Okinawa Is., Ryukyus, 1. ix. 1990 (Kouge) (S, W, 5 series); Mt. Yonahadake, Okinawa Is., Ryukyus, 9. ii. 1991 (Ogata) (S, W); Nakijin, Okinawa Is., Ryukyus, 6. viii. 1992 (Takematsu) (S, W, 3 series); Sata-Utaki, Okinawa Is., Ryukyus, 6. viii. 1992 (Takematsu) (S, W).

Distribution. Japan (Okinawa Is.).

Remarks. This species was described as a subspecies of *R. speratus* (Morimoto, 1968). But, it is fairly different from the latter by chemical and morphological features. Morphologically, it distinguished from *R. speratus* by bearing many hairs on the disc of pronotum and head with sides slightly convex in soldier. In cuticular hydrocarbon composition, this species has many unique chemicals (Takematsu & Yamaoka, 1999).

***Reticulitermes yaeyamanus* Morimoto, stat. nov.**

(Figs. 13, 19)

Reticulitermes speratus yaeyamanus Morimoto, 1968, 70.

Alate. Unknown.

Soldier. Head capsule yellowish; labrum and antennae yellow; mandibles dark brown, paler basally. Thorax and abdomen yellowish white.

Head capsule subrectangular, with sides slightly tapering anteriorly, widest at posterior one third, with many long and short hairs; cephalic index 1.64–1.84; frontal area weakly convex. Antennae with 14–17 segments. Clypeus trapezoidal; clypeal setae absent or minute. Labrum subtriangular, longer than wide, slender, triangularly pointed at apex, weakly rounded at sides, with two long terminal setae at apex and with a few minute hairs or bald on surface, without paraterminal setae; labrum index 1.39–1.42. Mandibular index 0.57–0.62. Right mandible with inner margin curved. Postmentum widest at anterior one third, narrowed posteriorly at narrowest portion, with several long and short hairs on anterior surface and with a few hairs or without hairs on posterior surface; postmentum 0.38–0.43.

Pronotum flat, subtrapezoidal, with more than 15 hairs abounding on posterior half, with many long and short hairs at marginal portions.

Measurements (mm). Soldier: HL 1.60–1.75 (1.70); HW 0.95–0.98 (0.96); LML 0.99–1.00 (1.00); LL 0.43–0.45 (0.43); LW 0.30–0.31 (0.30); HH 0.78–0.83 (0.80); PmL 1.20–1.30 (1.26); PmW1 0.41–0.43 (0.42); PmW2 0.16–0.18 (0.17); PnL 0.48–0.49 (0.48); PnW 0.74–0.76 (0.75) (n=20).

Materials examined. JAPAN: Mt. Omotodake, Ishigaki Is., Ryukyus, 26. x. 1991 (Takematsu) (S, W); same locality, 4. viii. 1992 (Takematsu) (S, W, 2 series); Mt. Bannadake, Ishigaki Is., Ryukyus, 4. viii. 1992 (Takematsu) (S, W).

Distribution. Japan (Ishigaki Is., Iriomote Is.).

Remarks. This species was described as a subspecies of *R. speratus* (Morimoto, 1968). But, it is fairly

different from *R. speratus* by chemical and morphological features. Morphologically, it distinguished from *R. speratus* by bearing many hairs on the disc of pronotum and head with sides slightly tapering anteriorly in soldier. Furthermore, in cuticular hydrocarbon composition, this species has many unique chemicals as shown by Takematsu & Yamaoka (1999).

Key to the Japanese species of *Reticulitermes*

Alate

1. Pronotum with small number of hairs; less than 25 on disc *speratus*
- Pronotum with many hairs; more than 30 on disc 2
2. Pronotum brownish as head *miyatakei*
- Pronotum whitish 3
3. Head widest at the base of the mandibles *kanmonensis*
- Head widest at the compound eyes *amamianus*

Soldier

1. Pronotum with a few hairs; less than 10 on disc (*speratus*) 2
- Pronotum with many hairs; more than 15 on disc 4
2. Labrum with long hairs on surface *s. kyushuensis*
- Labrum with minute hairs or without hairs on surface 3
3. Labrum rounded at tip, wide, labrum index less than 1.30 *s. speratus*
- Labrum more or less rectangular at tip, slender, labrum index more than 1.30 *s. leptolabralis*
4. Labrum with paraterminal setae 5
- Labrum without paraterminal setae 6
5. Right mandible with inner margin straight and curved inward at tip; postmentum with sides straight at narrowest portion *flaviceps*
- Right mandible with inner margin gently curved; postmentum with sides concave at narrowest portion *amamianus*
6. Postmentum slender; postmentum index less than 0.25 *miyatakei*
- Postmentum wider; postmentum index more than 0.30 7
7. Head with sides slightly tapering anteriorly, broadest at posterior one third *yaeyamanus*
- Head with sides slightly convex, broadest at middle 8

8. Smaller species, head length without mandibles less than 1.70 *okinawanus*
- Larger species, head length without mandibles more than 1.75 *kanmonensis*

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