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Review of the paper wasps of the *Parapolybia indica* species-group (Hymenoptera: Vespidae, Polistinae) in eastern parts of Asia

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Abstract

Nine species of the *Parapolybia indica* species-group in eastern parts of Asia are reviewed. Four new species are described: *P. flava* **sp. nov.** (Vietnam), *P. crocea* **sp. nov.** (Japan), *P. nana* **sp. nov.** (Vietnam), and *P. albida* **sp. nov.** (Vietnam). *Parapolybia indica* (de Saussure, 1854), *P. bioculata* van der Vecht, 1966 and *P. tinctipennis* (Cameron, 1900) are redescribed. The status is reinstanted for *P. fulvinerva* (Cameron, 1900), **stat. resurr.** and *P. tinctipennis* (Cameron, 1900), **stat. resurr.** and new status is proposed for *P. bioculata* van der Vecht, 1966, **stat. nov.** *Parapolybia tinctipennis* (Cameron, 1900) is newly recorded from China, Vietnam and Laos. The key to species is given. The nests of *P. indica*, *P. bioculata*, *P. tinctipennis*, *P. flava* and *P. crocea* are remarked.

Key words: Ropalidiini, new species, new records, social wasp, East Asia

Introduction

Parapolybia de Saussure, 1854 is one of the four genera in the Old World endemic polistine tribe Ropalidiini. While the wasps of the ropalidiine genera other than *Parapolybia* are predominantly tropical and subtropical in their distribution, *Parapolybia* wasps are in general more temperate, spreading northwards well beyond the Tropic of Cancer. They are distributed in the Middle East, the Indo-Papuan region and East Asia, from Turkey in the west to New Guinea in the east, and to the Korean Peninsula and Honshu Island of Japan in the northeast. Two species, *P. escalerae* (Meade-Waldo, 1911) and *P. persica* (Meade-Waldo, 1911), are known to occur only in the Middle East, and the other four species currently treated as valid, *P. indica* (de Saussure, 1854), *P. varia* (Fabricius, 1787), *P. takasagona* Sonan, 1944 and *P. nodosa* van der Vecht, 1966, occur mainly in the eastern parts of Asia.

Van der Vecht (1966) intensively studied the taxonomy of the East-Asiatic and Indo-Papuan *Parapolybia* wasps and divided the Oriental *Parapolybia* "species" into two groups in a form of key-to-species. That is, one includes only *P. indica* and is characterized with the female occipital carina reaching the mandibular bases (Fig. 1) and the male terminal antennal flagellomere prominently elongated [*P. indica* species-group]; the other includes *P. varia* and *P. nodosa* and is characterized by the female occipital carina obliterated ventrally (Fig. 2) and the male terminal antennal flagellomere not prominently elongated, less than 3 × as long as its basal width [*P. varia* species-group]. *Parapolybia takasagona*, which van der Vecht (1966) overlooked (see Kojima & Carpenter 1997), also has the female complete occipital carina and the male prominently elongated terminal flagellomere (Yamane *et al*. 1995; Kojima *et al*. 2011). Some or all of the four species described herein as new to science may correspond to van der Vecht's (1966) "typical *Parapolybia indica*".

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Material and methods

The adult morphological and color characters except for male genitalia were observed on pinned and dried specimens under a stereoscopic dissecting microscope. Apical parts of male metasoma were dissected for the terminal sterna and genitalia. They were put in lactic acid for several hours, washed in distilled water, and observed in glycerin under a stereoscopic dissecting microscope, and/or dried and observed using a scanning electron microscope (S-3400N, Hitachi High-Technologies Corporation) without coating. The terminology of male genitalia follows Kojima (1999). Line drawings were made with the aid of a drawing tube installed on the stereoscopic dissecting microscope. Setae of wings were photographed by digital microscope using Focus Stacking function (VHX-2000, KEYENCE Corporation).

In the descriptions of adult morphology, the following abbreviations are used: The abbreviations F, S and T refer to numbered flagellomeres, metasomal sterna and metasomal terga, respectively; POD = postocellar distance; OOD = ocelloocular distance; Od = transverse diameter of the posterior ocellus. The body parts measured for the morphometric characters are defined as follows: body length is the lengths of head, mesosoma and first two metasomal segments combined; clypeus width, the distance between the uppermost points where clypeus touches eyes; clypeus height, the distance from the bottom of the dorsal emergination to the apex; the distance between the inner eye margins at vertex and at clypeus, the distance between the inner eye margins at the level of anterior ocellus in frontal view of head and at the level where inner eye margins approached each other most closely, respectively; the width of the eye and the gena, the maximum width for each in strictly lateral view of the head; T1 length, the distance in lateral view from the posterior end of the basal slit for the reception of the propodeal suspensory ligament to the posterodorsal end of the tergum; T2 length, the distance in lateral view from the bottom of the basal depression or "neck" to the posterodorsal end of the tergum; T1 and T2 width, the maximum width for each in dorsal view. The nest characters were examined after the immatures had been taken out and the nests had been air-dried. The terminology of nest characters follows Wenzel (1998).

The specimens examined in the present study are deposited in the following museums/institutions:

AMNH	American Museum of Natural History, New York, USA;
BMNH	The Natural History Museum, London, UK;
BPBM	Bernice P. Bishop Museum, Honolulu, USA;
IEBR	Institute of Ecology and Biological Resources, Hanoi, Vietnam;
IUNH	Natural History Collection of Ibaraki University, Mito, Japan, including the specimens tentatively deposited in the IUNH as a long-term loan from the IEBR (IUNH/IEBR);
MNHN	Museum national d'Histoire naturelle, Paris, France;
NIAES	National Institute for Agro-Environmental Sciences, Tsukuba, Japan;
NMNS	National Museum of Natural Science, Taichung, Taiwan;
NTM	National Taiwan Museum, Taipei, Taiwan;
OUM	Oxford University Museum of Natural History, Oxford, UK;
SEHU	Systematic Entomology, Hokkaido University Museum, Japan;
TARI	Taiwan Agricultural Research Institute, Wufeng, Taiwan;
TFRI	Taiwan Forestry Research Institute, Taipei, Taiwan.

Genus *Parapolybia* de Saussure, 1854

Parapolybia de Saussure 1854: 207; von Schulthess 1913: 152; van der Vecht 1966: 5, 21; Gadagkar 1991: 149.
Type species. *Polybia indica* de Saussure, 1854, by subsequent designation (Bingham 1897: 382).

Parapolybia is one of the four genera of the tribe Ropalidiini. It differs from other ropalidiine genera in the combination of the following characters: female and male antenna with respectively ten and 11 flagellomeres; pronotal carina incomplete, obliterated ventrally; pronotum with pretegular carina; mesepisternum with scrobal sulcus; T1 much longer than T2 width, posteriorly more or less distinctly swollen dorsally and laterally.

FIGURES 1–6. *Parapolybia varia*, *P. crocea* **sp. nov.** and holotype of *P. indica* (de Saussure, 1854). 1, 2. Head, lateral view, ♀. 1. *P. crocea* **sp. nov.** 2. *P. varia*. 3, 4. Dried specimens of *P. crocea* **sp. nov.** from the same colony. 3. Body color in live more or less well preserved. 4. Discolored while drying. 5, 6. Holotype of *P. indica*. 5. Dorsal view, metasomal segments 2–6 glued upside down. 6. Labels of holotype.

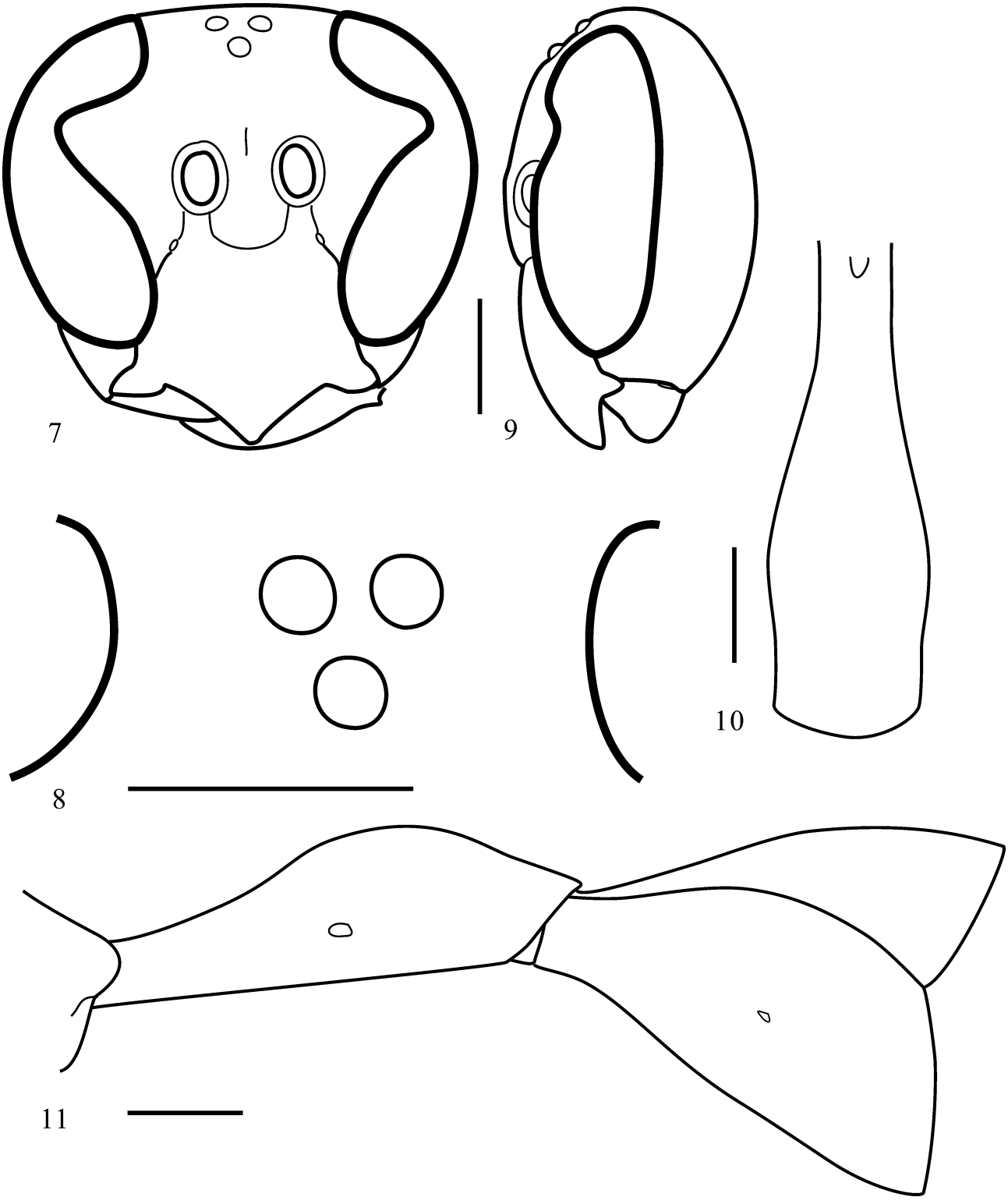
Parapolybia indica (de Saussure, 1854)

(Figs 5–18, 83, 85)

Polybia indica de Saussure 1854: 207, pl. 26, fig. 3, ♀, holotype "La Chine" [MNHN].
Stelopolybia indica: du Buysson 1913: 298.
Parapolybia indica: von Schulthess 1913: 153 (key), 154, pl. 11 fig. 1, pl. 11B fig. 7 (distribution).
Parapolybia indica indica: van der Vecht 1966: 26 (key), 27, fig. 11a–b (distribution) [part, as aberrant color form].

Diagnosis. This species can be distinguished from other species of the *P. indica* species-group by the combination of the following characters: body ground color yellow, with abundant brown and dark brown markings; female clypesus without dark spots; female paired longitudinal yellow bands on mesoscutum and paired yellow spots on T2 absent or obscure; wings covered with short black setae; female gena not strongly swollen, in lateral view

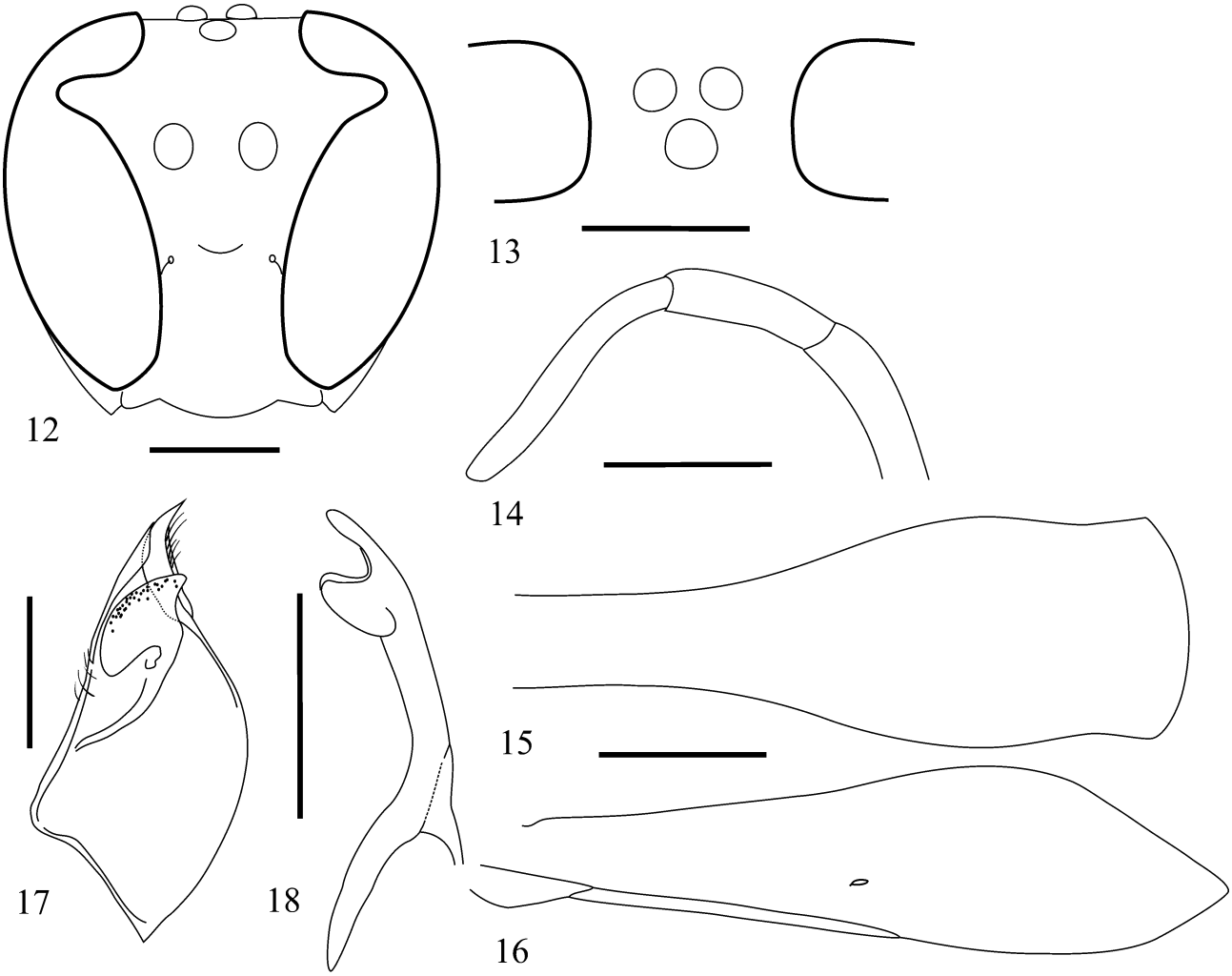
narrower than eye; antenna and legs not prominantly elongated; T2 moderately concave sublaterally; male genital volsella apically produced.



FIGURES 7–11. *Parapolybia indica*, holotype ♀. 7, 9. Head. 7. Frontal view. 9. Lateral view. 8. Ocelli, dorsal view. 10. T1, dorsal view. 11. Metasomal segments 1–2, lateral view, segment 2 glued upside down. Scale 1 mm.

Material examined. HOLOTYPE of *Polybia indica* de Saussure, ♀, "La Chine" [MNHN]: **Other material.** CHINA: Guangdong: 1 ♀ (BPBM), Lo-fou Shan, [23°40'N, 114°36'E], 100–1000 ft., 1906, F.M.; Hong Kong: 23 ♀ (BPBM), N.T.Taipokau *et al.*, [3 ♀, 6, 30–31.vi.1964; 7 ♀, 2–6, 3–4, 10–14, 17, 27.vii.1964; 1 ♀, 30.vi.1965; 9

♀, 2, 7, 20, 21, 27.vii.1965; 2 ♀, 13, 17.viii.1965; 1 ♀, 15.ix.1965]. VIETNAM: Cao Bang: 47 ♀ 6 ♂ (IUNH, IEBR), Thanh Cong, Nguyen Binh, [21 ♀ 2 ♂, 22°34'N, 105°53'E, 1000 m, 9.viii.2012, Nest# VN-NE2012-Pp-12 & 13, S.D. Tran, J. Kojima & H. Nugroho; 26 ♀ 4 ♂, 22°34'14"N, 105°52'41"E, 1920 m, 10.viii.2012, Nest# VN-NE2012-Pp-09, IED-c (IEBR Insect Ecology Department collectors)]; Vinh Phuc: 2 ♀ 7 ♂ (IUNH), Tam Dao, 21°27.5'N, 105°38'E, 800 m, 31.viii.2006, F. Saito & J. Kojima; 11 ♀ 6 ♂ (IEBR), Tam Dao, D.T. Tran [4 ♂, 20.ix.2011; 11 ♀ 2 ♂, 900–1200 m, 30.vii–3.viii.2012]. LAOS: 1 ♀ (BPBM), Phon Tiou, Khammouane, 11.vi.1965, N. Wilson.



FIGURES 12–18. *Parapolybia indica*, ♂. 12. Head, frontal view. 13. Ocelli, dorsal view. 14. F9–F11. 15, 16. T1 (15. Dorsal view, 16. Lateral view). 17. Volsella and digitus. 18. Aedeagus. Scale 1 mm.

Redescription (characters for the holotype female are given in blackets). FEMALE. Body length 13.5–16.5 [14.0] mm; fore wing length 13.0–16.0 [13.0] mm. Head in frontal view 1.1 × as wide as high (Fig. 7). Ocelli close to each other (Fig. 8); distance between anterior and posterior ocelli less than half of Od; POD less than half of Od; anterior ocellus diameter 0.3 mm, slightly larger than that of posterior ocellus (about 0.25 mm); OOD 1.8 × as large as Od. Gena narrower than eye in lateral view (Fig. 9). Eyes sparsely with short fine setae. Vertex and frons densely with fine setae. Clypeus with sparse setae, anterior margin with dense short setae. Pronotum laterally with shallow furrows just behind fovea. Scutum, scutellum and metanotum densely setose. Scutellum and metanotum convex. Propodeum with dense setae, dorsolaterally distinctly striate. T1 more or less slender, 3.2–4.6 [3.9] mm long (Fig. 10), posteriorly weakly swollen dorsally in lateral view (Fig. 11), 3.1 × longer than maximum height, 2.7 × as long as its own maximum width. T2 moderately concave sublaterally.

Color. Ground color yellow, with following parts dark brown and brown; dark brown: scape dorsally and F1–F6, inner margin of mandible, anterior margin of clypeus, posteromedian and dorsolateral narrow bands of

propodeum, median furrow of mesopleuron, posterior margin of metasomal segments, and all tarsi; brown: paired ill-defined small spots on clypeus (sometimes absent), frons, dorsolateral lines of pronotum, mesoscutum except for paired yellow longitudinal lines (often ambiguous), scutellum, metasomal segments. Wings brown, semi-hyaline.

MALE. Body length 13.0–14.5 mm; fore wing length 12.5–14.0 mm. Head in frontal view 0.9 × as wide as high (Fig. 12). Ocelli close to each other (Fig. 13); distance between anterior and posterior ocelli less than half of Od; POD less than half of Od; anterior ocellus 0.24–0.32 mm in diameter, larger than posterior ocellus (0.23–0.28 mm in Od); OOD about equal to Od. Antenna 10.0 mm long; F11 1.6 × as long as F10 (0.9–1.0 mm long, Fig. 14). Pronotum dorsolaterally slightly ridged, laterally with shallow furrows. Propodeum drosolaterally striate. T1 (3.6–4.0 mm long, Figs 15–16) less swollen posterodorsally than in female, 3.6 × longer than the maximum height, 3.2 × as long as its own maximum width. Parameral spine with hairy setae (Fig. 17). Volsella produced apically (Fig. 17). Digitus ventroapically slightly projected. Proximal margin of aedeagus produced (Fig. 18).

Color. As in female, but mesoscutum entirely brown.

Distribution. China (Guangdong, Hong Kong), Vietnam (North Vietnam), Laos.

Remarks. Van der Vecht (1966) examined the de Saussure's holotype of *Polybia indica* [=*Parapolybia indica*], and stated that it "agrees better with De Saussure's figure than with his description. … The general appearance of the body suggests that the aberrant coloration is very probably due to poor preservation. … I have therefore treated the richly maculated common Chinese form as "typical", even though it does not agree well with the original description." This interpretation has been followed by most researchers, including Yamane *et al.* (1995), who synonymized *Parapolybia takasagona* Sonan 1944 under *P. indica*.

As van der Vecht (1966) pointed out, the holotype specimen of *Polybia indica* agrees better with de Saussure's (1854) figure (pl. 26, fig. 3) than with his text description, which does not refer to the yellow markings on the mesosoma. However, it is not rare that not only de Saussure (1853–1858) but also even modern works seldom refer to details of all the color markings in text descriptions, and thus this cannot be a reason to consider that the holotype of *P. indica* had "aberrant colorations due to poor preservation" and the richly yellow-marked Chinese form was treated as "typical". In fact, specimens of yellow-ground-colored *Parapolybia* species sometimes become "blackish" brown or greenish-brown or even blackish brown possibly due to a short period from the emergence to the time being killed (Figs 3–4), but such the discoloration can be recognized with careful observation. Furthermore, we collected a colony of which all the resident female wasps had the live coloration agreeing with the holotype of *P. indica* in the locality where we also collected the other colonies with all the resident females being richly yellow-marked. These findings strongly suggest that the holotype of *P. indica* deserves its original coloration and richly-yellow-marked *Parapolybia* wasps belong to species different from *P. indica* (de Saussure, 1854) that are described in this paper as new to science.

Parapolybia bioculata van der Vecht, 1966, stat. nov.

(Figs 19–30, 76, 89, 90)

Parapolybia indica bioculata van der Vecht 1966: 26, 29, fig. 11c, ♀, holotype "Birma: Tenasserim, Haundraw Valley, April 1894, C.T. Bingham" (BMNH); Das & Gupta 1984: 429 (catalog); 1989: 179, map 27 (distribution).
Polybia indica (de Saussure): Bingham 1897: 383, 384, fig. 115, part.

Diagnosis. This species can be easily distinguished from other species of *Parapolybia* by the following characters: in both sexes, second and following metasomal segments nearly entirely black but paired large and small yellow spots respectively on T2 and T3; anntena and legs, especially in male, prominently elongated.

Material examined. HOLOTYPE and PARATYPE of *Parapolybia indica bioculata*, 2 ♀, MYANMAR: Tenasserim: Haundraw Valley, April and October 1894, C.T. Bingham [BMNH]. **Other material.** VIETNAM: Lai Chau: 27 ♀ (IUNH), Huoi Long, 22°30'N, 103°15'E, 1500 m, 23.viii.2006, L.T.P. Nguyen, F. Saito & J. Kojima, Nest#VN-Pp-2006-6; Dien Bien: 4 ♀ 40 ♂ (IUNH), Muong Phang, 21°27.5'N, 103°07'E, 700 m, 25.viii.2006, L.T.P. Nguyen, F. Saito & J. Kojima, Nest#VN-Pp-2006-12; 1 ♀ (IUNH), Muong Phang, 23.vii.2009, J. Kojima; 6 ♀ (IUNH), Muong Nhe, 22.vii.2009, J. Kojima; Cao Bang: 5 ♀ (IUNH), Thanh Cong, Nguyen Binh, 22°32.5'N, 105°53'E, 8.viii.2012, J. Kojima, H. Nugroho & IED-c; 1 ♀ (IEBR), Thanh Cong, Nguyen Binh, vi.2014, T.V. Hoang; Bac Kan: 1 ♀ (IUNH), Kim Hy NP, Bach Thong, Vu Muon, 22°13'N, 105°59'E, 5.viii.2012, J. Kojima, H.

Nugroho & IED-c; 3 ♂ (IUNH), Lang Ngam, Ngan Son, 22°19.5'N, 105°54.5'E, 300 m, 5.viii.2012, J. Kojima & H. Nugroho, Nest#VN-NE2012-Pp-03; Phu Tho: 5 ♀ (IUNH/IEBR), Xuan Son NP, [1 ♀, 500 m, 6–9.xii.2003, L.X. Truong; 2 ♀, 300–400 m, 11.vi.2004, L.T.P. Nguyen; 2 ♀, 300–400 m, 25.ix.2005, L.T.P. Nguyen]; Vinh Phuc: 14 ♀ (IUNH/IEBR), Tam Dao, 800 m, 1–4.vii.2003, L.T.P. Nguyen; 4 ♀ (IUNH/IEBR), Tam Dao, 900 m, L.T.P. Nguyen [2 ♀, 8.ix.2000; 1 ♀, 9.ix.2000; 1 ♀, 1.vii.2003]; 3 ♀ (IUNH/IEBR), Ngoc Thanh, Me Linh, 11.v.2000, L.T.P. Nguyen; 1 ♀(IUNH), Tam Dao, 900 m, 20.viii.2005, L.T.P. Nguyen & J. Kojima; 1 ♀ (IUNH), Tam Dao, 21°26'N, 105°37'E, 400 m, 20.viii.2005, J. Kojima; 124 ♀ (IUNH), Tam Dao, 21°26.5'N, 105°38.5'E, 700 m, 30.viii.2006, F. Saito & J. Kojima, Nest#VN-Pp-2006-20; 5 ♀ (IUNH) Tam Dao, 30.vii.2009, J. Kojima; Hoa Binh: 2 ♀ (IUNH), Pa Co, Mai Chau, 20°44.5'N, 104°56'E, 1350 m, 28.viii.2006, L.T.P. Nguyen, F. Saito & J. Kojima; Ha Tay: 1 ♀ (IUNH/IEBR), Suoi Mo, Yen Bai, Ba Vi, 100 m, 1.vi.2001, L.T.P. Nguyen; Hai Phong: 1 ♀ (IUNH/IEBR), Cat Ba, 10.vi.2003, K.D. Long; Thanh Hoa: 1 ♀ (IUNH), Xuan Lien NR, Hon Can, Van Xuan, Thuong Xuan, 19°52.5'N, 105°14.5'E, 24.viii.2012, L.T.P. Nguyen; Nghe An: 1 ♀ (IUNH/IEBR), Chau Cuong, Quy Hop, 19.vii.2004, X.H. Le; Ha Tinh: 1 ♀ (AMNH), 17km South East Huong Son, 18°22'N, 105°13'E, 180 m, 19–23.iv.1998, J.M. Carpenter; 1 ♀ (IUNH/IEBR), Son Kim, Huong Son, 3.v.2004, L.X. Truong; Thua Thien Hue: 4 ♀ (IUNH/IEBR), Phong My, Phong Dien, 600 m, 1–5.iv.2001, L.X. Truong; 1 ♀ 8 ♂ (IUNH), Bach Ma, 16°11'N, 107°50'E, 13.viii.2005, L.T.P. Nguyen & J. Kojima, Nest#VNM-Pp-2005-1; 2 ♀ (IUNH), Bach Ma, 1350–1450 m, 14.viii.2005, L.T.P. Nguyen & J. Kojima; 1 ♀ (IUNH) Bach Ma, 1200 m, 17.v.2012, L.T.P. Nguyen. LAOS: Vientiane: 5 ♀ (BPBM), Ban Van Eue, native collector [1 ♀, 28.ii.1966; 1 ♀, 29.ii.1966; 1 ♀, 2.iii.1966; 2 ♀, 30.ii.1967].

Redescription. FEMALE. Body length 15.0–17.5 mm; fore wing length 11.5–16.5 mm. Head in frontal view 1.1 × as wide as high (Fig. 19). Ocelli close to each other (Fig. 20); distance between anterior and posterior ocelli shorter than Od; POD less than their Od; anterior ocellus 0.28–0.34 mm in diameter, slightly larger than posterior ocellus (0.25–0.30 mm in Od); OOD 1.5 × as large as Od. Propodeum finely and shallowly striate anteriorly, deeply striate posteriorly. T1 more or less slender and long (3.2–4.6 mm long, Figs 21–22), 2.9 × longer than the maximum height, 2.6 × as long as its own maximum width. T2 moderately concave sublaterally.

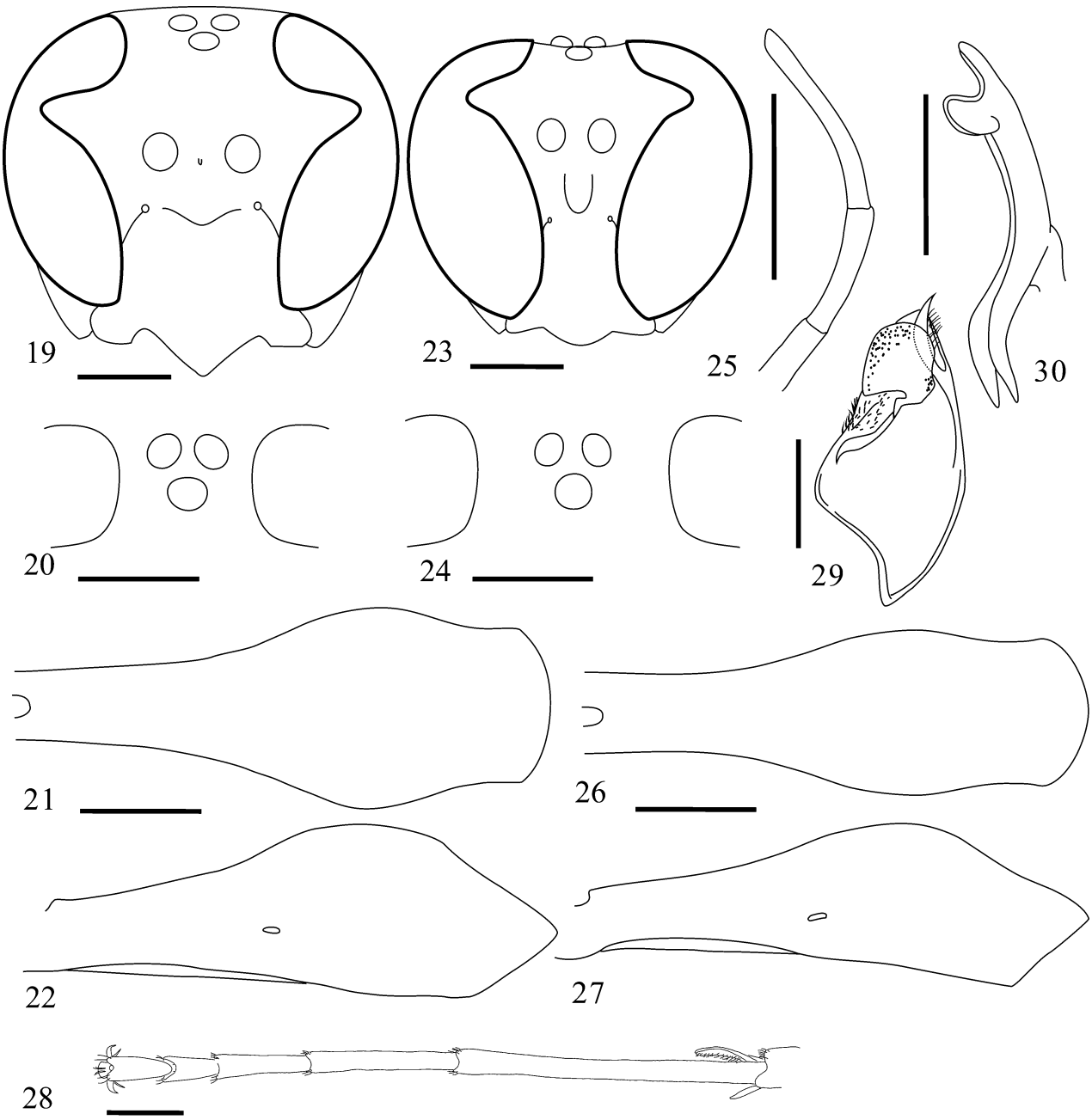
Color. Ground color of head to metasomal segment 1 yellow to light yellow (Fig. 76), with following parts brown to dark brown: antenna (gradually paler towards apex), pair of obscure spots of clypeus, frons, vertex, mesoscutum except paired yellow markings and black median lines, posterodorsal face of propodeum except paired yellow markings, basal one third of femurs, dorsal side of mid and hind tibiae, mid and hind tarsi; and following parts black: scape dorsally, supraclypeal area, anterior margin of clypeus, teeth of mandible, margins of ocelli, anterior and dorsolateral markings of pronotum, margins and median longitudinal line of mesoscutum, dorsal marking and ventral line of mesopleuron, anterior side of metapleuron, anterolateral margin of propodeum, and dorsal face of T1. Second to terminal metasomal segments black, with large and small paired yellow spots respectively on T2 and T3.

MALE. Body length 13.5–15.0 mm; fore wing length 13.5–15.0 mm. Head in frontal view 1.1 × higher than wide (Fig. 23). Eyes enlarged. Ocelli close to each other (Fig. 24); distance between anterior and posterior ocelli less than half of Od; POD less than one-third of Od; anterior ocellus diameter 0.31–0.35 mm, larger than that of posterior ocellus (0.28–0.31 mm); OOD about equal to Od. Antenna extremely thin and long, 13 mm in length; F11 1.6 × as long as F10 (0.9–1.0 mm long, Fig. 25). Pronotal carina dorsolaterally bluntly angled. Metanotum anteriorly acutely angled and posteriorly bluntly angled. Propodeum finely striate between sparse distinct striae. T1 not robust and long (3.6–3.9 mm, Figs 26–27), 3.4 × longer than its maximum height, 2.9 × as long as its own maximum width. Legs extremely thin and long (Fig. 28), hind tibia more than 5.0 mm. Volsella elongate. Digitus broadly bulged (Fig. 29). Parameral spine short, with rather sparse fine setae. Proximal margin of aedeagus ventrally produced (Fig. 30).

Color. As in female, but face entirely brown.

Distribution. Myanmar (Tenasserim), Vietnam (North and Central Vietnam), Laos.

Remarks. Van der Vecht (1966) described *P. indica bioculata* based on two females from "Tenasserim". Not only because its characteristic coloration and marking pattern (second and following metasomal segments nearly black, with paired large and small yellow spots respectively on T2 and T3) are stable among all the specimens including those collected from several colonies, but also because the male antennae and legs are prominently elongated in *Parapolybia* wasps, *bioculata* can be reasonably treated as a good species.



FIGURES 19–30. *Parapolybia bioculata*. 19–22. ♀. 23–30. ♂. 19, 23. Head, frontal view. 20, 24. Ocelli, dorsal view. 21, 22, 26, 27. T1 (21, 26. Dorsal view, 22, 27. Lateral view). 25. F9–F11 28. Hind tarsus. 29. Volsella and digitus. 30. Aedeagus. Scale 1 mm.

***Parapolybia fulvinerva* (Cameron, 1900), stat, resurr.**
(Figs 31, 77)

Icaria fulvinerva Cameron 1900: 504, ♀, lectotype (designated by van der Vecht 1966), "Khasia Hills" [India] [OUM].
Parapolybia indica var. (or subsp.) *fulvinerva*: van der Vecht 1966: 26 (key), 30.
Parapolybia indica fulvinerva: Das & Gupta 1984: 429 (catalog); 1989: 179, map 27 (distribution).

Diagnosis. This species can be easily distinguished from other species of the *P. indica* species-group by the following characters: body ground color orenge; wings covered with yellow setae.

Type material. INDIA: LECTOTYPE of *Icaria fulvinerva* Cameron, ♀, type no. 2074, Khasia [OUM]; PARALECTOTYPES of *I. fulvinerva*, 6 ♀, Khasia, G.A.J. Rothney [OUM]; 1 ♀ 1 ♂, Khasia Hills, Assam [IUNH]; 1 ♀, Khasia, P. Cameron coll, 1914-10 [BMNH].

Description. FEMALE. Body length (based on the specimens deposited in the IUNH) 15.0 mm; fore wing length 16.0 mm.

MALE. Body length 10.5 mm; fore wing length 12.0 mm. Male antenna length 8.0 mm; F11 1.6 × as long as F10 (0.6 mm long).

Distribution. India (Assam).

Remarks. Designating the lectotype and a paralectotype of *Icaria fulvinerva*, van der Vecht (1966) remarked "this [*fulvinerva*] will prove to be the worker of *tinctipennis*, but the status of both forms remains doubtful until nest populations have become available…" We examined the types and found that the body coloration (Fig. 77, mesosoma and metasomal segment 1 orange-colored, metasomal segments 2–6 dark brown) and, as pointed out by van der Vecht (1966: 26), the wings with pronounced yellow tinge (wing setae yellow, Fig. 31; wing setae black in other species, Fig. 32) are distinct enough to diagnose this taxon as a good species.

Parapolybia takasagona Sonan, 1944

(Figs 33–35, 78)

Parapolybia takasagona Sonan 1944: 344, ♀, ♂ "Taipei, Tamaru, Rato" (holotype, ♀ from "Tamaru (Rato)", TARI); Starr 1992, 112, figs. 28b, 30 (syn.: *nodosa* van der Vecht, 1966); Yamane *et al.* 1995: 75 (redescription of the type; synonym of *Parapolybia indica* (de Saussure, 1854)).

Diagnosis. This species similar to *P. indica*, *P. nana* **sp. nov.**, *P. crocea* **sp. nov.**, but differs in nodulated T1.

Material examined. HOLOTYPE of *P. takasagona* Sonan 1944, 1 ♀ Tamaru, Rato [= Tianwan, in Datong Township, Yilan County, 24°39'N, 121°27.5'E, 1090 m], 30.viii.1923, J. Sonan [TARI]; PARATYPES of *P. takasagona*, 3 ♀5 ♂, [3 ♂, Kobayashi, Rato (=? no modern name, 24°39'N, 121°30.5'E, 670 m, Datong Township, Yilan County), 28.viii.1923, J. Sonan; 1 ♀, Taiheizan (Taipingshan or Taiping Mountain, Yilan County, 24°30'N, 121°32'E, 1900 m), ii.1930, S. Minowa; 1 ♀, Kobayashi, Rato, 29.viii.1923, J. Sonan; 1 ♀, Arisan (= Alishan, 23°32'N, 120°48'E), 2.v.1917, T. Shiraki; 1 ♂, Taiheizan, 26.viii.1923, J. Sonan] [TARI]. **Other material.** 3 ♂ (TARI), Lienhuachih, 650 m, Nantou Hsien, xii.1984, K.S. Lin & K.C. Chou; 2 ♀ (NTM; both identified as "*Parapolybia indica*" by Sk. Yamane in 1994), 159 K, Central Cross Highway, Hualien, [9.ix.1989, C.C. Chiou; 12.viii.1989, J.T. Chao]; 1 ♀ (NTM), Yangmingshan [25°09'N, 121°33'E, 450–550 m], Taipei, 31.v.1994, H.Y. Wang.

Description. FEMALE. Body length 14.0–15.0 mm (holotype, 14.0 mm); fore wing length 12.0–13.5 mm (holotype, 13.0 mm).

MALE. Body length 12.0–13.0 mm; fore wing length 10.0–11.5 mm. Male antenna length 9.0 mm; F11 about 0.8 mm long, 1.8 × as long as F10.

Distribution. Taiwan.

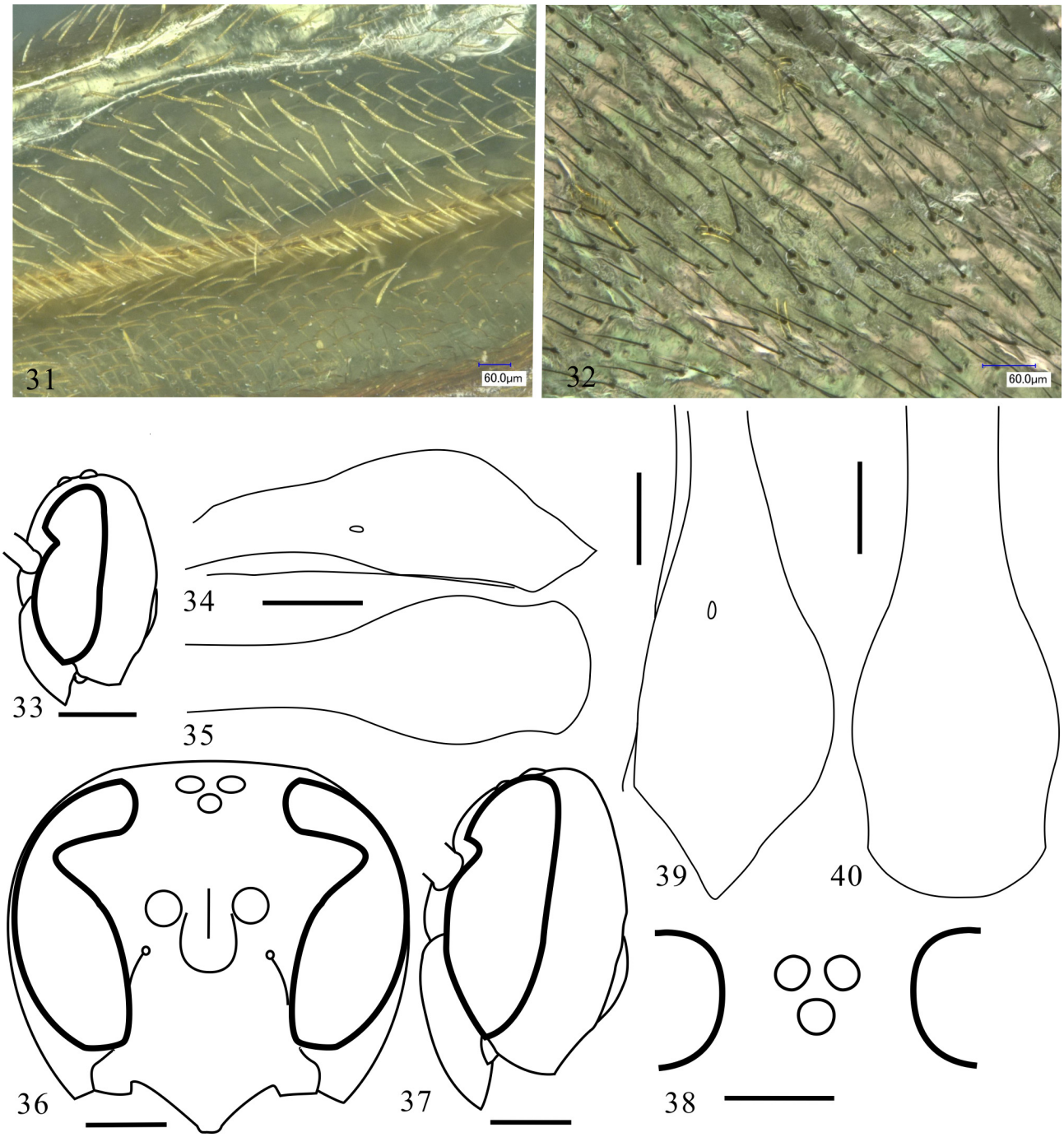
Remarks. Starr (1992), having examined the holotype of *P. takasagona*, concluded that *P. takasagona* was a valid species and the senior synonym of *Parapolybia nodosa* van der Vecht, 1966; this synonymy, however, has not been accepted (see Yamane *et al.* 1995; Kojima *et al*. 2011). Yamane *et al*. (1995) examined the holotype of *P. takasagona* and concluded that *P. takasagona* was a junior synonym of *P. indica* (de Saussure 1854). Their synonymy, however, as pointed out by Kojima *et al*. (2011), was not based on a robust taxonomic considaration. Not only based on differences in coloration (Fig. 78) but also morphological differences [less developed female gena (Fig. 33), club-shaped T1 (Figs. 34–35)], we have concluded that *P. takasagona* is a good species and might be endemic to Taiwan.

Parapolybia tinctipennis (Cameron, 1900), stat. resurr.

(Figs 36–40, 79, 88)

Icaria tinctipennis Cameron 1900: 503, ♀, designated here, "Khasia Hills" [India] [OUM].

Parapolybia indica tinctipennis: van der Vecht 1966: 29; Das & Gupta 1984: 429 (catalog); 1989: 179, fig. 30a, map 27 (distribution).



FIGURES 31–40. *Parapolybia fulvenerva*, *P. crocea* **sp. nov.**, *P. takasagona* and *P. tinctipennis*. 31–32. Setae of wings. 31. *Paraplybia fulvinerva*. 32. *P. crocea* **sp. nov.** 33–35. *Parapolybia takasagona*, ♀. 33. Head, lateral view. 34, 35. T1 (34. Lateral view, 35. Dorsal view). 36–40. *Parapolybia tinctipennis*, ♀. 36, 37. Head (36. Frontal view, 37. Lateral view). 38. Ocelli, dorsal view. 39, 40. T1 (39. Lateral view, 40. Dorsal view). Scale 1 mm.

Diagnosis. This species can be distinguished from other *Parapolybia* species by dark body color, by large body size, by strong striation on the propodeum, by strongly swollen T1 posteriorly.

Material examined. LECTOTYPE of *Icaria tinctipennis* Cameron, 1900 (designate here, see Remarks). INDIA: 1 ♀, Khasia [Meghalaya] [OUM]; PARALECTOTYPES of *Icaria tinctipennis*, 4 ♀, Khasia, G.A.J. Rothney [OUM]. 1 ♀, Khasia [BMNH]. **Other material.** CHINA: Fujian, 1 ♀ (AMNH), Yen-ping [26°38'42"N, 118°10'25"E], 8.ix.1917, Ac.5148. VIETNAM: Bac Kan: 4 ♀ (IUNH), 4 ♀ (IEBR), Kim Hy NP, Lang San, Na Ri, 22°14'N, 106°05'E, 600–700 m, 4.viii.2012, L.T.P. Nguyen & IED-c, Nest#VN-NE2012-Pp-01; 1 ♀ (IEBR), Kim Hy NP, Yen Binh, Na Ri, 200 m, 4.vi.2014, L.T.P. Nguyen, D.D. Tran & D.D. Nguyen; Phu Tho: 3 ♀ (IUNH/

IEBR), Xuan Son NP, 600 m, 16.vi.2004, L.T.P. Nguyen; Vinh Phuc: 1 ♀ (IUNH/IEBR), Tam Dao, 1000 m, 8.ix.2000, L.T.P. Nguyen; 8 ♀ (IUNH/IEBR), Tam Dao NP, 800 m, 1–4.vii.2003, L.T.P. Nguyen; 3 ♀ (IUNH/IEBR), Tam Dao, 800 m, 1.vii.2003, L.T.P. Nguyen; 1 ♀ (IEBR), Tam Dao, 900–1200 m, 30.vii–3.viii.2012, D.T. Tran; 1 ♀ (IEBR), Tam Dao, 10.v.2013, D.D. Nguyen; Ha Tinh: 1 ♀ (AMNH), Huong Son, 18°21'N, 106°15'E, 600 m, 22.IV–1.V.1998, Malaise trap, J.M. Carpenter *et al*.; 4 ♀ (AMNH), Huong Son, 18°22'N, 106°13'E, Malaise trap, J.M. Carpenter *et al*. [2 ♀, 15–21.iv.1998, 600 m; 2 ♀, 5.v.1998, 900 m]. LAOS: 1 ♀ (BPBM), Pakkading, Borikhane Prov., 22.iii.1965, native collector.

Redescription. FEMALE. Body length 16.5–19.5 mm; fore wing length 15.5–17.0 mm. Head in frontal view 1.1 × as wide as high (Fig. 36). Gena developed, swollen laterally, in frontal view of head visible in its nearly entire height (Fig. 36), in lateral view slightly narrow than eye (Fig. 37). Ocelli close to each other (Fig. 38); both POD and distance between anterior and posterior ocelli shorter than Od; anterior ocellus diameter 0.29–0.33 mm, slightly larger than that posterior ocellus (0.26–0.30 mm); OOD 2.0 × as large as Od. Propodeum with prominantly strong transverse striae (sometimes only slightly weaker). T1 relatively short and strongly swollen posterodorsally (4.0–4.9 mm long, Figs 39–40), 2.6 × as long as its maximum height, 2.4 × longer than its own maximum width. T2 weakly concave sublaterally.

Color. Body ground color brown to dark reddish brown (Fig. 79), usually with following black and yellow markings (sometimes entirely dark reddish brown): black: teeth of mandible, apical margin of clypeus, central spot on clypeus, anterior margin of scutum, groove on metapleuron, dorsolateral lines on pronotum, T2–T6; yellow: central spot on pronotal collar, paired basal spots on T2 and T3 [not confirmed in the lectotype due to the basal part of T3 being covered by T2]. Antenna brown to yellow, usually darker beneath. Wings brown, semi-hyaline.

MALE. Unknown.

Distribution. India (Meghalaya), China (Fujian, new record), Vietnam (North Vietnam, new record), Laos (new record).

Remarks. Despite that Cameron (1900) neither mentioned nor gave any indication that he examined more than one specimen, his description of *Icaria tinctipennis* was certainly based on several female specimens as mentioned by van der Vecht (1966) "the typical specimens in the Oxford University Museum … a female of this form in the British Museum, belonging to the type series (ex coll. Cameron)." (p. 29). The female specimen in the OUM labeled "*Icaria tinctipennis* Cam, type Khasia", "TYPE HYME 2073 *Icaria tinctipennis* Cameron, 1900 HOLOTYPE ♀" "HOPE ENT COLL., OUMNH" and "type no. 2073" is herewith designated as the lectotype of *Icaria tinctipennis* Cameron, 1900. Other four female specimens (labeled "Khasia Coll. G.A.J. Rothney" and "G.A.J. Rothney Coll. Donated 1910") in the OUM and one female specimen (labeled "1♀ *Icaria tinctipennis* Cam Khasia" "P. Cameron Coll. 1914-110" and "Para-type") in the BMNH are paralectotypes.

Based only on the presence of the complete female occipital carina, van der Vecht (1966) "Provisionally … regard *tinctipenis* as a subspecies of *P. indica*" (P. 29), but he also mentioned that "It would be desiable to compare the male of this form with that of typical *indica*." (P. 29) and "the status of the two forms … *fulvinerva* and *tinctipennis* is doubtful; they may represent different species, but it seems as well possible that they are castes or colour variations of one and the same species" (P. 26). No male specimens were available to us, but we have concluded that *P. tinctipennis* can be diagnosed as a good species by the combination of the following characters: dark body color, large body size, strong striation on the propodeum and the posteriorly strongly swollen T1.

Parapolybia flava Saito-Morooka, Nguyen & Kojima, sp. nov.

(Figs 41–52, 80, 86)

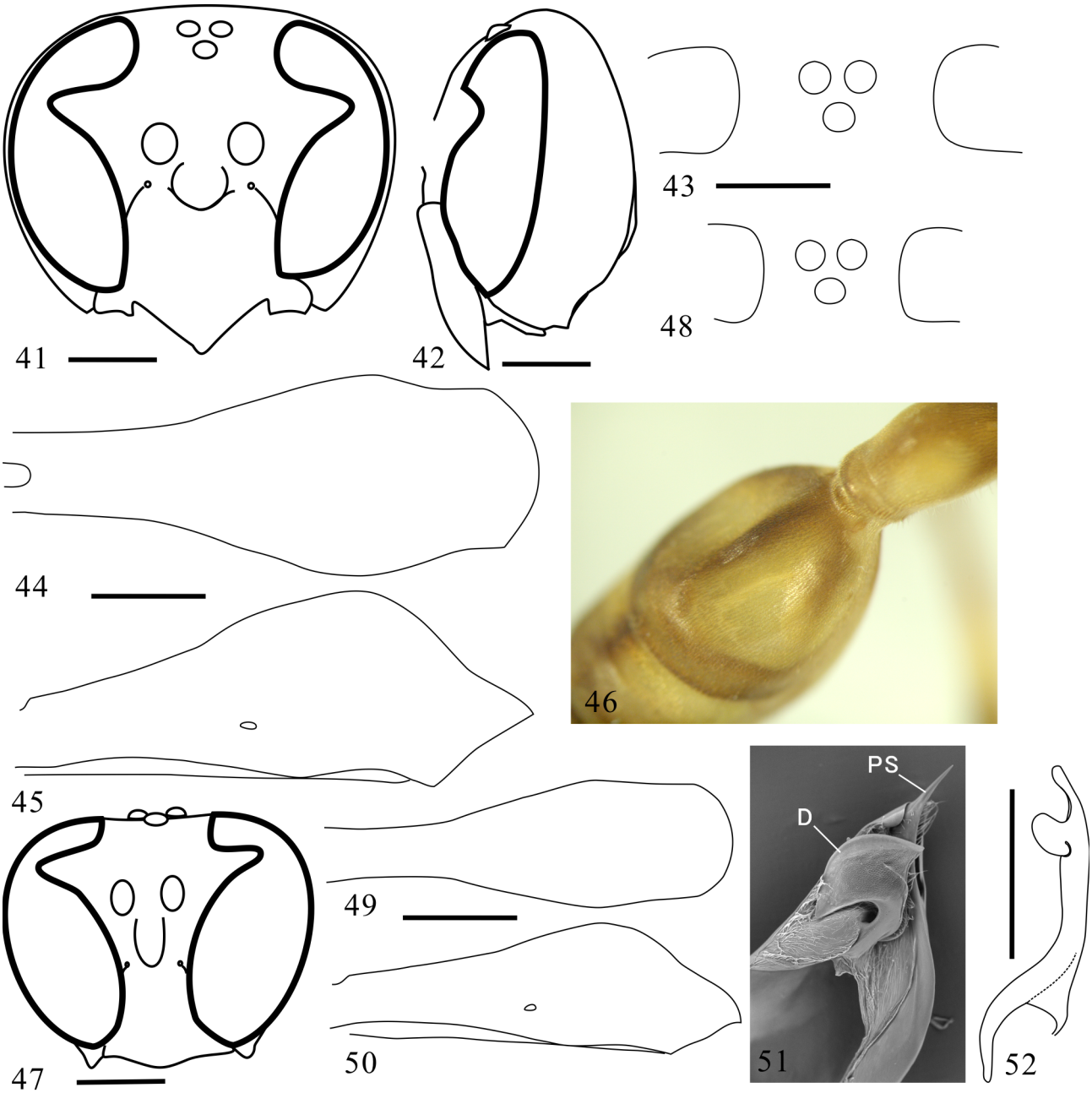
Parapolybia indica indica (?): van der Vecht 1966: 29, part.

Diagnosis. This species can be distinguished from other species of the *P. indica* species-group by the combination of the following characters: female gena well developed, swollen posterolaterally; in both sexes, T2 distinctly concave on both sides of median line.

Type material. HOLOTYPE: ♀, VIETNAM: Thanh Cong, Nguyen Binh, Cao Bang Prov., 22°32.5'N, 105°52'E, 700 m, 7.viii.2012, J. Kojima & H. Nugroho, nest# VN-NE2012-Pp-10" [IUNH, long-term loan from IEBR], PARATYPES: VIETNAM: Cao Bang: 7 ♀ 2 ♂ [IUNH], Thanh Cong, Nguyen Binh, J. Kojima & H.

Nugroho, [5 ♀ 2 ♂, 22°32.5'N, 105°52'E, 700 m, 7.viii.2012, nest# VN-NE2012-Pp-10; 3 ♀, 22°34'N, 105°52.5'E, 1000 m, 9.viii.2012, nest# VN-NE2012-Pp-11]; 6 ♀ [IUNH], Nguyen Binh, Thanh Cong, J. Kojima, H. Nugroho & IED-c [4 ♀, 22°34'N, 105°53'E; 1 ♀, 22°32.5'N, 105°52'E]; Bac Kan: 4 ♀1 ♂ [IUNH], Na Ri, 22°12'51"N, 105°58'42"E, 550 m, 5.viii.2012, J. Kojima & H. Nugroho, nest# VN-NE2012-Pp-09; Ha Tinh: 700 m, 30.v.2004, L.T.P. Nguyen.

Description. FEMALE. Body length 15.0–18.0 mm; fore wing length 14.0–15.5 mm. Head in frontal view 1.1 × as wide as high (Fig. 41). Gena developed, swollen laterally, in frontal view of head visible in its entire height (Fig. 41), in lateral view about as wide as eye (Fig. 42). Ocelli close to each other (Fig. 43); distance between anterior and posterior ocelli shorter than Od; POD less than their Od; anterior ocellus diameter 0.20–0.24 mm, posterior ocellus diameter 0.20–0.24 mm; OOD 2.0 × as large as Od. Propodeum finely and shallowly striate in anterior half, deeper posteriorly. T1 posteriorly swollen (4.0–5.0 mm long, Figs 44–45), 3.0 × longer than the maximum height, 3.0 × as long as its own maximum width. T2 distinctly depressed sublaterally (Fig. 46).



FIGURES 41–52. *Parapolybia flava* **sp. nov.** 41–46. ♀. 47–52. ♂. 41–42, 47. Head, 41, 47. Frontal view. 42. Lateral view. 43, 48. Ocelli, dorsal view. 44, 45, 49, 50. T1 (44, 49. Dorsal view, 45, 50. Lateral view). 46. T2, laterodorsal view. 51. Volsella and digitus. PS, parameral spine. D, Digitus. 52. Aedeagus. Scale 1 mm.

Color. Body yellow (Fig. 80), with following parts brown to dark brown: dorsal part of scape, pedicel, basal half of flagellum (varying between individuals), paired ill-defined spots on clypeus, frons, vertex, anterior spot and line along posterodorsal margin of pronotum, median longitudinal band of mesoscutum, scutellum, tegula, median longitudinal band of propodeum, anterodorsal half of T1, anterior half of S1, S2–S6 except for dorsal yellow markings (remarkably varying in size and shape), basal spot of mid and hind femerora, basal half of mid and hind tibiae. Following parts black: anterior margin of clypeus, teeth of mandible, margin of ocelli, anterior margin and posterior line of mesoscutum, groove of mesopleuron, mid and hind tarsi.

MALE. Body length about 13.0 mm; fore wing length 12.0 mm. Head in frontal view 1.1 × higher than wide (Fig. 47). Eye enlarged. Ocelli close to each other (Fig. 48); distance between anterior and posterior ocelli less than half of Od; POD about half of their Od; anterior ocellus diameter 0.24–0.26 mm, posterior ocellus diameter 0.22–0.24 mm; OOD 1.3 × as Od. Antenna thin and long, F11 2.0 × as long as F10. T1 not robust (about 3.5 mm, Figs 49–50), 3.0 × longer than its maximum height, 3.0 × as long as its own maximum width. T2 distinctly depressed sublaterally (Fig. 46). Legs thin and long, hind tibia 4 mm. Volsella elongate. Digitus broadly bulged, strongly bend inward. Parameral spine short, with dense hairy setae (Fig. 51). Proximal margin of aedeagus ventrally produced (Fig. 52).

Color. Body light yellow (Fig. 80); following parts light brown to orange: mesoscutum and scutellum; following parts brown to dark brown: dorsal part of scape, pedicel, dorsal side of flagellum (darker basally), frons, vertex, anterial mark and dorsolateral line of pronotum, median line and anterior margin of mesoscutum, median line of scutellum, median and dorsolateral lines of propodeum, groove on mesopleuron, dorsal mark of T1, T2 except for paired large yellow spots, tarsi.

Etymology. The specific name originates from a Latin *flavus* with reference to the body coloration.

Distribution. Vietnam (North Vietnam).

Parapolybia crocea **Saito-Morooka, Nguyen & Kojima, sp. nov.**

(Figs 3, 4, 53–64, 84, 87)

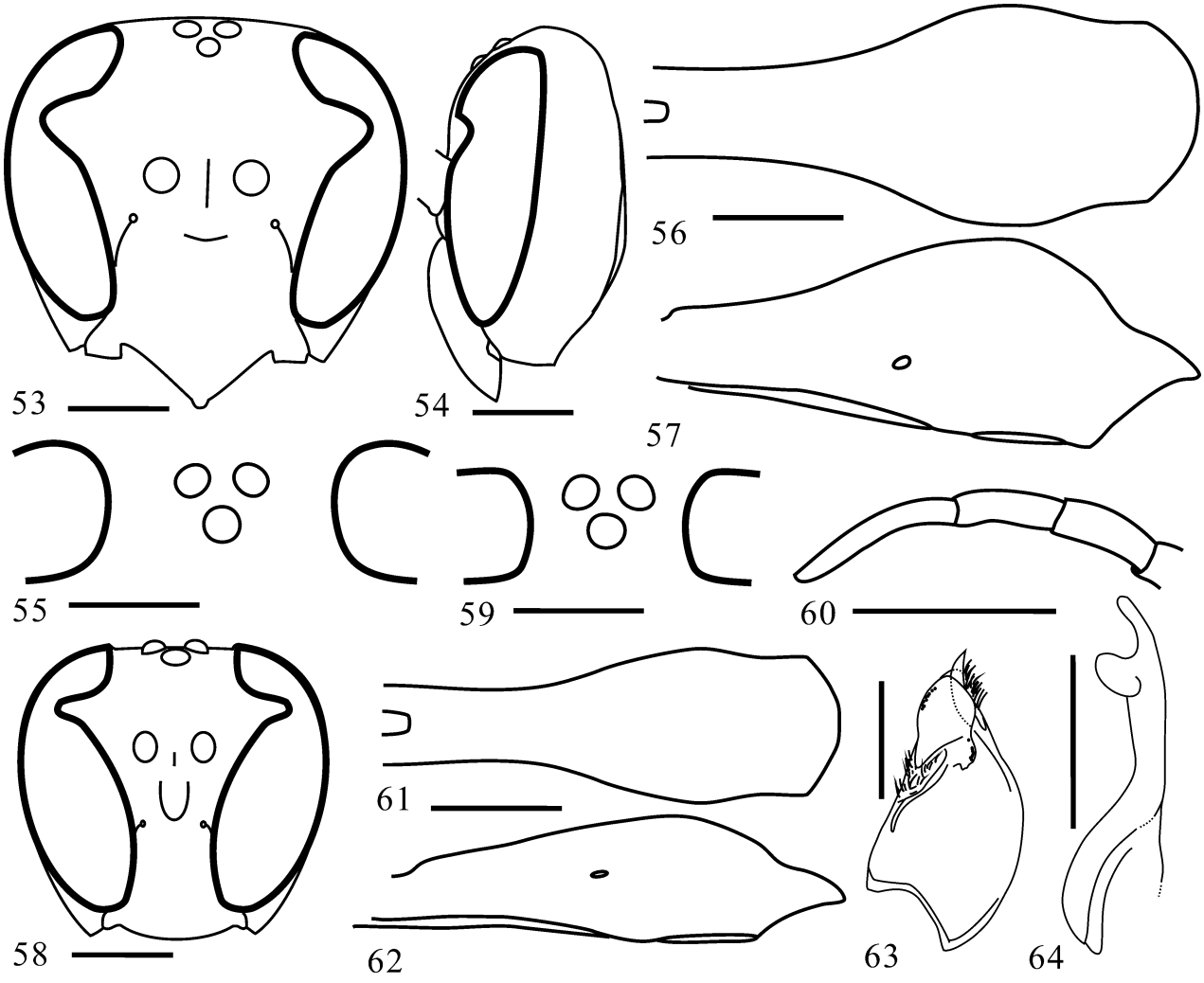
Parapolybia indica: Yamane *et al*. 1995: 75 (syn.: *P. takasagona* Sonan, 1944), 77; Kurzenko 1995: 282 (key); Yamane *et al*. 1999: 452.

Parapolybia indica indica: van der Vecht 1966: 26 (key), 27, fig. 11a, part.

Diagnosis. This species is similar to *P. indica*, but distinguished from the latter by the following characters: female paired longitudinal yellow band on mesoscutum and paired yellow spots on T2 distinct; male genital volsella apically rounded.

Type material. HOLOTYPE: ♀, JAPAN: Shimonomiya, Daigo, Ibaraki, 15.ix.2014, 36°49'15"N, 140°23'07"E, 190 m, F. S.-Morooka [IUNH]. PARATYPES. JAPAN: Ibaraki: 2 ♀ [IUNH], Mito, 24.vii.2008, S. Nohara; 4 ♀ 2 ♂ [IUNH], Daigo, 24–27.viii.2010, J. Kojima; 2 ♂ [IUNH], Diago, 15.ix.2014, F. S.-Morooka; 3 ♀ [IUNH] Shimonomiya, Daigo, 36°49'15"N 140°23'07.5"E, 190 m, 30.vii.2014, J. Kojima; 1 ♂ [NIAES], Kouyadai, Tsukuba, 15–26.ix.1993, T. Matsumura; Tokyo: 14 ♂ [NIAES], Mt. Takao, J. Minamikawa, [6 ♂, 9.ix.1963; 1 ♂, 15.ix.1963; 6 ♂, 22.ix.1963; 1 ♂, 29.ix.1963]; Chiba: 2 ♀ [NIAES], Godaibata, Kimitsu, M. Nitta *et al.* [1 ♀, 2–9.vii.1997; 1 ♀, 25.vi.–2.vii.1997]; Yamanashi: 2 ♂ [NIAES], Shiotu, 14.ix.1964. KOREA: Seoul: 20 ♀ (IUNH), 37°28'N, 126°57'E, Seoul National Univ., 12.viii.2010, J. Kojima, [10 ♀, Nest#Pp-K-2010-2; 10 ♀, Nest#Pp-K-2010-3]. CHINA: Guangdong (=Kwangtung): 1 ♀ (BPBM), N. Kwangtung, Loh-Chang Dist., 11.ix.1947, J.L. Gressitt. VIETNAM: Vinh Phuc: 2 ♀1 ♂ (IUNH), Tam Dao, 900–1200 m, 30.vii–3.viii.2012, D.T. Tran. **Other material.** JAPAN: Akita: 3 ♀ (IUNH), Yuse SA, Kazuno, 40°07'33"N 140°50'06"E, ca. 275m, 6.ix.2014, J. Kojima; 10 ♀ (IUNH), Kosaka PA, Kosaka, 40°20'40"N 140°43'53"E, ca. 260 m, 5.x.2014, J. Kojima; Iwate: 3 ♀ (IUNH), Kinshuko SA, Nishiwaga, 39°17'56"N 140°50'35"E, ca. 310 m, 5.ix.2014, J. Kojima; Fukushima: 1 ♀ (IUNH), Ishikawa-machi, 37°08'26.90"N 140°27'39.46"E, ca. 400 m, 14.viii–25.xi.2013, Bait Traps, F. S.-Morooka; Saitama: 1 ♀ (IUNH), Kumagaya, 36°06'N; 139°22'E, 50 m, 9–17.viii.2012, Bait Traps, F.S.-Morooka; 1 ♀ (IUNH), Nourin park, Fukaya, 36°06'N; 139°17'E, 90 m, F. S.-Morooka; Tokyo: 1 ♀ (SEHU), Mt. Mitake, 23.vi.1962, K. Kondo; 2 ♂, Mt. Takao, 27.viii.1966, M. Suwa; Toyama: 1♀ (SEHU), Ooiwa, Toyama, 27.vii.1983, S. Takagi; Gifu: 1 ♀ (SEHU), Dachi, Tokishi, 8.x–8.xii.2007, Malaise Trap, S. Tsukamoto; Shizuoka: 3 ♀ 4 ♂ (SEHU), Shizuoka, Hirano, T. Hattori, (3 ♀ 3 ♂, 18.ix.1977, 1 ♂, 14.ix.1977); Wakayama: 1 ♂ (SEHU),

Kozagawa, Wakayama-shi, 21.ix.1974, T. Kumata; 2 ♀ 1 ♂ (SEHU), Kiiohshima, Kushimoto-cho, E. Ikeda [2 ♀, 29.iv.1991, 1 ♂, 6.ix.1990]; 1 ♀ (IUNH), Megurogawa, Wakayama, 24.vii.2000, J. Kojima; Kochi: 1 ♀ (SEHU), Kochi-shi, 16.ix.1934, K. Oike; Nagasaki: 2 ♀ (IUNH), Mine, Tsushima, 34°27'41"N 129°18'42"E, 26.vii.2014, J. Kojima; Fukuoka: 3 ♀ (SEHU), [2 ♀, Hisayama, Fukuoka, 2.vii.1992, E. Ikeda; Kyoto: 1 ♀, Daimonjiyma, Sakyo, Kyoto[-shi], 28.vii.1992]; Kumamoto: 1 ♂ (SEHU), Neko-Dake, Takamori-cho, 12.ix.2006, S. Imamura; 1 ♀, Otogase, chouyou-son, 30.iv.2007, S. Imamura; Kagoshima: 1 ♀ (SEHU), Mt. Takakuma, 26.iv.1967, T. Kocha; 1 ♀ (SEHU), Kirishima jingu, 500–900 m, 10–12.vi.1980, M. Suwa; 2 ♀ (SEHU), 31°53'N, 130°50'E, Kirishima onsen, Makizono-cho, 24–25.viii.2002, T. Yoshida; 3 ♀ (SEHU), Y. Rokusawa [1 ♀, vi.2004; 1 ♀, Oyamda-cho, Kagoshima-shi, 3.vii.2004; 1 ♀, Kenminno-mori, Aira-cho, 14.v.2004]; 4 ♀ (SEHU), Isa, Okujissou, 28.vii.2007, T. Yamasaki. CHINA: Fujian: 1 ♀ (BPBM), Foochow, vii.1924, J.F. Illingworth; Hong Kong: 1 ♀ (BPBM), N.T. Taipokau, 15.vi.1964, W.J. Voss & W.M. Hui. TAIWAN: Taipei: 1 ♀ (NMNS), Yangminshan, 27–28.vii.1998, M.M. Yang & M.L. Chan; Yilan: 1 ♀ (TARI, PARATYPE of *Paraplybia takasagona* Sonan), Taiheizan [=Taipingshan], ii.1930, S. Minowa, 84; Taoyuan: 1 ♀ (NMNS), No.07 Prov. RD, 43–57 km, 11–12.ix.1999, M.M. Yang; Nantou: 1 ♀ (NMNS), Lienhuachin, 2.v–12.vi.2001, C.S. Lin & W.T. Yang. VIETNAM: Cao Bang: 2 ♀ (IUNH), Thanh Cong, Nguyen Binh, J. Kojima *et al*. [1 ♀, 22°32.5'N, 105°52'E, 7.viii.2012; 1 ♀, 22°34'N, 105°53'E, 9.viii.2012]; Hoa Binh: 8 ♀ (IUNH/IEBR), Pa Co, Mai Chau, 20°44.5'N, 104°53.5'E, 1450 m, 27.viii.2006, L.T.P. Nguyen, F. Saito & J. Kojima, Nest#VN-Pp-2006-16. LAOS: Vientiane: 4 ♀ (BPBM), Ban Van Heue, [2 ♀, 14–15.iv.1965, J.L. Gressitt; 1 ♀, 20 km E of Phou-know-kuei, 15–31.iv.1965, native collector; 1 ♀, 20 km E of Phou-know-kuei, 1–15.iv.1965, J.A. Rondon]. THAILAND: Chon Buri: 1 ♀ (BPBM), Ban Bang Phra, 6.iii.1968, D.E. Hardy.



FIGURES 53–64. *Parapolybia crocea* **sp. nov.** 53–57. ♀. 58–64. ♂. 53–54, 58. Head. 53, 58. Frontal view. 54. Lateral view. 55, 59. Ocelli, dorsal view. 56, 57, 61, 62. T1 (56, 61. Dorsal view, 57, 62. Lateral view). 60. F9–F11 63. Volsella and digitus. 64. Aedeagus. Scale 1 mm.

Description. FEMALE. Body length 12.0–15.0 mm; fore wing length 10.5–14.5 mm. Head in frontal view, about as wide as high (Fig. 53). Gena developed, somewhat swollen laterally, but hardly visible in frontal view of head (Fig. 53), in lateral view about as wide as eye (Fig. 54). Ocelli close to each other (Fig. 55); distance between anterior and posterior ocelli rarely longer than half of Od; POD less than Od; anterior ocellus diameter 0.25–0.28 mm, larger than Od (0.22–0.27 mm); OOD 1.9 × as large as Od. Eyes with sparse, short setae. T1 long (2.9–3.9 mm long, Figs 56–57), posteriorly swollen dorsally, 3.0 × longer than the maximum height, 2.5 × as long as its own maximum width.

Color. Body ground color yellow (Fig. 3); following parts brown to dark brown: scape and pedicel dorsally, anterior margin of clypeus, teeth of mandible, narrow ill-defined band in bottom of supraclypeal area, spot above antennal socket, vertex, median spot on pronotal collar, narrow band along posterodorsal margin of pronotum, median furrow of mesopleuron, anterior margin of mesoscutum, mesoscutum except for paired longitudinal yellow bands, anterior margin, median line and dorsolateral lines of propodeum, dorsal side of T1, T2–T6 except for paired large basal yellow spots, posterior margin of S2–S5. Legs yellow; mid and hind trochanters, dorsal line of femur, apical one-third of tibia, brown. Wings semihyaline, pale brown (Figs 3–4).

MALE. Body length 12.0–13.0 mm; fore wing length 12.0–13.0 mm. Head in frontal view 0.9 × as wide as high (Fig. 58). Ocelli close to each other (Fig. 59); distance between anterior and posterior ocelli less than Od; POD less than Od; anterior ocellus diameter 0.24–0.29 mm, larger than Od (0.21–0.26 mm); OOD about equal to Od. F11 1.6 × as long as F10 (0.7–0.8 mm, Fig. 60). T1 less swollen than in female (3.1–3.4 mm long, Figs 61–62), 3.3 × longer than the maximum height, 2.8 × as long as its own maximum width. Parameral spine with dense hairy setae (Fig. 63). Digitus apically slightly bulged. Proximal margin of aedeagus ventrally produced (Fig. 64).

Color. Similar to female, but narrow brown band at bottom of supraclypeal area and small spot above antennal socket absent.

Etymology. The specific name originates from a Latine *croceus* (yellow, golden) with reference to the body coloration.

Distribution. Japan (except Hokkaido and south of Kuchino-jima island in the Nansei Islands) (Yamane *et al.* 1999, Takamizawa 2005, cited as "*Parapolybia indica*"), South Korea, China (Guangdong, Fujian, Hong Kong), Taiwan, Thailand, Laos, Vietnam (North Vietnam).

Remarks. In addition to the references listed in the synonimies, all of the refernces describing biological aspects of the Japanese population under "*Parapolybia indica*", such as Sekijima *et al*. (1981), Sugiura *et al*. (1983a, b), Kojima (1992a, b) and Saito-Morooka (2014), are of this species.

Parapolybia nana **Saito-Morooka, Nguyen & Kojima, sp. nov.**

(Figs 65–69, 81, 82)

Parapolybia indica indica (?): van der Vecht 1966: 29, part.

Diagnosis. This species is similar in the external morphology to *P. indica* and *P. crocea* **sp. nov.**, but can be easily distinguished from the latters by the female vertex behind the posterior ocelli sloping down to the occipital carina after a narrower flat area.

Type material. HOLOTYPE: ♀, VIETNAM: Mai Chau, Pa Co, Hoa Binh Prov., 20°44.5'N, 104°53.5'E, ca. 1450 m, 27.viii.2006, L.T.P. Nguyen, F. Saito & J. Kojima, nest# VN-Pp-2006-16" [IUNH, long-term loan from IEBR]. PARATYPES: VIETNAM: Hoa Binh: 7 ♀ with same data as holotype [IEBR, IUNH].

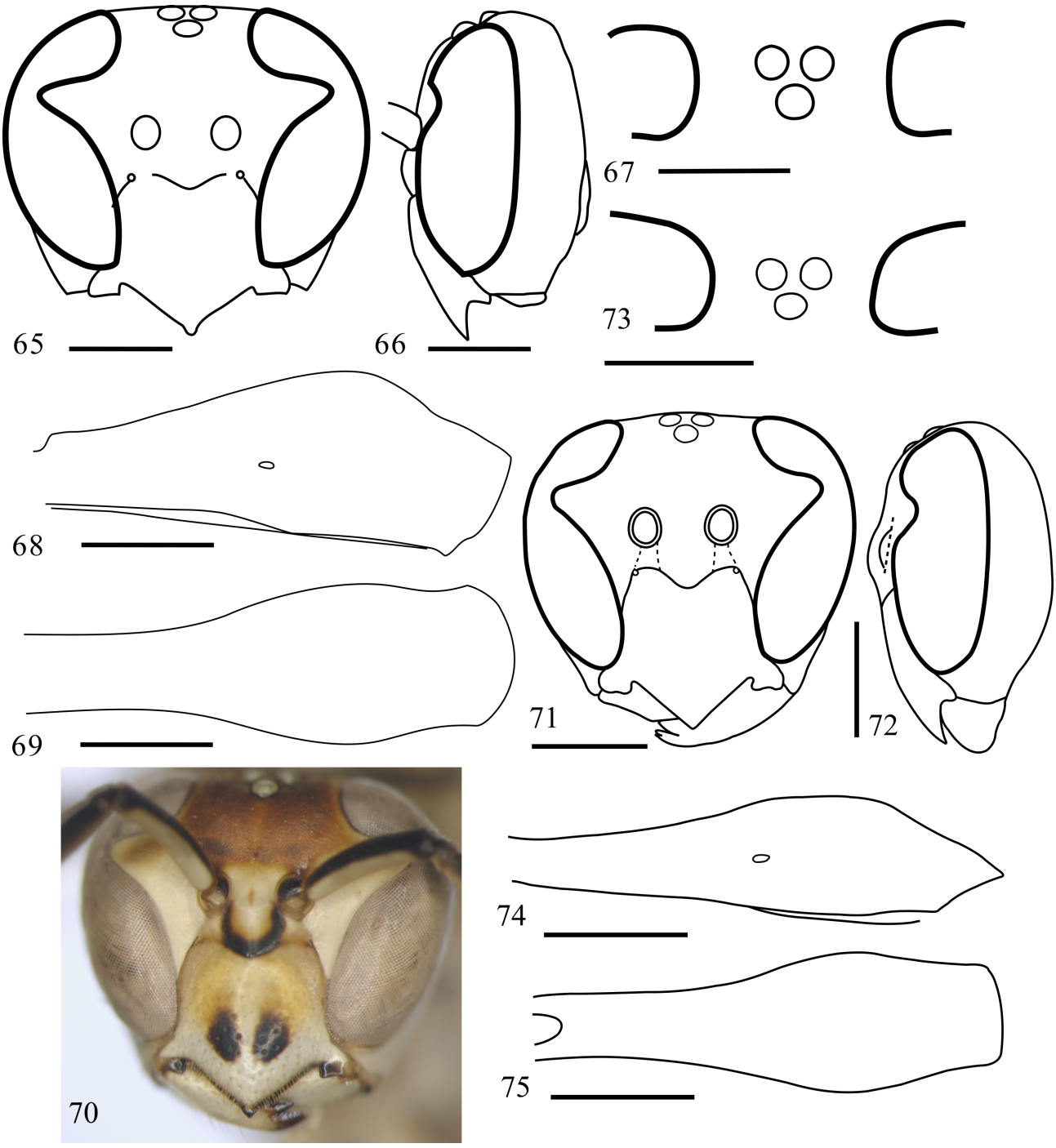
Description. FEMALE. Body length about 14.0 mm; fore wing length 12.5–14.0 mm. Head in frontal view 1.1 × as wide as high (Fig. 65). Gena barely swollen laterally, in frontal view of head invisible (Fig. 65), in lateral view 0.7 × as wide as eye (Fig. 66). Vertex behind posterior ocelli sloping down to occipital carina after narrow flat area (Fig. 82). Ocelli close to each other (Fig. 67); distance between anterior and posterior ocelli shorter than Od; POD less than their Od; anterior ocellus diameter 0.25 mm, Od 0.20 mm; OOD 2.0 × as large as Od. Propodeum with fine shallow transverse striae in anterior one third, striation stronger and deeper posteriorly. T1 thin and long (about 3.8 mm long, Figs 68–69), 3.5 × longer than the maximum height, 3.0 × as long as its own maximum width.

Color. Similar to *P. crocea*, but ambiguous paired brown spots on clypeus and metasoma distinctly darker (Fig. 81) as follows: segments 2–6 brown to dark brown, with paler colored lateral spots on T2.

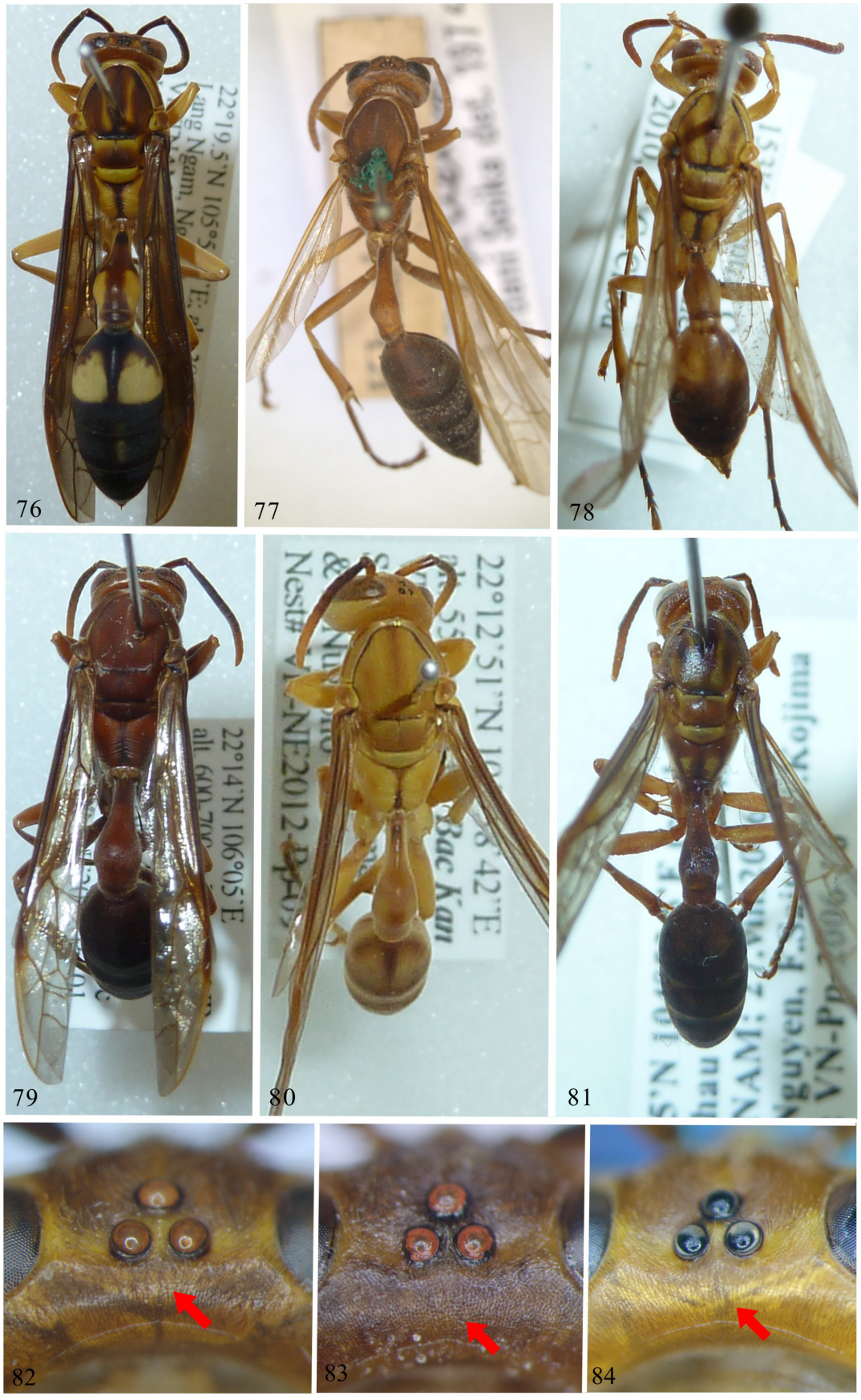
MALE. Unknown.

Etymology. The specific name originates from a Latin *nanus* with reference to the appearance.

Distribution. Vietnam (North Vietnam).



FIGURES 65–75. *Parapolybia nana* **sp. nov.** and *P. albida* **sp. nov.** 65–69. *P. nana* **sp. nov.**, ♀. 65, 66. Head (65. Frontal view, 66. Lateral view). 67. Ocelli, dorsal view. 68, 69. T1 (68. Lateral view, 69. Dorsal view). 70–75. *P. albida* **sp. nov.**, ♀. 70, 71, 75. Head (70, 75. Frontal view, 71. Lateral view). 72. Ocelli, dorsal view. 73, 74. T1 (73. Lateral view, 74. Dorsal view). Scale 1 mm.



FIGURES 76–84. 76. *Parapolybia bioculata*. 77. *P. fulvinerva*. 78. *P. takasagona*. 79. *P. tinctipennis*. 80. *P. flava* **sp. nov.** 81. *P. nana* **sp. nov.** 82. *P. nana* **sp. nov.** 83. *P. indica*. 84. *P. crocea* **sp. nov.** 76–81. ♀, dorsal view. 82–84. Vertex, ♀, dorsal view. An arrow indicating flat area behind ocelli.

***Parapolybia albida* Saito-Morooka, Nguyen & Kojima, sp. nov.**
(Figs 70–75)

Diagnosis. This species is similar in the external morphology with *P. nana* **sp. nov.**, but can be easily distinguished from other species of the *P. indica* species-group by the presence of paired dark brown spots on female clypeus (Fig. 70) and ivory white body ground color.

Type material. HOLOTYPE: ♀, VIETNAM: Thanh My, Thanh Chuong, Nghe An Prov., 28.v.2008, L.T.P. Nguyen [IEBR]. PARATYPES: VIETNAM: Vinh Phuc: 1 ♀ [IEBR], Ngoc Thanh, Me Linh, 13–14.v.2013, L.T.P. Nguyen; Lang Son: 1 ♀ [IEBR/IUNH], Na Tan, Binh Gia, 3.vi.2014, L.T.P. Nguyen; Hai Phong: 2 ♀ [IEBR], Cat Ba, Cat Hai, 20°47'36"N, 106°59'25"E, 25.vii.2013, L.T.P. Nguyen & D.D. Nguyen; Nahe An: 6 ♀ [IEBR], same collection data as holotype.

Description. FEMALE. Body length 13.5 mm; fore wing length 12.5 mm. Head in frontal view slightly wider than high (Fig. 71). Gena narrow, invisible in frontal view of head (Fig. 71), in lateral view 0.7 × as wide as eye (Fig. 72). Ocelli close to each other (Fig. 73); distance between anterior and posterior ocelli rarely longer than half of Od; POD less than Od; anterior ocellus diameter 0.2 mm, as large as Od; OOD 1.5 × as large as Od. T1 slender (about 3.5 mm long, Figs 74–75), posteriorly weakly swollen, 3.0 × longer than the maximum height, 3.0 × as long as its own maximum width.

Color. Ground color ivory white. Following parts brown to dark brown: scape and pedicel dorsally, anterior margin of clypeus, paired spots on clypeus (Fig. 70), teeth of mandible, narrow U-shaped mark in suproclypeal area, frons (light brown), vertex, dosal area of pronotal collar, narrow band along posterodorsal margin of pronotum, median furrow of mesopleuron, mesoscutum except for paired longitudinal yellow bands, anterior margin, median line and dorsolateral lines of propodeum, dorsal side and posterior margin of T1, margin and arrow-shaped mark on T2, margin and posteromedial area of T3–T6, posterior margin and posteromedial spot of S2–S5. Legs grey; dorsal half of mid and hind trochanters, dorsobasal one-third of hind femur, tarsi, brown to dark brown. Wings semi-hyaline, pale brown.

MALE. Unknown.

Etymology. The specific name is a Latin adjective *albidus*, with reference to the body coloration.

Distribution. Vietnam (North Vietnam).

Key to species of *Parapolybia indica* species-group

Unless the sexes are mentioned, the characters given in the following key are of females.

1. Body ground color brown to dark brown (Fig. 79); mesoscutum more than 4 mm wide; propodeum with strongly striate; T1 strongly swollen in posterior half (Figs 39–40) . . . . . *P. tinctipennis* (Cameron)
- Body ground color, at least of head and mesosoma, much less dark, ivory white, yellow to light brown or orange. Mesoscutum less than 3.5 mm wide; T1 weakly to moderately swollen posteriorly 2
2. Body ground color orange (Fig. 77); wings yellow tinged (covered with yellow setae) (Fig. 31) . . . . . *P. fulvinerva* (Cameron)
- Body ground color ivory white or yellow to light brown, with brown to black markings (Figs 3, 5, 76, 78, 80–81); wings with black setae (Fig. 32) 3
3. Metasomal segments 2 and 3 much darker than mesosoma, nearly black, T2 and T3 respectively with large and paired small yellow spots (Fig. 76); antenna and legs, especially in male, prominently elongated . . . . . *P. bioculata* (van der Vecht)
- Metasomal segments 2 and 3 more or less same colored as mesosoma, with or without darker markings; antenna and legs not prominently elongated. 4
4. In both sexes, T2 distinctly concave sublaterally (Fig. 46). Gena developed, visible in frontal view of head (Fig. 41), in lateral view slightly wider than eye (Fig. 42). . . . . *P. flava* **sp. nov.**
- In both sexes, T2 barely or only weakly concave sublaterally. Gena not strongly swollen laterally, invisible in frontal view of head (Figs 7, 53, 65, 71), in lateral view as wide as or narrower than eye (Figs 9, 33, 54, 66, 72) 5
5. Body ground color ivory white. Clypeus with distinct paired dark brown spots (Fig. 70). . . . . *P. albida* **sp. nov.**
- Body ground color yellow to light brown. Clypeus without dark spots 6
6. T1 in lateral view nodulated posteriorly (Fig. 34) . . . . . *P. takasagona* Sonan
- T1 in lateral view more or less smoothly swollen dorsally toward level of spiracle (Figs 11, 57, 68) 7
7. Flat area of vertex behind posterior ocelli narrow (Fig. 82) . . . . . *P. nana* **sp. nov.**
- Flat area of vertex behing posterior ocelli wide (Figs 83–84) 8
8. Paired yellow longitudinal lines on mesoscutum and spots on T2 absent or obscure (Fig. 5) . . . . . *P. indica* (de Saussure)
- Paired yellow longitudinal lines on mesoscutum and spots on T2 distinct (Fig. 3) . . . . . *P. crocea* **sp. nov.**

Notes on nests of *Parapolybia indica* species-group

Of the nine species recognized in the *Parapolybia indica* species-group in this study, five (*P. bioculata*, *P. flava* **sp. nov.**, *P. indica*, *P. tinctipennis*, and *P. crocea* **sp. nov.**) are known for their nests [our own examination of the nests of these five species (Figs 85–90); Takamizawa (2005) for *P. crocea* **sp. nov.** as "*P. indica*"]. Their nest characters are basically the same as follows: comb: single, platy in shape, generally positioning vertically, pale yellow to pale brown in color, made of rather long plant fibers mixed with adult wasps' oral secretion, attached to the substrate via single or sometimes multiple (in later stage of colony development) pedicels; cell: slightly diverging towards open end, more or less regularly arranged, hexagonal in transverse cross section, but outer free margins of peripheral cells rounded, with transparent "window" (closed with adult wasps' oral secretion) at the bottom (of a cell with thin layer of silken cocoon); cocoon cap: barely domed, rarely produced beyond the rim of cell, often applied with pulpy material. The nest pedicels in mature nests, except those in *P. bioculata*, are usually single, but when a comb is parallel to the substrate one to few additional pedicels may be made, buttress-like, wide, usually thick, more or less the same color as the combs, and made of mainly plant fibers mixed with adult wasps' oral secrtion. Nests in the pre-emergence stage [before the emargence of first brood adult wasps] were available only for *P. crocea*, in which the pedicels are column-shaped, thin and coated with adult wasps' oral secrtion. In *P. bioculata*, the pedicels are thin, column-shaped, shiny black in color, and thickened by repeated coating of adult wasps' oral secretion over the central core of plant fibers; a relatively smaller nest has a single pedicel (Fig. 89), and a large nest may have additional thin pedicels, which usually made only with adult wasps' oral secretion (lacking the central core of plant fibers) (Fig. 90; with 15 petioles).

Discussion

In this study, we revised the taxonomy of the *Parapolyia indica* species-group occurring in East Asia and areas along the eastern slope of the Himalayas, and recognized nine species. Other than the areas treated in this study, a single female of "*P. indica indica*" was recorded from Borneo (Samarang near Sandakan, Sabah) (van der Vecht 1966), but the specific identity of the specimen is not yet confirmed.

Wasps of the *Parapolyia indica* species-group show the distribution pattern similar to that of the *Polistes* (*Polistella*) species with the second metasomal sternum basally strongly swollen (Nguyen *et al*. 2011), though their occurrence on the southern slopes of the Himalayas (so-called "Himalayan Corridor") has not yet known. Putting aside the record from Borneo (van der Vecht 1966), all the known distribution records of the *P. indica* species-group, namely from the eastern slope of the Himalayas, through eastern parts of China, and to the Korean Peninsula and Honshu Island of Japan, are areas with more or less temperate climate. It seems highly possible that the center of divergence of the *P. indica* species-group is in the northern parts of the Indochina on the eastern slope of the Himalayas. However, it does not necessary means that the origin of the *P. indica* species-group is in that area. A discussion on the zoogeography of the *P. indica* species-group will be made only after a detailed species-level phylogenetic analysis of *Parapolybia* that includes the species of the other Oriental species-group, namely the *P. varia* species-group, is carried out.

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FIGURES 85–90. Nests. 85. *Parapolybia indica*. 86. *P. flava* **sp. nov.** 87. *P. crocea* **sp. nov.** 88. *P. tinctipennis*. 89, 90. *P. bioculata.*

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