



***Polistes (Polistella)* wasps (Hymenoptera: Vespidae: Polistinae) from mountainous areas of northern Vietnam, with description of five new species**

LIEN THI PHUONG NGUYEN^{1,4}, JUN-ICHI KOJIMA² & FUKI SAITO³

¹*Insect Ecology Department, Institute of Ecology and Biological Resources, Vietnamese Academy of Science and Technology, 18 Hoang Quoc Viet Road, Nghia Do, Cau Giay, Hanoi, Vietnam and Natural History Laboratory, Faculty of Science, Ibaraki University, Mito, 310-8512 Japan. E-mail: phuonglientit@yahoo.com*

²*Natural History Laboratory, Faculty of Science, Ibaraki University, Mito, 310-8512 Japan. E-mail: jkrte@mx.ibaraki.ac.jp*

³*Natural History Laboratory, Faculty of Science, Ibaraki University, Mito, 310-8512 Japan. E-mail: fsfsaito@gmail.com*

⁴*Corresponding author: E-mail: phuonglientit@yahoo.com*

Table of contents

Abstract	1
Introduction	2
Material & methods	2
Subgenus <i>Polistella</i> Ashmead 1904	3
<i>Polistes (Polistella) dawnae</i> Dover & Rao 1922	3
<i>Polistes (Polistella) lepcha</i> Cameron 1900	7
<i>Polistes (Polistella) relicinicypeus</i> Nguyen, Kojima & Saito, sp. nov.	9
<i>Polistes (Polistella) paco</i> Nguyen, Kojima & Saito, sp. nov.	14
<i>Polistes (Polistella) curcipunctum</i> Nguyen, Kojima & Saito, sp. nov.	15
<i>Polistes (Polistella) gilvus</i> Nguyen, Kojima & Saito, sp. nov.	17
<i>Polistes (Polistella) clandestinus</i> Nguyen, Kojima & Saito, sp. nov.	19
Notes on other species of subgenus <i>Polistella</i>	21
<i>Polistes (Polistella) adustus</i> Bingham 1897	22
<i>Polistes (Polistella) affinis</i> Gusenleitner 2006	22
<i>Polistes (Polistella) horrendus</i> Gusenleitner 2006	22
<i>Polistes (Polistella) mandarinus</i> de Saussure 1853	22
<i>Polistes (Polistella) nigerrimus</i> Gusenleitner 2006	22
<i>Polistes (Polistella) nipponensis</i> Pérez 1905	24
<i>Polistes (Polistella) opacus</i> Gusenleitner 2006	24
<i>Polistes (Polistella) quadricingulatus</i> Gusenleitner 2006	24
<i>Polistes (Polistella) rubellus</i> Gusenleitner 2006	24
<i>Polistes (Polistella) santoshae</i> Das & Gupta 1989	24
Key to species of subgenus <i>Polistella</i> of northern Vietnamese mountainous areas	24
Discussion	26
Acknowledgments	29
References	29

Abstract

A total of 14 species of subgenus *Polistella* Ashmead 1904 of genus *Polistes* Latreille 1802 are recognized in the mountainous areas of northern Vietnam, the eastern margin of the eastern slope of the Himalayas. A key to these species is provided. Five new species are described: *P. curcipunctum* Nguyen, Kojima & Saito, **sp. nov.**; *P. relicinicypeus* Nguyen, Kojima & Saito, **sp. nov.**; *P. gilvus* Nguyen, Kojima & Saito, **sp. nov.**; *P. paco* Nguyen, Kojima & Saito, **sp. nov.**; and *P. clandestinus* Nguyen, Kojima & Saito, **sp. nov.** The male of *P. dawnae* Dover & Rao is described for the first time. Nests of *P. lepcha* Cameron, *P. dawnae* Dover & Rao, *P. relicinicypeus* and *P.*

gilvus are also described. All of these 14 *Polistella* species are characterized by having the second metasomal sternum that is basally strongly swollen. Distribution patterns of these 14 *Polistella* species are discussed. *Polistes nipponensis* Pérez is newly recorded from Vietnam, *P. affinis* Gusenleitner, *P. horrendus* Gusenleitner are newly recorded from northern Vietnam, *P. santoshae* Das & Gupta is newly recorded from central Vietnam, and *P. adustus* Bingham is newly recorded from Bhutan.

Key words: paper wasps, Vespidae, *Polistes*, *Polistella*, new species, nests, Vietnam

Introduction

The genus *Polistes* Latreille 1802 is the only cosmopolitan genus in the social Vespidae (Stenogastrinae, Polistinae, and Vespinae). With more than 200 valid species, the genus is currently divided into four subgenera, with their phylogenetic relationships expressed as (*Gyrostoma* + (*Polistella* + (*Polistes* s. str. + *Aphanilopterus*))) (Carpenter 1996a). The subgenera *Gyrostoma* Kirby & Spence 1828, *Polistella* Ashmead 1904, and *Polistes* Latreille 1802 are distributed in the Old World (including Australasia), but a few species of subgenera *Gyrostoma* and *Polistes* have been accidentally introduced into the New World; and subgenus *Aphanilopterus* Meunier 1888 is distributed exclusively in the New World.

Among three Old World subgenera, *Polistella*, with 78 valid species, is the largest in term of the number of species and most widely distributed, occurring in most parts of the Old World except in Europe, Mediterranean Africa and the Arabian Peninsula (Carpenter 1996a, b). Notably, 12 of the 14 species of subgenus *Polistella* known from the northern part of the Indo-Burma biodiversity hot spot, the area on the eastern slope of the Himalaya, are endemic to this area (Das & Gupta 1984, 1989; Gusenleitner 2006). This suggests that the northern part of the Indo-Burma biodiversity hot spot is a center of divergence of subgenus *Polistella*. Faunas of social vespid wasps including that of subgenus *Polistella* in this area, especially in northern Indochina, are still poorly investigated, however.

In our researches on the social wasp faunas in the northern parts of Vietnam conducted in these several years, we have recognized 14 species of subgenus *Polistella* in the mountainous areas. The present paper deals with the taxonomy and nesting biology of these paper wasps, including the description of the following five species as new to science: *Polistes curcipunctum* **sp. nov.**, *P. relicinicypeus* **sp. nov.**, *P. gilvus* **sp. nov.**, *P. paco* **sp. nov.**, and *P. clandestinus* **sp. nov.** A key to the species of subgenus *Polistella* known from northern Vietnam is provided to facilitate further studies on social wasps in the area. Finally, the distribution pattern of these species of subgenus *Polistella* occurring in the mountainous areas of northern Vietnam is discussed.

Material and methods

Most of the specimens examined in the present study were those collected by ourselves and those having been deposited in the Institute of Ecology and Biological Resources (IEBR), Hanoi, Vietnam. Acronyms of other collections/institutions where the specimens examined are housed are as follows:

AMNH, American Museum of Natural History, New York, USA;

IUNH, Natural History Collection at Ibaraki University, Mito, Japan;

NIAES, National Institute for Agro-Environmental Sciences, Tsukuba, Japan;

NSM, National Science Museum, Tsukuba, Japan;

OLM, Oberösterreich Landesmuseum, Linz, Austria;

RMNH, Nationaal Natuurhistorische Museum - Naturalis, Leiden, the Netherlands.

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 metasomata 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. The terminology of male genitalia follows Kojima (1999). Drawings were made with the aid of a drawing tube installed on the stereoscopic dissecting microscope.

In the descriptions of adult morphology, the following abbreviations are used: POD, distance between the inner margins of the posterior ocelli; OOD, distance between the outer margin of the posterior ocellus and the inner margin of the eye at vertex; Od, transverse diameter of the posterior ocellus.

The parts measured for the morphometric characters referred to in the descriptions are defined as follows: body length, the lengths of head, mesosoma and first two metasomal segments combined; the width of the clypeus, the distance between the uppermost points where clypeus touches eyes; the height of the clypeus, the distance from the bottom of the dorsal emargination 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 interantennal and antennocular distances, the horizontal distance between the inner margins of antennal sockets and between the outer margin of antennal socket and inner eye margin at the level of middle of antennal socket, respectively; the width of antennal socket, the horizontal diameter; the width of the eye and the gena, the maximum width for each in strictly lateral view of the head; the length of metasomal tergum 1, 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; the length of metasomal tergum 2 (or segment), the distance in lateral view from the bottom of the basal depression or “neck” to the posterodorsal end of the tergum; the width of the first and second metasomal segments, the maximum width for each in dorsal view.

The nest characters, including measurements of various parts given below, were examined after the immatures had been taken out and the nests had been air-dried. The length and thickness (minimum and maximum thicknesses at the mid-length) of a nest pedicel and the distance between opposite sides of a cell containing a pupa or having the trace of a cocoon cap (“cell width”) were measured to the nearest 0.1 mm with vernier calipers. The thickness of cell wall was taken with a micrometer to the nearest 0.01 mm. The terminology of nest characters follows Wenzel (1998). In the description of nest comb shapes, “ventral” and “dorsal” refer to the directions corresponding to cell openings and cell bottoms, respectively.

Personal names and collectors are abbreviated as follows: FS, F. Saito; HP, H. P. Pham; ISD-c, staff members of the Insect Systematic Department (IEBR); JK, J. Kojima; and LN, L. T. P. Nguyen. “NP” stands for National Park.

Subgenus *Polistella* Ashmead 1904

Polistella Ashmead 1904: 133, as genus. Type species: *Polistes manillensis* de Saussure 1853, by original designation.

***Polistes (Polistella) dawnae* Dover & Rao 1922**

(Figs 1–13, 85)

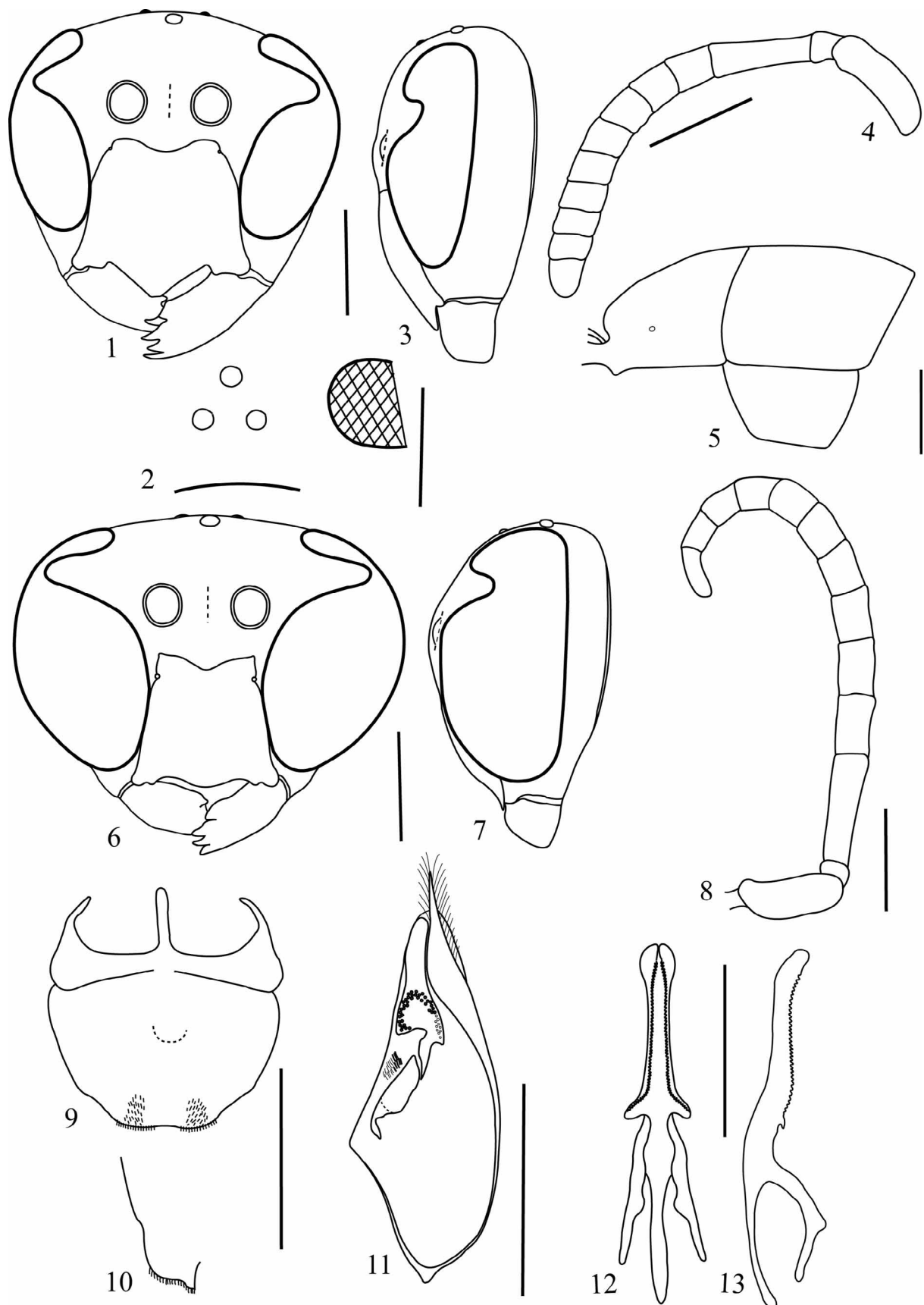
Polistes dawnae Dover & Rao 1922: 248, ♀, holotype Dawna Hills [16°50'N, 98°15'E], Burma [Myanmar], [Zoological Survey of India, Kolikata].

Polistes dawnae was described by Dover & Rao (1922) based on a single female specimen (holotype) from Dawna Hills [16°50'N, 98°15'E], Burma [Myanmar], which is housed in the Zoological Survey of India, Kolikata. Das and Gupta (1989) gave a detailed description of the characters of the holotype, and no further information on this species has been added since then. The male and a nest of this species are herewith described.

The female specimens we examined well agreed well with the description by Das and Gupta (1989). One of the seven females collected at the Muong Nhe NP Station was the only adult found on the nest described here. The nest was made in a cut bamboo and had no immatures in it. The other six females and a male were collected in flight near the nest site and may have emerged from the nest. As described below, the male is similar to the female both in structure and coloration except for some characters.

Material examined. 1 ♀ (NSM), Thung Man Pass, Phong Tho, Lai Chau, alt. 1200 m, 9.V.1995, A. Shinohara; 7 ♀, 1 ♂ (IEBR, IUNH), Muong Nhe NP Station, Dien Bien, 22°18.5'N, 102°24'E, 23.VII.2009, LN, HP & JK; 1 ♂ (IEBR), Pa Co, Mai Chau, Hoa Binh, alt. 1000 m, 23.VIII.2005, LN & JK.

Description. MALE [female characters in square brackets]. Body length about 10 mm [10.5–11 mm]; fore wing length about 10 mm [10.5–11 mm].



FIGURES 1–13. *Polistes (Polistella) dawnae*. 1–5. ♀. 6–13. ♂. 1, 3, 6–7. Head. 1, 6. Frontal view. 3, 7. Lateral view. 2. Ocelli, eye and posterior margin of vertex. 4, 8. Right antenna. 5. Metasomal segments 1 and 2, lateral view. 9–10. Terminal sterna. 9. Ventral view. 10. Apical part, lateral view. 11. Inner aspect of paramere with digitus and volsella. 12–13. Aedeagus. 12. Ventral view. 13. Lateral view. Scale 1 mm.

Head in frontal view (Fig. 6) about $1.4 \times$ [about $1.2 \times$ (Fig. 1)] as wide as high. Vertex slightly raised in area among ocelli; POD:OOD=1:1.5 [1:1.9 (Fig. 2)]; POD about $1.7 \times$ [about $1.6 \times$] Od. Eye much more strongly swollen laterally than in female; inner eye margins about $1.4 \times$ [about $1.1 \times$] further apart from each other at vertex than at clypeus. Gena narrow [more or less wide], in lateral view (Fig. 7) about $0.3 \times$ [about $0.8 \times$ (Fig. 3)] as wide as eye; weakly raised blunt ridge present, running along posterior margin of eye [absent]. Clypeus in frontal view (Fig. 6) about as wide as high, apical margin slightly produced, broadly rounded [pointed apically (Fig. 1)]; in lateral view (Fig. 7) slightly convex dorsally, slightly concave ventrally [weakly swollen anteriorly in dorsal half (Fig. 3)]; surface covered with dense short golden hairs [upper half of clypeus covered with fine pale pubescence and lower half with scattered deep large punctures each bearing sharply pointed golden bristle]. Antenna (Fig. 8) with slenderer flagellum than in female (Fig. 4); scape short and thick, about $2.8 \times$ [about $3.0 \times$] as long as its maximum width; flagellomere 1 as long as [slightly longer than] length of flagellomeres 2 and 3 combined; flagellomeres 2 and 3 each longer than wide [as long as wide]; terminal flagellomere slightly curved [bullet shaped], about $2.5 \times$ longer than [as long as] its basal width.

Mesosoma as in female. Pronotal carina sharply raised, produced into thin lamella in dorsal part, slightly sinuate on lateral sides, reaching ventral corner of pronotum. Mesoscutum weakly convex, about as long as wide between tegulae; anterior margin broadly rounded. Disc of scutellum flat, in profile at the same level as mesoscutum. Metanotum weakly convex, strongly depressed along anterior margin. Propodeum short; posterior face widely (about half the maximum width of propodeum) and shallowly excavated medially, more or less smoothly passing into lateral faces; propodeal orifice elongate, about $1.8 \times$ as long as wide (measured at widest part), somewhat narrowed in dorsal half. Jugal lobe of hind wing large, rounded.

Metasoma except terminal two segments as in female (Fig. 5). Tergum 1 distinctly shorter than its apical width, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament; corner between anterior and dorsal faces bluntly angled. Sternum 2 in lateral view strongly swollen ventrally in anterior one-third, then ventral margin bluntly angled into nearly straight line parallel to ventral margin of the tergum. Metasomal sternum 7 depressed medially, without tubercle (Figs 9, 10).

Body surface sculpture as in female, except for densely-haired clypeus. Mandible with scattered shallow punctures. Frons and vertex up to level of posterior ocelli with close fine punctures. Vertex behind posterior ocelli and gena with sparse fine punctures; spaces between punctures smooth; punctures in ventral one third of gena scattered and deep. Pronotum with dense deep punctures; spaces between punctures very narrow, slightly raised to form reticulation. Mesoscutum with scattered deep flat-bottomed punctures and dense fine punctures between flat-bottomed punctures. Scutellum and metanotum with scattered deep punctures. Mesepisternum with coarse dense well-defined punctures in posterodorsal part; punctures in dorsal margin similar to those on pronotum. Dorsal metapleuron with weak striation; ventral metapleuron with shallow large punctures. Propodeum with distinct transverse striation and punctures between striae on lateral faces; interpuncture spaces weakly raised to interconnect striae. Metasomal segments densely covered with minute punctures in addition to scattered small punctures (ill-defined on terga; more or less well-defined on sterna).

Color. Similar to female [body black, with following yellow markings: large apical spot on clypeus, narrow band along inner eye margin extending from bottom of frons to middle of eye emargination, narrow short band on gena along posterodorsal margin of eye, narrow band along pronotal carina, paired anterolateral spots on metanotum, scrobal spot on mesepisternum, paired large lateral spots on propodeum, propodeal valvula, metasomal tergum 1 except for basal triangular dark-brown spot, and apical margin of tergum 4; legs black], but more extensively marked with yellow as follows: clypeus entirely, mandible except for small basal black spot, ventral half of frons, narrow long band on gena along posterior margin of eye, antennal scape beneath, paired anterolateral spots (sometimes united to form narrow transverse band) on metanotum, spot on propodeal valvula, ventral face of fore coxa and spot on mid-coxa; antennal flagellum reddish brown to dark yellow beneath; paired lateral yellow spots on propodeum much reduced in size.

Male genitalia. Lamina volsellaris desclerotized and fused with cuspis. Digitus in inner aspect of paramere (Fig. 11) slightly more than $3.5 \times$ as long as wide (measured at widest part). Aedeagus (Figs 12–13): penis valve slightly longer than basal apodeme, in ventral view swollen laterally in proximal one fourth and distinctly produced laterally near proximal margin, in lateral view slightly thickened in proximal one fourth and with dorsal margin weakly and smoothly sinuate, with proximoventral corner produced into small tooth (Fig. 13); ventral margin of penis valve finely serrated along entire length.

TABLE 1. Biological data of examined nests of *Polistes* species from subgenus *Polistella*.

Species and nest code	Substrate	Date of collection	Height from ground (m)	Number of					Number of adults collected	
				cells	eggs	larvae	pupae	empty cells	female	male
<i>Polistes lepcha</i>										
VN-P-2006-3	Rock	20.VIII.2006	1.3	229	29	32	41	127	13	0
VN-P-2006-7	Rock	22.VIII.2006	4.0	390	62	53	15	260	38	17
VN-P-2006-9	Rock	22.VIII.2006	1.6	161	29	25	19	88	11	0
<i>Polistes dawnae</i>										
2009-DB-P-01	Inside cut bamboo	21.VII. 2009	1.3	247	0	0	0	247	1	0
<i>Polistes relicinicypeus</i>										
VN-P-2006-4	Palm leaf	21.VIII.2006	0.5	287	5	14	0	268	3	2
VN-P-2006-10	Rock	22.VIII.2006	-	245	0	44	32	169	0	14
VN-P-2006-11	Rock	22.VIII.2006	-	107	22	34	15	36	3	3
VN-P-2006-12	Rock	22.VIII.2006	-	68	2	20	3	43	3	
VN-P-2006-13	Rock	22.VIII.2006	-	580	57	13	55	455	15	15
2008-LC-P-02	unrecorded	25.VI.2008	-	55	0	0	0	55	4	0
2008-LC-P-03	unrecorded	26.VI.2008	-	19	0	0	0	19	2	0
2008-HB-P-03	unrecorded	11.VI.2008	-	63	0	0	0	63	5	0
2009-Sapa-P-01	Rock	5.VII.2009	-	53	0	19	0	34	6	0
<i>Polistes gilvus</i>										
2008-SL-P-1	Shrub branch	7.VI.2008	1.2	126	0	0	2	124	7	0

Nest. A nest (Nest# 2009-DB-P-01) collected in Muong Nhe, Dien Bien on 21 July 2009 was examined (Table 1). As mentioned above, the nest was collected, together with a single female, from the inside of a cut bamboo used for the wall of the kitchen at the Muong Nhe NP Station.

The nest characters other than the nesting site are as follows. Single combed (Fig. 85); comb vertically elongate to fit the space inside the bamboo, about 170 mm long and about 20 mm wide, tough paper-like in texture, uniformly grayish brown. Four nest petioles present (indicated by arrows in Fig. 85); primary petiole (lost while collecting the nest) situated near mid-length of comb, first two cells having been constructed on its tip; other three petioles subsidiary, constructed to connect bottom of preexisting cell and substrate, made exclusively with adult salivary secretion, dark brown and lustrous; one of the subsidiary petioles situated about 34 mm lower from the primary petiole, 4.6 mm long and 0.96×1.4 mm thick; remaining petioles respectively about 49 mm and 57 mm above the primary petiole, and 4.7 mm long and 0.94×1.6 mm thick, and 4.2 mm long and 0.43×1.1 mm thick. Cells generally arranged in regular rows, hexagonal at open end, but partly irregularly arranged, where some cells are pentagonal; outer free margins of peripheral cells rounded; cell gradually expanded towards open end, 3.2 mm (range 2.9–3.6; n=10) wide at bottom and 4.2 mm (range 4.0–4.5 mm; n=10) wide at open end, 11.8 mm (range 10.9–12.1 mm; n=10) deep; cell wall about 0.02 mm thick; cocoon cap slightly domed beyond level of cell opening, pale gray.

Distribution. Northern Myanmar; Northwestern Vietnam.

Polistes (Polistella) lepcha Cameron 1900

(Figs 14–26, 86)

Polistes khasianus Cameron 1900: 415, ♀, "Khasia Hills, Coll. Rothney", nom. praeocc., non Cameron 1900: 413.

Polistes lepcha Cameron 1900: 506. Replacement name for *khasianus* Cameron 1900: 415.

Cameron (1900) described this species based only on the female. The male characters except for the genitalia were described by Das and Gupta (1989). Followings are detailed descriptions of the characters based on the specimens from Vietnam, and the nest is also described.

Material examined. VIETNAM: Binh Lu, Phong Tho, Lai Chau, 22°21.5N 103°46E, 22.VIII.2006, LN, FS & JK [7 ♂, 62 ♀ (IEBR, IUNH), alt. 1600 m, Nest# VN-P-2006-7; 11 ♀ (IEBR), alt. 2000 m, Nest# VN-P-2006-9]; 6 ♂, 19 ♀ (IEBR, IUNH), Sa Pa NP (Silver Waterfall), alt. 2000 m, Nest# VN-P-2006-3, 20.VIII.2006, LN, FS & JK.

Description. FEMALE. Body length 10.5–11mm; fore wing length 11–13.5 mm

Head in frontal view about 1.2 × as wide as high (Fig. 14); in dorsal view weakly swollen laterally just behind eyes, then narrowed posteriorly, with posterior margin shallowly and broadly emarginated. Vertex slightly raised in area among ocelli, slightly slope down behind posterior ocelli towards occipital carina; POD:OOD=1:2.2; POD about 1.4 × Od (Fig. 15). Gena in lateral view about 0.8 × as wide as eye (Fig. 16); occipital carina fine, evanescent in ventral one third of gena. Inner eye margins weakly convergent ventrally, in frontal view of head about 1.1 × further apart from each other at vertex than at clypeus. Antennal sockets closer to inner eye margin than to each other. Anterior tentorial pit slightly further apart from ventral margin of antennal socket than from inner eye margin. Clypeus in frontal view as wide as high (Fig. 14); in lateral view weakly convex (Fig. 16); length of lateral margin of clypeus lying along inner eye margin shorter than diameter of antennal socket. Malar space longer than diameter of antennal socket. Antenna (Fig. 17) with scape slightly more than 3 × as long as its maximum width; flagellomere 1 slightly more than 2.5 × as long as its apical width, longer than length of flagellomeres 2 and 3 combined; flagellomere 2 as long as wide; terminal flagellomere bullet shaped, as long as its basal width.

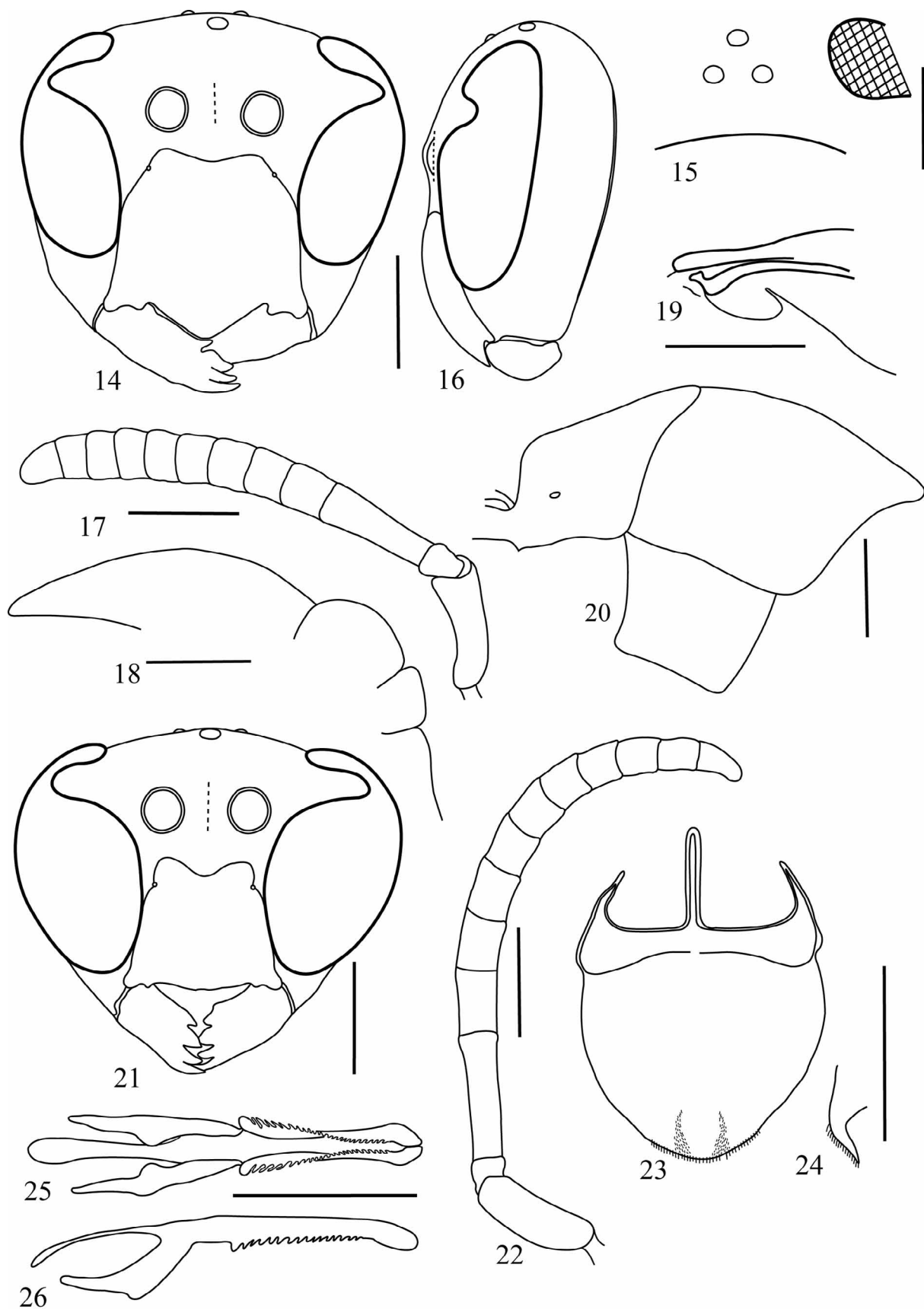
Pronotal carina sharply raised, produced dorsally into thin lamella in dorsal part, slightly sinuate backward on lateral sides, reaching ventral corner of pronotum. Mesoscutum weakly convex (Fig. 18), about as long as wide between tegulae; anterior margin broadly rounded. Scutellum convex, slightly depressed medially. Metanotum weakly convex, strongly depressed along anterior margin. Propodeum short; posterior face with shallow wide median excavation, of which width is about 0.4 × maximum width of propodeum; border between posterior and lateral faces bluntly angled, marked with slightly raised carina; propodeal orifice about 2 × as long as wide (measured at widest part), somewhat narrowed in dorsal half. Jugal lobe of hind wing rounded (Fig. 19).

Metasomal tergum 1 distinctly shorter than its apical width, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament; corner between anterior and dorsal face bluntly angled (Fig. 20). Sternum 2 in lateral view with dorsal margin slightly longer than its ventral margin; anteroventral corner in nearly right-angle (Fig. 20).

Clypeus with scattered large punctures, each bearing sharply pointed golden bristle. Mandible with several deep punctures. Frons densely covered with coarse flat-bottomed punctures. Vertex and gena with sparse strong punctures; punctures around ocelli strong and sparse; ventral one third of gena with sparse strong puncture. Pronotum with dense deep punctures; spaces between punctures very narrow, slightly raised to form reticulation. Mesoscutum with coarse dense flat-bottomed punctures; punctures on scutellum and metanotum dense, smaller than those on mesoscutum. Mesepisternum densely with coarse punctures in posterodorsal part, barely punctured in anteroventral part; border between them distinct. Dorsal metapleuron with striae and sparse punctures. Propodeum with strong sharply-raised transverse striae; lateral face with strong punctures between striae, interpuncture spaces weakly raised to interconnect striae. Metasomal segments densely covered with minute punctures in addition to scattered small punctures (ill-defined on terga; more or less well-defined on sterna).

Color. Black, with following parts orange-yellow: clypeus except black margins, line on gena along postero-dorsal margin of eye, narrow band along pronotal carina with branches running along posterior margin of pronotum, scutellum, apical bands on terga 1 and 5 (wide), orange-yellow. Legs black. Wings pale brown, weakly infusate, slightly more strongly infusate along anterior margin of forewing; veins dark brown.

MALE. Body length 10.5–11mm; fore wing length 11.5–12 mm.



FIGURES 14–26. *Polistes (Polistella) lepcha*. 14–20. ♀. 21–26. ♂. 14, 16, 21. Head. 14, 21. Frontal view. 16. Lateral view. 15. Ocelli, eye and posterior margin of vertex. 17. Right antenna. 18. mesosoma, lateral view. 19. Jugal lobe of right hind wing. 20. Metasomal segments 1 and 2, lateral view. 22. Left antenna. 23–24. Terminal sterna. 23. Ventral view. 24. Apical part, lateral view. 25–26. Aedeagus. 25. Ventral view. 26. Lateral view. Scale 1 mm.

Structure as in female except: head proportionally smaller, more transverse, about $1.5 \times$ as wide as high in frontal view (Fig. 21); eye strongly swollen laterally, inner eye margins about $1.4 \times$ further apart from each other at vertex than at clypeus; gena narrow, in lateral view about $0.6 \times$ as wide as eye, with weakly raised blunt ridge running along posterior margin of eye; clypeus in frontal view with apical margin slightly rounded, about $1.1 \times$ as wide as high, covered with dense short golden hairs; antenna (Fig. 22) slender than in female; scape short, about $3 \times$ as long as its maximum width; flagellomere 1 as long as length of flagellomeres 2 and 3 combined; flagellomeres 2 and 3 each longer than wide; terminal flagellomere elongate, slightly curved, about twice as long as its basal width. Metasomal sternum 7 depressed medially, without tubercle (Figs 23, 24).

Color. Similar to female, but antennal flagellomeres 5-11 reddish-brown to dark yellow beneath.

Genitalia. Similar to that of *Polistes dawnae*, but ventral serration of penis valves coarse and strong, especially in proximal half of penis valves (Fig. 25); penis valves in lateral view with dorsal margin and proximoventral margins both nearly straight (Fig. 26).

Nest. The following three nests were examined: Nest# VN-P-2006-3, Silver Waterfall (22°21.5'N, 103°46.5'E, alt. 1500-2000 m), Sa Pa, Lao Cai, 20.VIII.2006, LN, FS & JK; Nest# VN-P-2006-7 at alt. 1600 m and Nest# VN-P-2006-9 at alt. 2000 m, Binh Lu, Phong Tho, Lai Chau, 22°21.5'N, 103°46'E, 22.VIII.2006, LN, FS & JK (Table 2). They were all collected along the Hoang Lien Pass road, where the nests were on the cliffs along the road and attached directly to rocks 1.3 to 4 m above the road.

Nest structural characters are as follows. Petiole single, terminal, with thin central core of plant fibers (in VN-P-2006-7 petiole with thick irregular central core of plant fibers, Table 2), enlarged strictly with adult salivary secretion, black and lustrous; salivary coating extending onto substrate and back of comb. Comb tough, pliable in texture, dark brownish gray, expanded from the petiole to form fan-shaped in ventral view, with ventral surface convex and dorsal surface deeply concave. Cells generally arranged in regular rows and hexagonal at open end, but partly irregularly arranged and some cells pentagonal; outer free margins of peripheral cells round; each cell expanded towards open end, with width at opening more than $1.5 \times$ larger than that at bottom (Table 2); cell wall about 0.03 mm thick. Cocoon cap slightly domed beyond rim of cell, pale green when spun, weathered with time to become pale gray.

TABLE 2. Measurements of nests of *Polistes lepcha*.

Nest code	Petiole length (mm)	Petiole thickness (mm)	Cell width at open end (mm) (n=10)		Cell width at bottom (mm) (n=10)		Cell depth (mm) (n=10)	
			Mean	Range	Mean	Range	Mean	Range
VN-P-2006-3	3.5	1.5 x 2.1	5.1	4.8–5.4	3.2	3.0–3.6	17.0	16.0–19.1
VN-P-2006-7	3.3	4.2 x 5.1	5.2	5.0–5.6	3.1	2.9–3.7	17.2	15.6–18.4
VN-P-2006-9	3.2	1.7 x 1.8	5.0	4.7–5.3	3.0	2.6–3.4	17.6	16.6–19.1

Remark. This species is distinguished from other species of subgenus *Polistella* occurring in northern Vietnam in having the combination of the following characters: propodeum with strongly and sharply raised transverse striae and strong punctures between the striae on lateral faces; border between the posterior and lateral faces of the propodeum well-defined and weakly carinate; anteriorly truncate second metasomal sternum; penis valves with strong serration along their ventral margins.

Distribution. India: Haryana, Meghalaya, Manipur; northern Vietnam.

***Polistes (Polistella) relicinicypeus* Nguyen, Kojima & Saito, sp. nov.**
(Figs 27–41, 87)

Type material. HOLOTYPE: ♀ (deposited in the IUNH, on long-term loan from the IEBR), labeled “VIETNAM, Binh Lu, Phong Tho, Lai Chau, 22°21'N 103°43.5'E, alt. 1600 m, Nest#: VN-P-2006-13, L.T.P. Nguyen, F. Saito & J. Kojima, 22.viii.2006”. PARATYPES (IUNH and AMNH, on long-term loan from the IEBR): VIETNAM: **Lai Chau:** Binh Lu, Phong Tho, 22°21'N 103°43.5'E, alt. 1600 m, LN, FS & JK, 22. VIII.2006 [15 ♂, Nest# VN-P-

2006-10; 3 ♂, 3 ♀, Nest# VN-P-2006-11; 3 ♀, Nest# VN-P-2006-12]; 15 ♂, 11 ♀, same data as holotype; **Lao Cai**: 2 ♂, 3 ♀, Sa Pa (City, NP office), 22°20'N 103°50'E, alt. 1600 m, Nest# VN-P-2006-4, 21.VIII.2006, LN, FS & JK; 5 ♀, Xin Chai, Sa Pa, alt. 1350 m, 6.VII.2009, HP; 4 ♀, Cat Cat, Sa Pa, alt. 1450 m, 7.VII.2009, HP; 2 ♂, Ta Pin, Sa Pa, alt. 1600 m, 20.VIII.2006, LN, FS & JK; 1 ♀, Ban Khoang, Sa Pa, alt. 1800 m, 20.VIII.2006, LN, FS & JK; 1 ♂, 3 ♀, Sa Pa NP (Silver Waterfall), 22°21.5'N 103°46.5'E, alt. 2000 m, 21.VIII.2006, LN, FS & JK; 3 ♀, Xeomity, Sa Pa, alt. 1700 m, 9.VII.2009, HP; 1 ♂, Sa Pa town, alt. 1600 m, 8.VII.2009, HP, 1 ♂, Sa Pa, alt. 1500–2000 m, 17-18.V. 2003, ISD-c; 6 ♀, Sa Pa, alt. 1600 m, Nest# Sapa-P-01, 5.VII.2009, HP; 4 ♀, Ban Pho, Bac Ha, Nest# 2008-LC-P-02, 25.VI.2008, LN & HP; 2 ♀, Nam Lung, Bac Ha, Nest# 2008-LC-P-03, 26.VI.2008, LN & HP; **Dien Bien**: 2 ♀, Ban Bua, Muong Fang, alt. 1000 m, 14.VI.2001, ISD-c; 1 ♂, Tuan Giao, alt. 1168 m, 25.VI.2009, LN, HP & JK; 1 ♂, Co Ma, Thuan Chau, Son La, alt. 1400 m, 4.V.2009, HP; **Hoa Binh**: 13 ♀, Pa Co, Mai Chau, 20°44.5'N 104°53.5'E, alt. 1450 m, Nest # VN-P-2006-17, 27.VIII.2006, LN, FS & JK; 2 ♂, 6 ♀, Pa Co, Mai Chau, alt. 1000 m, 23.VIII.2006, LN & JK; Pa Co, Mai Chau [1 ♀, alt. 900–1000 m, 27.VI.2001, ISD-c; 1 ♀, alt. 1100 m, 20.V.2002, V. T. Hoang; 5 ♀, alt. 1400 m, Nest# 2008-HB-P-03, 11.VI.2008, LN & HP; 1 ♂, 2 ♀, Pa Co, Mai Chau, alt. 1000 m, 23.VIII.2005, LN & J K.

Diagnosis. This species can be distinguished from all other known species of subgenus *Polistella* by the following combination of characters: female clypeus convex, produced ventrally into blunt angle, in lateral view prominently swollen anteriorly in dorsal one-third; male clypeus bent backward apically; metasomal tergum 1 short and thick, about $0.9 \times$ as long as its apical width, in lateral view abruptly swollen dorsally at base, with corner between anterior and dorsal faces bluntly angled; metasomal sternum 2 in lateral view strongly swollen ventrally in anterior half to two thirds, then ventral margin bluntly angled into straight line parallel to ventral margin of the tergum.

Description. FEMALE. Body length 10.5–11.5 mm (holotype: about 11 mm); fore wing length 11–12 mm (holotype: about 11 mm).

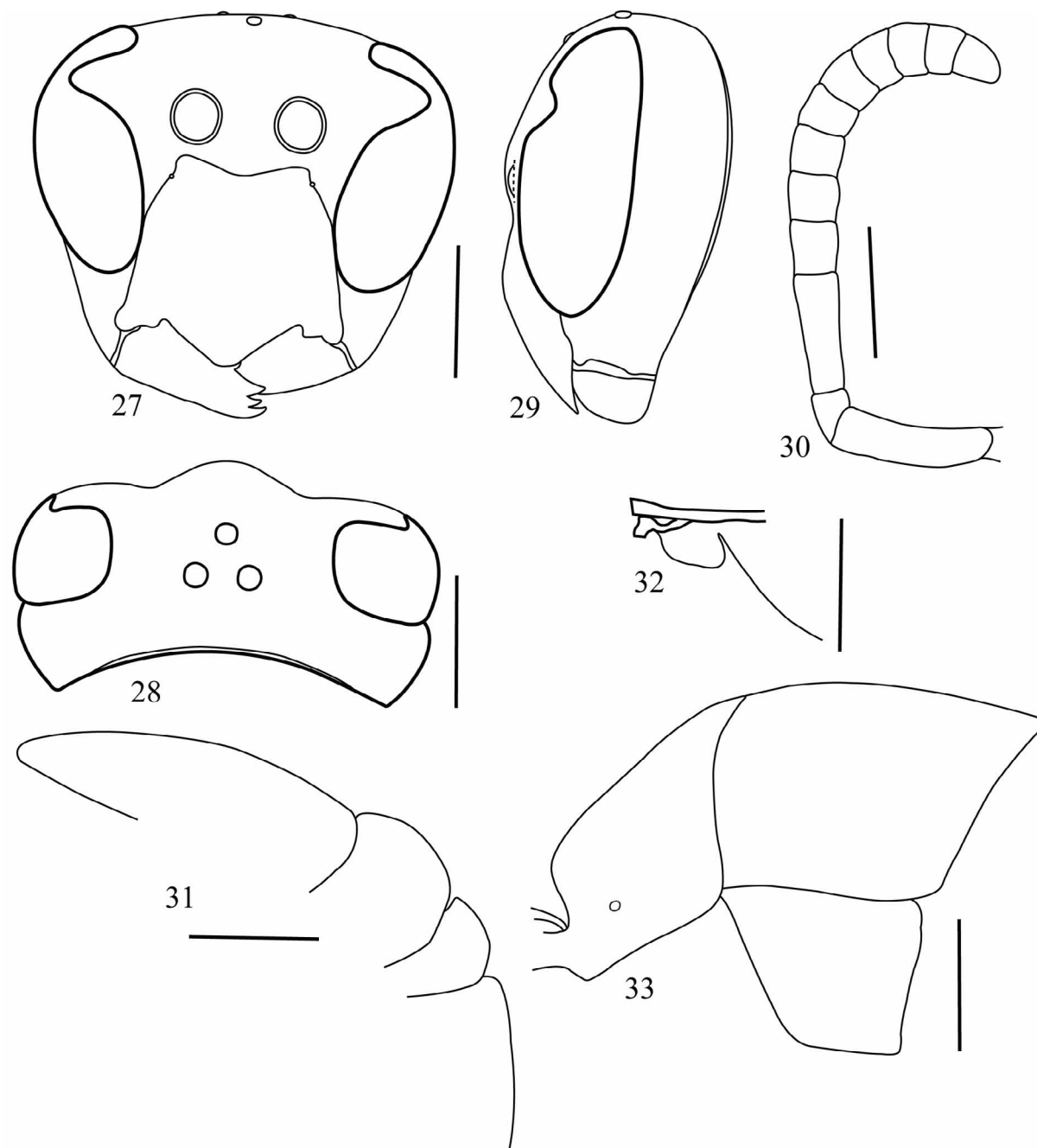
Head in frontal view about $1.2 \times$ as wide as high (Fig. 27); in dorsal view weakly swollen laterally just behind eyes, then narrowed posteriorly, with posterior margin shallowly and broadly emarginate (Fig. 28). Vertex slightly raised in area among ocelli, slightly slope down behind posterior ocelli towards occipital carina; POD:OOD = about 1:1.9; POD about $1.5 \times$ Od. Gena in lateral view about $0.8 \times$ as wide as eye (Fig. 29); occipital carina fine, evanescent in ventral one third of gena. Inner eye margins weakly convergent ventrally, in frontal view about $1.2 \times$ further apart from each other at vertex than at clypeus (Fig. 27). Antennal sockets closer to inner eye margin than to each other; anterior tentorial pit slightly further from antennal socket than from inner eye margin; interantennal space weakly raised. Clypeus in frontal view as wide as high, produced ventrally into blunt angle; in lateral view convex, prominently swollen anteriorly in upper one third (Fig. 29); lateral margin of clypeus lying along inner eye margin about as long as diameter of antennal socket and shorter than length of malar space. Antenna (Fig. 30): scape more than $3 \times$ as long as its maximum width; flagellomere 1 slightly less than $3 \times$ as long as its maximum width, longer than length of flagellomeres 2 and 3 combined; flagellomere 2 as long as wide; terminal flagellomere bullet-shaped, as long as its basal width.

Pronotal carina sharply raised, produced dorsally into thin lamella in dorsal part, slightly sinuate backward on lateral sides, reaching ventral corner of pronotum. Mesoscutum weakly convex (Fig. 31), about as long as wide between tegulae; anterior margin broadly rounded. Scutellum strongly convex except nearly flat median part. Metanotum weakly convex, strongly depressed along anterior margin. Propodeum short; posterior face widely (about half the maximum width of propodeum) and shallowly excavated medially, more or less smoothly passing into lateral faces; propodeal orifice elongate, about $1.8 \times$ as long as wide (measured at widest part), somewhat narrowed in dorsal half. Jugal lobe of hind wing rounded (Fig. 32).

Metasomal tergum 1 short and thick, about $0.9 \times$ as long as its apical width, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament; corner between anterior and dorsal faces bluntly angled (Fig. 33). Sternum 2 in lateral view strongly swollen ventrally in anterior half, then ventral margin bluntly angled into nearly straight line parallel to ventral margin of the tergum.

Clypeus with scattered large punctures, each bearing sharply pointed golden bristle. Mandible with several deep punctures. Frons densely covered with coarse punctures. Vertex and gena with sparse punctures less coarse than those on frons; punctures around ocelli sparse strong; ventral one third of gena with coarse punctures. Pronotum with dense coarse flat-bottomed punctures; spaces between punctures very narrow, slightly raised to form reticulation. Mesoscutum densely with coarse flat-bottomed punctures; punctures on scutellum and metanotum

dense coarse but smaller than those on mesoscutum. Mesepisternum with dense coarse well-defined punctures in posterodorsal part (punctures in dorsal margin similar to those on pronotum), barely punctured in anteroventral part; border between posterodorsal and anteroventral parts distinct. Dorsal metapleuron with striae; ventral metapleuron with sparse strong punctures. Propodeum with strong transverse striae; lateral face with sparse ill-defined punctures. Metasomal segments densely covered with minute punctures in addition to scattered small punctures (ill-defined on terga; more or less well-defined on sterna).



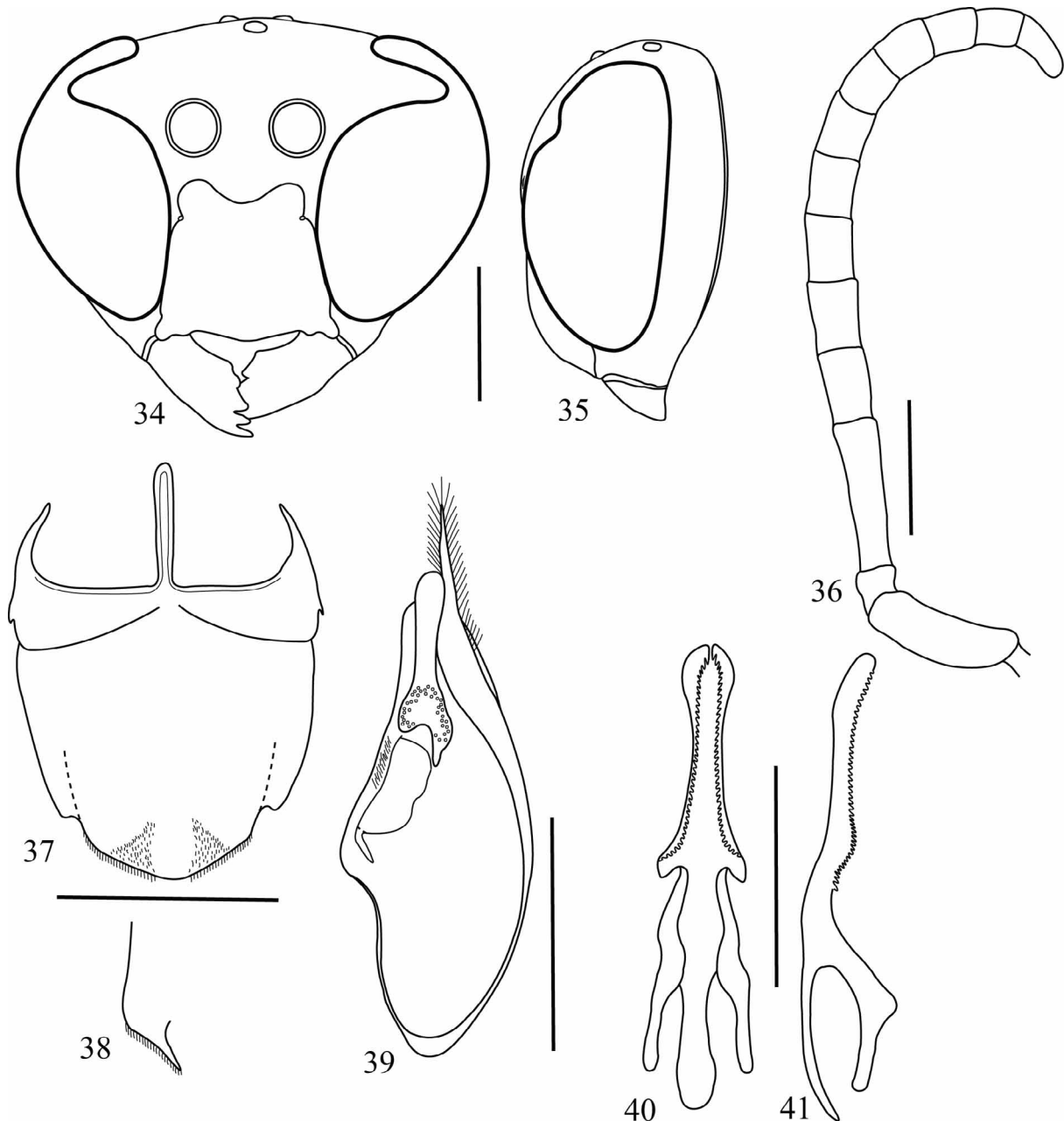
FIGURES 27–33. *Polistes (Polistella) relicinicypeus* sp. nov., ♀. 27–29. Head. 27. Frontal view. 28. Dorsal view. 29. Lateral view. 30. Left antenna. 31. Jugal lobe of left hind wing. 32. Mesosoma, lateral view. 33. Metasomal segments 1 and 2, lateral view. Scale 1 mm.

Color. Black; following parts yellow to orange-yellow: clypeus except black margins, narrow band along inner eye margin extending from bottom of frons to middle of eye emargination, narrow short band along eye margin in dorsal part of gena, narrow band along pronotal carina with branches extending along posterodorsal margin of pronotum, anterior transverse band on scutellum (often most of scutellar disc, sometimes reduced to paired anterolat-

eral spots), paired anterolateral spots on metanotum (sometimes united into narrow to wide anterior band), spot on propodeal valvula, narrow subapical band on tergum 1 (often narrowly interrupted medially), wide apical band with irregular anterior margin on tergum 6; following parts reddish brown: mandible except black basal margin and teeth, antennal scape beneath, pedicel, basal part of flagellomere 1, apical flagellomeres beneath, pronotum ventrolaterally, tegulae, ill-defined wide bands on tergum 1 (in front of yellow band), narrow apical bands on terga 2, 3 and 5 and sterna 2–5, entire visible part of metasomal segment 6. Legs black, dorsal surface of femora and ventral surface of tibiae largely reddish brown. Wings yellowish-brown, weakly infusate, slightly more strongly infusate along anterior margin of fore wing; veins dark brown.

MALE. Body length 9.0 mm–9.5 mm; forewing length 9.5–10.5 mm.

Structure as in female, but differing from the latter as follows: head proportionally smaller, transverse, about $1.4 \times$ as wide as high in frontal view (Fig. 34); eye strongly swollen laterally; inner eye margins strongly



FIGURES 34–41. *Polistes (Polistella) relicinicypeus* sp. nov., ♂. 34–35. Head. 34. Frontal view. 35. Lateral view. 36. Left antenna. 37–38. Terminal sterna. 37. Ventral view. 38. Apical part, lateral view. 39. Inner aspect of paramere with digitus and volsella. 40–41. Aedeagus. 40. Ventral view. 41. Lateral view. Scale 1mm.

convergent, about $1.5 \times$ further apart from each other at vertex than at clypeus; gena narrow, in lateral view about $0.4 \times$ as wide as eye (Fig. 35), with weakly raised blunt ridge running along posterior margin of eye; clypeus in frontal view about $1.1 \times$ as wide as high (Fig. 34), only slightly produced ventrally, evenly and very weakly rounded apically, in lateral view weakly convex dorsally, bent backward ventrally (Fig. 35). Antenna slenderer than in female (Fig. 36); scape short, about $2.8 \times$ as long as its maximum width; flagellomere 1 as long as length of flagellomeres 2 and 3 combined; flagellomeres 2 and 3 each longer than wide; terminal flagellomere elongate, slightly curved, about $2 \times$ as long as its basal width. Metasomal sternum 7 depressed medially (Fig. 37), without tubercle (Fig. 38).

Body surface sculpture as in female, but clypeus without large punctures and densely covered with long golden hairs.

Color. Similar to female, but reddish-brown markings on head and mesosoma reduced, while more extensively marked with yellow as follows: clypeus entirely, mandible except for small basal black spot, ventral half of frons except for ill-defined black band connecting anterior tentorial pit and antennal socket and interantennal black spot, narrow long band on gena along posterodorsal margin of eye, antennal scape beneath, disc of scutellum (sometimes reduced into wide anterior band), paired anterolateral spots (sometimes narrow transverse band) on metanotum, spot on propodeal valvula, ventral face of fore coxa and spot on mid-coxa; antennal flagellum reddish-brown to dark yellow beneath.

Genitalia. Generally similar to that of *Polistes dawnae*. Lamina volsellaris desclerotized and fused with cuspis. Digitus in inner aspect of paramere (Fig. 39) slightly more than $3.5 \times$ as long as wide (measured at widest part), distinctly swollen near base, gradually narrowed apically to mid-length, then slightly swollen towards the rounded apex. Aedeagus (Figs 40, 41): penis valves slightly longer than basal apodeme, in ventral view narrowest near mid-length, distally club-shaped, weakly swollen proximally from mid-length, strongly swollen and produced proximolaterally in about proximal one fourth and distinctly produced laterally near proximal margins, in lateral view slightly thickened in proximal one fourth and with dorsal margin weakly and smoothly sinuate, with proximoventral corner produced into obtuse angle (Fig. 41); ventral margins of penis valves finely serrated along entire length.

Nest. The following nine nests were examined: Nest# VN-P-2006-4, Sa Pa, Lao Cai, alt. 1600 m, 21.VIII.2006, LN, FS & JK; Nest# 2009-Sapa-P-01, Sa Pa, Lao Cai, alt. 1600 m, 5.VII.2009, HP; Nest# VN-P-2006-10 to -13, Phong Tho, Lai Chau, alt. 1600 m, 22.VIII.2006, LN, FS & JK; Nest# 2008-LC-P-02 & 03, Bac Ha, Lao Cai, 25 & 26.VI.2008, LN & HP; Nest# 2008-HB-P-03, Mai Chau, Hoa Binh, alt. 1400 m, 11.VI.2008, HP.

Nest VN-P-2006-4 was found under the leaf of a palm about 0.5 m above the ground. Five nests (VN-P-2006-10 to 13 and 2009-Sapa-P-01) were found on the cliffs along the Hoang Lien Pass road, and they all were directly attached to rocks 1 to 2 m above the road. The two nests collected in Bac Ha and one in Mai Chau were at the early nest-founding stage and had a comb comprised of only empty shallow cells (Table 1).

Nest structural characters are as follows (for measurements see Table 3). Petiole single, terminal, with thin central core of plant fibers, enlarged strictly with adult salivary secretion, black and lustrous; salivary coating extended onto substrate and largely onto back of comb. Comb tough, pliable in texture, dark brownish gray, expanded from

TABLE 3. Measurements of nests of *Polistes relicinicypeus* sp. nov.

Nest coder	Petiolate length (mm)	Petiole thickness (mm)	Cell width at open end (mm) (n=10)		Cell width at bottom (mm) (n=10)		Cell depth (mm) (N=10)	
			Mean	Range	Mean	Range	Mean	Range
VN-P-2006-4	5.1	1.1 x 1.4	4.0	3.5–4.5	2.8	2.5–3.2	16.3	15.1–17.2
VN-P-2006-10	3.8	1.4 x 1.5	4.1	3.9–4.3	3.1	2.7–3.9	16.7	15.6–17.9
VN-P-2006-11	1.9	1.6 x 2.0	4.7	4.3–5.2	3.0	2.5–3.7	16.4	15.3–17.7
VN-P-2006-12	-	-	3.9	3.7–4.2	2.7	2.2–3.4	17.5	15.9–19.6
VN-P-2006-13	4.4	1.6 x 1.9	4.4	4.0–5.0	2.8	2.4–3.4	17.6	16.2–19.2
2009-Sapa-P-01	5.7	1.2 x 1.8	4.0	3.6–4.4	2.8	2.4–3.3	16.6	16.3–17.0

the petiole to become fan-shaped in ventral view; ventral surface convex; dorsal surface deeply concave. Nest cells generally arranged regularly and hexagonal at open end, but partly irregularly arranged, where some cells are pentagonal; outer free margins of peripheral cells rounded; cell expanded towards open end, with width at open end about $1.5 \times$ larger than that at bottom (Table 3); cell wall about 0.03 mm thick. Cocoon caps pale gray, domed, projecting 1 to 2 mm beyond rim of cell.

Remark. Along the Hoang Lien Pass road this species and *P. lepcha* nested on the cliffs. While the nests of *P. lepcha*, having pale-green cocoon caps, were rather conspicuous to us, it seemed to us that the nests of this new species are well camouflaged. Two nests collected in Bac Ha and one in Mai Chau suggested that this species commonly founds a nest by multiple females.

Etymology. The specific name refers to the male clypeus bent back (*relicinus* in Latin) ventrally and is treated as a noun in apposition.

Distribution. Known only from northern Vietnam.

***Polistes (Polistella) paco* Nguyen, Kojima & Saito, sp. nov.**

(Figs 42–46)

Type material. HOLOTYPE: ♀ (IUNH, on long-term loan from the IEBR), labeled “VIETNAM, Pa Co, Mai Chau, Hoa Binh, 1000 m, L.T.P. Nguyen & J. Kojima, 23.viii.2005”.

Diagnosis. This species can be distinguished from all other known species of subgenus *Polistella* by the following combination of characters: female clypeus convex; scutellum strongly depressed medially; propodeum with weak striae; metasomal tergum 1 short and thick, about $0.8 \times$ as long as its apical width, in lateral view abruptly swollen dorsally at base, then broadly convex dorsally; metasomal sternum 2 in lateral view abruptly swollen ventrally in anterior one-third, then ventral margin rounded into straight line.

Description. FEMALE. Body length about 9.5 mm; fore wing length about 9.5 mm (holotype)

Structure as in *Polistes relicinicypeus*, but differing as follows: POD:OOD=1:2; POD about $1.3 \times$ Od (Fig. 42); inner eye margins less strongly convergent ventrally, about $1.1 \times$ further apart from each other at vertex than at clypeus (Fig. 43); interantennal space strongly raised; clypeus in frontal view as wide as high (Fig. 43), in lateral view distinctly convex (Fig. 44), lateral margin lying along inner eye margin slightly shorter than diameter of antennal socket; gena wider, in lateral view nearly as wide as eye (Fig. 44); antennal flagellomere 1 about $2.5 \times$ as long as its apical width (Fig. 45); scutellum strongly depressed medially; propodeal orifice elongate, about $1.9 \times$ as long as wide (measured at widest part), somewhat narrowed in dorsal half; metasomal tergum 1 about $0.8 \times$ as long as its apical width, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament, then dorsal face broadly convex; corner between anterior and dorsal faces rounded (Fig. 46); metasomal sternum 2 in lateral view basally abruptly swollen ventrally in anterior one-third, then ventral margin broadly rounded into straight line in posterior half of the sternum (Fig. 46).

Body surface sculpture as in *P. relicinicypeus*, but clypeus except margins with scattered deep large punctures, each of which bears a golden sharply pointed bristle, apical margin of metanotum smooth and without punctures, propodeum with weak transverse striation.

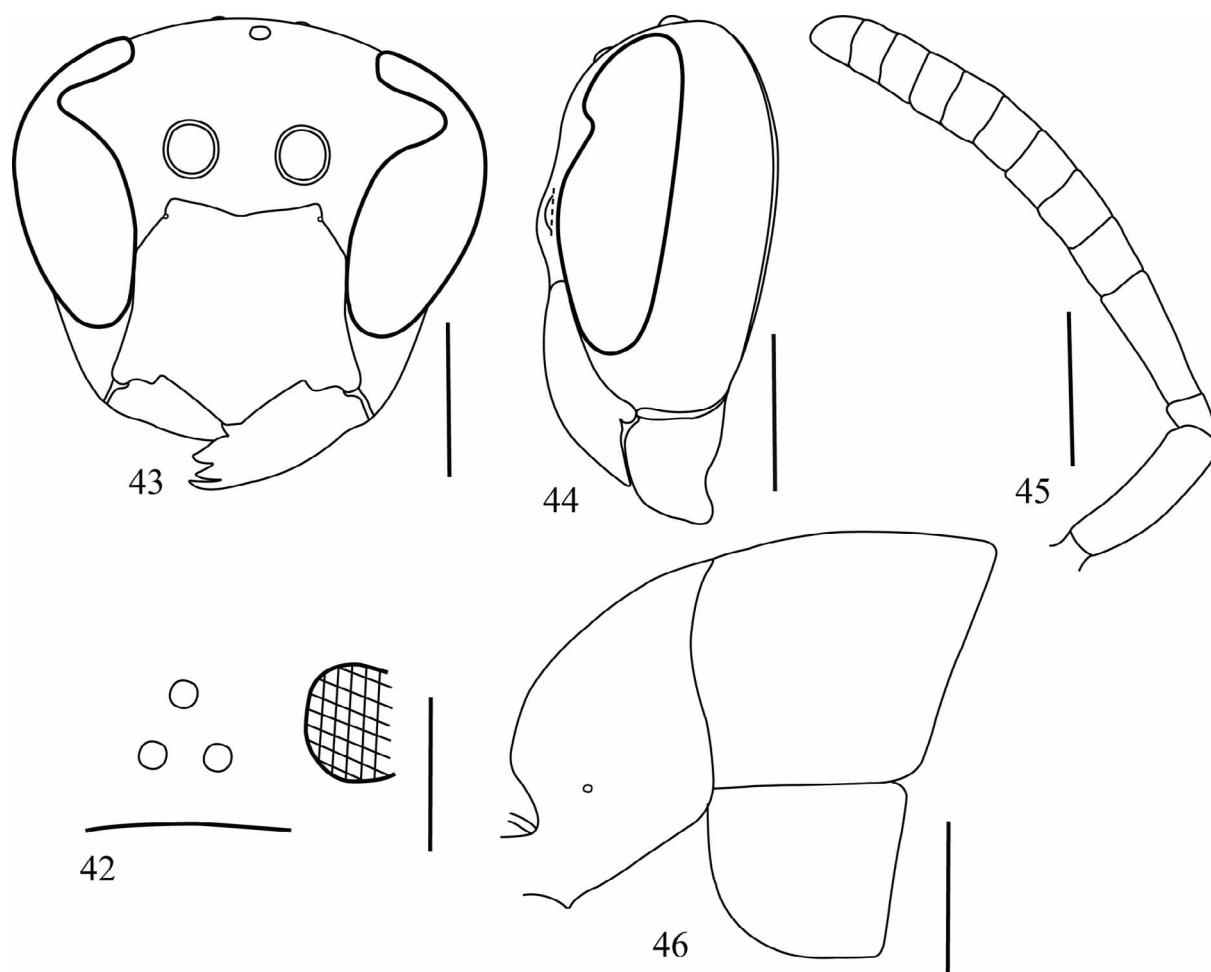
Color. As in *P. relicinicypeus*.

MALE. Unknown.

Remark. This species is most similar to *P. relicinicypeus*, but can be easily distinguished from the latter by having the female clypeus in lateral view evenly curved anteriorly, not prominently swollen anteriorly in upper part, the scutellum strongly depressed medially, the second metasomal sternum with the anteroventral corner broadly rounded, and the striation on propodeum much weaker.

Etymology. The specific name refers to the type locality, Pa Co in Hoa Binh Province of Vietnam.

Distribution. Known only from the type locality, northern Vietnam.



FIGURES 42–46. *Polistes (Polistella) paco* sp. nov., ♀. 42. Ocelli, eye and posterior margin of vertex. 43–44. Head. 43. Frontal view. 44. Lateral view. 45. Right antenna. 46. Metasomal segments 1 and 2, lateral view. Scale 1 mm.

***Polistes (Polistella) curcipunctum* Nguyen, Kojima & Saito, sp. nov.**

(Figs 47–53)

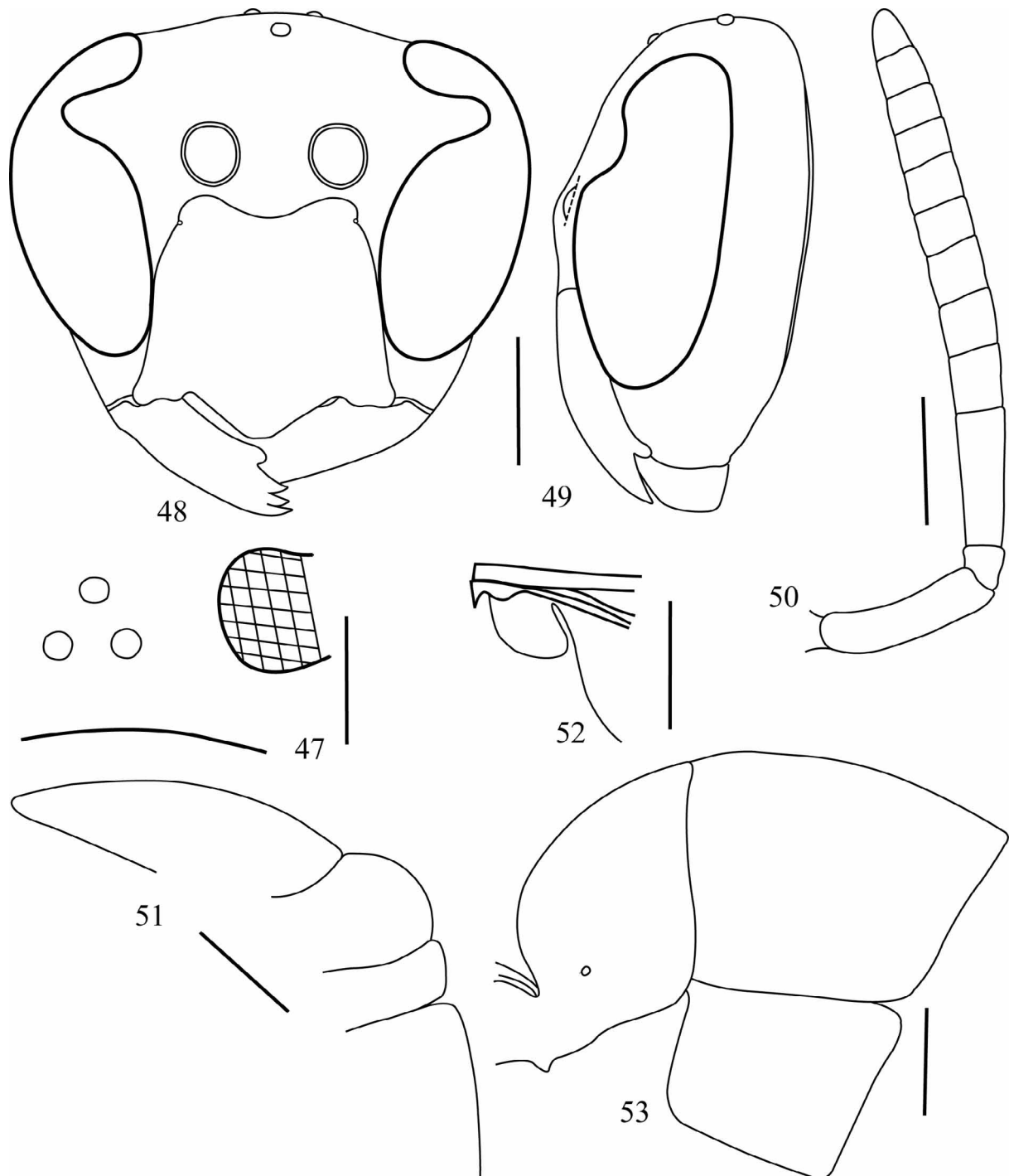
Type material. HOLOTYPE: ♀ (IUNH on long-term loan from the IEBR), labeled “VIETNAM, Tam Dao NP, Vinh Phuc, 800 m, L.T.P. Nguyen & J. Kojima, 19.viii.2005”. PARATYPES: 1 ♀ (IEBR), same data as holotype; 1 ♀ (AMNH), Huang Son, Ha Tinh, 18°21'N 106°15'E, alt. 900 m, Malaise Trap, 18.V.1998, Carpenter, Long, Grimaldi, Herman and Silva; 3 ♀ (IEBR, IUNH, AMNH), Lo Xo, Phuoc Son, Quang Nam, alt. 700 m, 28.VII.2004, ISD-c.

Diagnosis. This species can be distinguished from other known species of subgenus *Polistella* by the following combination of characters: body surface with very coarse and large punctures; posterior face of propodeum with wide median excavation (width about $0.7 \times$ maximum width of propodeum); border between posterior and lateral faces of propodeum bluntly angulate; metasomal tergum 1 short and robust, about $0.7 \times$ as long as its apical width, in lateral view abruptly swollen dorsally at base, then dorsal face weakly convex, corner between anterior and dorsal faces broadly rounded; metasomal sternum 2 in lateral view with square outline, basally abruptly swollen ventrally, then ventral margin bluntly angled into straight line.

Description. FEMALE. Body length 11.5–12.5 mm (holotype: about 12.5 mm); forewing length 11.5–12.5 mm (holotype: about 12.5 mm).

Structure as in *Polistes relicinicypeus*, but differing as follows: POD:OOD=1:2; POD about $1.3 \times$ Od (Fig. 47); inner eye margins in frontal view less strongly convergent ventrally, about $1.1 \times$ further apart from each other at vertex than at clypeus (Fig. 48); clypeus in frontal view slightly wider than high (Fig. 48); lateral margin of

clypeus touching inner eye margin by length longer than malar space and antennal socket diameter; gena proportionally narrower, in lateral view about $0.6 \times$ as wide as eye (Fig. 49); antennal scape slightly more than $3 \times$ as long as its maximum width (Fig. 50); flagellomere 1 slightly greater than $2.5 \times$ as long as its maximum width; flagellomere 2 longer than wide; terminal flagellomere about $1.3 \times$ as long as its basal width; mesoscutum weakly convex; scutellum strongly convex (Fig. 51), with median part weakly depressed or nearly flat; posterior face of propodeum with shallow wide median excavation, of which width is about $0.7 \times$ maximum width of propodeum, border between posterior and lateral faces bluntly angulate; propodeal orifice elongate, about $2 \times$ as long as wide (measured at widest part); jugal lobe of hind wing rounded (Fig. 52); metasomal tergum 1 short and robust, about



FIGURES 47–53. *Polistes (Polistella) curcipunctum* sp. nov., ♀. 47. Ocelli, eye and posterior margin of vertex. 48–49. Head. 48. Frontal view. 49. Lateral view. 50. Right antenna. 51. Mesosoma, lateral view. 52. Jugal lobe of left hind wing. 53. Metasomal segments 1 and 2, lateral view. Scale 1 mm.

0.7 × as long as its apical width, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament, then dorsal face weakly convex; corner between anterior and dorsal faces broadly rounded (Fig. 53); metasomal sternum 2 in lateral view with square outline (Fig. 53), basally abruptly swollen ventrally, then ventral margin bluntly angled into straight line nearly parallel to ventral margin of the tergum.

Body surface with much coarser punctures than in *P. relicinicypeus*. Clypeus densely covered with very coarse large punctures, each bearing sharply pointed golden bristle; basal one-third to half of clypeus covered with fine pale-yellow pubescence. Mandible with scattered deep punctures, punctures denser at basal margin. Frons and vertex anterior to level of posterior ocelli densely covered with very coarse deep punctures; punctures around ocelli less coarse; vertex behind posterior ocelli and gena densely covered with very coarse punctures. Pronotum with punctures similar to those in *P. relicinicypeus* (dense and deep; spaces between punctures very narrow, slightly raised to form reticulation). Scutellum, metanotum and posterodorsal part of mesepisternum with punctures similar to those on pronotum. Dorsal metapleuron with striae and strong punctures; ventral metapleuron with dense coarse punctures. Propodeum with distinct transverse striae with coarse punctures between striae; lateral face with well-defined punctures between striae, interpuncture spaces weakly raised to interconnect striae. Metasomal terga with dense coarse punctures.

Color. Body black, with following parts orange-yellow: apical one to two-thirds of clypeus, narrow band along inner eye margin extending from bottom of frons to middle of eye emargination, narrow short band on gena along posterodorsal margin of eye, narrow band along pronotal carina, paired spots on propodeal valvula; reddish brown as follows: mandible except black basal margin and teeth, ventral side of antennal scape, pedicel and basal part of flagellomere 1, sometimes posterolateral spots on scutellum and narrow apical band on metasomal tergum 2. Legs black; dorsal surface of femora, ventral surface of tibiae and tarsomeres 1 largely reddish brown. Wings yellowish-brown, weakly infuscate, slightly more strongly infuscate along anterior margin of forewing; veins dark brown.

MALE. Unknown.

Remark. Among the species of subgenus *Polistella* occurring in Vietnam, this species can be recognized by extremely coarse punctures.

Etymology. The specific name refer to the coarse (*curcus* in Latin) punctures in this species.

Distribution. Known only from type localities, northern Vietnam.

***Polistes (Polistella) gilvus* Nguyen, Kojima & Saito, sp. nov.**

(Figs 54–60, 88)

Type material. HOLOTYPE: ♀ (IUNH, on long-term loan from the IEBR), labeled “VIETNAM, Co Ma, Thuan Chau, Son La, 1600 m, Nest #: 2008-SL-P-1, L.P.T. Nguyen, H.P. Pham, 07.vi.2008”. PARATYPES: Vietnam: **Son La:** 8 ♀ (IEBR, IUNH, AMNH), same data as holotype; **Lao Cai:** 1 ♀ (IEBR), Sa Pa, alt. 1500–2000 m, 17–18.V.2003, ISD-c; 1 ♀ (NSM), Mt. Phan Xi Pang, alt. 1750–1950 m, Hoang Lien Son Mts., 2–5.X.1995, M. Tomokuni.

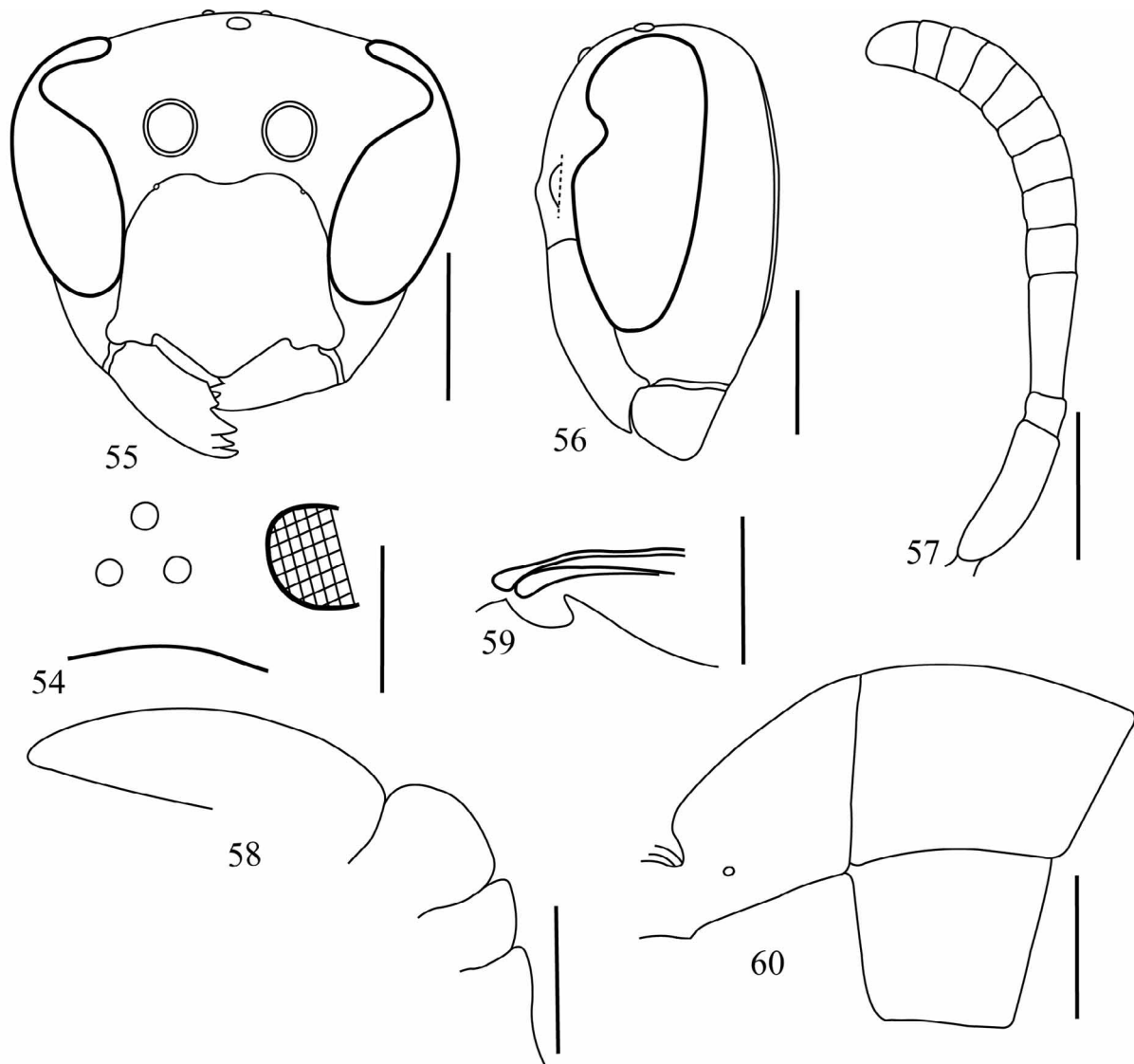
Diagnosis. This species can be distinguished from other known species of subgenus *Polistella* by the following combination of characters: female clypeus weakly convex, in lateral view anterior margin smoothly passing into supraclypeal area; propodeum with strongly and sharply raised transverse striae; border between posterior and lateral faces of propodeum marked by blunt angulation; metasomal sternum 2 in lateral view square in outline, with corner between anterior and ventral faces bluntly angled.

Description. FEMALE. Body length 8.5–9.5 mm (holotype: about 8.5 mm); fore wing length 9–10 mm (holotype: about 9 mm).

Structure similar to that of *Polistes lepcha*, but different as follows: POD:OOD=1:1.9; POD about 1.6 × Od (Fig. 54); clypeus in frontal view about 1.1 × as wide as long (Fig. 55), in lateral view weakly convex (Fig. 56); antennal flagellomere 1 slightly greater than 2.5 × as long as its maximum width (Fig. 57); scutellum convex (Fig. 58); jugal lobe of hind wing rounded (Fig. 59); metasomal sternum 2 in lateral view square in outline, with corner between anterior and ventral faces bluntly angled (Fig. 60).

Body surface sculpture as in *P. lepcha*, but propodeal striae weaker.

Color. As in *P. lepcha* except paired small lateral spots on metanotum present.



FIGURES 54–60. *Polistes (Polistella) gilvus* sp. nov., ♀. 54. Ocelli, eye and posterior margin of vertex. 55–56. Head. 55. Frontal view. 56. Lateral view. 57. Right antenna. 58. Mesosoma, lateral view. 59. Jugal lobe of left hind wing. 60. Metasomal segments 1 and 2, lateral view. Scale 1 mm.

MALE. Unknown.

Nest. A nest (Nest#: 2008-SL-P-1) collected in Thuan Chau, Son La was examined (Table 1); one of its resident females is designated as the holotype of this species.

The nest had only two pupae as immatures, and was attached to a thin branch of a shrub about 1.5 m above the ground. The nest characters are as follows: Petiole single, terminal, 3.5 mm long, 2×2.5 mm thick, with thin core of plant fibers, enlarged strictly with adult salivary secretion, black and lustrous; salivary coating extended onto substrate and largely onto back of comb. Comb rather tough, pliable in texture, uniformly grayish brown, fan shape in ventral view, ventral surface convex, dorsal surface deeply concave. Cells arranged in regular rows and round at open end, but partly irregularly arranged, where some cells are pentagonal; each cell gradually expanded towards open end, 2.5 mm (range 2.3–3.0 mm; n=10) wide at bottom and 4.1 mm (range 3.9–4.6 mm; n=10) wide at open end, 12.6 mm (range 11.2–13.4 mm; n=10) deep; cell wall about 0.02 mm thick. Cocoon caps slightly domed beyond rim of cell, pale yellow.

Remark. Among species of subgenus *Polistella* occurring in Vietnam, this species is most similar to *Polistes lepcha*, but can be easily distinguished from the latter by having the clypeus in lateral view less swollen and smoothly passing into the supraclypeal area (Fig. 56) (in *P. lepcha*, slightly concave in the supraclypeal area; Fig.

16), propodeal striae weaker, the border between posterior and lateral faces of the propodeum less sharp, and the second metasomal sternum in lateral view with the anteroventral corner angled, not produced anteriorly (Fig. 60) (in *P. lepcha* sharply angled, slightly produced anteriorly, Fig. 20). The nest cocoon caps are also different in color, namely pale yellow in this species while pale green in *P. lepcha*.

Etymology. The specific name, *gilvus*, is a Latin adjective and refers to the pale-yellow cocoon caps.

Distribution. Known only from northern Vietnam.

***Polistes (Polistella) clandestinus* Nguyen, Kojima & Saito, sp. nov.**

(Figs 61–74)

Type material. HOLOTYPE: ♀ (IUNH, on long-term loan from the IEBR), labeled “VIETNAM, Sa Pa NP office, Lao Cai, 1600 m, L.P.T. Nguyen, F. Saito & J. Kojima, 22.viii.2006”. PARATYPES: Vietnam: **Lao Cai:** 5 ♂, 3 ♀ (IEBR, IUNH, AMNH), same data as holotype; 3 ♂, 3 ♀ (IEBR, IUNH), alt. 1600 m, Sa Pa Town, 8.VII.2009, HP; 1 ♀, 2 ♂ (IEBR), Xin Chai, Sa Pa, alt. 1350 m, 6.VII.2009, HP; 1 ♀ (IEBR), Hoang Lien NP, alt. 1660 m, 6.VII.2009, HP; 1 ♀ (IEBR), Cat Cat, Sa Pa, alt. 1450 m, 7.VII.2009, HP.

Diagnosis. This species can be distinguished from other known species of subgenus *Polistella* by the following combination of characters: scutellum entirely flat, in lateral view dorsal margin smoothly passing into either mesoscutum and metanotum; posterior face of propodeum with shallow median excavation about $0.3 \times$ the maximum width of propodeum, in lateral view slope down in nearly straight line; metasomal sternum 2 in lateral view basally abruptly swollen ventrally, then ventral margin broadly rounded; male clypeus as wide as high.

Description. FEMALE. Body length 9–11 mm (holotype: about 9.5 mm); fore wing length 10–11.5 mm (holotype: about 10.5 mm).

Structure as in *Polistes relicinicypeus*, but differing as follows: POD:OOD=1:2.1 (Fig. 61); inner eye margins in frontal view about $1.1 \times$ further apart from each other at vertex than at clypeus (Fig. 62); anterior tentorial pit as far from eye margin as from antennal socket; clypeus in frontal view about $1.1 \times$ as wide as high (Fig. 62), in lateral view convex, smoothly curved anteriorly (Fig. 63); antennal flagellomere 1 nearly $3 \times$ as long as its apical width (Fig. 64); scutellum entirely flat, in lateral view dorsal margin smoothly passing into either mesoscutum and metanotum (Fig. 65); jugal lobe of hind wing rounded (Fig. 66); posterior face of propodeum with shallow median excavation about $0.3 \times$ maximum width of propodeum, in lateral view slope down in nearly straight line (Fig. 65) (slightly convex in *P. relicinicypeus*; Fig. 31); metasomal sternum 2 in lateral view basally abruptly swollen ventrally in anterior half to two-third, then ventral margin broadly rounded (Fig. 67).

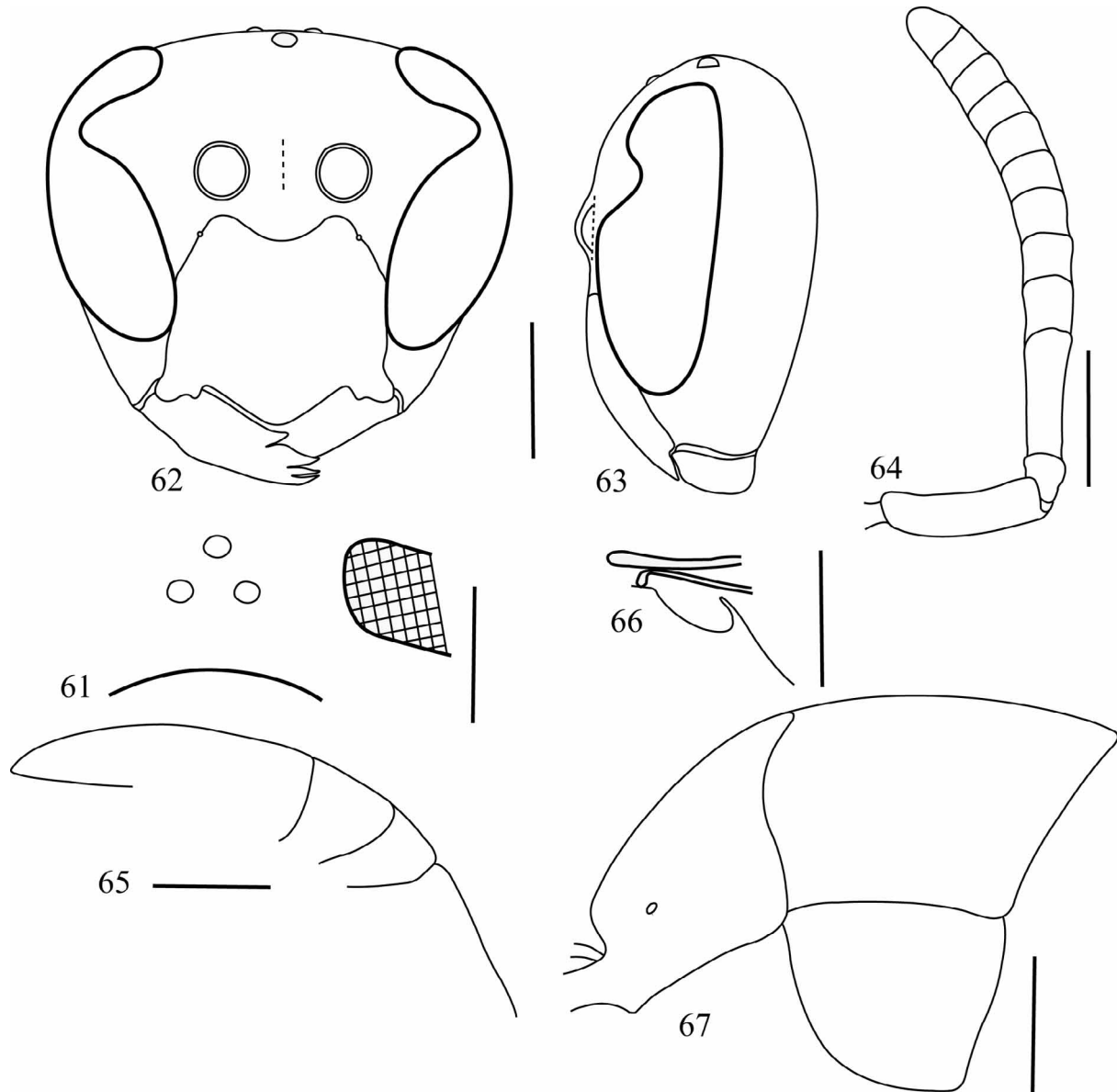
Body surface sculpture as in *P. relicinicypeus*, but dorsal half of clypeus covered with fine pale pubescence and ventral half with scattered deep large punctures, each bearing sharply pointed golden bristle; mandible with scattered shallow punctures; frons and vertex to level of posterior ocelli with moderately close fine punctures; vertex behind posterior ocelli and gena with sparse fine punctures (punctures in ventral third of gena scattered and deep), with space between punctures smooth; mesoscutum with dense fine punctures in addition to scattered deep flat-bottomed punctures; scutellum and metanotum with scattered moderately deep punctures; ventral metapleuron smooth, without punctures; propodeum with distinct transverse striae, and punctures between striae on lateral faces, interpuncture spaces weakly raised to interconnect striae.

Color. Black, with following parts yellow: clypeus except black basal and lateral margins, broad band along inner eye margin extending from bottom of frons to middle of eye emargination, line in dorsal part of gena along posterodorsal margin of eye, most ventral part of gena, narrow band along pronotal carina with branches running along posterodorsal margin of pronotum, scutellum except for anterior margin, paired anterolateral spots on metanotum, scrobal spot on mesepisternum, paired lateral oval spot on posterior face of propodeum, propodeal valvula, narrow apical band on metasomal terga 1–5, entire visible part of tergum 4. Legs black, dorsal surface of femora and ventral surface of tibiae, all tarsus largely reddish brown. Wings semitransparent, pale brown; veins dark brown.

MALE. Body length 9.0–10.0 mm; fore wing length 9.0–10.5 mm.

Structure as in female, but head in frontal view about $1.5 \times$ as wide as high, eye strongly swollen laterally, inner eye margins about $1.4 \times$ as further apart from each other at vertex as at clypeus (Fig. 68); gena narrow, about $0.3 \times$ as wide as eye in lateral view, with weakly raised blunt ridge running along posterior margin of eye; clypeus

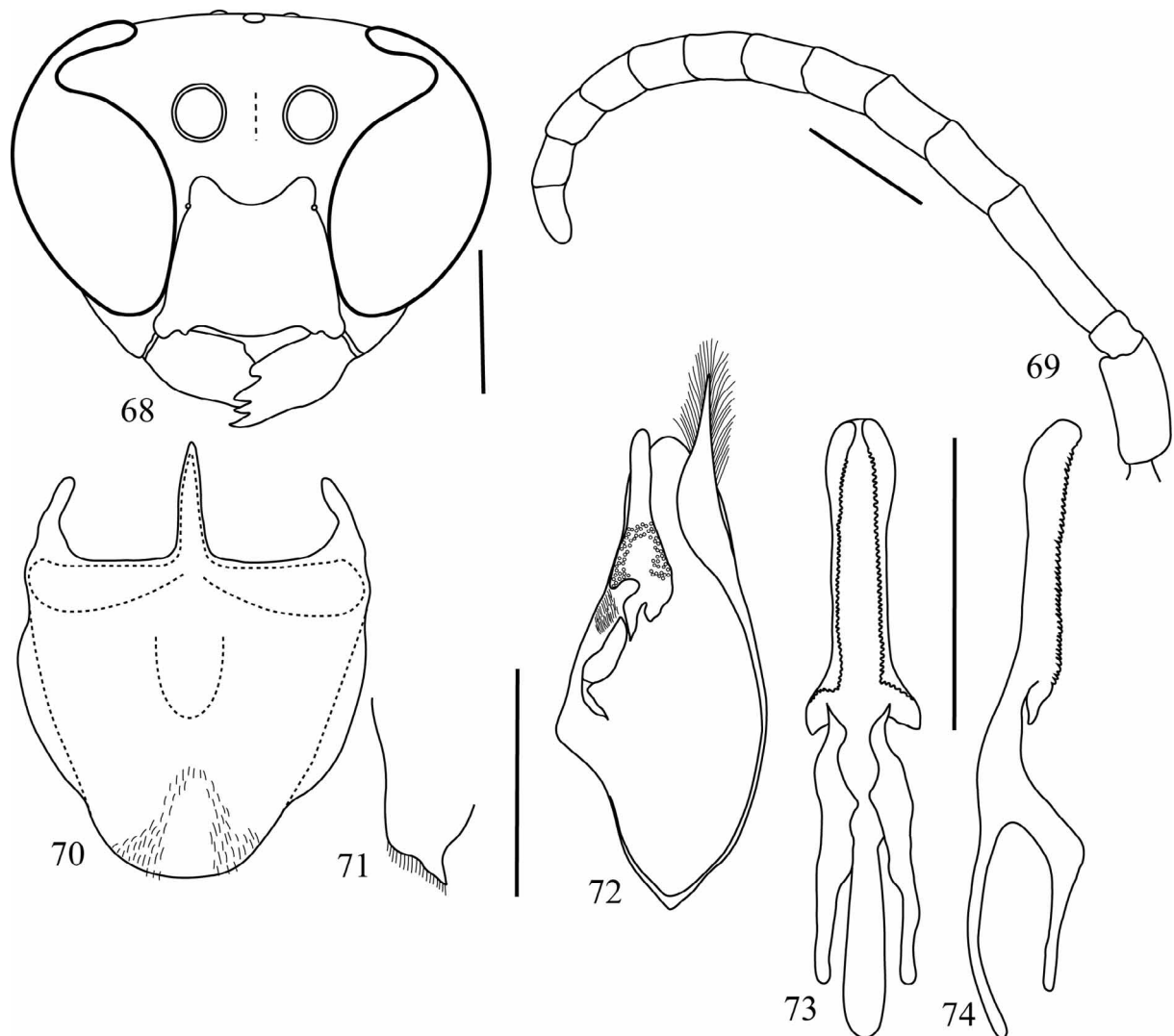
in frontal view about $1.2 \times$ as wide as high (Fig. 68), barely produced medioventrally, with apical margin very weakly and broadly rounded, in lateral view slightly convex dorsally, slightly bent backwards ventrally, and covered with dense short golden hairs; antennal scape short and thick, about $2.8 \times$ as long as its maximum width; flagellum slender, flagellomere 1 as long as length of flagellomeres 2 and 3 combined, flagellomeres 2 and 3 each longer than wide; terminal flagellomere elongate, slightly curved, about $2 \times$ as long as its basal width (Fig. 69). Metasomal sternum 7 depressed medially (Fig. 70), without tubercle (Fig. 71).



FIGURES 61–67. *Polistes (Polistella) clandestinus* sp. nov., ♀. 61. Ocelli, eye and posterior margin of vertex. 62–63. Head. 62. Frontal view. 63. Lateral view. 64. Right antenna. 65. Mesosoma, lateral view. 66. Jugal lobe of left hind wing. 67. Metasomal segments 1 and 2, lateral view. Scale 1 mm.

Color. Similar to female, but with more abundant yellow markings as follows: clypeus entirely, mandible except for small black basal spot, ventral half of frons, narrow short band on gena along posterior margin of eye, antennal scape beneath, paired anterolateral spots on metanotum. Antennal flagellum reddish-brown to dark yellow beneath. Paired lateral yellow spots on propodeum much reduced in size.

Genitalia. Similar to that of *Polistes relicinicypeus* sp. nov. except: the digitus distinctly swollen near base, narrowed in apical half (Fig. 72); aedeagus with proximoventral corner prominently produced proximally (Figs 73, 74).



FIGURES 68–74. *Polistes (Polistella) clandestinus* sp. nov., ♂. 68. Head, frontal view. 69. Left antenna. 70–71. Terminal sterna. 70. Ventral view. 71. Apical part, lateral view. 72. Inner aspect of paramere with digitus and volsella. 73–74. Aedeagus. 73. Ventral view. 74. Lateral view. Scale 1 mm.

Nest. Although we were unable to collect the nest of this species, we saw frequent traffic of the wasps coming in and out through a small hole respectively of an electric meter and a window frame.

Remark. Among species of subgenus *Polistella* occurring in Vietnam, this species is most similar to *Polistes dawnae*, but it can be easily distinguished from the later by having the deeper median excavation of the propodeum, the metasomal tergum 1 with the anterodorsal corner between the anterior and dorsal faces more angulated, the second metasomal sternum in lateral view swollen ventrally in anterior half to two-third (one-third in *P. dawnae*), the paired lateral yellow spots on propodeum small (large in *P. dawnae*), and the male clypeus wider than high (as wide as high in *P. dawnae*).

Etymology. The specific name, *clandestinus*, is a Latin adjective and refers to nesting of this species in a hidden place.

Notes on other species of subgenus *Polistella*

All the seven species described and/or treated above have the second metasomal sternum that is more or less truncated anteriorly or has a prominent anterior bulge. In addition to these seven species, the below-mentioned ten spe-

cies of subgenus *Polistella* have such a second metasomal sternum and have been known to occur on the eastern slope of the Himalaya and/or in northern parts of Vietnam.

***Polistes (Polistella) adustus* Bingham 1897**

(Figs 81, 83)

Polistes adustus Bingham 1897: 397, ♀, holotype, "Sikkim, up to 6000 feet" [The Natural History Museum, London].

Material examined. BHUTAN: 1 ♀ (RMNH), Lungtenphu, alt. 2300 m, 22–27.VII.1990, H.R. Feijen; INDIA: 1 ♀ (NIAES), Mussoorie, Uttar Pradesh, 24.V.1970, I. Hattori.

Distribution. India: Himachal Pradesh, Delhi, Uttaranchal, Sikkim, Meghalaya, West Bengal; Bhutan (new record); Nepal; China.

***Polistes (Polistella) affinis* Gusenleitner 2006**

Polistes affinis Gusenleitner 2006: 672, ♀, holotype, Phongsaly env., Prov. Phongsaly, 1500 m, Laos [OLM].

Material examined. LAOS: 2 ♀ (paratypes, OLM), Phongsaly Province, 21°41'N 102°06'E, alt. 1500 m, 28.V–20.VI.2003, Vit Kuban; VIETNAM: 1 ♀ (IEBR), Sa Pa, Lao Cai, alt. 1500–2000 m, 17–18.V.2003, ISD-c; 1 ♀ (IEBR), Tam Dao NP, Vinh Phuc, alt. 800 m, 1–4.VII.2003, LN.

Distribution. Laos; northern Vietnam (new record).

***Polistes (Polistella) horrendus* Gusenleitner 2006**

Polistes horrendus Gusenleitner 2006: 671, ♀, holotype, Phongsaly env., Prov. Phongsaly, 1500 m, Laos [OLM].

Material examined. LAOS: 1 ♀ (paratype, OLM), Phongsaly Province, 21°41'N 102°06'E, alt. 1500 m, 28.V–20.VI.2003, Vit Kuban; 1 ♀ (OLM), Phongsaly, 21°41'N 102°06'E, alt. 1500 m, Pacholatko, VI.2003; VIETNAM: 1 ♀ (IEBR), Pa Co, Mai Chau, Hoa Binh, alt. 900–1000 m, 27.VI.2001, ISD-c.

Distribution. Laos; northern Vietnam (new record).

***Polistes (Polistella) mandarinus* de Saussure 1853**

(Figs 75, 77, 79)

Polistes mandarinus de Saussure 1853: 58, ♀, lectotype, "Le norde de la Chine" [The Natural History Museum, London].

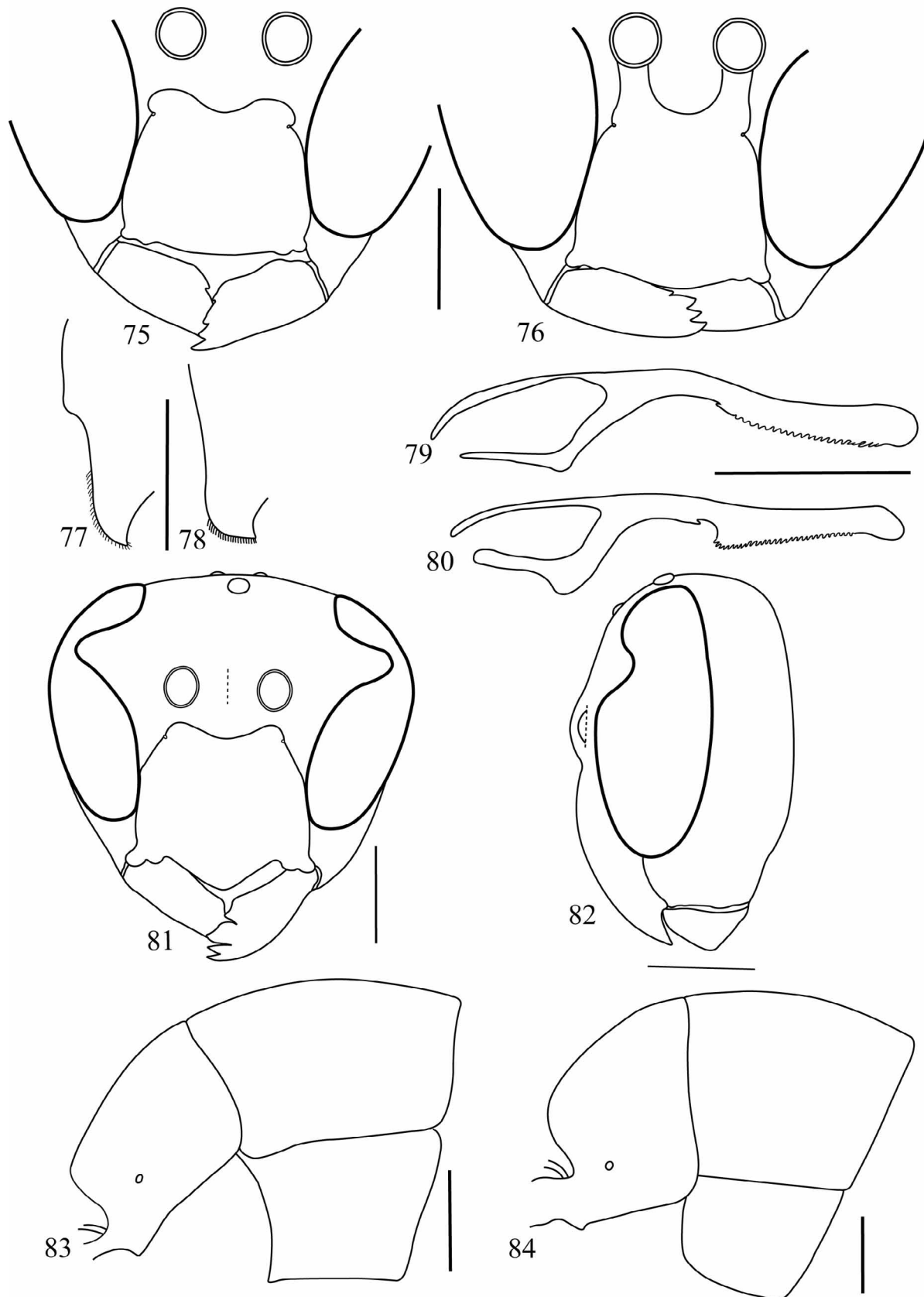
Material examined. CHINA: 2 ♀ (AMNH), Yen-Ping [1 ♀, 19.VIII.1917; 1 ♀, 10.IX.1917]; VIETNAM: 11 ♂, 10 ♀ (IEBR, IUNH), Xuan Son NP, Phu Tho, alt. 400–500 m, 11–12.IV.2004, LN; 3 ♂ (IEBR), Tam Dao NP, Vinh Phuc, alt. 800 m, 4.VII.2003, LN; 1 ♀ (IEBR), Bach Ma NP, Thua Thien Hue, alt. 1000 m, 27.VII.2003, X.L. Truong.

Distribution. North China; Korea; Vietnam.

***Polistes (Polistella) nigerrimus* Gusenleitner 2006**

(Figs 82, 84)

Polistes nigerrimus Gusenleitner 2006: 674, ♀, holotype, "Vietnam, Phongsaly [not mentioned on the label], Tam Dao, Vinh Phu [= part of current Vinh Phuc] Province, 27.5-2.6.1986, M. Hradsky" [OLM].



FIGURES 75–84. Characters of *Polistes* species of subgenus *Polistella* occurring in northern Vietnam. 75–80. ♂. 81–84. ♀. 75, 77, 79. *P. mandarinus*. 76, 78, 80. *P. nipponensis*. 81, 83. *P. adustus*. 82, 84. *P. nigerrimus*. 75–76, 81. Head, frontal view. 77–78. terminal sterna, lateral view. 79–80. Aedeagus, lateral view. 82. Head, lateral view. 83–84. Metasomal segments 1 and 2 in lateral view. Scale 1 mm.

Material examined. VIETNAM: 1 ♀ (holotype, OLM), Tam Dao, Vinh Phu, 27.V–2.VI.1986, M. Hradsky; 2 ♀ (IEBR), Lung Cao, Ba Thuoc, Thanh Hoa, alt. 500 m, 12.VI.2003, X.H. Le.

Distribution. Vietnam.

***Polistes (Polistella) nipponensis* Pérez 1905**

(Figs 76, 78, 80)

Polistes nipponensis Pérez 1905: 82, ♀, holotype, Yokohama, Japan [Muséum National d'Histoire Naturelle, Paris].

Polistes yamanakai Sonan 1937: 169, ♀, holotype, Tokyo, Japan [Taiwan Agricultural Research Institute, Wufeng]. Junior subjective synonym of *Polistes nipponensis* Pérez 1905 according to Kojima *et al.* 2011: 60.

Material examined. JAPAN: Daigo, Ibaraki, [1 ♂ (IUNH), 14.VIII.1978, JK; 2 ♀ (IUNH), 10.IX.2000, JK]. VIETNAM: 1 ♂, 2 ♀ (IEBR), Tam Dao NP, Vinh Phuc, alt. 800 m [1 ♂, 1 ♀, 4.VII.2003; 1 ♀, 12.V.2003], LN; 1 ♂, 1 ♀ (IEBR), Cat Ba NP, Hai Phong, 15–18.VII.2003, LN; 1 ♀ (IEBR), Lac Thinh, Yen Thuy, Hoa Binh, 30.IV.2002, D.L. Khuat; 2 ♀ (IEBR, IUNH), Cuc Phuong NP, Ninh Binh, 7.V.2002, V.T. Hoang.

Distribution. China; Japan; Vietnam (new record).

***Polistes (Polistella) opacus* Guisenleitner 2006**

Polistes opacus Guisenleitner 2006: 681, ♀, holotype, Paykong, W-Sikkim, India [OLM].

Distribution. India: Sikkim, West Bengal.

***Polistes (Polistella) quadricingulatus* Guisenleitner 2006**

Polistes quadricingulatus Guisenleitner 2006: 683, ♀, holotype, Bhimtal, 1500 m, N-India [OLM].

Distribution. India: Kashmir, Uttar Pradesh; Nepal.

***Polistes (Polistella) rubellus* Guisenleitner 2006**

Polistes rubellus Guisenleitner 2006: 684, ♀, holotype, Yuksam 8 km S, W-Sikkim, India [OLM].

Distribution. India: Sikkim; Nepal.

***Polistes (Polistella) santoshae* Das et Gupta 1989**

Polistes shantoshae Das & Gupta 1989: 72, ♀, holotype, Shillong, 1524 m, Meghalaya [Zoological Survey of India, Kolikata].

Material examined. VIETNAM: 1 ♀ (IEBR), Ngoc Linh Mt., Quang Nam, alt. 1500 m, X.H. Le, 31.III.2004.

Distribution. India: Sikkim, Meghalaya; Nepal; central Vietnam (new record).

Key to species of subgenus *Polistella* of northern Vietnamese mountainous areas

This key is for the 14 northern Vietnamese species of subgenus *Polistella* treated in this paper. They all have the second metasomal sternum more or less truncated anteriorly or with a prominent anterior bulge.

The characters are applicable to both sexes unless the sex is specified.

1. Marginal cell of fore wing with dark spot. Metasomal terga entirely black *P. horrendus* Gusenleitner
- Marginal cell of forewing without dark spot 2
2. Wings transparent 3
- Wings yellowish-brown or pale brown 4
3. Female clypeus with dense, fine pubescence in dosal half. Male clypeus wider than high, nearly straight apically (Fig. 75). Male metasomal sternum 7 with weak tubercle (Fig. 77). Penis valve in lateral view with ventral margin barely produced at proximoventral margin (Fig. 79) *P. mandarinus* de Saussure
- Female clypeus with dense, fine pubescence restricted to dosal one third, sometimes extending halfway down on each lateral side. Male clypeus slightly higher than wide, broadly rounded apically (Fig. 76). Male metasomal sternum 7 without tubercle (Fig. 78). Penis valve in lateral view produced ventrally at proximoventral margin to form right-angle (Fig. 80) *P. nipponensis* Pérez
4. Disc of scutellum flat, in profile smoothly passing from dorsal margin of mesoscutum (Fig. 65). Punctures on vertex, gena and metasomal terga fine, clathrae 5
- Disc of scutellum convex (Figs 18, 31, 51, 58). Punctures on vertex and gena very coarse, larger than their interstices; punctures on terga coarse 6
5. Propodeum shallowly excavated medially. Metasomal sternum 2 in lateral view strongly swollen ventrally in anterior one-third (Fig. 5). Male clypeus as wide as high with apical margin slightly produced, broadly rounded (Fig. 6). Scutellum black; propodeum with large lateral yellow spots *P. dawnae* Dover & Rao
- Propodeum deeply excavated medially. Metasomal sternum 2 in lateral view strongly swollen ventrally in anterior half to two-third (Fig. 67). Male clypeus wider than high with apical margin hardly produced, very weakly rounded (Fig. 68). Scutellum brown; propodeum with small lateral yellow spots *P. clandestinus* **sp. nov.**
6. Propodeum with border between posterior and lateral faces bluntly angled 7
- Propodeum with border between posterior and lateral faces not angled, round 10
7. Metasomal tergum 1 thick, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament, then weakly convex dosally after broadly rounded corner between anterior and dorsal faces. Metasomal sternum 2 in lateral view with anteroventral corner bluntly angled, with hypothetical angle formed by anterior and ventral faces in nearly right-angle (Fig. 53). Punctures on body surface very coarse and dense; dorsal metapleuron with punctures. In female, lateral margin of clypeus that lies along the inner eye margin much longer than malar space (Fig. 48). Metasomal terga black *P. curcipunctum* **sp. nov.**
- Metasomal tergum 1 not thick, in lateral view abruptly swollen dorsally just behind basal slit for reception of propodeal suspensory ligament, then bluntly angled into slightly or barely convex dorsal margin. Metasomal sternum 2 in lateral view with anteroventral corner sharply angled (Fig. 60) or slightly produced anteriorly (Figs 20, 83). Punctures on body surface less coarse and sparser; dorsal metapleuron without punctures. In female, lateral margin of clypeus that lies along the inner eye margin as short as or shorter than malar space (Figs 14, 55, 81). Metasomal terga black, with orange-yellow apical bands 8
8. Propodeum with moderately strong transverse striae; border between posterior and lateral faces well-defined, but not carinate. Metasomal tergum 1 in lateral view with corner between anterior and dorsal faces nearly right-angled (Fig. 83). Border between anterior and ventral faces of metasomal sternum 2 carinate *P. adustus* Bingham
- Propodeum with very strongly and sharply raised transverse striae; border between posterior and lateral faces well-defined, slightly raised into carina. Metasomal tergum 1 in lateral view with corner between anterior and dorsal faces bluntly angled (Figs 20, 60). Metasomal sternum 2 without such carina 9
9. Medium-sized, robust wasp; fore wing length 11–13.5 mm. Female clypeus in lateral view convex, passing into slightly concave supraclypeal area (Fig. 16). Punctures on vertex strong; those on pronotum, scutum, scutellum and metanotum coarse. Metasomal sternum 2 in lateral view with anteroventral corner slightly produced anteriorly (Fig. 20). Pair lateral yellow spots on metanotum absent *lepcha* Cameron
- Small, medium-robust wasp; fore wing length 9–10 mm; Female clypeus in lateral view weakly convex, smoothly passing into supraclypeal area (Fig. 56). Punctures on vertex weaker; those on pronotum, scutum, scutellum and metanotum strong, less coarse. Metasomal sternum 2 in lateral view with anteroventral corner angled, not produced anteriorly (Fig. 60). Pair lateral yellow spots on metanotum present *P. gilvus* **sp. nov.**
10. Female head higher than wide (Fig. 43). Dorsal metapleuron smooth, without punctures 11
- Female head as wide as high as or wider than high (Fig. 27). Dorsal metapleuron punctured. 12
11. Propodeum with weak striation. Disc of scutellum strongly and evenly convex, in profile strongly raised above level of mesoscutum. Vertex, scutellum and propodeum black *P. paco* **sp. nov.**
- Propodeum with strong striation. Disc of scutellum slightly convex, in profile weakly raised above the level of mesoscutum. Vertex, scutellum and propodeum brown *p. santoshae* Das et Gupta
12. Female clypeus as wide as high *P. affinis* Gusenleitner
- Female clypeus wider than high 13
13. Clypeus in lateral view prominently swollen anteriorly in upper one-third (Fig. 29). Metasomal sternum 2 in profile swollen posteriorly in anterior half (Fig. 33). Metasomal terga black, with yellow apical bands *P. relicinictypeus* **sp. nov.**
- Clypeus in lateral view swollen anteriorly at middle (Fig. 82). Metasomal sternum 2 in profile swollen posteriorly in anterior one-third (Fig. 84). Metasomal terga black, with yellow apical band only on tergum 1 (sometimes absent) *P. nigerrimus* Gusenleitner

Discussion

Das and Gupta (1989) recognized three groups among the species of the subgenus *Polistella* occurring in the Indian subcontinent: *Polistes adustus* group, *P. stigma* group and *P. maculipennis* group. However, they did not examine any specimen of *P. maculipennis* de Saussure, 1853, which is now treated as a subspecies of *P. stigma* (Petersen 1987; Carpenter 1996a, b). Carpenter (1996a) recognized four groups in subgenus *Polistella*, namely *Polistes adustus* group, *P. stigma* group, *P. sagittarius* group (judging from the included species, *P. maculipennis* group of Das & Gupta corresponds to this group) and the “*Stenopolistes*” group. Das and Gupta (1989) diagnosed the *P. adustus* group as “body black with extensive red markings; propodeum with wide and deep median groove; wings dark brownish hyaline, stigma brownish; fore wing without apical fuscous cloud; first gastral sternite with well developed margin at base and second gastral sternite angled or rounded at base.” Carpenter (1996a), however, pointed out that the composition of the *P. adustus* group as defined by Das and Gupta (1989) is unclear. All the 14 species of subgenus *Polistella* that occur in the mountainous areas in northern Vietnam have the metasomal sternum 2 angled or strongly rounded at the base. Our preliminary cladistic analysis of the relationships among *Polistella* species has suggested that the species having such a metasomal sternum 2 form a clade (LN *et al.* unpublished). Pending further intensive analyses on their phylogenetic relationships to discuss their detailed biogeography including the origin and dispersal, we summarize their distribution records and discuss their distribution pattern in terms of center of divergence.

As summarized in Fig. 88 the distribution records for ten *Polistes* species of subgenus *Polistella* (*P. dawnae*, *P. lepcha*, *P. relicinicypeus*, *P. paco*, *P. curcipunctum*, *P. gilvus*, *P. clandestinus*, *P. affinis*, and *P. horrendus*) in Vietnam are more or less restricted to northern mountainous areas popular with entomologists, such as Sa Pa in Lao Cai Province, Tam Dao in Vinh Phuc Province and Pa Co in Hoa Binh Province. These wasps may be widely distributed in mountainous areas in northern provinces in Vietnam; they may also be distributed in mountainous areas in Laos as in the case with *P. affinis* and *P. horrendus*, in Myanmar as with *P. dawnae*, and possibly in southern China. Of these ten species, only *P. lepcha* is known from areas west of the eastern margin of India, where five *Polistes* species of subgenus *Polistella* with a basally strongly swollen metasomal sternum 2 (*P. adustus*, *P. opacus*, *P. quadricingulatus*, *P. rubellus* and *P. santoshae*) are distributed (Fig. 89).

Based on the available data, *Polistes santoshae* shows a disjunct distribution pattern, that is, the species occurs in Nepal and eastern India (Sikkim and Meghalaya) and mountainous area in Quang Nam in Vietnam (Fig. 88). A similar disjunct distribution pattern is known in a hover wasp, *Eustenogaster scitula* (Bingham 1897), which occurs in eastern India (Assam, Meghalaya and Sikkim), Myanmar, Peninsular Malaysia, and in mountainous areas in central and southern provinces of Vietnam (Quang Binh, Quang Tri, Bach Ma in Thua Thien-Hue, Quang Nam and Lam Dong); on the eastern slope of the Himalayas including northern Vietnam and in the northeastern coast of Vietnam and southeastern area of China up to Hong Kong, *E. nigra* Saito *et* Nguyen, 2006, the species closely related to *E. scitula*, is distributed (Saito & Kojima 2007). This case of *Eustenogaster* van der Vecht and the observation that the gap in the distribution of *P. santoshae* is filled by its closely related species suggest that the eastern slope of the Himalayas is, in general, a center of divergence of social wasps.

Polistes mandarinus and *P. nipponensis* are, among species of subgenus *Polistella* composing the Vietnamese fauna, the only species that occur in areas of lower altitudes as well as in higher latitudes (China, Korea and Japan). The information currently available to us is, however, insufficient to discuss their occurrence in Vietnam—whether the eastern slope of the Himalayas is the area of their origins or they originated in more northern areas and have dispersed into northern Vietnam.

These *Polistes* species of subgenus *Polistella* with a basally strongly swollen second metasomal sternum are distributed from the southern slopes of the Himalayas, through the eastern slope of the Himalayas and eastern China, to Ussuri and eastern Siberia in Russia and Hokkaido in Japan, with *P. snelleni* de Saussure and *P. diakonovi* Kostylev 1940 as the northern-most species (Fig. 89). The distribution pattern is similar to that of some East-Asian plants of the “Himalayan Corridor” origin (Tabata 1988, 2004). Although the area of origin for these *Polistes* species of subgenus *Polistella* is hardly specifiable with the data available to us at this moment, it seems certain that the eastern slope of the Himalayas is the center of divergence of this social wasp group. Another area with relatively high divergence is Taiwan, where at least four species of this group are endemic (Kojima *et al.* 2011).



FIGURES 85–88. Nests of *Polistes* species of subgenus *Polistella* occurring in northern Vietnam. 85. *P. dawnae* (Nest# 2009-DB-P-01). The thick and thin arrows indicate the position of the primary petiole and the subsidiary petioles, respectively. 86. *P. lepcha* (Nest# VN-P-2006-3). 87. *P. relicinicypeus* **sp. nov.** (Nest# VN-P-2006-13). 88. *P. gilvus* **sp. nov.** (Nest# 2008-SL-P-1).

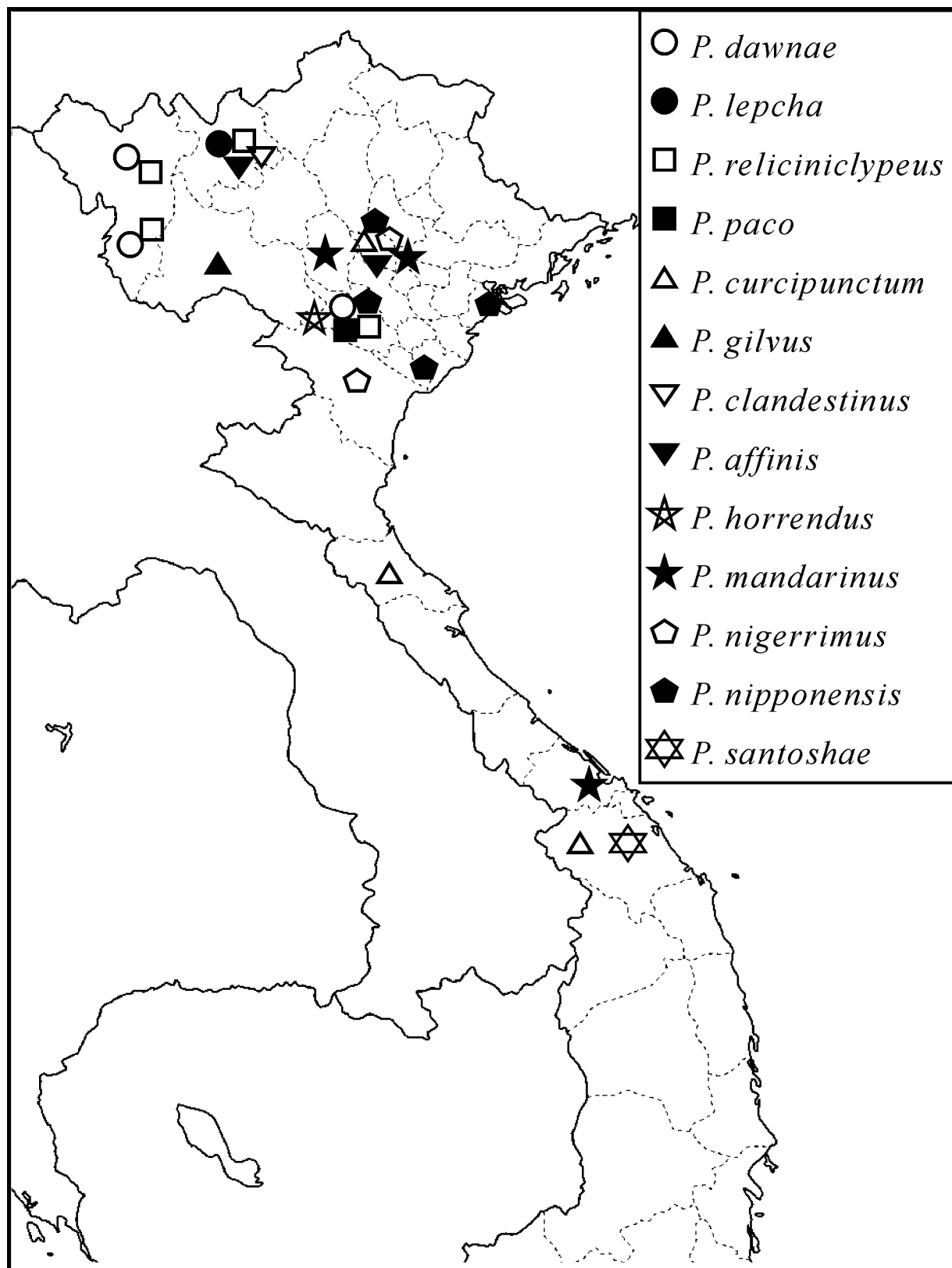


FIGURE 89. Distribution records of the 13 *Polistes* species of subgenus *Polistella* with a basally strongly swollen second metasomal sternum in Vietnam.

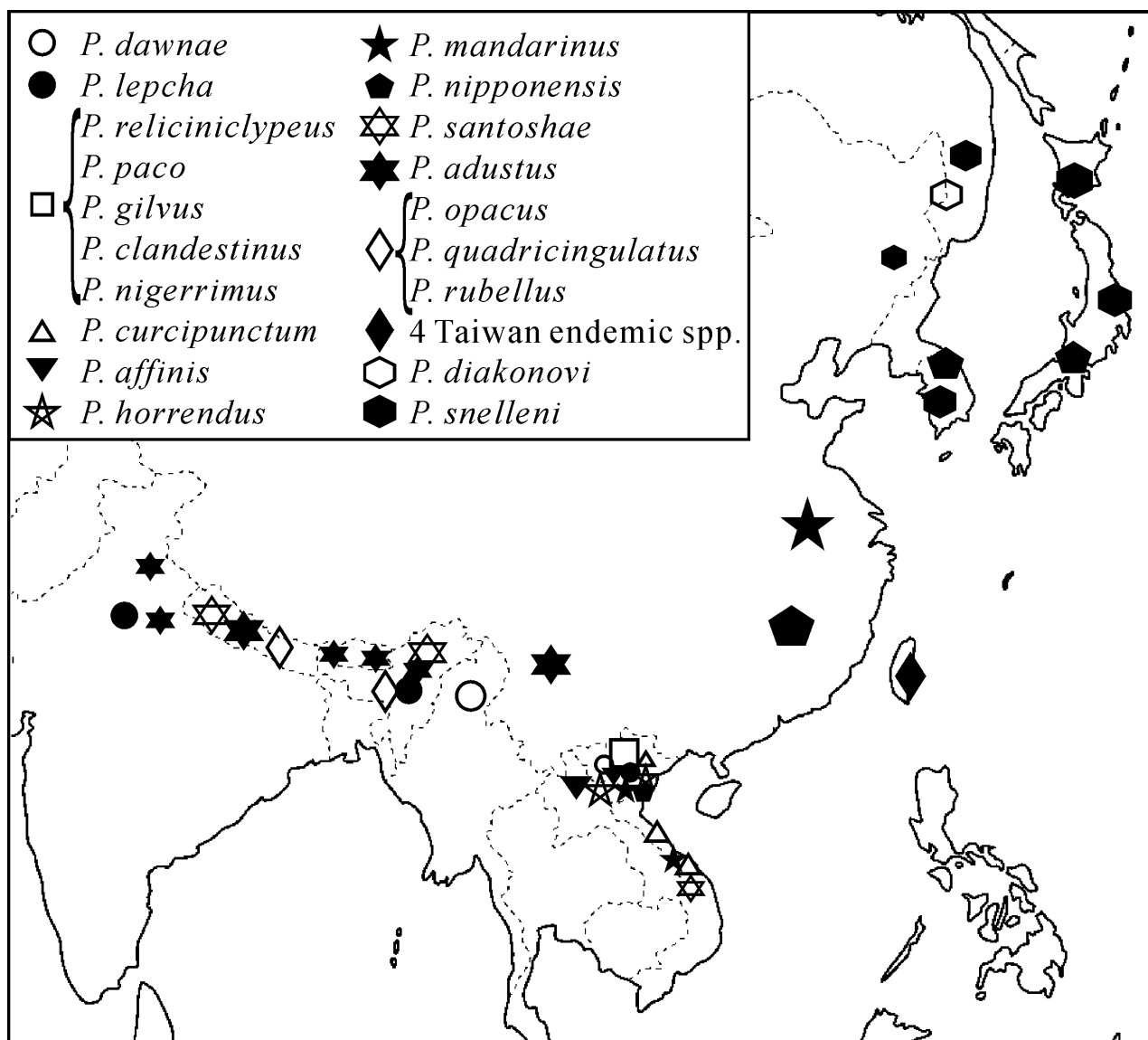


FIGURE 90. Distribution records of the *Polistes* species of subgenus *Polistella* with a basally strongly swollen second metasomal sternum. The four species endemic to Taiwan are *P. eboshinus* Sonan, *P. huisunensis* Kuo, *P. shirakii* Sonan, and *P. takasagonus* Sonan.

Acknowledgments

The present study was supported by the Postdoctoral Fellowships for Foreign Researchers of the Japan Society for the Promotion of Science (JSPS) and the Nagao Natural Environment Foundation (NEF) to LN, and grants from the JSPS (no. 20•08416 to JK and LN; no. 21570088 to JK). Our thanks go to G. Kumar for kindly sending digital pictures of the specimens in the Zoological Survey of India (the holotypes of *P. dawnae* and *P. santoshae* and non-type specimens of *P. lepcha*). We thank James M. Carpenter (American Museum of Natural History, New York, USA) and an anonymous reviewer for their valuable comments and suggestions.

References

- Ashmead, W.H. (1904) Descriptions of new genera and species of Hymenoptera from the Philippine Islands. *Proceedings of the United States National Museum*, 28, 127–158.
- Bingham, C.T. (1897) *The Fauna of British India, including Ceylon and Burma. Hymenoptera. Vol. I. Wasps and Bees*. Taylor and Francis, London. xxix + 579 pp. + 4 pls.

- Cameron, P. (1900) Description of new genera and species of Hymenoptera. A. New species of Vespidae from India and Japan. *Annals and Magazine of Natural History*, ser. 7, 6, 410–419, 495–506, 530–537.
- Carpenter, J.M. (1996a) Phylogeny and biogeography of *Polistes*. In: Turillazzi, S. & West-Eberhard, M. J. (Eds.), *Natural History and Evolution of Paper-Wasps*. Oxford University Press, Oxford, pp. 18–57.
- Carpenter, J.M. (1996b) Distributional checklist of species of the genus *Polistes* (Hymenoptera: Vespidae; Polistinae, Polistini). *American Museum Novitates*, 3188, 1–39.
- Das, B.P. & Gupta, V.K. (1984) ["1983"] A catalogue of the families Stenogastridae and Vespidae from the Indian subregion (Hymenoptera: Vespidae). *Oriental Insects*, 17, 395–464.
- Das, B.P. & Gupta, V.K. (1989) *The Social Wasps of India and the Adjacent Countries (Hymenoptera: Vespidae)*. *Oriental Insects Monograph 11*. The Association for the Study of Oriental Insects, Gainesville, 292 pp.
- Dover, C. & Rao, S. (1922) A note on the diplopterous wasps in the collection of the Indian Museum. *Journal and Proceedings, Asiatic Society of Bengal*, 18(4), 236–249.
- Gusenleitner, J. (2006) Drei neue *Polistes*-Arten aus Laos und Vietnam (Hymenoptera: Vespidae). *Linzer Biologische Beiträge*, 38(1), 671–675.
- Kirby, W. & Spence, W. (1828) *An Introduction to Entomology, or Elements of the Natural History of Insects, Fifth edition*, 3. Longman, Rees, Orme, Brown and Green, London, viii + 732 pp. + 15 pls.
- Kojima, J. (1999) Male genitalia and antennae on an Old World paper wasp genus *Ropalidia* Guérin-Méneville, 1831 (Insecta: Hymenoptera; Vespidae, Polistinae). *Natural History Bulletin of Ibaraki University*, 3, 51–68.
- Kojima, J., Saito, F. & Nguyen, L.T.P. (2011) On the species-group taxa of Taiwanese social wasps (Hymenoptera: Vespidae) described and/or treated by J. Sonan. *Zootaxa*, 2920, 42–64.
- Kostylev, G. (1940) Espèces nouvelles et peu connues de Vespides, d'Euménides et de Masarides paléarctiques (Hymenoptera). II. *Bulletin de la Société des naturalistes de Moscou, Section biologique (N.S.)*, 49, 24–42, 137–154.
- Latreille, P.A. (1802) *Histoire naturelle, générale et particulière des Crustacés et des Insectes. Ouvrage faisant suite à l'Histoire Naturelle générale et particulière, composée par Leclerc de Buffon, et rédigée par C. S. Sonnini, Membre de plusieurs Sociétés savantes. Tome III*. F. Dufart, Paris, i–xii + 13–467 pp.
- Meunier, F. (1888) Description d'une nouvelle espèce de Sphérides du Brésil. *Naturalista Siciliano*, 7, 301–303.
- Pérez, J. (1905) Hyménoptères recueillis dans le Japon central par M. Harmand, Ministre Plénipotentiaire de France à Tokio. *Bulletin du Muséum National d'Histoire Naturelle, Paris*, 1905, 23–41, 79–87, 148–158.
- Petersen, B. (1987) Subspecies of the Indo-Australian *Polistes stigma* (Fabricius) (Hymenoptera: Vespidae). *Entomologica Scandinavica*, 18, 227–259.
- Saito, F. & Kojima, J. (2007) A taxonomic revision of the hover wasp genus *Eustenogaster* van der Vecht (Insecta: Hymenoptera; Vespidae, Stenogastrina). *Zootaxa*, 1556, 1–30.
- Saito, F., Nguyen, L.T.P., Carpenter, J.M., Kojima, J. (2006) A new *Eustenogaster* species (Hymenoptera: Vespidae; Stenogastrinae), the first hover wasp known to overwinter on the nest. *American Museum Novitates*, 3534, 1–11.
- Saussure H. de, 1853–1858. *Études sur la Famille des Vespides. 2. Monographie des Guêpes Sociales, ou de la Tribe de Vespiciens, ouvrage faisant à la Monographies des Guêpes Solitaires*. V. Masson, Paris & J. Kessmann, Genève, i–cxliv + 1–256 pp. + 37 pls. (1853) 1–96 + pls. 2–8, 13; (1854) 97–256 + pls. 9–12, 14–18, 20–24, 27–33; (1855) pl. 1; (1857) i–xlvi + pls. 35–37; (1858) xlix–cxliv + pls. 19 bis, 30 bis. (Date of publication after Griffin 1939).
- Sonan J. (1937) Two new species and one new genus of Hymenoptera. *Transactions of the Natural History Society of Formosa*, 27, 169–174.
- Tabata H. (1988) On the Himalayan corridor. *Acta Phytotaxonomica et Geobotanica*, 39, 13–24. (In Japanese with English summary).
- Tabata H. (2004) On the Himalayan uplift and Himalayan corridors. *Himalayan Journal of Sciences*, 2 Issue 4 (Special issue), 256–257.
- Wenzel J. W. (1998) A generic key to the nests of hornets, yellowjackets, and paper wasps worldwide (Vespidae: Vespinae, Polistinae). *American Museum Novitates*, 3224, 1–39.