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A Taxonomic Note and Nest Description of an Australian Paper Wasp, *Polistes variabilis* (FABRICIUS) (Hymenoptera, Vespidae, Polistinae)

Jun-ichi KOJIMA
Natural History Laboratory, Faculty of Science, Ibaraki University, Mito 310, Japan

and

James M. CARPENTER
Department of Entomology, American Museum of Natural History
Central Park West at 79th Street, New York, NY 10024, U.S.A.

Abstract Diagnostic characters of an Australian paper wasp, *Polistes variabilis* (FABRICIUS), are given in comparison with *P. humilis* and *P. stigma*; the latter two species occur sympatrically with *P. variabilis* and have often been misidentified as *P. variabilis*. Nests of *P. variabilis* are described for the first time.

Australian fauna of the paper wasp genus *Polistes* comprises 11 extant species (RICHARDS, 1978; CARDALE, 1985; PETERSEN, 1987) in two subgenera, *Gyrostoma* KIRBY (five species) and *Polistella* ASHMEAD (six species) (CARPENTER, 1996). Among them, *Polistes* (*Polistella*) *variabilis* (FABRICIUS) has often been involved in taxonomic confusion in terms of its correct identification. FABRICIUS (1781: 466) described *Polistes variabilis* (originally as *Vespa*) based on a male from "New Holland", which is now deposited in the Banks collection of the Natural History Museum, London. Since then, the species has received little attention by biologists until RICHARDS (1978). Although distributional and biological notes on Australian paper wasps have appeared under the name of *P. variabilis* or *P. humilis variabilis* (MEADE-WALDO, 1912; MCKEOWN, 1942; DOUGLAS and SERVENTY, 1951; ZECK, 1965; GIORDANI SOIKA, 1975), these reports were based on misidentification of *P. humilis* (FABRICIUS) and/or *P. stigma* (FABRICIUS) (RICHARDS, 1978; for the taxonomy of *P. stigma*, see PETERSEN, 1987).

RICHARDS (1978) provided a key to distinguish *P. variabilis* from other Australian *Polistes* species, and descriptions of both sexes. However, he referred mainly to coloration, and the description of structural characters was not sufficient to distinguish *P. variabilis* from *P. humilis* or *P. stigma*. Further, he (1978: 42) referred to "*P. humilis variabilis*" in comparison with *P. sgarambus* GIRODANI SOIKA; such an inconsistent use of the scientific names in a single paper might have brought further confusion into the taxonomy of the Australian *Polistes*.

Polistes variabilis is, as far as is known, distributed in northern part of Queensland, where two consubgenerics, *P. stigma* and *P. humilis*, occur sympatrically (RICHARDS, 1978; PETERSEN, 1987). The present paper aims to list the previous misidentifications that RICHARDS (1978) did not refer to and describes diagnostic characters of *P. variabilis* mainly in comparison with these sympatrically occurring consubgenerics. Nests are also described for the first time.

Abbreviations for the institutions in which the specimens examined are housed are as follows: ANIC, Australian National Insect Collection, CSIRO, Canberra; BMNH, the Natural History Museum, London; IUNH, Ibaraki University (Natural History Laboratory), Mito; AMNH, American Museum of Natural History, New York; RMNH, Nationaal Natuurhistorisch Museum, Leiden; OUM, Hope Entomological Collection, University Museum, Oxford.

Polistes (*Polistella*) *variabilis* (FABRICIUS)

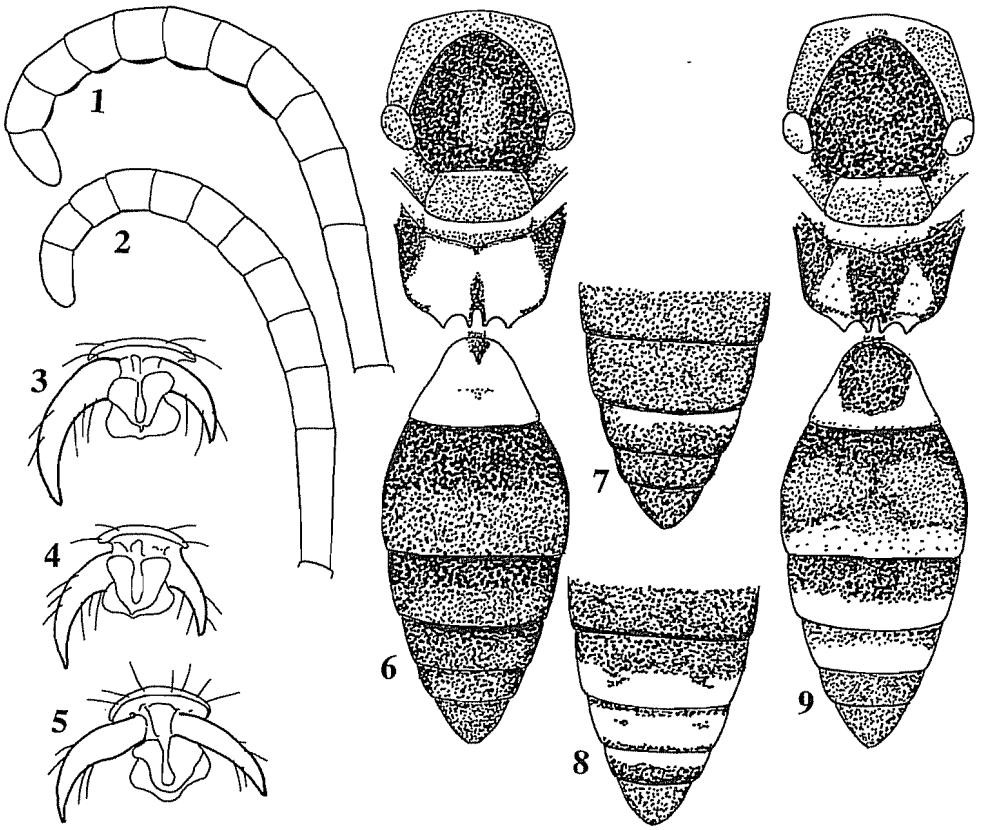
Vespa variabilis FABRICIUS, 1781: 466; OLIVIER, 1792: 690.
Polistes variabilis; FABRICIUS, 1804: 273; DE SAUSSURE, 1853: 66 (redescription of the type); MEADE-WALDO, 1912: 452 (New Guinea: Wataikwa River; Queensland: Inkerman, near Townsville; Mackay; Port Darwin; Bathurst Island) [we examined the specimens in BMNH except that from Port Darwin (not found), and revealed MEADE-WALDO's misidentification of *P. stigma*]; CHEESMAN, 1951: 991 (compared the type of *Vespa variabilis* FABRICIUS with *Polistes comis* sp. n.); RICHARDS, 1978: 10 (key), 40 (descriptions of female and male; Queensland).
Polistes humilis var. *variabilis*; BEQUAERT, 1928: 58 ("The holotype agrees structurally with *P. humilis*").
Polistes humilis variabilis; RICHARDS, 1978: 42 (compared with *P. sgarambus*; "very rare in Northern Territory") [probably *P. humilis*].

Diagnostic structural characters. Male clypeus rather strongly bent backward near the ventral margin (similar in *P. humilis*; weakly and smoothly curved in *P. stigma*). Male antennal segments VI-XII with rather strongly raised tyloids of longitudinal ridges (Fig. 1; similar in *P. humilis*; tyloids very weak in *P. stigma*: Fig. 2). Punctures on scutum coarse, as strong as those on pronotum, flat-bottomed with central postules (similar in *P. humilis*; shallow, ill-defined and without distinct central postules in *P. stigma*). Tarsal claws of mid and hind legs strongly asymmetrical, inner claw about 1.5 times as long as outer one (Fig. 3; similarly strongly asymmetrical in *P. stigma*: Fig. 4; only weakly asymmetrical in *P. humilis*: Fig. 5). Posterior face of propodeum with concavity, which is wide and more or less defined in oval outline (posterior face nearly flat in *P. stigma*; concavity ill-defined in *P. humilis*). Wings hyaline, hardly infuscate apically (similar in *P. humilis*; infuscate in apical half to two-thirds of the marginal cell in *P. stigma*).

Color of male. Holotype: black; antennal scape ferruginous below, flagellum yellowish-ferruginous below; ferruginous band on pronotal carina with narrow branches along posterodorsal margin of pronotum; tegula and disk of scutellum dark ferruginous. Following parts yellow or ivory-yellow: antennal radicle, clypeus, inner orbit, mandible, anterior transverse band on metanotum, wide paired longitudinal bands on posterior face of propodeum, propodeal valvula, metasomal tergum I except large black spot on anterior face (posteriorly ferruginous, possibly due to discolouration), sternum I, minute spots near posterior margin of tergum II, posterior bands on tergum III and sterna III-VI, irregularly incised in their anterior margins, anterior bands on visible parts of terga IV-V, most visible parts of tergum VII and sternum VII. Legs black; fore coxa with small yellow spot, mid and hind coxae with rather large spots on outer surface; femora dark ferruginous, with ill-defined yellow spot at apices; tibia and tarsi ferruginous.

Males from Granite Gorge generally with brighter head and mesosoma, but darker metasoma than the holotype as follows: Space between antennal sockets yellow, often narrowly extending laterally along the upper margin of the antennal socket to unite with band at inner orbit; clypeus sometimes with ill-defined dark spot; gena often with narrow stripe along posterior margin of eye; entire posterior face of propodeum, except narrow posteromedian black stripe, yellow or ivory-yellow; metasomal segments II-VII without yellow markings.

Color of female. Black; antenna including radicle dark brown above, pale brown below; most of gena, paired spots behind ocelli, mandible, pronotal carina and dorsal face of pronotum, spots on dorsal and posteroventral corners of mesepisternum, tegulae, scutellum, posterior half of metanotum, femora (with blackish band on ventral face), ferruginous; clypeus, except black margins and ill-defined, central brown spot, inner orbit, spot between antennal sockets, anterior margin of scutellum, anterior half of metanotum, dorsal spot of metapluron and axillary region, yellow or ivory-yellow.



Figs. 1-9. *Polistes* spp. in Australia. — 1, 2, Male antenna (1. *P. variabilis*; 2. *P. stigma*); 3-5, female tarsal claws (3. *P. variabilis*; 4. *P. stigma*; 5. *P. humilis*); 6-8, marking pattern of female *P. variabilis*; 9, marking pattern of female *P. stigma*.

Coloration in other parts of mesosoma and metasoma as in males from Granite Gorge.

Some specimens have brighter coloration. Color pattern among specimens from Granite Gorge shows intra-colonial variation as follows; although the variations are given for each body part, various combinations actually occur: Frons with ill-defined reddish-brown markings; yellow markings on clypeus and head largely replaced with reddish brown; posterior margin of pronotum yellow; scutum with ill-defined reddish brown marking; metanotum mostly yellow; dorsal face of metasomal tergum I with small, black spot.

Further variations in the marking pattern in the specimens from the other localities are as follows (various combinations occurring); head mostly reddish brown except yellow clypeus, or marked extensively with reddish brown; clypeus with large black medial mark; malar space with small yellow spot; pronotal carina and posterior margin of pronotum yellow, pronotum mostly reddish brown; nearly whole area of scutum ferruginous; metanotum yellow, except black posterior margin, or entirely ferruginous; mesepisternum with yellow spot at the dorsal corner; propodeum reddish brown laterally; coxal yellow spot larger; apices of mid and hind femora yellow; median black stripe on propodeum complete but quite narrow dorsally, or almost absent; metasomal segments III-V or some of them with yellow apical bands (Figs. 7 and 8).

Diagnostic color characters. Both in the male and female, *P. variabilis* can be

distinguished from other Australian *Polistes* by the posterior face of propodeum and the ♂♀ first metasomal tergum both largely yellow or ivory-yellow (*cf.* Figs. 6 and 9).

Specimens examined. ♂, "New Holland" (holotype, BMNH); 9♀, 4♂, from Nest PA-01, Granite Gorge near Mareeba, 7. ii. 1988, J. KOJIMA (ANIC, IUNH, AMNH, RMNH); 1♀, near Tinaroo Lake, 22. iii. 1992, J. KOJIMA (IUNH); 2♀ from Nest AP-08, Atherton, 15. vi. 1992, J. KOJIMA (IUNH); 1♀, from Nest AP-03, 12. vi. 1992, J. KOJIMA (IUNH); 1♀, 15°16'S 144°59'E, 14 km W by N Hope Vale Mission, 8-10. x. 1980, J. C. CARDALE (ANIC); 1♀, 15°17'S 145°13'E 1 km N of Round Hill, 5-7. v. 1988, I. D. NAUMANN (ANIC); 1♀, Sandstone Hilltop 12 km N of Hole Valley, N. Qld, G. B. & S. R. MONTEITH (ANIC); 1♀, Sandstone outcrops, 30 km W of Fairview via Laura, N. Qld, 22-24. vi. 1976, G. B. & S. R. MONTEITH (ANIC); 1♀, Split Rock, 14 km S. of Laura, N. Qld, 23-26. vi. 1975, S. R. MONTEITH (ANIC); 1♀, Tinaroo Lake nr. Atherton, N. Qld, 23. iv. 1980, H. E. & M. A. EVANS (AMNH); 2♀, 15 km SW Mareeba, N. Qld, 28.iii. and 14. iv. 1987, H. E. & M. A. EVANS (AMNH); 1♀, nr. Dimbulah, N. Qld, 19. iv. 1987, H. E. & M. A. EVANS (AMNH); 1♀, Davis Creek, 12 km W of Kuranda, N. Qld, 14. xi. 1971, C. G. ROCHE (BMNH); 1♀, nr Davies Crk, N. Qld, 4. xi. 1972, O. W. RICHARDS (BMNH); 1♀, Cairns, R. E. TURNER (BMNH); 1♀, 1♂, locality unknown, KIRBY (OUM).

Nests and colonies. Nests are deposited in IUNH and ANIC.

PA-01: collected with three females and a male (at least three individuals escaped at collection), made on underside of a *Pandanus* sp. leaf at about 0.8 m above ground; attached to the mid-rib. With 192 cells arranged to form a nearly circular comb of 57 x 55 mm; all cells containing immatures, six cells each bearing more than one immature. Pedicel located near the center of comb, plate-like, 7.8 x 1.5 mm thick and 5.9 mm long; enlarged with pulpy material (reinforcement with plant fiber also on back of comb and on substrate around pedicel), on which salivary secretion was heavily coated. Back of comb nearly flat, slightly raised around pedicel, and showing the tendency to warping up at periphery. Cells weakly widening towards opening; diameter of cells containing or having contained pupae 3.5 mm (3.3-3.7 mm, n=5) at base and 5.8 mm (4.9-5.9 mm, n=10) at opening, length of such cells 19 mm (18-20.5 mm, n=5). Cocoon caps white in color, weakly domed, sometimes protruding beyond rim of cell up to 5 mm, without application of plant fibers.

PA-02: collected with 4 females, made on a mid-rib of the leaf of the *Pandanus* tree on which PA-01 was made, at 1.4 m above ground. With 85 cells arranged in a circular comb of 35 x 32 mm; 37 peripheral cells shallow and empty. Pedicel located near center of comb, column-like, 1.5 x 1.4 mm thick at mid-length, 3.2 mm long, enlarged strictly with salivary secretion. Back of comb weakly domed around pedicel, nearly flat peripherally. Cells and cocoon caps similar to those of PA-01, with cell diameter of 4.9 mm (4.5-5.3 mm, n=10) at opening and length of 15 mm (13.5-16.5 mm, n=5).

AP-08: collected with two females, both of which were inseminated. Although neither female had mature oocytes, one of them had submature oocytes and the other had less developed ovaries. The nest was on the frame of a greenhouse and with the following characters: with 14 shallow (depth about 5-6 mm) cells arranged in nearly circular comb of 11 x 9.5 mm; 12 cells bearing eggs and the remaining two empty; pedicel located at the center of comb, 0.5 x 0.8 mm thick near the mid length, 3.7 mm long, with coating of oral secretions; diameter of cells at opening 3.0 to 3.4 mm, and their depth about 7 mm in the longest one.

AP-03: collected with one inseminated female, which had three submature oocytes. With four shallow cells, all of which had eggs, arranged in a 7 x 6.5 mm comb. First

two cells, respectively 3.6 mm diameter at opening and 5.1 mm deep, and 3.4 mm in diameter and 5.8 mm deep, sharing a wall, where the nest pedicel is located. The bottom of the third and forth cells initiated on walls of the first and second at 1.3-1.4 mm below the level of the bottom of the first and second. Pedicel 0.9 x 0.6 mm thick, and 3.0 mm long, with a little coating of oral secretion.

Notes on nest structure. Basic structure of *P. variabilis* nests is the same as those of the consubgeners so far reported in Papua-Australian regions (RICHARDS, 1978; KOJIMA & KOJIMA, 1988). The pedicel reinforced exclusively with oral secretion in tropical species and tendency to the use of a larger amount of pulp in pedicel construction in several temperate species have been interpreted in terms of defense function of the pedicel against ants (DOWNING & JEANNE, 1986; WENZEL, 1996). Observations that *Polistella* species reinforce the pedicel exclusively with oral secretion in the cool temperate zone (KOJIMA, 1993) may suggest that the secretion reinforced pedicel should be interpreted not only in terms of ecological factors but also in the contex of the phylogeny of *Polistes*. The pedicel flattened distally to provide the common wall between the first two cells was found in *P. variablis*; the state is commonly recognized in the genus *Polistes* and is primitive in the Polistinae (WENZEL, 1996).

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