

TAXONOMY OF SOCIAL WASPS OF THE POLISTINE TRIBE ROPALIDIINI (HYMENOPTERA: VESPIDAE) IN THE EASTERN PART OF THE LESSER SUNDA ISLANDS

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Abstract

The taxonomy of social wasps of the polistine tribe Ropalidiini in the eastern part of the Lesser Sunda Islands (viz., Sumba, Flores and Timor as included major islands) was studied based mainly on specimens recently collected by ourselves and those deposited in the Museum Zoologicum Bogoriense, Bogor. *Parapolybia varia* (Fabricius) and 11 species of *Ropalidia* are recognized in the region and their faunal characteristics are discussed. Nomenclatural changes included are: synonymy of *Ropalidia laticincta floresinana van der Vecht, 1962* under *R. laticincta van der Vecht, 1962*; synonymies of *Icaria nigroplagiata Cameron, 1900*, *R. mathematica binotata van der Vecht, 1941* and *R. mathematica sumbaensis van der Vecht, 1962*, all under *R. mathematica* (Smith, 1860); revised status of *R. socialis trimaculata van der Vecht, 1962*, and *R. variegata dichroma van der Vecht, 1941*, both being raised to species rank. New locality records are *R. cyathiformis* from Lombok and Flores Islands, *R. laticincta* from Sabu (or Sawu) Island, *R. rufoplagiata* (Cameron) from Timor Island, and *R. javanica van der Vecht* from Smabawa Island.

Key words: Hymenoptera, Vespidae, Polistinae, Ropalidiini, distribution, Indonesia, synonymy.

Introduction

The social wasps consist of three vespidae subfamilies (Stenogastrinae, Polistinae and Vespinae). The islands expanding eastward from Sumatra to New Guinea harbor a rich social wasp fauna, with about 130 species, of which 17 have been recorded from the eastern part of the Lesser Sunda Islands, with Sumba, Flores and Timor as major islands: no species of the Stenogastrinae has been recorded from the region (Carpenter and Kojima, 1997a); four species of the polistine genus *Polistes* (Carpenter, 1996); nine and one species of *Ropalidia* and *Parapolybia* of the polistine tribe Ropalidiini, respectively (Kojima and Carpenter, 1997); and three species of the vespine genus *Vespa* (Carpenter and Kojima, 1997b). The taxonomy and distribution of the species of the Ropalidiini in this region are, however, still poorly studied despite the fact that the area undoubtedly harbors social wasps key to understanding diversification and dispersal events between the Oriental region and New Guinea and/or Australia.

In the present paper, mainly based on the adult wasps collected during field research conducted in 2003 and adult specimens deposited in the Museum Zoologicum

Bogoriense, Bogor (MZB), we will discuss the taxonomy and faunal characteristics of the ropalidiine wasps in the eastern part of the Lesser Sunda Islands. A key to species not only of the Ropalidiini but also of all social wasp species known from the region is given. In the present study we adopt the phylogenetic species concept elaborated by Nixon and Wheeler (1990), but all the nomenclatural changes made in the present paper are the responsibility of JK and FS.

Materials and Methods

Field collection of the wasps was conducted in Sumba and Flores Islands and the eastern part of Timor Island during the period from 23 January to 3 February 2003. These specimens, as well as those from several localities outside the eastern part of the Lesser Sunda Islands, which are deposited in the MZB, the Natural History Collection at Ibaraki University, Mito (IUNH), the Australian National Insect Collection in the CSIRO, Canberra (ANIC), US National Museum of Natural History, Washington, D. C. (USNM) were examined. Type material in the Hope Entomological Collection at Oxford University, Oxford (OUM) and National Natuurhistorisch Museum, Leiden (RMNH) was examined by JK. Specimens for which the depositories are not given are tentatively deposited in the IUNH and will be shared between the MZB and IUNH.

Adult morphology was observed on pinned and dried specimens under a stereoscopic dissecting microscope.

Results and Discussion

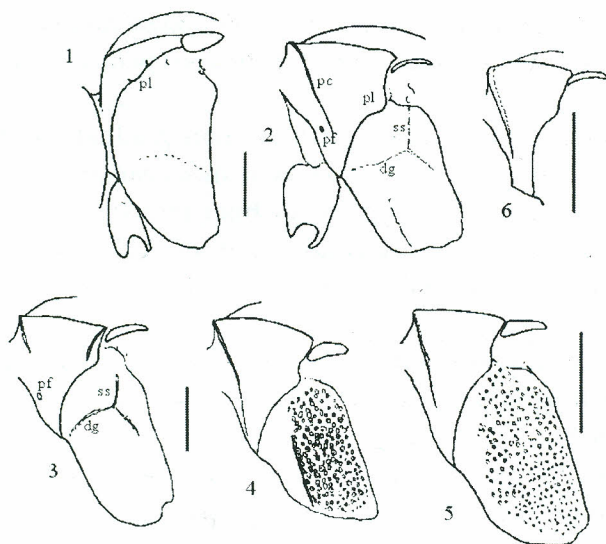
Key to species of social wasps in the eastern part of Lesser Sunda Islands

1. Wings at rest not longitudinally plaited. Mandible elongate. Antennal sockets far apart, separated from dorsal margin of clypeus by a long supraclypeal area. Pronotal lobe separated by a distance twice its length from tegula, to a point half way between fore- and mid-coxa (Fig. 1). Stenogastrinae (no species of the subfamily has been recorded from the region, but as we collected a *Parischnogaster* species on Flores Island the subfamily is included in this key; its species level taxonomy is under study)
- Wings at rest longitudinally plaited. Mandible short. Antennal sockets apart each other by a distance about as long as their diameter. Pronotal lobe separated by a distance about equal to its length from tegula (Figs. 2-6, 14, 15). 2
2. Hind coxa with dorsal carina on posterior surface (Fig. 7). Hind wing without jugal lobe (Fig. 8). Metasoma sessile; first tergum with abrupt declivity (Fig. 10). 3, Vespinae, *Vespa*

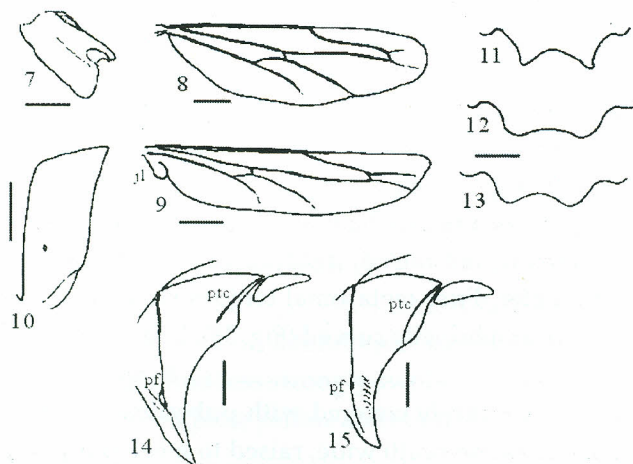
- Hind cox without dorsal carina. Hind wing with jugal lobe (Fig. 9). Metasoma petiolate or subsessile..... 5, Polistinae
- 3. Anterior margin of clypeus with bluntly triangular tooth on each side of the median excision (Fig. 11). Lower, vertical area of pronotum with strong, transverse striae. Body covered with strong and stiff bristles..... *V. tropica* (Linnaeus, 1758)
- Anterior margin of clypeus on each side of the median excision with short, broadly rounded lobe (Figs. 12, 13). Body pubescence finer..... 4
- 4. Pronotal carina with large interruption. Pretegular carina only extending to center of pronotal tubercle (Fig. 14). First metasomal tergum of female in dorsal view less than half as long as wide..... *V. velutina* Lepeletier, 1836
- Pronotal carina with small interruption by pronotal fovea. Pretegular carina completely crossing pronotal tubercle (Fig. 15). First metasomal tergum of female in dorsal view half as long as or longer than wide..... *V. affinis* (Linnaeus, 1764)
- 5. Metasoma subsessile; first segment more or less smoothly passing into second segment; first sternum in lateral view with blunt angle basally (Fig. 16) 6, Polistini, *Polistes* [for species occurring in the region, also see Saito *et al.* (2005)]
- Metasoma petiolate; first sternum more or less flat throughout..... 9, Ropalidiini
- 6. Clypeus not produced above anterior tentorial pits. Pronotal fovea present..... 7
- Clypeus dorsally produced well above anterior tentorial pits. Pronotal fovea, epicnemial carina and dorsal groove all absent..... 8
- 7. Smaller species; forewing length 11-16 mm. Epicnemial carina and dorsal groove present. Body black, extensively marked with bright-yellow..... *P. diabolicus* de Saussure, 1853
- Larger species; forewing length 17-22 mm. Epicnemial carina and dorsal groove both absent. Body ferruginous to orange-brown; first two metasomal tergum extensively marked with yellow, or nearly entirely dark orange-brown..... *P. tenebricosus* Lepeletier, 1836
- 8. Smaller species; forewing length 8.5-11 mm. Body black, extensively marked with brown and yellow; wings transparent, with dark spot in marginal cell..... *P. callimorpha* de Saussure, 1853
- Larger species; forewing length 18-20 mm. Gena wider, in profile about 0.9 times as wide as eye in female. Body ferruginous to dark brown, sometimes with dark orange-brown bands on second and/or first metasomal terga; wings entirely strongly fuscous..... *P. sagittarius* de Saussure, 1853
- 9. Pronotal fovea, dorsal groove of mesepisternum, pretegular carina, all present (Fig. 3). Second metasomal tergum and sternum not fused, overlapping (Fig. 17)..... *Parapolybia varia* (Fabricius, 1787)
- Pronotal fovea, dorsal groove of mesepisternum, pretegular carina, all absent

- (Figs. 4, 5). Second metasomal tergum and sternum fused, leaving at most suture (Figs. 23, 32) 10, *Ropalidia*
10. Mesepisternum punctured posterodorsally, unpunctured anteroventrally, with indistinct border between punctured and unpunctured areas (Fig. 5). Propodeal valvula small, rounded triangle in outline; in profile, most part of propodeal teeth forming orifice visible (Fig. 18)..... 11
- Mesepisternum with distinct border between punctured posterodorsal and unpunctured anteroventral areas; border sometimes raised into carina (Fig. 4). Propodeal valvula proportionately large, subcircle or hemicircle in outline, in profile covering most part of propodeal teeth (Figs. 21-23)..... 12
11. Female body black, with abundant yellow markings; antennal scape entirely ferruginous or sometimes marked with yellow at extreme base and/or apex; posterior margin of mandible rather widely black.....
..... *R. javanica* van der Vecht, 1962
- Female body black, with ochreous to orange-brown markings; mandible black with orange-brown spot at base..... *R. ochracea* van der Vecht, 1962
12. First metasomal tergum abruptly swollen dorsally at posterior margin of basal slit for reception of propodeal suspensory ligament (Fig. 19). Ventral corner of pronotum obliquely cut off (Fig. 9).....
..... *R. rufoplagiata* (Cameron, 1905)
- First metasomal tergum more or less smoothly swollen posteriorly (Figs. 21-23, 32, 34, 38). Ventral corner of pronotum gradually narrowed to pointed apex (Figs. 4, 5)..... 13
13. Propodeum with paired basal carinae, running from posterolateral corners of metanotum in direction to base of first metasomal tergum (Fig. 20)..... 14
- Propodeum without such carinae 15
14. Propodeum slightly shorter, in lateral view weakly convex. First metasomal tergum relatively shorter and strongly swollen (Fig. 21). Clypeus of female as a rule without complete yellow apical band.....
..... *R. laticincta* van der Vecht, 1962
- Propodeum relatively longer, in lateral view barely convex. First metasomal tergum relatively longer and less strongly swollen posteriorly (Fig. 22). Clypeus of female as a rule with complete yellow apical band.....
..... *R. marginata* (Lepelletier, 1836)
15. Propodeum more or less evenly, weakly convex, with median furrow very narrow and shallow, often obsolete anteriorly (Fig. 25). First metasomal segment flask-shaped, with relatively long basal petiolate part (Figs. 23, 24).....
..... 16, *R. stigma*-group

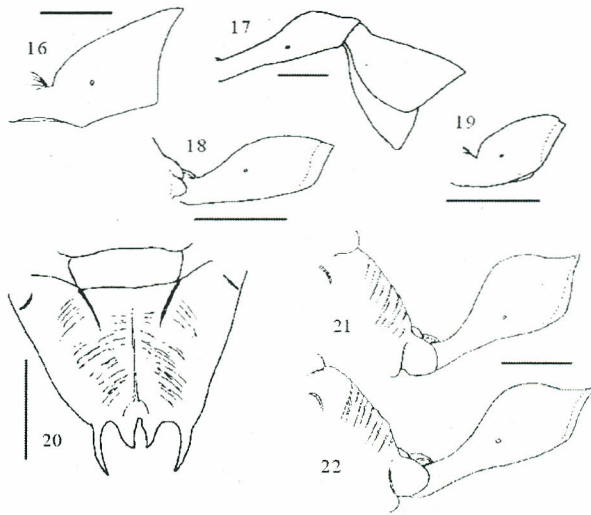
- Propodeum with median furrow wide or prominent median excavation (Figs. 40, 41). First metasomal segment short, with basal petiolate part short (Figs. 34, 35, 38, 39) 18
- 16. Second metasomal segment in dorsal view more gradually swollen posteriorly in anterior two-thirds length of the segment, then nearly parallel-sided (Figs. 26, 27). Metapleura with more or less distinct punctures. Median furrow of propodeum obsolete in its extreme anteriority (Fig. 25). Disks of scutellum and metanotum not entirely yellow if marked with yellow.....
..... *R. mathematica* (Smith, 1860)
- Second metasomal segment in dorsal view strongly swollen posteriorly in its anterior half, then slightly narrowed toward the posterior margin or parallel-sided (Figs. 28, 29)..... 17
- 17. Propodeum with median furrow fine, reaching anterior margin of propodeum. Metapleura with more or less distinct punctures. Body dark brown to dark ferruginous, sometimes with ill-defined, yellowish brown bands along inner eye margins and at posterior margin of second metasomal tergum.....
..... *R. socialis* (de Saussure, 1862)
- Median furrow of propodeum obsolete anteriorly in some distance from anterior margin of propodeum. Metapleura unpunctured. Disks of scutellum and metanotum, and broad median band of propodeum bright lemon-yellow.....
..... *R. trimaculata* van der Vecht, 1962
- 18. First metasomal segment longer than half length of second tergum (Fig. 32); in dorsal view posterior part swollen and narrowed again near apical margin (Fig. 33)..... *R. fasciata* (Fabricius, 1804)
- First metasomal segment short; in dorsal view posterior part gradually widened to apical margin, or parallel-sided near apical margin, or slightly narrowed in extreme posteriority (Figs. 35, 39)..... 18
- 19. Clypeus, at least in its anterior half, shiny, with nearly no punctures. Space between ocelli narrow, not raised; distance between posterior ocelli about as long as their diameter. First metasomal tergum short, with dorsal surface in lateral view weakly and broadly curved (Fig. 38). Body extensively marked with pale- yellow *R. cyathiformis* (Fabricius, 1804)
- Clypeus dull, nearly entirely covered with pubescence, with sparse, shallow punctures. Space between ocelli wide, raised to level of top of posterior ocelli; distance between posterior ocelli about twice their diameter. First metasomal tergum longer, with dorsal surface in lateral view more strongly convex (Fig. 34). Body without bright-yellow markings.....
..... *R. dichroma* van der Vecht, 1941



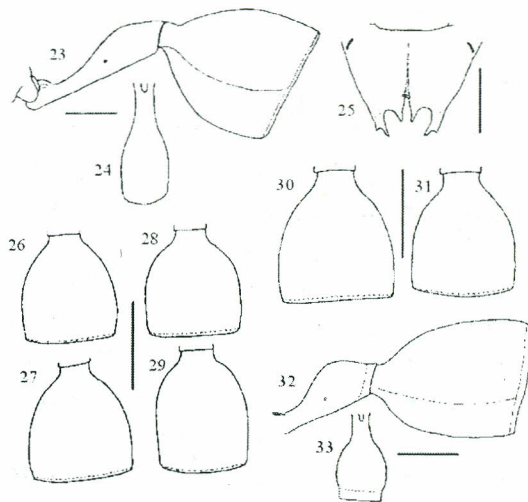
Figs. 1-6. Anterior parts of mesosoma. 1. *Parischnogaster mellyi* de Saussure, 1852; 2. *Polistes diabolicus* de Saussure, 1853; 3. *Parapolybia varia* (Fabricius, 1787); 4. *Ropalidia laticincta* van der Vecht, 1962; 5. *R. javanica* van der Vecht, 1962; 6. *R. rufoplagiata* (Cameron, 1905). Abbreviations: dg, dorsal groove; pl, pronotal lobe; pc, pronotal carina; pf, pronotal fovea; ptc, pretegar carina; ss, scrobal sulcus. Scale lines: 1 mm.



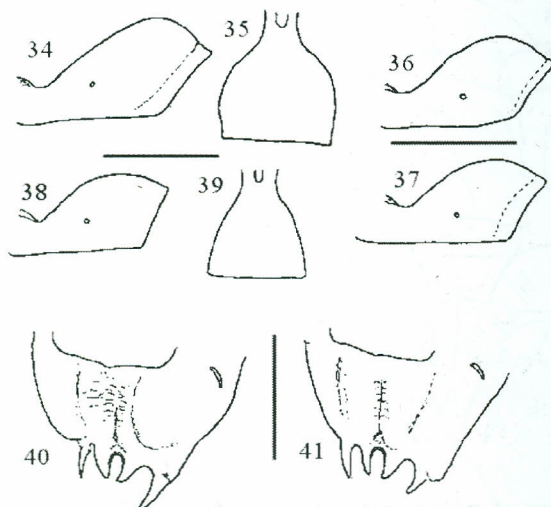
Figs. 7-15. Characters of the social wasps. 7, hind coxa of *Vespa affinis* (Linnaeus, 1764); 8, 9, hind wing (8, *V. tropica* (Linnaeus, 1758); 9, *Ropalidia laticincta* van der Vecht, 1962); 10, first metasomal segment of *V. velutina* Lepeletier, 1836; 11-13, apical part of clypeus (11, *V. tropica*; 12, *V. velutina*; 13, *V. affinis*); 14, 15, pronotum (14, *V. velutina*; 15, *V. affinis*). Abbreviations: jl, jugal lobe; ptc, pretegar carina. Scale lines: 1 mm, but 2 mm for Figs. 8 and 10.



Figs. 16-22. Characters of polistine wasps. 16, first metasomal segment of *Polistes diabolicus*, lateral view; 17, first and second metasomal segments of *Parapolybia varia*; 18, apex of propodeum and first metasomal segment of *R. javanica*, lateral view; 19, first metasomal segment of *R. rufoplagiata*; 20, poterodorsal view of propodeum of *R. marginata* (Lepeletier, 1836); 21, 22, propodeum and first metasomal segment, lateral view (21, *R. laticincta*; 22, *R. marginata*).



Figs. 23-33. Characters of *Ropalidia* wasps. 23, 24, *R. socialis* (de Saussure, 1862) (23, apex of propodeum and first two metasomal segments, lateral view; 24, first metasomal tergum, dorsal view); 25, propodeum of *R. mathematica* (Smith, 1860); 26-31, second metasomal tergum, dorsal view (26, *R. mtathmeatica* from Timor Island; 27, *R. mathematica* from Sumba Island; 28, *R. socialis*; 29, *R. trimaculata* van der Vecht, 1962; 30, 31, *R. unicolor* (Smith, 1859)); 32, 33, *R. fasciata* (Fabricius, 1804) (32, first two metasomal segments, lateral view; 33, first metasomal tergum, dorsal view). Scale lines: 1 mm.



Figs. 34-41. Characters of *Ropalidia* wasps. 34-39, first metasomal tergum (34, 36-38, lateral view; 35, 39, dorsal view; 34, 35, *R. dichroma* van der Vecht, 1941; 36, *R. jacobsoni* (du Buysson, 1908); 37, *R. variegata* (Smith, 1852); 38, 39, *R. cyathiformis* (Fabricius, 1804)); 40, 41, propodeum, posterolateral view (40, *R. dichroma*; 41, *R. jacobsoni*).

Taxonomic notes and distribution of ropalidiine species

Parapolybia varia (Fabricius, 1787)

This species was originally described from China (Fabricius, 1787: 293), and is now known to be widely distributed from India in the west, to New Guinea in the east and Japan in the north (Kojima and Carpenter, 1997). Five species are at this moment recognized as valid in the genus; two (*P. escalera* (Meade-Waldo, 1911), *P. persica* (Meade-Waldo, 1911)) from the Middle-East, and three (*P. indica* (de Saussure, 1854), *P. nodosa* van der Vecht, 1966, and *P. varia*) from the Indo-Papuan region. The species in the Indo-Papuan region seem to need further intensive taxonomic study (J. Carpenter, personal communication, 2004) and thus our present identification of the specimen as *P. varia* is still tentative.

Specimen examined. Sumba I: 1 female, 09°45'S 120°35'E, Wanga, Sumba Timur, 29.i.2003, JK & RU.

Ropalidia cyathiformis (Fabricius, 1804)

The present species is known to have a rather wide distribution range, from India in the west to Sulawesi in the east and to the Philippines in the north. Recorded from the Lesser Sunda Islands is a single female specimen collected in Sumba (van der

Vecht 1962: 32). We examined the specimens from Lombok and Flores Island, which are new records for both islands.

Specimens examined. **Lombok I.:** 1 female (ANIC), [no detailed locality given], 29-30.vi.1929, I. M. Mackerras; 4 females, 1 male, 08°36'S 116°07'E, Mataram, 7.xi.2000, JK. **Flores I.:** 1 female (ANIC), Ende, 4.vi.1929, I. M. Mackerras.

***Ropalidia dichroma* van der Vecht, 1941, Stat. Nov.**

Ropalidia variegata dichroma van der Vecht, 1941: 157, female, male – "Timor" (holotype female in the RMNH, examined).

In addition to its remarkably dark body color, the propodeum with a narrower and deeper median excavation should diagnose the concept associated with the name *dichroma* as a species distinguished from *R. variegata* (Smith, 1852) or *R. jacobsoni* (du Buysson, 1908); *R. dichroma* also has the first metasomal tergum in lateral view (Fig. 34) more strongly convex dorsally than in *R. variegata* or *R. jacobsoni* (Figs. 36, 37).

The present species has been known from Timor and Roti Islands. Neither this species nor its closely related species (*R. variegata* or *R. jacobsoni*) have been recorded from other islands of the Lesser Sunda Islands.

Specimens examined. **Timor I.:** 1 female, 3 males, 10°12'S 123°40'E, Fenonisa, Kupang, 23.i.2003, JK; 1 female, 1 male, 10°11'S 123°36'E, Kupang (central part), 27.i.2003, JK; 1 female (MZB), forest, Kupang, 28.ii.1982, A. Hana; 5 females (MZB), Benlutu, 23.iii.1985, H. K. Sudarman (1 female, 3.iii.1985; 3 females, 6.iii.1985; 1 female, 23.iii.1985); 1 female (MZB), Takari, 12.iii.1985, H. K. Sudarman; 19 females (MZB), Polen, H. K. Sudarman (18 females, 21.ii.1985; 1 female, 3.iii.1985); 3 females (MZB), Lapangan, 2.iii.1985, H. K. Sudarman; 1 female (MZB), Tasi, 13.iii.1985, H. K. Sudarman; 1 female (MZB), Batu Putih, 14.iii.1985, H. K. Sudarman; 2 females (MZB), Olikuku, 1.iii.1982, A. Hana. **Sabu I.:** 5 females (MZB), H. K. Sudarman (1 female, 20.ii.1985; 3 females, 15.iii.1985; 1 female, 27.iii.1985).

***Ropalidia fasciata* (Fabricius, 1804)**

This species is widely distributed from India to the eastern margin of the Sunda shelf (including Palawan), extending eastward on the Lesser Sunda Islands and northward in Taiwan and on Okinawa Islands. In the Philippines except for Palawan, Sulawesi, and further eastward the species is replaced by its closely related species, *R. impetuosa* (Smith, 1860) [*"R. gregaria"* of authors; see Kojima 2001a]. As far as is known, the two species never co-occur.

Specimens examined. **Komodo I.:** 4 females (MZB), Waeliang, Djafar (3 females, 2.viii.1962; 1 female, 3.viii.1962). **Timor I.:** 1 female, 2 males (MZB), Polen, 21.ii.1985, H. K. Sudarman; 1 female (MZB), Camplong, 22.ii.1982, A. Hana; 1 female, 1 male (MZB), Olikuku, 2.iii.1982, A. Hana; 1 female (MZB), Olbola, 27.ii.1982, A. Hana.

Ropalidia javanica van der Vecht, 1962

This species was originally described as a subspecies of *R. flavopicta* (van der Vecht, 1962: 54) and later Kojima (1996: 325-326, 334) raised it to species. The species was recorded from Java and Flores in the original description (van der Vecht, 1962: 54); we did not collect any wasps of this species during our field research.

Specimen examined. Flores I.: 3 females (MZB), Rama, Mese, A. M. R. Wegner (2 females, 4.ix.1958; 1 female, 5.ix.1958). Sumbawa I.: 1 female (IUNH), 08°35'S 117°17'E, 800 m alt., Batudulang, Batulanteli, Sumbawa Besar, 10.xi.2000, JK (NEW RECORDS for the island).

Ropalidia laticincta van der Vecht, 1962

Ropalidia laticincta laticincta van der Vecht 1962: 14, male, female – “Sumba, Waikarudi” (holotype male in Naturhistorisches Museum, Basel, not examined).

Ropalidia laticincta floresiana van der Vecht 1962: 16, male, female – “Flores, Boa Wae, 450 m” (holotype male in the RMNH, examined). **NEW SYNONYMY**

When he described the present species, van der Vecht (1962) recognized two local color forms as formal subspecies: nominate subspecies from Sumba, Timor, Roti, Wetar, Roma, Kisar Islands and the Moluccas, and *R. laticincta floresiana* from Flores Island. The main distinction for this separation is in the apical yellow band of the second metasomal segment; that is, it is wide in *R. l. laticincta* and narrower in *R. l. floresiana*. This difference in marking pattern appears generally stable, but is regarded as no more than local variation; there is no place for local forms as formal taxa in a phylogenetic system (Nixon and Wheeler, 1990). We have synonymized *R. laticincta floresiana* under *R. laticincta*.

The specimens from Sumbawa and Komodo Islands have a yellow apical band on the second metasomal segment as narrow as that in the Flores specimens. Female specimens from Sumbawa have a relatively large dark brown spot at the central part of clypeus and their mesosomata largely marked with black.

Specimens examined. Sumbawa I.: 2 females (ANIC), Bima, 2.vi.1929, I. M. Mackerras; 1 female, 1 male (MZB), Brang Baru (north of Plampang), 24.i.1980, A. Saim; 2 females (MZB), Sermong, Jaliloang, 25.i.1980, A. Saim (NEW RECORDS for the island). Komodo I.: 1 female (MZB), Waeling, 1.viii.1962, H. K. Djafar (NEW RECORD for the island). Flores I.: 1 female, 2 males (MZB), Labuan Badjo, West Flores, vi. 1937, J. K. de Jong; 1 male (MZB), Mbura, West Flores, vi.1937, J. K. de Jong; 2 females, 1 male (ANIC), Ende, 4.vi.1929, I. M. Mackerras. Sumba I.: 2 females (ANIC), Waingapu, 25.vi.1929, I. M. Mackerras. Sabu (or Sawu) I.: 1 female, 11 males (MZB), 20.ii.1985, H. K. Sudarman; 2 females (ANIC), Seba, 23.vi.1929, I. M. Mackerras (NEW RECORDS for the island). Timor I.: 2 males (MZB), Kapan, 11.ii.1985, H. K. Sudarman; 1 female (MZB), Camplong, 22.ii.1982, A. Hana; 2 females (MZB), Camplong Barat Daya, 21.ii.1982, A. Hana; 1 female (MZB), Camplong Timur, 200 m, 20.ii.1981, A. Hana; 1

female (MZB), Gillu, 500 m, 4.iii.1982, A. Hana; 1 female (MZB), Olikuku, 2.iii.1982, A. Hana; 2 males (MZB), Polen, 21.ii.1985, H. K. Sudarman.

Ropalidia marginata (Lepeletire, 1836)

The present species, represented by four color forms with formal subspecies names, is widely distributed from India through Southeast Asia to New Guinea and northern Queensland of Australia and some Pacific islands. In Lesser Sunda Islands, the present species has been recorded from Lombok, Sumbawa and Sumba Islands. Van der Vecht (1962) found that in Sumba this species co-occurs with its closely related species, *R. laticincta* van der Vecht, 1962. We failed to collect any wasps of this species during the research and the MZB does not have any specimens from the eastern Lesser Sunda Islands.

Ropalidia mathematica (Smith) and its closely related species

Except for *torrida* Smith, 1863 (for its taxonomic status, see Saito and Kojima (2005)), in *R. mathematica* the following four color forms have been recognized as formal taxa, subspecies (van der Vecht, 1941, 1962; also see Kojima and Carpenter, 1997): *R. m. mathematica* from Sulawesi, Lombok and Flores; *R. m. binotata* van der Vecht, 1941, from Bangka, Sumatra, Java, Karimun Djawa, Bali, Sumbawa and Flores; *R. m. sumbaensis* van der Vecht, 1962, from Sumba and Timor; and *R. m. nigroplagiata* (Cameron, 1900) from Meghalaya in India. JK has examined the name-bearing types of all but *R. m. sumbaensis* and we have also seen additional specimens from various localities, which have led us to conclude that the concepts associated with these four names are no more than color variations intergrading in every direction; thus they should be synonymized. Other than color pattern, there is only a slight structural difference between *R. mathematica* and *R. unicolor* (Smith, 1859): the posterior face of propodeum is nearly flat in *R. mathematica* while weakly convex in *R. unicolor*.

The new taxonomic system follows.

Ropalidia mathematica (Smith)

Polybia mathematica Smith, 1860 (1861): 90, female – “Makassar” [Sulawesi] (holotype in the OUM, examined).

Icaria nigroplagiata Cameron 1900: 498, female – “Khasia Hills” [India] (holotype in the OUM, examined). **NEW SYNONYMY**

Ropalidia mathematica binotata van der Vecht, 1941: 131, female, male – “W. Java, Tapos on Mt. Gedeh (800 m)” (holotype female in the RMNH, examined). **NEW SYNONYMY**

Ropalidia mathematica sumbaensis van der Vecht, 1962: 20, female, male – “Sumba: Langgaliru” (holotype female in Naturhistorisches Museum, Basel, not examined). **NEW SYNONYMY**

Specimens examined. **Java I.:** 2 females, 1 male (ANIC), Buitenzorg [=Jakarta] G. L. Windred. **Bali I.:** 2 males (ANIC), Buleleng Git-Git, 31.v.1929, I. M. Mackerras. **Lombok I.:** 1 female (ANIC), 29-30.vi.1929, I. M. Mackerras; 1 female (IUNH), 08°36'S, 116°07'E, Mataram, 4.xi.2000, JK. **Sumbawa I.:** 2 females, 1 male (ANIC), Bima, vi.1929, I. M. Mackerras; 1 male (ANIC), Sumbawa-Besar, 1.vi.1929, I. M. Mackerras. **Sumba I.:** 1 female (IUNH), 09°45'S, 120°35'E, Wanga, Sumba Timur, 29.i.2003, JK & RU. **Timor I.:** 1 female (IUNH), 10°12'S, 123°50'E, Nonbes, Amarasi, 2.ii.2003, JK; 2 females, 2 males (MZB), Polen, 21.ii.1985, H. K. Sudarman; 1 male (MZB), Batu Putih, 6.iii.1985, H. K. Sudarman; 1 male (MZB), Lapangan, 2.iii.1985, H. K. Sudarman; 2 females, 1 male (MZB), Olikuku, A. Hana (1 female, 1 male, 1.iii.1982; 1 female, 2.iii.1982); 1 female (MZB), Oibola, 27.ii.1982, A. Hana. **India:** 1 female (USNM), Nilgiri Hills, Gudalur, Amarasi, iv.1949, P. S. Nathan. **Thailand:** 2 females (IUNH), NamNao Nat. Park, 1.xii.2003, S. Yamane. **Vietnam:** 8 females (tentatively in IUNH; also other specimens from Vietnam), Mon Son-Con Cuong, Nghe An Prov., 22-24.vii.2004, L. T. P. Nguyen; 2 females, Son Hong, Huong Son, Ha Tinh Prov., 25.iv.2004, X. L. Truong; 3 females, Son Tay, Huong Son, Ha Tinh Prov., 19.v.2004, L. T. P. Nguyen; 5 females, Xuan Son Nat. Park, Phu Tho Prov., 600m, 11-13.vi.2004, L. T. P. Nguyen; 1 female, Lac Thinh-Yen Thuy, Hoa Binh Prov., 1.v.2002, V. T. Hoang; 5 males, Cat Ba Nat. Park, Hai Phong, 15-18.vii.2003, L. T. P. Nguyen; 1 female, 2 males, Pu Mat Nat. Park, Nghe An Prov., 21.vii.2004, L. T. P. Nguyen; 1 female, Khe Sanh, Quang Tri Prov., 26.iii.2003, L. T. P. Nguyen.

Ropalidia socialis (de Saussure)

Icaria socialis de Saussure, 1862: 136, female – “Probablement l’archipel indien” (holotype in the RMNH, examined).

Ropalidia mathematica unicolor (Smith); van der Vecht, 1941: 104 (syn.; *I. socialis* de Saussure), 133.

Ropalidia socialis socialis; van der Vecht, 1962: 21 (“Whether *R. socialis* is indeed conspecific with *R. unicolor* cannot be determined with certainty at this moment.”).

This species is closely related to *R. mathematica* and *R. unicolor*, but can be distinguished from the latter two species by the shape of the second metasomal segment as given in the key.

Specimens examined. **Timor I.:** 2 females (ANIC), Soe (2000 ft.), 21.vi.1929, I. M. Mackerras. 1 female, 10°15'S 123°50'E, nr. Beherdi di Taman Raya, 2.ii.2003, JK; 1 female, 09°59'S 120°01'E, Takari, 1.ii.2003, JK; 1 female, 09°57'S 124°09'E, Boentuka, Timur Tengah Selatan, 1.ii.2003, JK; 1 female (MZB), Tasi, 13.iii.1985, H. K. Sudarman; 4 females (MZB), Benlutu (between Camplong and Niki Niki), H. K. Sudarman (1 female, 23.ii.1985; 2 females, 3.iii.1985; 1 female, 6.iii.1985); 2 females (MZB), Lapangan, H. K. Sudarman (1 female, 11.ii.1985; 1 female, 2.iii.1985); 1 female (MZB), Batu Putih,

14.iii.1985, H. K. Sudarman; 9 females (MZB), Polen, H. K. Sudarman (6 females, 21.ii.1985; 3 females, 3.iii.1985); 1 female (MZB), Camplong Timur, 200 m, 28.ii.1982, A. Hana; 3 females (MZB), Daya, Camplong Barat, 26.ii.1982, A. Hana; 1 male (MZB), Olikuku, 1.iii.1982, A. Hana. **Sabu I.**: 3 females (MZB), 15.iii.1985, H. K. Sudarman.

***Ropalidia trimaculata* van der Vecht, 1962, stat. nov.**

Ropalidia socialis trimaculata van der Vecht, 1962, Zool. Verh., Leiden 57: 21, female – “Sumba, Pogobina” (holotype in Naturhistorisches Museum, Basel, not examined).

The specimen listed below was given to JK by the late Prof. van der Vecht and judging from its collection data the specimen might be a paratype though it has only the label of collection data.

Beside color pattern given in van der Vecht (1962), this species can be distinguished from either *R. mathematica* or *R. socialis* in having the metapleura unpunctured.

Specimen examined. **Sumba I.**: 1 female (IUNH), Latuka, East Sumba, 4.vii.1949, Bühner & Sutter.

***Ropalidia ochracea* van der Vecht, 1962**

This species was originally described from Sumba Island as a subspecies of *R. flavopicta* (van der Vecht, 1962: 54) and later Kojima (1996: 325-326, 336) raised it to species. We did not collect any wasps and the MZB does not have any specimens of this species; considering that the species is endemic to Sumba Island, a small island with natural habitat dramatically decreasing, the species may have been already extinct or extant in small fragmented populations elsewhere.

***Ropalidia rufoplagiata* (Cameron, 1905)**

The present species is known to occur widely from India in the west, through Myanmar, Thailand and Malay Peninsular, to Sumbawa Islands in the east (van der Vecht, 1941, 1962; Das and Gupta, 1989; Kojima *et al.*, 2002). We did not collect any specimens during our field research. A female and a male from Timor housed in the MZB are much darker than specimens so far recorded in any other localities as follows.

Female. Dark ferruginous, with following parts black: spot above each antennal socket, large spot among and around ocelli, median wide band in anterior two-thirds of scutum and wide sublateral bands on scutum, metanotum except for posterior yellow band, narrow and interrupted medially, mesepisternum except for large scrobal spot colored dark ferruginous, metapleura, and propodeum. First metasomal tergum blackish ferruginous, with narrow, yellow preapical (anterior to posterior depressed lamella)

band, which is widely interrupted medially; second to fifth metasomal segments with ill-defined apical band colored dark yellowish ferruginous. Mid and hind coxae with small yellow spot dorsoapically.

Male. Coloration as in the female, but with yellow spot at bottom of inner orbit.

Specimens examined. Timor I.: 1 female, 1 male (MZB), Benlutu, 23.iii.1985, H. K. Sudarman (NEW RECORD for the island).

Faunal characteristics of ropalidiine wasps in eastern part of the Lesser Sunda Islands

The eleven species of the tribe Ropalidiini known from the eastern part of the Lesser Sunda Islands can be categorized into the following four groups with respect to their distribution pattern: (1) species distributed in continental Asia and over the arch of islands from Sumatra to the Lesser Sunda Islands (*Parapolybia varia*, *R. cyathiformis*, *R. fasciata*, *R. marginata*, *R. mathematica*); (2) species distributed from Java to Flores, but not on Timor Island (*R. javanica*); (3) species endemic to one or a few adjacently located islands (*R. ochracea* and *R. trimaculata* on Sumba Island; and *R. socialis* and *R. dichnoma* on Timor and Sabu Islands); and (4) species occurring on the Lesser Sunda Islands and the Moluccas (*R. laticincta*). Among these 11 species only *R. javanica* and *R. ochracea* are thought to be swarm founders, which found a colony by a swarm of workers accompanying one to a few tens of queens (Jeanne, 1991). Workers may use chemical cues to lead the swarm to a new nest site, and this could be the only possible way for their dispersal. Considering that no swarm-founding species are known in Timor and that these two species are closely related and their closely related species (*R. flavopicta* Smith, 1857) occurs from Indo-China to Sumatra, their common ancestor may have been from continental Asia and speciation took place while they dispersed eastward along the arch of Java and the Lesser Sunda Islands.

All other species are independent-founders, which initiate a new colony by one or a group of inseminated females. This mode of colony founding may ensure easier and relatively longer distance dispersal than swarm-founding wasps. Nevertheless, the independent-founding species of the third and fourth groups have restricted distribution ranges. On the other hand, these species are closely related to species with much wider distribution ranges; they may occur sympatrically or parapatrically. For example, *R. laticincta* is closely related to *R. marginata* and they co-occur on Sumbawa and Sumba Islands (van der Vecht, 1962; and present study), and *R. socialis* and *R. trimaculata* are related to *R. mathematica*. All these observations suggest that their speciation events occurred relatively recently. Endemic occurrence of *R. dichroma* on Timor and Roti Islands, however, may need further intensive study on the distribution of this species and/or its related species (*R. variegata* and *R. jacobsoni*). No record is available for any of the three species on the islands east of Java, except for Timor and Roti.

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