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DISTRIBUTIONAL SUMMARY, TAXONOMIC NOTES AND A PUTATIVE SCENARIO OF DISPERSAL OF SOCIAL WASPS (HYMENOPTERA: VESPIDAE) IN THE SUNDA ISLANDS

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ABSTRACT

Summary of distribution records, including new records, of social wasps on the Sunda Islands (Sumatra, Borneo, Java, and the Lesser Sunda Islands) are given and a scenario of their dispersal to and diversification in the islands is briefly discussed. Taxonomic notes on some species are also given, including the following new synonymy: *Polistes strigosus baliensis* Gusenleitner, 2000, under *Polistes sagittarius* de Saussure, 1853.

ABSTRAK

Ikhtisar mengenai rekod taburan, mencakup rekod taburan baru lebah sosial di semenanjung pulau-pulau Sunda (Sumatra, Borneo, Java dan pulau-pulau Lesser Sunda) akan di berikan dan senario

penyebaran ke dalam dan diversifikasi di dalam pulau-pulau secara singkat dibincangkan. Catatan taksonomi daripada beberapa spesies juga disertakan, termasuk sinonim baru dari: *Polistes strigosus baliensis* Gusenleitner, 2000 di dalam *Polistes sagittarius* de Saussure, 1853.

INTRODUCTION

The social wasps are comprised of three vespid subfamilies namely Stenogastrinae, Polistinae and Vespinae. Although the phylognetic position of the Stenogastrinae in the Aculeata is still under argument (Carpenter 1982; Schmitz and Moritz 1998), there are no robust analyses to proof that the three social wasp subfamilies do not form a monophyletic group (Carpenter 2003). All the three social wasp subfamilies occur together only in monsoonal Southeast Asia, and it has long been the view that the social wasps originally evolved in this area (van der Vecht 1965; Richards 1971). In fact, social wasps show considerable divergence in Southeast Asia, including the Sunda Islands (Sumatra, Borneo, Java, and the Lesser Sunda Islands). However, an area of divergence is not necessarily the area of origin of the group concerened; this sort of biogeographical scenario should be analyzed with reference to detailed current distribution patterns and phylogenetic relationships, both of which should be based on a decisive species concept (Wheeler 2005), as well as to historical geography.

Among the present Sunda Islands, Borneo, Sumatra and Java were connected to the present continental Southeast Asia, directly to the Malay Peninsula during the period from 30 (mid Oligocene) to 25 Ma (end Oligocene), when the current Lesser Sunda Islands were not in existence. From about 20 (early Miocene) to 15 Ma (mid Miocene), Borneo and Bangka might have been above the sea and formed an extension of Asian continent together with Malay Peninsula, while most part of Sumatra and entire part of Java seemed to be under the sea. From about 10 (late Miocene) to 5 Ma (early Pliocene), almost all the Southeast Asian and Papuan islands were in nearly the same arrangement as they are now; however, Sumatra, except for southwestern margin, was

under the sea, and Borneo was on land extension of Asian continent, and most of the Lesser Sunda Islands were still under the sea (Hall 1998). Thus, it was relatively recent event that the Lesser Sunda Islands emerged from the sea and the islands had never had a close geographical contact with Papuan region. An expected consequence would be that components of the terrestrial fauna of the Sunda Islands are continental Asian origin or those resulting from speciation in the Sunda Islands.

In the present paper, we summarize the distribution records of social wasps on the Sunda Islands based on our recent researches. We basically, unless otherwise noted for a few specific cases, adopt an elaborated phylogenetic species concept (Nixon and Wheeler 1990; Wheeler and Platnick 2000) in which species is defined as "the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of character states." (Wheeler and Platnick 2000). Taxonomic notes are also provided for some species for which the concepts are not yet well established. Finally, we briefly discuss a putative scenario of their dispersal to and diversification in the Sunda Islands.

DISTRIBUTION RECORDS AND TAXONOMIC NOTES

Before summarizing the distribution records (by island, or country and/or area when distributional records are on the continents), the specimens for each species examined are listed and the taxonomic notes are given when necessary. Acronyms for the depositories of the specimens are as follows: IUNH, Natural History Collection, Ibaraki University, Mito, Japan; MZB, Museum Zoologicum Bogoriense, Bogor, Indonesia; NIAES, National Institute for Agro-Environmental Sciences, Tsukuba, Japan; RMNH, Nationaal Naturhistorische Museum, Leiden, the Netherlands.

Subfamily Stenogastrinae

Genus *Eustenogaster* van der Vecht, 1969

Of the 11 species so far recognized as valid (Carpenter and Kojima 1997a; Saito *et al*. 2006), seven species occurs in continental

Southeast Asia and possibly also in the Indian subcontinent. *Euestenogaster luzonensis* (Rohwer, 1919) has been known only from Luzon, the Philippines and *E. palawanica* Reyes, 1988 only from Palawan, *E. fulvipennis* (Cameron, 1902) only from Borneo, and *E. agilis* (Smith, 1860) is endemic to Sulawesi (see Carpenter and Kojima 1997a). The following four species are so far known to occur in the Sunda Islands.

***Eustenogaster calyptodoma* (Sakagami and Yoshikawa, 1968)**
Distribution. Sumatra, Borneo; Malay Peninsula (Sakagami and Yoshikawa 1968; Ohgushi *et al*. 1983; Hansell 1987) (Fig. 1).

***Eustenogaster fulvipennis* (Cameron, 1902)**
Specimens examined. Borneo: 6 males (RMNH), Mt. Dulit, 4,000ft., Moss forest, 19-29.x.1932.
Distribution. Borneo (Fig. 1).

***Eustenogaster hauxwellii* (Bingham, 1894)**
Specimens examined. Sumatra: 1 female, 1 male (RMNH), South Sumatra, P. Hegundi, 20.vi.1956, A.M.R. Wagner; **Kurakatau Islands:** 2 males (RMNH, MZB), South Sumatra, P. Sebuku, 17.vi.1955, A.M.R. Wagner; 7 males (MZB), P. Rakata Besar, 16.vii.1982, Sk. Yamane; 2 females, 3 males (MZB), P. Rakata Kecil, Sk. Yamane,16-28.vii.1982; **Bangka Is.:** 1 female (RMNH), Tjeluak, 13.iii.1935, J.v.d. Vecht; **Java:** 1 female (MZB), West Java, 100-250m, Djasinga, 11.x.1938, M.A. Lieftinck; 2 males (MZB), West Java, Tdjag Along, Wdjung Kulon, A.M.R. Wagner, 8-18.vii.1955; 1 male (IUNH), Kumpung, Sumur, Cimanggi, Ujung Kulong, 06°42'S, 105°38'E, 24.iii.2005, J. Kojima.
Distribution. Sumatra, Borneo, Bangka, Kurakatau, Java; India, Thailand, Malay Peninsula, Mindanao (Dover and Rao 1922; Dover 1929; Reyes 1988) (Fig. 1).

***Eustenogaster micans* (de Saussure, 1852)**
Specimens examined. Sumatra: 1 male (MZB), Mt. Tanggamoes, Giesting, 600m S.W. Lampungs, 27.vi.1933, Lieftinck & Toxopeus; 2 females (IUNH), Sumatera Barat, MukoMuko,

21.x.1980; **Bangka Islands:** 1 female (RMNH), Tjeloeak, ex nest K, 13.iii.1935, J.v.d. Vecht; **Borneo:** 1 female (MZB), 125m, Bengen River, Tabang, East Borneo, 24.x.1956, A.M.R. Wegner. **Java**: 2 males (RMNH), Noesa Kambangan, iii.1911, E. Jacobson; 2 females, 2 males (MZB), Mt. Gede, West Java, i.1935, native collected; 1 female (RMNH), 600m, Mt. Salak, Tjianten, West Java, 26.iii.1939, J.v.d. Vecht; 1 female (MZB), 100m, Dungus Iwul, West Java, 9.i.1953, A.M.R. Wegner.
Distribution. Sumatra, Bangka, Borneo, Java; Myanmar, Thailand, Malay Peninsula (Fig. 1).

Genus *Liostenogaster* van der Vecht, 1969

So far 12 species have been recognized in this genus (Turillazzi 1999), of which eight were recorded in the continental Southeast Asia and/or the Malay Peninsula as well as on the Sunda Islands. Seven of the eight species known to exist, in the Sunda Islands, are only found in Sumatra and/or Borneo; but *L. varipicta* is also known from the Philippine Islands (Palawan, Luzon, Visayas, and Mindanao). *Liostenogaster nitidipennis* has been recorded from continetal Southeast Asia, Borneo Java and the Philippine Islands (Luzon and Palawan). *Liostenogaster picta* (Smith, 1860) is endemic to Sulawesi Island; and three other species but *L. filicis* Turillazzi, 1999 (*L. abstrusa* Turillazzi, 1999, and *L. tutua* Turillazzi, 1999) are known only from Malay Peninsula (*L. filicis* is also known from Myanmar and Laos).

Liostenogaster campanulae Turillazzi, 1999

Distribution. Sumatra; Malay Peninsula (Turillazzi 1999) (Fig. 2).

Liostenogaster flaviplagiata (Cameron, 1902)

Specimens examined. Sumatra; 1 female (IUNH), Ul Gadat, Padang, 7.xi.2001, J. Kojima.
Distribution. Sumatra, Borneo; Thailand (Turillazzi 1999) (Fig. 2).

***Liostenogaster flavolineata* (Cameron, 1902)**

Distribution. Sumatra, Borneo; Malay Peninsula (Turillazzi 1999) (Fig. 2).

***Liostenogaster nitidipennis* (de Saussure, 1853)**

Specimens examined. Bali: 1 female (IUNH), Tabanan, Baturiti, Perean, 08°26'S, 115°12'E, 8.ix.2005, J. Kojima & R. Ubaidillah.

Distribution. Sumatra, Borneo, Java, Bali (**new record**); Myanmar, Thailand, Malay Peninsula, Palawan, Luzon (Reyes 1988; Turillazzi 1999) (Fig. 2).

***Liostenogaster pardii* Turillazzi and Carfì, 1996**

Specimens examined. Borneo: 2 females, 1 male (MZB), 50 m, Mentawir River, Balikpapan, East Borneo, 13.x.1950, A.M.R. Wegner.

Distribution. Borneo; Malay Peninsula (Turillazzi and Carfì 1996) (Fig. 3).

***Liostenogaster topographica* Turillazzi, 1999**

Distribution. Borneo; Malay Peninsula (Turillazzi 1999) (Fig. 3).

***Liostenogaster varipicta* (Rohwer, 1919)**

Specimens examined. Borneo: 1 female (RMNH), 125m, Bengen River, Tabang, East Borneo, 25.ix.1956, A.M.R. Wegner.

Distribution. Sumatra, Borneo; Thailand, Malay Peninsula, Palawan, Luzon, Mindanao (Rohwer 1919; Reyes 1988; Turillazzi 1999) (Fig. 3).

***Liostenogaster vechti* Turillazzi, 1987**

Distribution. Sumatra (Ohgushi *et al*. 1983, as *Liostenogaster* sp. 2); Malay Peninsula (Turillazzi 1988) (Fig. 3).

Genus *Metischnogaster* van der Vecht, 1977

Two species are recognized in this genus, both occuring in the Sunda Islands (van der Vecht 1977).

***Metischnogaster cilipennis* (Smith, 1857)**

Specimens examined. Borneo: 1 female (MZB), Kaltim, Tanah Merah, Lempake, Samarinda, 18.iii.1978, R.S.Yayuk.

Distribution. Sumatra, Borneo; Malay Peninsula (van der Vecht 1977) (Fig.4).

***Metischnogaster drewseni* (de Saussure, 1857)**

Specimens examined. Belitung: 2 males (MZB), sea-level, Tjeroetjoek, [2.viii.1935 and 14.xii.1936], F.J. Kuiper; **Java:** 1 female, 1 male (RMNH), Djansinga, 150m, Bogor, M.A. Lieftinck [1 male, 8. iv. 1935; 1 female, 7.ii.1937]; 1 female, 3 males (MZB), Djansinga, 100-250m, Buitenzorg [=Bogor], M.A. Lieftinck [1 female, 6.v.1937; 1 male, 10.vii.1937; 2 males, 18.vii.1937].

Distribution. Sumatra, Borneo, Belitung, Java; Malay Peninsula, Palawan (van der Vecht 1977) (Fig. 4).

Genus *Parischnogaster* von Schelthess, 1914

Species-level taxonomy of *Parischnogaster* is still poorly resolved. Ten species are currently recognized as valid, but there would be more species (C. K. Starr, personal communication). From the Sunda Islands, the following seven species are recorded. The distributional summary mainly follows Carpenter and Kojima (1997a).

***Parischnogaster alternata* Sakagami, 1969**

Specimens examined. Sumatra: 2 females, 1 male (IUNH), Ul Gadat, Padang, 7.xi.2001, J. Kojima.

Distribution. Sumatra, Borneo; Thailand, Malay Peninsula (Dover and Rao 1922; Yoshikawa *et al*. 1969) (Fig. 5).

***Parischnogaster gracilipes* (van der Vecht, 1977)**

Distribution. Sumatra, Borneo (van der Vecht 1977) (Fig. 5).

***Parischnogaster jacobsoni* (du Buysson, 1913)**

Specimens examined. Krakatau: 1 female (MZB), xii.1991; **Java**: 3 females, 2 males (MZB), West Java, 500m, Djampang, Tengah, Panoem Bangan, 28.iv.1940, M.A. Lieftinck; 2 females

(IUNH), Kebun Raya Purwodadi, S-2001-24, 9.xi.2001, J. Kojima. **Distribution.** Borneo, Bangka, Sumatra, Krakatau, Java; China (Yunnan), Malay Peninsula (Fig. 5).

***Parischnogaster mellyi* (de Saussure, 1852)**

Specimens examined. Sumatra: 1 female (MZB), Arnhemia, Medan, iv.1928, J.C.v.d. MeerMohr; 2 females (MZB), Riouw Res., Inderagiri, Doerian, Tjatior, East Sumatra, iii.1939, P. Buwalda; 2 females (IUNH), Padang, 7.xi.2001, J. Kojima; 1 female (IUNH), Ul Gadat, Padang, 7.xi.2001, J. Kojima; 1 female (MZB), Giesting, 400 m, Mt. Tanggamoes, S.W. Lampong, xii.1934, Lieftinck & Toxopeus; 2 males (MZB), Way Kambas, Lampong, 3-4.ii.1972, S. Adisoemarto; 1 male (MZB), Sekincau, South Sumatra, 22.vii.1982, Sk. Yamane; **Kurakatau**; 2 females (MZB), Doerian, Riouw-Arch, xi.1923, Dammerman; 1 male (MZB), Z.O., xii.1933, Dammerman; 1 female (MZB), iv.1934, Dammerman; 2 males, P. Rakata, 22.vi.1955, A.M.R. Wegner; 1 female (MZB), P. Rakata Besar, 14.vii. 1982, Sk. Yamane; 2 females, 7 males (MZB), P. Rakata Kecil, 27.vii.1982, Sk. Yamane; 1 female, 1 male (MZB), Pulau Anak Krakatau, 29-30.vii.1982, Sk. Yamane; **Java**: 1 female, 1 male (MZB), Tjiduan, Udjung Kulon, 18.vi.1972; 1 female, 1 male (IUNH), Gunung [= Mt.] Salak, 1.xi.2001, J. Kojima; 1 female (MZB), Palaboean Ratoe, 2.v.1932, M.A. Lieftinck; 1 female, 2 males (MZB), Jakos, 7-8.vii.1932, L.G.E. Kalshoven; 1 female, 1 male (MZB), W. Preanger, Z. Soekaboem, iii.1933, J.v.d. Vecht; 1 male (MZB), Buitenzorg [= Bogor], 22.vi.1930, M.A. Lieftinck; 2 females (MZB), Ciapus, Bogor Barat, 12.ii.1981, Erniwati; 1 female (MZB), G. Djanccari, Bogor, 1997, M. Amir; 2 females, 1 male (IUNH), Bogor Botanical Garden, Bogor, 18.xi.2000, J. Kojima; 2 females (MZB), Bogor Botanical Garden, Bogor, 8.vi.2004, R. Ubaidillah; 2 females, 2 males (IUNH), West Java, Dati II Bogor, Jonggol, Sukamakmur, Cimeyan, 06°33'S, 107°04'E, 25.x.2000, J. Kojima; 2 females (MZB), Melang, v.1933, Betrem; 6 females, 7 males (MZB), Wijnkoopsbaai, xii.1935, F. Dupont; 2 males (MZB), Penandjoeng Bay, South Java, vii.1936, M.A. Lieftinck; 1 female, 2 males (MZB), Bantam, Halingping, West Java, 19.iv.1935, M.A. Lieftinck ; 1 female, 1 male (MZB), Depok, West

Java, M.A. Lieftinck [1 female, 25.ii.1932; 1 male, 27.ix.1936]; 2 females, 1 male (MZB), Gunung [=Mt.] Pantjar, i.1936, E. Franssen; 1 male (MZB), 500m, Gunung Pantjar, West Java, vii-viii.1936, F. Dupont; 1 female, 1 male (MZB), Gunung Pantjar, West Java, ix.1936, F. Dupont; 1 female, 3 males (MZB), Gn. Pantjan, 29.i.1936, F. Dupont; 1 female (MZB), C. Java, H.overback, Djokja, x.1936; 1 female (MZB), West Java, 600m, G. Tjimerang, Djampong Tengah, iii.1937, M.E. Walsh; 3 females, 1 male (MZB), Bantam, Pasaseran, West Java, 10.x.1937, M.A. Lieftinck; 1 male (MZB), Preanger, N.O. I., Banaceng, 750m, 13.ii.1938, F.C. Drescher; 5 females, 9 males (MZB), West Java, 400-1000 m, Soekanegara, ii.1940, Native coll.; 2 males (MZB), 100 m, Dungus Jwul, West Java, 17.xii.1952, M.A. Lieftinck; 2 males (MZB), 220 m, Dungus Jwul, West Java, 18.iii.1953, Amsari; 1 female, 2 males (MZB), P. Deli, Klapper eiland, West Java, 27.vi.1955, A.M. R. Wegner; 1 male (MZB), P. Tinjie, Trouwers eiland, West Java, 28.vi.1955, A.M. R. Wegner; 2 females (MZB), Carita, West Java, 3-25.vii.1982, Sk. Yamane; 1 male (MZB), Bandungan, Ambaraura, 800m dpe, 30.xii.1981, A.H.A. & B.J.; 2 males (MZB), Mt. Telamojo, 1200m, foot, res. Kedoe, C. Java, 27.x.1939, M.A. Lieftinck; 1 female, 1 male (IUNH), Purwodadi Botanical Garden, near Surabaya, 9.xi.2001, J. Kojima; **Bali:** 2 males (IUNH), Perean, 08°26'S, 115°12'E, Baturiti, Tabanan, 8.ix.2005, J. Kojima & R. Ubaidillah; **Lombok:** 1 male (IUNH), 08°34'S, 116°14'E, Suranadi, Lombok Barat, 3.xi.2000, J. Kojima; 1 female, 1 male (IUNH), 08°28'S, 116°05'E, 290m alt., Pusuk (Monkey Forest), Gunungsari, Lombok Barat, 3.xi.2000, J. Kojima; 1 female (IUNH), 08°33'S, 116°25'E, 540m alt., Tatebatu, Sikur, Lombok Barat, 5.xi.2000, J. Kojima; **Sumbawa:** 1 female, 1 male (IUNH), 08°50'S, 117°18'E, 100-140 m alt., Hutan Melake, Ropang, 9.xi.2000, J. Kojima; **Flores:** 1 female, 1 male (IUNH), 08°48'S, 121°40'E, Watumere (Lokomoko), Ende, 24.i.2003, J. Kojima.

Distribution. Sumatra, Borneo, Java, Bali (**new record**), Lombok (**new record**), Sumbawa (**new record**), Flores (**new record**); India (Assam, Meghalaya, Sikkim), China (Yunnan), Myanmar, Thailand, Malay Peninsula, Viet Nam, Mindanao (Reyes 1988; Dong and Otsuka 1997) (Fig. 5).

Parischnogaster nigricans (Cameron, 1902)

Two subspecies are currently recognized in *P. nigricans*, nominate subspecies and *serrei* (du Buysson, 1905). They have no more than color variations and are herewith treated without distinguishing from each other.

Specimens examined. Bangka: 1 male (RMNH), Pangkalpinang, 31.iv.[no year given], J.v.d. Vecht; **Java**: 2 females (MZB), 100-250m, Djasinga, Buitenzorg [= Bogor], West Java, M.A. Lieftinck [1 female, 6.vi.1937; 1 female, 30.iv.1937]; 1 female (MZB), 100m, Dungus Iwul, West Java, 18.ix.1952, A.M.R. Wegner; 1 female (MZB), 400-1000m, Soekanegara, West Java, ii.1940, Native Coll; 1 female (IUNH), Purwodadi Botanical Garden, near Surabaya, East Java, 9-10.xi.2001, J. Kojima.

Distribution. Sumatra, Bangka, Borneo, Krakatau, Java, Kangean; China (Yunnan), Malay Peninsula, Luzon (Reyes 1988; Dong and Otsuka 1997) (Fig. 4).

Parischnogaster striatula (du Buysson, 1905)

Du Buysson (1907) described *Ischongaster foveatus* from Salawati in New Guinea and the taxon has been treated as the synonym of *P. striatula*. Other than du Buysson's record, *P. striatula* has never been recorded from area east of Borneo and Java, nor any other *Parischnogaster* species are known from Moluccas and New Guinea. We doubt if the types of *I. foveatus* was correctly labeled, and the occurrence of *Parischnogaster* in Moluccas and New Guinea should be reconfirmed with further intensive field research.

Specimens examined. Sumatra: 2 females (RMNH), Sibolangit Nature Reserve, 03°19'N, 98°35'E, no.29, ca 500m, Deli, North Sumatra, 29.vii.1972, J. Krikken; 1 female (MZB), Siberut Island, West Sumatra, ix.1924, C.B.K. & N.S.; 1 female (MZB), 600m, Giesting, Mt. Tanggamoes, S.W. Lampung, South Sumatra, xii.1934, Lieftinck & Toxopeus; **Java**: 1 female (MZB), 300m, Penandjoeng Bay, Kaliroesjang, South Java, vii.1936, M.A. Lieftinck.

Distribution. Sumatra, Borneo, Java; Thailand, Malay Peninsula (Fig. 4).

Parischnogaster unicuspata Rayes, 1988

Specimens examined. Bangka; 1 male (RMNH), Petaling, ex nest d, 15.iii.1935, J.v.d Vecht. **Java**; 1 male (RMNH), West Java, 0-50m, 5-6.viii.1972, J.v.d. Vecht.

Distribution. Sumatra, Bangka, Borneo, Java; Thailand, Malay Peninsula, Palawan (Reyes 1988) (Fig. 4).

Polistinae
Tribe Polistini
Genus *Polistes* Latreille, 1802
Subgenus *Gyrostoma* Kirby, 1828

Polistes diabolicus de Saussure, 1853

Specimens examined. Sumbawa: 1 female (IUNH), 08°30'S, 118°33'E, Tolonggeru, Bolo, Bima, 11.xi.2000, J. Kojima.

Distribution. Java, Lombok, Sumbawa (**new record**), Flores, Sumba, Timor, Kai (von Schulthess 1935; Saito *et al*. 2005) (Fig. 6).

Polistes olivaceus (DeGeer, 1773)

This species has been recorded from many localities of the continental Africa and Madagascar in the west, through the Indian subcontinent, to Pacific Islands in the east. Although the origin is barely specified, wide distribution range of this species may be because of accidental introduction. In the Sunda Islands, the species occurs on Sumatra and Borneo.

Distribution. Sumatra, Borneo; many localities from Madgascar, continental Africa, India, to Pacific Islands (Bequaert 1918; Dover 1929; Richards 1978a, b, 1985; Das and Gupta 1989) (Fig. 6).

Polistes rothneyi Cameron, 1900

Including the nominotypical subspecies and one having originally described as a species, *yayeyamae* Matsumura, 1908, van der Vecht (1968) recognized 16 subspecies and two informal local color forms in *P. rothneyi*. Later, Das and Gupta (1989) added another subspecies, *P. rothneyi vechti*, from India and Myanmar.

These subspecies could be no more than local color forms; however, we leave the formal taxonomic decision of their status, synonym of the nominotypical species or diagnozable species, to

a future study. In this paper, the distribution records for all of them are summarized under *P. rothneyi*.
Distribution. Sumatra, Java; Pakistan, India, Nepal, Myanmar, Viet Nam, Malay Peninsula, China, Korea, Japan (van der Vecht 1968; Das and Gupta 1989) (Fig. 6).

Polistes tenebricosus Lepeletier, 1836

Saito *et al*. (2005) synonymized all the taxa having been treated (or once treated) as subspecies of *P. tenebricosus* (*hoplitus* de Saussure, 1853, *leopoldi* Bequaert, 1934, *nigrosericans* Bequaert, 1940 and *sibuyanensis* Bequaert, 1940) under the nominotypical species.
Specimens examined. Sulawesi: 2 females (IUNH), Bantimurong, 18.ix.2003, J. Kojima.
Distribution. Borneo, Sumatra, Java, Bali, Lombok, Sumbawa, Flores, Sumba; Sulawesi (**new record**); the Philippines (Luzon, Negros, Sibuyan); Myanmar to Malay Peninsular, Viet Nam (Bequaert 1940; Das and Gupta, 1989; Saito *et al*. 2005) (Fig. 6).

Subgenus *Polistella* Ashmead, 1904

Polistes callimorpha de Saussure, 1853

Distribution. Sumba, Timor; Kai Is. (du Buysson 1913; Saito *et al*. 2005) (Fig. 7).

Polistes meadeanus (von Schulthess, 1913)

Distribution. Borneo; Malay Peninsula (von Schulthess 1913; van der Vecht 1966) (Fig. 7).

Polistes sagittarius de Saussure, 1853

Polistes sagittarius de Saussure 1853: 56.
Polistes sagittarium [!]; Das and Gupta 1989: 67.
Polistes sagittarius var (or subsp.) *indonesicus* Bequaert 1940: 267.
Polistes strigosus baliensis Gusenleitner 2000: 939. New synonymy.

Gusenleitner (2000) described *P. strigosus baliensis* from Bali based on the holotype male collected at Nusa Dua Beach and one male and three female paratypes collected in Celik (western end of Bali). We have examined the paratype male and a female paratype; they have neither a ribbed pronotum, most distinctive characteristics of *P. strigosus* Bequaert, 1940, nor any significant difference from *P. sagittarius*, and thus *P. strigosus baliensis* was synonymized under *P. sagittarius* (**new synonym**). *Polistes strigosus* Bequaert, 1940 has not been recorded from the Sunda Islands.

Bequaert (1940) treated *P. philippinensis* de Saussure, 1853 as a variety of *P. sagittarius* and described *funebris* from Luzon, the Philippines, as a variety (or subspecies) of *P. sagittarius*. Carpenter (1996), without mentioning any details, reinstated *philippinensis* in the species rank and treated *funebris* as a subspecies of *P. philippinensis*. We have examined specimens from various localities and have agreed to the treatment by Carpenter (1996). In the Philippines, *P. sagittarius* is distributed only on Palawan Islands where *P. philippinensis* does not occur.

Specimens examined. Bali: 2 females (NIAES), iii-iv.1960, Y. Fujioka; **Java**: 3 females (NIAES), Batavia (= Jakarta); **Lombok**: 1 female (IUNH), 08° 41'S, 116° 07'E, Mesanggok, Gerung, Lombok Barat, 7.xi.2000, J. Kojima. **Sulawesi**: 1 female (IUNH), 05°01'S, 119°41'E, Maros, near Makassar, 27.x.2000, J. Kojima.

Distribution. Sumatra, Borneo, Java, Bali (**new record**), Lombok (**new record**), Sumbawa, Sumba, Flores, Sulawesi; India, Nepal, Myanmar, Thailand, Viet Nam, Malay Peninsula, Palawan (Bequaert 1940; Saito *et al*. 2005) (Fig. 7).

Polistes stigma stigma (Fabricius, 1793)

Petersen (1987) revised taxonomy of *P. stigma* and recognized that, represented by 19 subspecies, the species is widely distributed from India, through Southeast Asia, to South Pacific Islands and Australian continent. Allopatric (and/or possibly sympatric) occurrence of closely similar species, such as *P. callimorpha* on Timor (Saito *et al*. 2005), and considerable color variation within a given colony members (J. Kojima, unpublished)

suggest that further intensive comparative study is necessary to decide their status, spcies or local color forms. In this paper, thus, we treat only the nominotypical subspecies, which has been recorded from the Sunda Islands.

Specimens examined. Java: 3 females (IUNH), 07°50'S, 114°26'E, Baluran, 15.ix.2005, J. Kojima & R. Ubaidillah; **Bali**: 2 females (IUNH), 08°08'S 115°04'E, Singaraja, 9.ix.2005, J. Kojima & R. Ubaidillah.

Distribution. Sumatra, Java (**new record**), Bali (**new record**), Lombok; Thailand; Malaysia; Singapore; Taiwan (Dover 1929; Petersen 1987; Kojima and Yamane 1990; Starr 1992; Saito *et al*. 2005) (Fig. 7).

Tribe Ropalidiini

Genus *Ropalidia* Guérin-Méneville, 1831

Species-level taxonomy of the Ropalidiini, especially of the genus *Parapolybia*, is still poorly resolved. Although the taxa currently treated as subspecies in *Ropalidia* and *Parapolybia* may well be local variations or good species, and some taxa currently treated as species may eventually be revealed synonyms of others, the taxonomic system and distribution records in the present study follow the catalog published by Kojima and Carpenter (1997) and its up-dated version on a web-site (Kojima 2006).

Ropalidia aristcratica (de Saussure, 1853)

Distribution. Sumatra; Thailand, Malay Peninsula (van der Vecht 1962) (Fig. 8).

Ropalidia artifex (de Saussure, 1854)

Distribution. Sumatra, Borneo, Java; Myanmar, Malay Peninsula (van der Vecht 1941, 1962; Kojima and van Achterberg 1997) (Fig. 11).

Ropalidia bicolorata van der Vecht, 1962

Nguyen *et al*. (2006a) synonymized *Ropalidia bicolorata parvula* van der Vecht, 1962 under the nominate species. This species is, in the Sunda Islands, known only from Borneo, and is also distributed in continental Southeast Asia. The taxonomic status

of another subspecies, *shiba* Das and Gupta, 1989, described from India is still uncertain.
Distribution. Borneo; India, Myanmar, Thailand, China (Yunnan), Viet Nam (van der Vecht 1962; Li 1985; Das and Gupta 1989; Kojima and van Achterberg 1997; Nguyen *et al*. 2006a) (Fig. 9).

Ropalidia binghami van der Vecht, 1941

Currently two subspecies are recognized in this species, the nominate subspecies in continental Southeast Asia and *wegneri* van der Vecht, 1962 from Borneo.
Distribution. Borneo; Myanmar, Thailand, Laos (van der Vecht 1941, 1962) (Fig. 12).

Ropalidia copiaria (de Saussure, 1872)

Distribution. Sumatra, Java (van der Vecht 1962; Kojima and Yamane 1990.) (Fig. 8).

Ropalidia curvilineata (Cameron, 1908)

Distribution. Malay Peninsula; Borneo; Sumatra (van der Vecht 1941, 1962; Kojima and Yamane 1990) (Fig. 10).

Ropalidia cyathiformis (Fabricius, 1804)

Specimens examined. Bali: 2 females (IUNH), 08°11'S, 114°26'E, Gilimanuk, 11.ix.2005, J. Kojima & R. Ubaidillah.
Distribution. Java, Bali (**new record**), Lombok, Flores, Sumba; Sulawesi; India, Nepal, Sri Lanka, Myanmar, Malay Peninsula, Viet Nam, the Philippines (van der Vecht 1941, 1962; Kojima *et al*. 2005; Nguyen *et al*. 2006a) (Fig. 14).

Ropalidia decorata (Smith, 1858)

Distribution. Sumatra, Borneo; Malay Peninsula (van der Vecht 1962) (Fig. 8).

Ropalidia dichroma van der Vecht, 1941

Distribution. Timor (Kojima *et al*. 2005) (Fig. 14).

Ropalidia erythrospila van der Vecht, 1941

Distribution. Sumatra, Borneo; Malay Peninsula (van der Vecht 1941, 1962; Kojima 1996a) (Fig. 12).

Ropalidia fasciata (Fabricius, 1804)

Specimens examined. Bali: 4 females, 2 males (IUNH), 08°08'S 115°04'E, Singaraja, 9.ix.2005, J. Kojima & R. Ubaidillah; **Lombok**: 1 female, 4 males (IUNH), 08°41'S, 116°07'E, Mesanggok, Gerung, Lombok Barat, 6.xi.2000, J. Kojima.
Distribution. Sumatra, Borneo, Nias, Bangka, Java, Karimon Djawa, Bali, Lombok (**new record**), Komodo, Flores, Timor; Nepal, India, Myanmar, Thailand, Malay Peninsula, Viet Nam, South China, Pawalan, Taiwan, Ryukyus (van der Vecht 1941, 1962; Kojima *et al*. 2005; Nguyen *et al*. 2006a) (Fig. 14).

Ropalidia flavopicta (Smith, 1857)

Distribution. Sumatra, Borneo; Hong Kong, Viet Nam, Malay Peninsula (van der Vecht 1962; Kojima 1996b) (Fig. 9).

Ropalidia granulata van der Vecht, 1941

Two subspecies are currently recognized in this species; the nominate subspecies in Smatra and Malay Peninsula, and *borneensis* van der Vecht, 1941 in Borneo and Malay Peninsula.
Distribution. Sumatra, Borneo; Malay Peninsula (van der Vecht, 1941; Kojima and Yamane, 1990) (Fig. 13).

Ropalidia hongkongensis (de Saussure, 1854)

Nguyen *et al*. (2006a) synonymized *Ropalidia hongkongensis juncta* van der Vecht, 1941 under the nominate species.
Distribution. Bangka, Java; India, Myanmar, South China, Hongkong, Viet Nam (van der Vecht 1941; Nguyen *et al*. 2006a) (Fig. 11).

Ropalidia horni Sonan, 1938

Distribution. Borneo; the Philippines (Palawan, Panay, Samar, Leyte, Mindanao) (van der Vecht 1941, 1962) (Fig. 13).

Ropalidia jacobsoni (du Buysson, 1908)

Das and Gupta (1989) described a subspecies, *flavoscutella* from Assam of India and recorded the nominate subspecies from other parts of India.

Specimens examined. Bali: 2 females (IUNH), 08°37'S 115°05'E, Tanah Lo, 10.ix.2005, J. Kojima & R. Ubaidillah.

Distribution. Bangka, Sumatra, Java, Bali (**new record**), Lombok; Sulawesi; India, Myanmar (van der Vecht 1941; Das and Gupta 1989; Fujiyama *et al*. 2002) (Fig. 14).

Ropalidia javanica van der Vecht, 1962

Distribution. Java, Sumbawa, Flores (van der Vecht 1962; Kojima *et al*. 2005) (Fig. 9).

Ropalidia latebalteata (Cameron, 1902)

Distribution. Sumatra; Malay Peninsula (van der Vecht 1941) (Fig. 13).

Ropalidia laticincta van der Vecht, 1962

Van der Vecht (1962) described *R. laticincta laticincta* from Sumba, Roti, Timor, Wetar, Romang, Kisar and Moluccas, and *R. l. floresiana* only from Flores; he noted that the species co-occur with its closely related spcies, *R. marginata*, only on Sumba Island. Gusenleitner (2000) recorded *R. laticincta laticincta* from Bali. Kojima *et al*. (2005) synonymized *R. l. floresiana* under the nominate species and added Sumbawa and Komodo to its distribution range. As listed below and under *R. marginata*, the two species may co-occur on Bali, Lombok, Sumbawa and Sumba.

Specimens examined. Bali: 1 female (IUNH), 08°37'S, 115°05'E, Tanah Lot, 10.ix.2005, J. Kojima & R. Ubaidillah; 3 females (IUNH), 08°11'S, 114°26'E, Gilimanuk, 11.ix.2005, J. Kojima & R. Ubaidillah; **Lombok**: 2 females (IUNH), Mataram, 4.xi.2000, J. Kojima; **Sumbawa**: 2 females (IUNH), 08°31'S, 116°59'E, Alas, Sumbawa Besar, 8.xi.2000, J. Kojima.

Distribution. Bali, Lombok (**new record**), Sumbawa (**new record**), Komodo, Flores, Sumba, Roti, Timor, Wetar, Romang, Kisar, Moluccas (Buru, Ceram, Ambon) (Fig. 15).

***Ropalidia lugbris* (Smith, 1858)**

The present species may belong to the same species as *R. sumatrae*, as pointed out by van der Vecht (1941).

Distribution. Borneo; India (West Bengal) (Fig. 10).

***Ropalidia malayana* (Cameron, 1903)**

Distribution. Sumatra, Borneo; Malay Peninsula (Kojima 1996a) (Fig. 12).

***Ropalidia marginata* (Lepeletier, 1836)**

In this species, four formally named color forms had been recognized until Nguyen *et al*. (2006a) synonymized *sundaica* van der Vecht, 1941 and *jucunda* Cameron, 1898 under the nominotypical species; taxonomic status of *rufitarsis* van der Vecht, 1941 is still uncertain. *Ropalidia marginata* is widely distributed from Pakistan in the west, through Southeast Asia, to New Guinea and the Pacific Islands in the east, and Queensland of Australia, but has not been known from eastern part of the Lesser Sunda Islands.

Specimens examined. Bali: 3 females (IUNH), 08°08'S, 115°04'E, Singaraja, 9.ix.2005, J. Kojima & R. Ubaidillah

Distribution. Borneo, Sumatra, Bangka, Java, Kariman Djawa, Bali, Lesser Sunda; Sulawesi, Talud, Tukang, Irian Jaya; Pakistan, India, Sri Lanka, Myanmar, Viet Nam, Malay Peninsula, Philippine Islands, Mariana, Palau, Volvano, New Guinea, Australia, New Britain (Fig. 15).

***Ropalidia mathematica* (Smith, 1860)**

The taxonomy and distribution of this species are detailed in Saito and Kojima (2005) and Kojima *et al*. (2005).

Distribution. Sumatra, Java, Karimon Djawa, Bali, Lombok, Sumbawa, Flores, Sumba, Timor; Sulawesi; India, Thailand, Viet Nam (Fig. 11).

***Ropalidia modesta* (Smith, 1858)**

Distribution. Sumatra, Borneo, Java; Myanmar, Thialand, Malay Peninsula, Viet Nam (van der Vecht 1941; Kojima and Yamane 1990; Nguyen *et al*. 2006a) (Fig. 13).

***Ropalidia nigerrima* van der Vecht, 1962**

Distribution. Borneo, Sumatra (van der Vecht 1962) (Fig. 9).

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

Distribution. Sumba (van der Vecht 1962; Kojima 1996b) (Fig. 9).

***Ropalidia opifex* van der Vecht, 1962**

Distribution. Borneo; Malay Peninsula (van der Vecht 1962; Kojima and van Achterberg 1997) (Fig. 8).

***Ropalidia opulenta* (Smith, 1857)**

Distribution. Borneo (van der Vecht 1941, 1962; Kojima and van Achterberg 1997) (Fig. 10).

***Ropalidia ornatipes* (Cameron, 1908)**

Distribution. Borneo, Sumatra (van der Vecht 1941, 1962; Kojima and Yamane 1990) (Fig. 14).

***Ropalidia pseudomalayana* Kojima, 1996**

Distribution. Borneo, Bangka (Kojima 1996a) (Fig. 12).

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

The taxonomy and distribution records of this species are detailed in Kojima *et al*. (2002).

Distribution. Sumatra, Bangka, Java, Sumbawa, Timor; India; Myanmar, Thailand, Malay Peninsula (Kojima *et al*. 2002, 2005) (Fig. 13).

***Ropalidia socialis* (de Saussure, 1862)**

Distribution. Timor (Kojima *et al*. 2005) (Fig. 11).

***Ropalidia stigma* (Smith, 1858)**

The taxonomy of this species is detailed in Nguyen *et al*. (2006a).

Distribution. Sumatra, Borneo, Java, Bali; India, Nepal, Sri Lanka, Myanmar, Thailand, Malay Peninsula, Viet Nam, Philippine Is. (van der Vecht 1941, 1962; Nguyen *et al*. 2006a) (Fig. 11).

***Ropalidia sumatrae* (Weber, 1801)**

Distribution. Sumatra, Borneo, Bangka; Myanmar; Thailand; China (Yunnan) (van der Vecht 1941, 1962; Das and Gupta 1989) (Fig. 10).

***Ropalidia timida* van der Vecht, 1962**

Distribution. Sumatra, Borneo; Malay Peninsula (van der Vecht 1962; Kojima and van Achterberg 1997) (Fig. 8).

***Ropalidia trimaculata* van der Vecht, 1962**

Distribution. Sumba (Kojima *et al*. 2005) (Fig. 11).

Genus *Parapolybia* de Saussre, 1854

The following five species are currently recognized in *Parapolybia*: *P. escalerae* (Meade-Waldo, 1911), *P. indica* (de Saussure, 1854), *P. nodosa* van der Vecht, 1966, *P. persica* (Meade-Waldo, 1911), and *P. varia* (Fabricius, 1787). Of them, *P. escalerae* and *P. persica* are endemic to the Middle-east, and *P. nodosa* is known from continental Asia and Taiwan. Both *P. indica* and *P. varia* are represented respectively by four and two subspecies respectively, are distributed widely in Asia, with the latter also in New Guinea. Their taxonomy is undoubtedly need future intensive revision, and the distributional summaries presented here at subspecific level are tentative.

***Parapolybia indica indica* (de Saussure, 1854)**

Distribution. Borneo; India, Myanmar, China, Taiwan, Korea, Japan (van der Vecht 1966) (Fig. 16).

***Parapolybia varia varia* (Fabricius, 1787)**

Distribution. Riouw-Archipelago, Borneo, Sumbawa, Sumba; Sulawesi; India, Nepal, Myanmar, Thailand, Malay Peninsula, Philippine Is., China, Korea, Japan (van der Vecht 1966) (Fig. 16).

Genus *Polybioides* du Buysson, 1913

***Polybioides psecas* du Buysson, 1913**

Distribution. Sumatra, Nias, Borneo; Thailand, Malay Peninsula (van der Vecht 1966) (Fig. 16).

***Polybioides raphigastra* (de Saussure, 1854)**

Distribution. Sumatra, Nias, Natuna, Borneo; Malay Peninsula (van der Vecht 1966) (Fig. 16).

Subfamily Vespinae

The distribution records of the vespine wasps are summarized by Capenter and Kojima (1997b). Nguyen *et al*. (2006b) revised the taxonomy of Vietnamese species of *Vespa* and synonymized *Vespa auraria* Smith, 1852 under *V. velutina* Lepeletier, 1836, which, however, does not affect the discussion on distributional pattern of the Vespinae in the Sunda Islands. The following distributional summary is based on Carpenter and Kojima (1997b).

Genus *Provespa* Ashmead, 1903

***Provespa anomala* (de Saussure, 1854)**

Distribution. Sumatra, Bangka, Batu, Java, Borneo; India, Myanmar, Thailand, Malay Peninsula (Fig. 17).

***Provespa nocturna* van der Vecht, 1935**

Distribution. Sumatra, Bangka, Borneo; Viet Nam, Malay Peninsula (Fig.17).

Genus *Vespa* Linnaeus, 1758

***Vespa affinis* (Linnaeus, 1764)**

Distribution. Borneo, Sumatra, Nias, Bangka, Java, Talaud, Buton, Salayar, Sunda, Timor; India to New Guinea, including Sulawesi, Moluccas and the Philipines (Fig. 18).

***Vespa analis* Fabricius, 1775**

Distribution. Sumatra, Bangka, Java, Bawean, Bali, Sebesi, Sangijiang, Sebuku, Sertung, Madura, Lombok, Legundi, Rakata, Krakatau, Panaitan, Deli; India to continental Southeast Asia including Malay Peninsula, China, Taiwan, Korea, Japan, Far East Russia (Fig. 18).

***Vespa basalis* Smith, 1852**

Distribution. Sumatra; Pakistan, India, Nepal, China, Myanmar, Thailand, Laos, Viet Nam, Taiwan (Fig. 18).

***Vespa bellicosa* de Saussure, 1854**

Distribution. Sumatra, Bengkalis, Borneo (Fig. 18).

***Vespa mocsaryana* du Buysson, 1905**

Distribution. Sumatra; India, Myanmar, Thailand, Laos, Viet Nam, Malay Peninsula (Fig. 19).

***Vespa multimaculata* Pérez, 1910**

Distribution. Sumatra, Borneo; Thailand, Malay Peninsula (Fig. 19).

***Vespa tropica* (Linnnaeus, 1758)**

Distribution. Anambas, Sumatra, Borneo, Nias, Batu, Enggano, Bangka, Belitung, Java, Bawean, Madura, Kangean Is., Bali, Lombok, Komodo, Sumbawa, Sumba, Flores, Wetar, Timor; Sulawesi, Salayar, Sula, Moluccas, Banda, Waigeo, Aru, Irian Jaya; Afganistan, Pakistan, India to New Guinea, the Philippines (Fig. 19).

***Vespa velutina* Lepeletier, 1836**

Distribution. Sumatra, Java, Bali, Lombok, Sumbawa, Komodo, Sumba, Flores, Timor; Sulawesi; Afganistan, Pakistan, India, Bhutan, China, Taiwan, Myanmar, Thailand, Laos, Viet Nam, Malay Peninsula (Fig. 19).

DISCUSSION

In terms of the distribution pattern, social wasp species occurring on the Sunda Islands can be, in general, divided into the following four groups:

(1) Species widely distributed from Indian subcontinent in the west to New Guinea (or Pacific Island and Australia) in the east: *Ropalidia marginata*, *Vespa affinis*, *V. tropica*; *Polistes stigma* and *Parapolybia varia* could be placed in this group, but further intensive study is needed to decide whether the populations currently treated as subspecies are good species or merely local variations.

(2) Species occurring in continental Southeast Asia and the Sunda Islands, and not found in the Papuan region. The wasps in this group may be further divided into three subgroups in terms of distribution pattern in the Sunda Islands.

(2-1) Borneo and/or Sumatra, Java and at least western part of the Lesser Sunda Islands: *Parischnogaster mellyi*, *Polistes tenebricosus*, *P. sagittarius*, *Ropalidia mathematica*, *R. rufoplagiata*, *R. cyathiformis*, *R. fasciata*, *R. jacobsoni*, *Vespa analis*, *V. velutina*.

(2-2) Borneo and/or Sumatra, and extending to Java or Bali: *Eustenogaster hauxwellii*, *E. micans*, *Liostenogaster nitidipennis*, *Parischnogaster nigricans*, *P. striatula*, *P. unicuspata*, *P. jacobsoni*, *Polistes rothneyi*, *Ropalidia stigma*, *R. hongkongensis*, *R. modesta*, *Provespa anomala*.

(2-3) Sumatra and/or Borneo: *Eustenogaster calyptodoma*, *Liostenogater campanulae*, *L. flaviplagiata*, *L. flavolineata*, *L. pardi*, *L. topographica*, *L. varipicta*, *L. vechti*, *Metischnogaster cilipennis*, *M. drewseni*, *Parischnogaster alternata*, *Polistes olivaceus*, *P. meadeanus*, *Ropalidia aristocratica*, *R. decorata*, *R. lugbris*, *R. opifex*, *R. timida*, *R. flavopicta*, *R. bicolorata*, *R. curvilineata*, *R. sumatrae*, *R. artifex*, *R. binghami*, *R. erythrospila*, *R. malayana*, *R. granulata*, *R. latebalteata*, *Polybioides psecas*, *P. raphigastra*, *Provespa nocturna*, *Vespa basalis*, *V. mocsaryana*, *V. multimaculata*.

(3) Species absent from continental Southeast Asia including Malay Peninsula, and occurring on Borneo and/or Sumatra and occassionally also on Java: *Eustenogaster fulvipennis*, *Parischnogaster gracilipes*, *Ropalidia copiaria*, *R. nigerrima*, *R. opulenta*, *R. pesudomalayana*, *R. horni*, *R. ornatipes*, *Vespa bellicosa.*

(4) Species endemic to Java and the Lesser Sunda Islands, or to one or several islands among them: *Polistes diabolicus*, *Ropalidia javanica*, *R. ochracea*, *R. socialis*, *R. trimaculata*, *R. dichroma*, *R. laticincta*.

As summarized above and also as have been discussed (Saito and Kojima 2005; Kojima *et al*. 2005), no Papua-Australian social wasp elements are distributed on the Sunda Islands, including Timor Island. The only three species (*Ropalidia marginata*, *Vespa affinis*, *V. tropica*) and the other two putative species (*Polistes stigma*, *Parapolybia varia*) that occur both on the Sunda Islands and New Guinea seem to be of continental Asian origin and may have spread eastward to reach New Guinea through Sulawesi and Moluccas but not via eastern part of the Lesser Sunda Islands.

In the Sunda Islands, the number of the social wasp species that also occur in the continental Southeast Asia drastically decreases eastward between Sumatra and Java and further decreases from Java to Bali (Fig. 20); the tendency to occur is at both subfamily and genus levels. Such distributional pattern of the species occurring both in continental Asia, especially Malay Peninsula, and the Sunda Islands lead us to conclude that events of speciation of these social wasps would have took place in the area consisting of the present Malay Peninsula, Sumatra and Borneo when they were connected each other (see INTRODUCTION) and dispersed eastward. To what extend they have reached may have depended on their dispersal ability, habitat preference (or tolerance) and other ecological factors, and also on by-chance dispersal.

The wasps categorized based on their distributional pattern into the third group may have resulted from speciation on Sumatra or Borneo, or speciation occurred as vicariance events around eastern part of the ancient land consisting of the present Malay Peninsula, Sumatra and Borneo.

The present distribution pattern of the wasps endemic to Java and the Lesser Sunda Islands, together with the facts that their closely related species distributed also in continental Southeast Asia (*Ropalidia javanica* - *R. ochracea* - *R. flavopicta*, *R. socialis* - *R. trimaculata* - *R. mathematica*, *R. laticincta* - *R. marginata*;

Polistes diabolicus - probably *P. olivaceus*) occur on the islands the same as or adjecent to their endemic islands, suggest the sympatric or allopatric speciation had occured.

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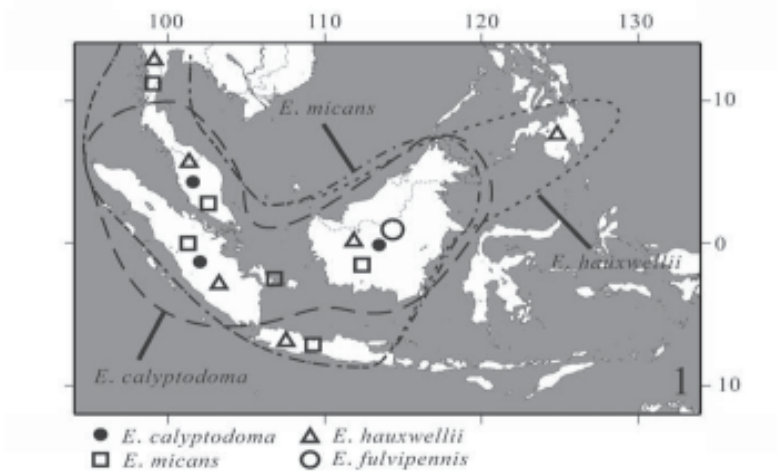
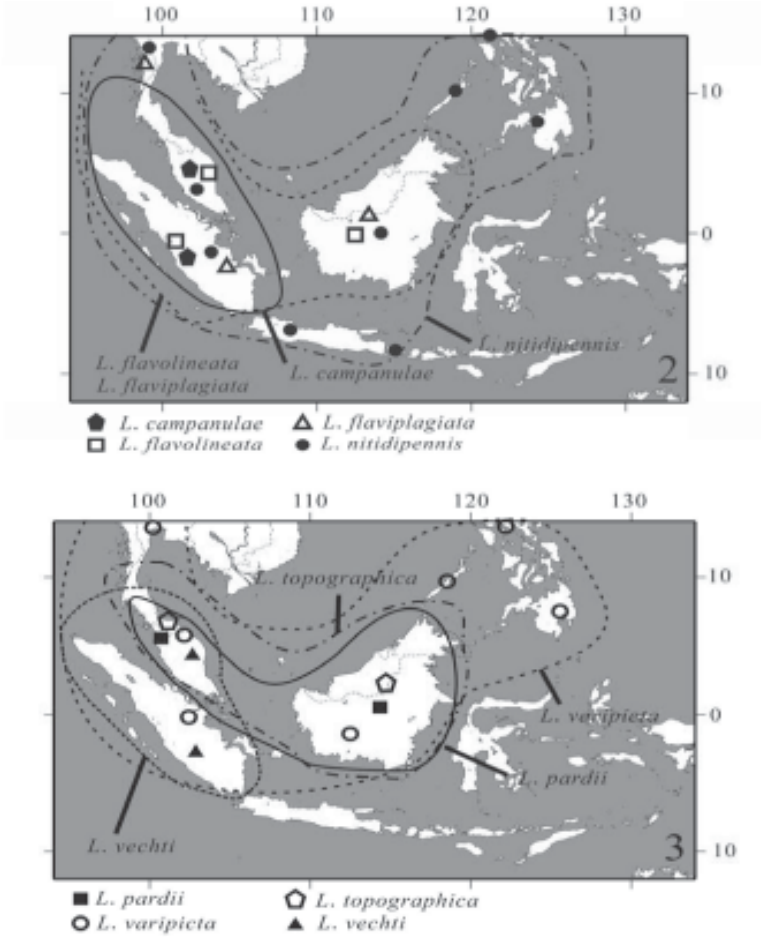
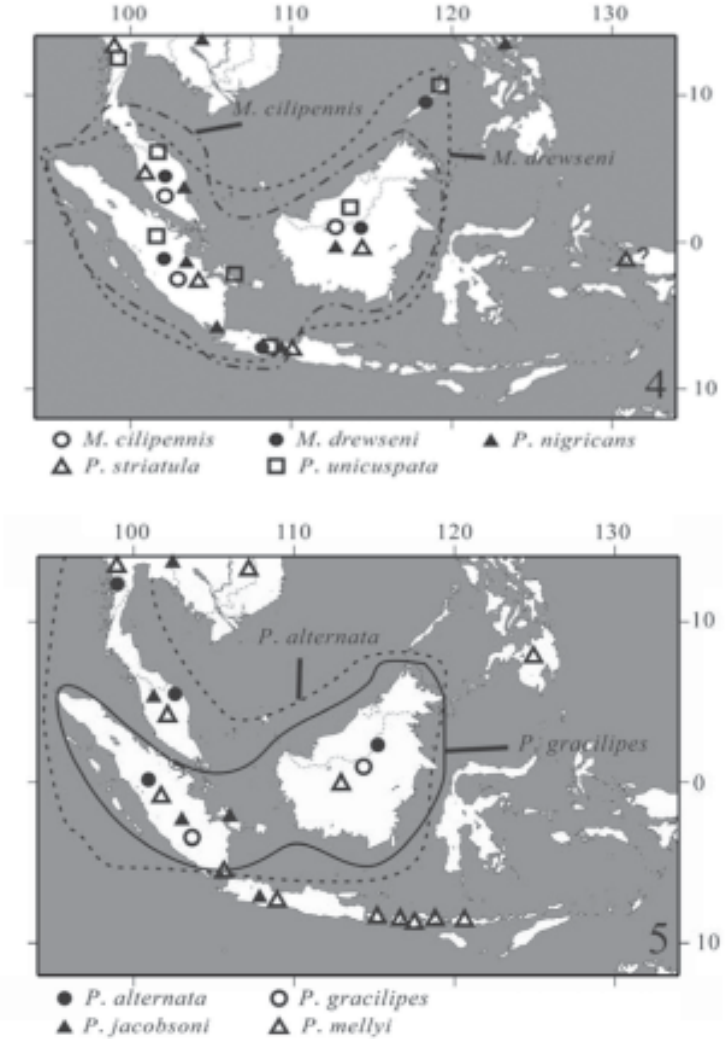


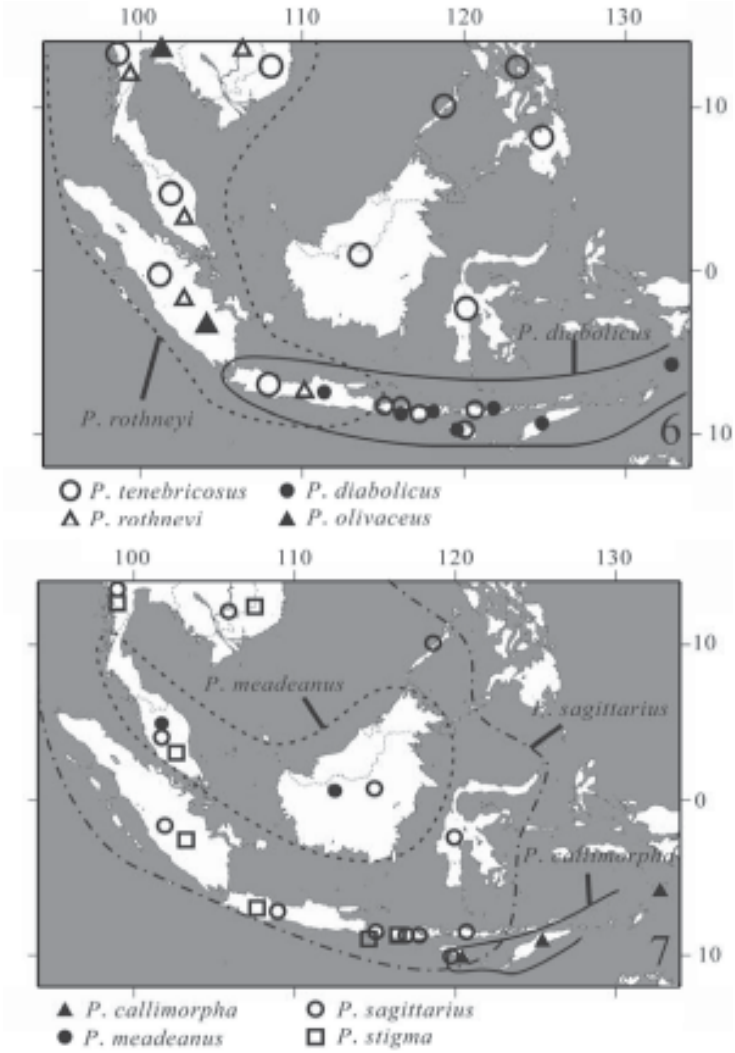
Fig. 1 Map showing distribution records and expected distribution ranges of stenogastrine genus *Eustenogaster* so far recorded in the Sunda Islands.



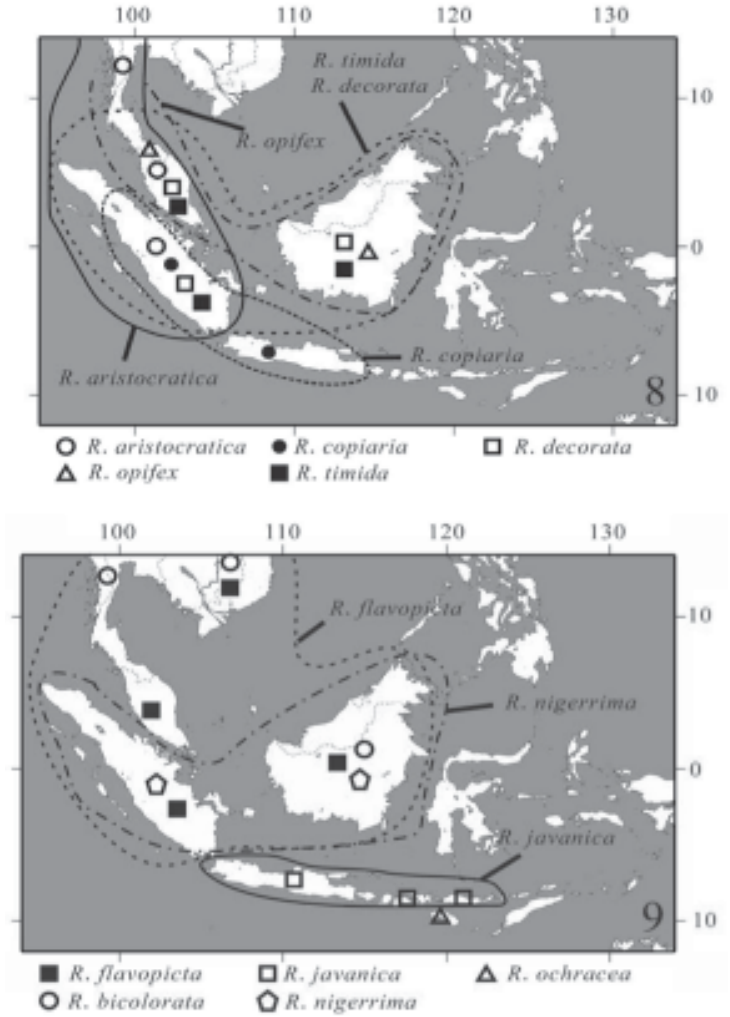
Figs. 2-3 Map showing distribution records and expected distribution ranges of stenogastrine genus *Liostenogaster* so far recorded in the Sunda Islands.



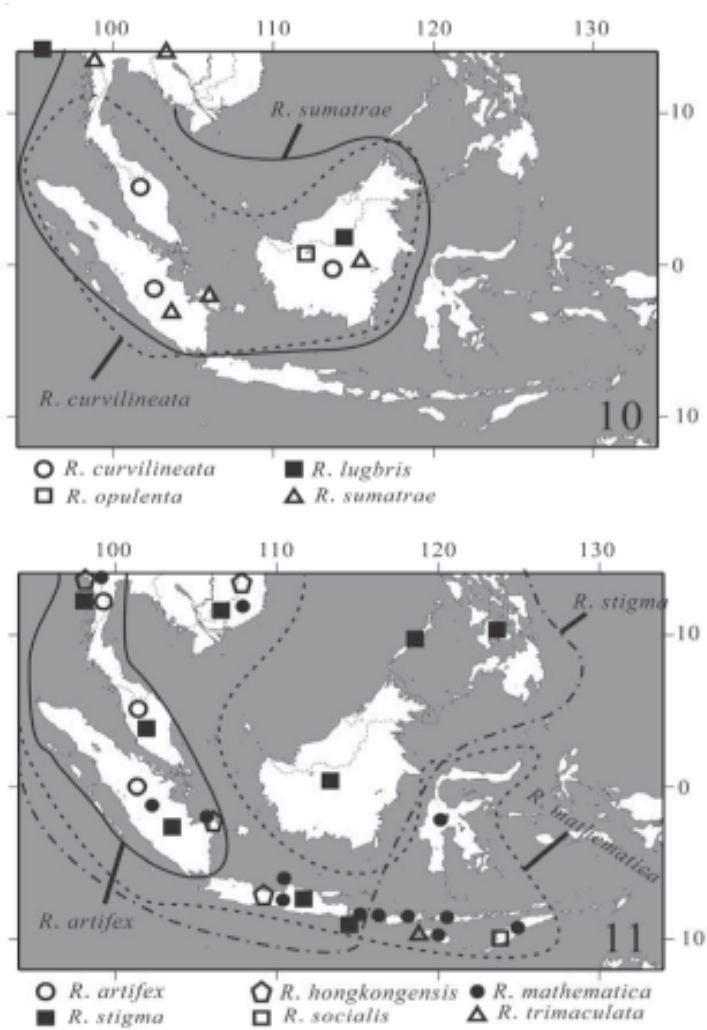
Figs. 4-5 Map showing distribution records and expected distribution ranges of stenogastrine wasps so far recorded in the Sunda Islands.; 4, *Metischnogaster* and *Parischonogaster*; 5, *Parischnogaster*.



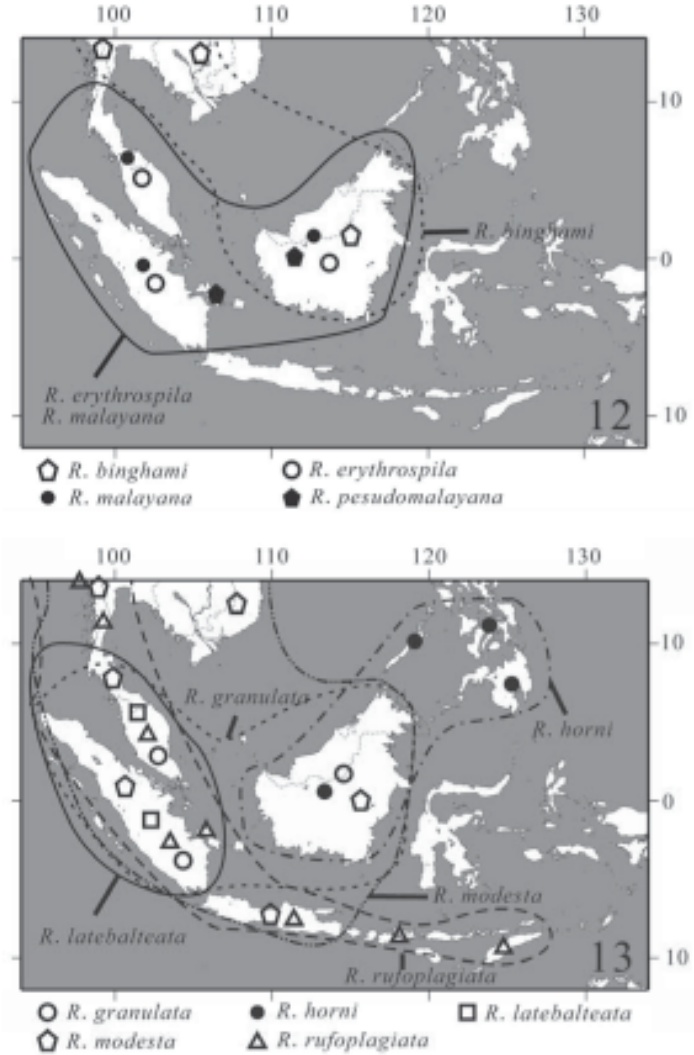
Figs. 6-7 Map showing distribution records and expected distribution rangesof polistine genus *Polistes* so far recorded in the Sunda Islands. 6, subgenus *Gyrostoma*; 7, subgenus *Polistella*.



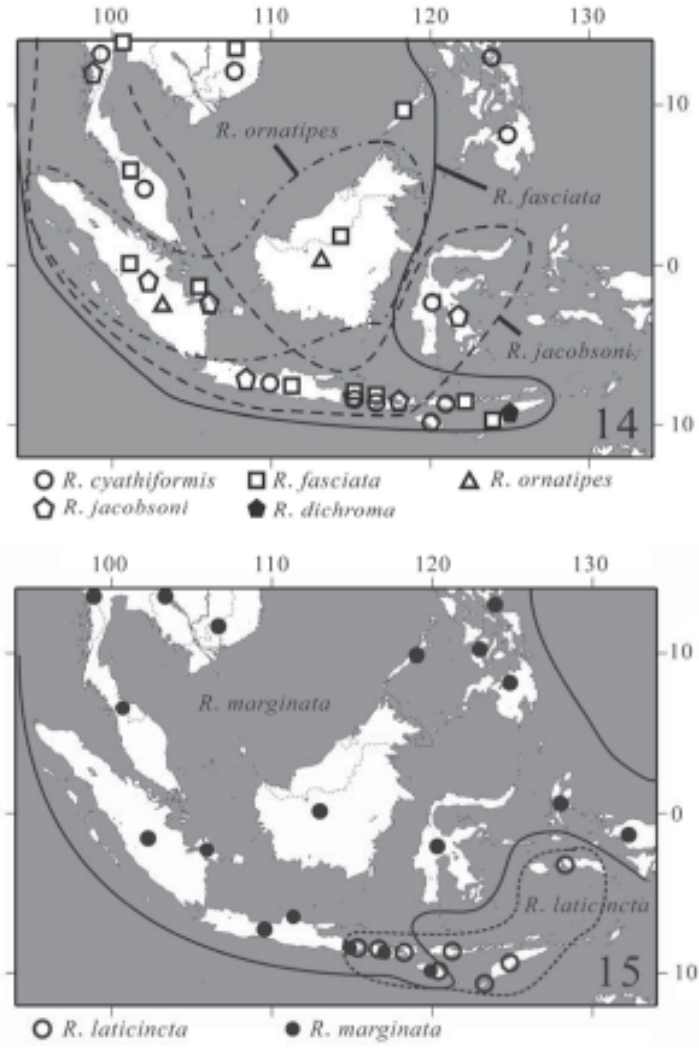
Figs. 8-9 Map showing distribution records and expected distribution ranges of polistine genus *Ropalidia* so far recorded in the Sunda Islands. 8, *R. flavopicta* species group, putative swarm-founding species; 9, *R. flavopicta* and its closely related species, and two species with the forewing having two submarginal cells (*R. bicolorata* and *R. nigerrima*).



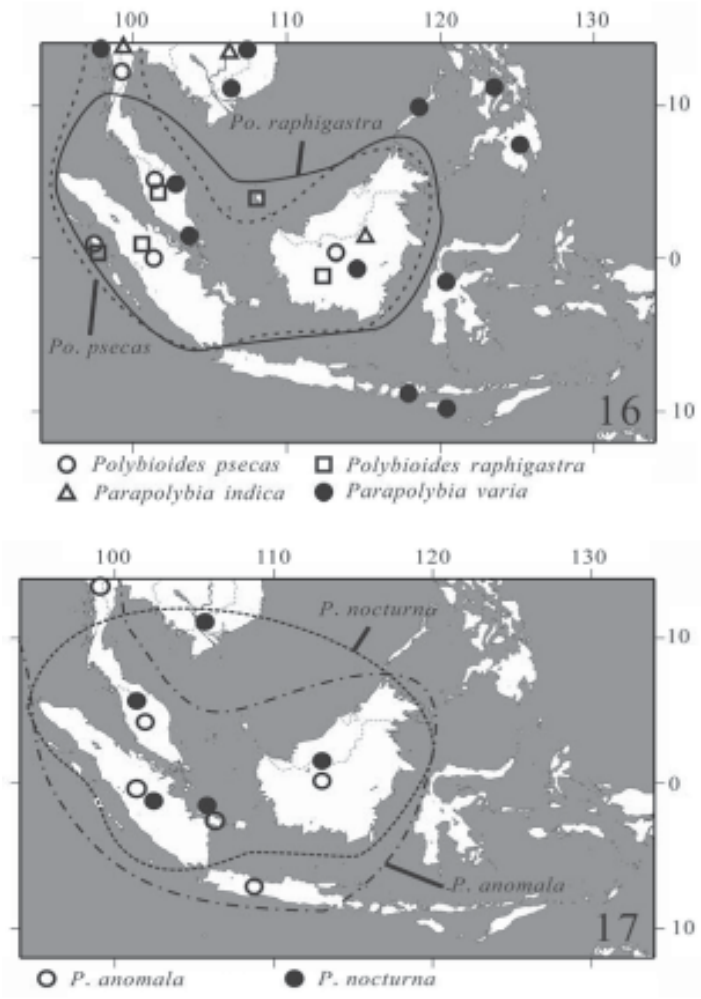
Figs. 10-11 Map showing distribution records and expected distribution ranges of polistine genus *Ropalidia* so far recorded in the Sunda Islands. 10, *R. sumatrae* and related species; 11, *R. stigma* species group.



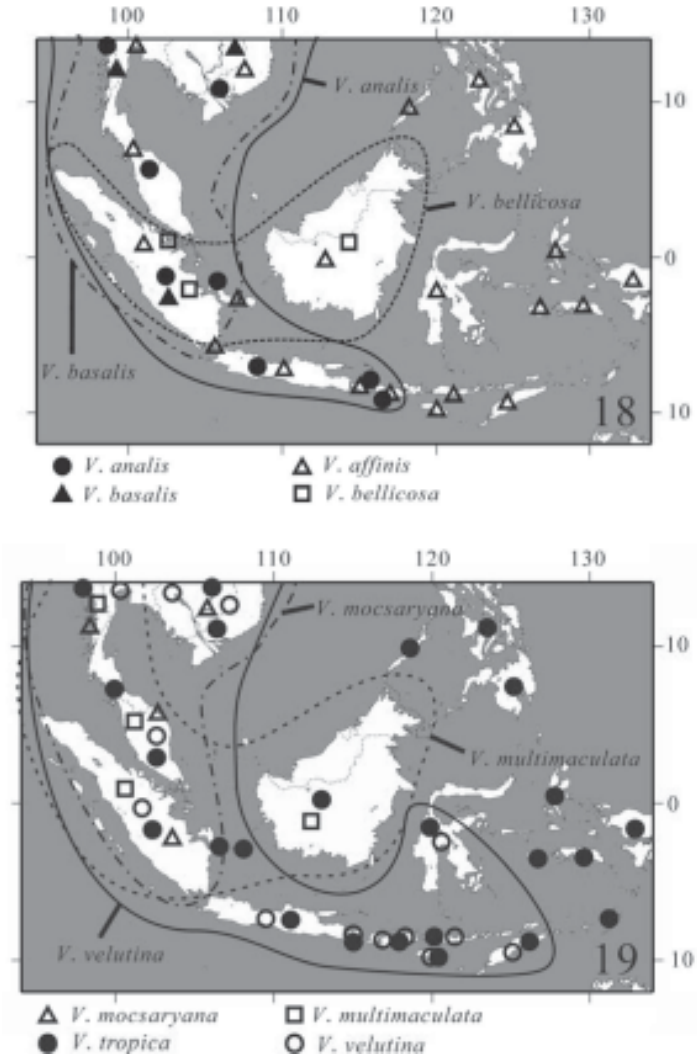
Figs. 12-13 Map showing distribution records and expected distribution ranges of polistine genus *Ropalidia* so far recorded in the Sunda Islands. 12, *R. malayana* species group; 13, independent-founding species of various species groups.



Figs. 14-15 Map showing distribution records and expected distribution ranges of polistine genus *Ropalidia* so far recorded in the Sunda Islands. 14, independent-founding species of various species groups; 15, *R. marginata* and *R. laticincta*.



Figs. 16-17 Map showing distribution records and expected distribution ranges of *Polybioides* (abbreviated as *Po.*) species and distribution records of *Parapolybia* (*Pp.*) species so far recorded in the Sunda Islands (16) and of the vespine genus *Provespa* (17).



Figs. 18-19 Map showing distribution records and expected distribution ranges of species of the vespine genus *Vespa* so far recorded in the Sunda Islands.

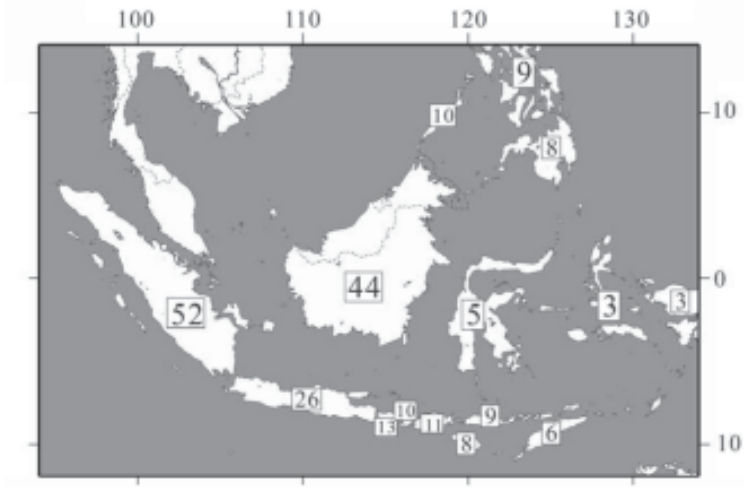


Fig. 20 Map showing the number of social wasp species that are also distributed in the Asian continent including Malay Peninsula occurring on each Southeast and Papuan islands.