

Vespidae of Viet Nam (Insecta: Hymenoptera) 2. Taxonomic Notes on Vespinae

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The taxonomy of the Vietnamese species of the social wasp subfamily Vespinae is revised. *Vespa auraria* Smith, 1852, is synonymized under *V. velutina* Lepeletier, 1836. *Vespula koreensis* (Radoszkowski, 1887) is recorded as new for Viet Nam, and its color characters are described. A key to vespine species of Viet Nam based on morphological characters is provided.

Key words: Hymenoptera, Vespidae, Vespinae, Viet Nam, identification key, new distribution record

INTRODUCTION

While the taxonomy and distribution of social wasps in Southeast Asia have, in general, been well studied (van der Vecht, 1941, 1957, 1962, 1966; Das and Gupta, 1989; Kojima *et al.*, 2005; Saito and Kojima, 2005; Saito *et al.*, 2005), until Nguyen and Carpenter (2002) the social wasp fauna of Viet Nam was very poorly known despite the expected species richness. That paper treated the Vespinae, one of the three social wasp subfamilies, and recorded 15 species of three genera (*Provespa* Ashmead, 1903, *Vespa* Linnaeus, 1758, and *Vespula* Thomson, 1869) and provided keys to vespine species occurring in Viet Nam, primarily following the treatment by Archer (1989).

In his keys to *Vespa* species, Archer (1989) treated as species the following three taxa that van der Vecht (1957, 1959) regarded as subspecies: *Vespa auraria* Smith, 1852, as distinct from *V. velutina* Lepeletier, 1836; *V. ducalis* Smith, 1852, separated from *V. tropica* (Linnaeus, 1758); and *V. soror* du Buysson, 1905, as a distinct species from *V. mandarinia* Smith, 1852. The reasoning for these treatments, however, was not mentioned until Archer (1991a: 163) stated "...*V. velutina auraria* and *V. velutina nigrithorax* du Buysson, 1905 are sympatric in north-eastern India ... but remain distinct color forms so *V. velutina auraria* may be considered as having reached specific rank", "...*V. mandarinia soror* du Buysson, 1905 is sympatric with *V. mandarinia magnifica* [Smith, 1852] ... but retains a distinct color form so it can be given specific rank...", and for *V. ducalis*, he mentioned "... *V. tropica ducalis* Smith, 1852 and *V. tropica*

pseudosoror van der Vecht, 1959 are sympatric with *V. tropica haematodes* Bequaert, 1936 and *V. tropica leefmansii* van der Vecht, 1957 ...". All these species were included in Nguyen and Carpenter (2002), with *V. auraria* and *V. mandarinia* being records new to Viet Nam.

In the published series of his study on the taxonomy and biology of *Vespa*, Archer (1991b, 1992, 1994, 1995, 1997) synonymized subspecies of *V. affinis* (Linnaeus, 1764), *V. crabro* Linnaeus, 1758, *V. ducalis*, *V. mandarinia*, *V. tropica*, and *V. velutina* by proposing informal names for local color forms instead of formal subspecies names. Carpenter and Kojima (1997) accepted Archer's work as a basis for extending the synonymy to the remaining subspecies and sank all subspecies in the Vespinae under the nominate species, although without being aware of that paper Archer (1998, 1999) returned to use of formal subspecies names in *V. orientalis* Linnaeus, 1771 and *V. luctuosa* de Saussure, 1854. Archer (1991b, 1994, 1995) provided the characters to differentiate between *V. tropica* and *V. ducalis*, between *V. auraria* and *V. velutina*, and between *V. mandarinia* and *V. soror* - all are color characters. At the same time, he recognized two, eight, three, and 11 color forms respectively in *V. ducalis*, *V. tropica*, *V. mandarinia*, and *V. velutina*. Archer's treatments may have introduced confusion into the taxonomy of these six "species". In each case, one of the two sympatric color forms was assigned a priori to one of the species in a pair concerned, without any explanation. By this logic, the alternative taxonomic conclusions are equally possible. For example, in the case of *V. velutina* and *V. auraria*, Archer a priori assigned *nigrithorax* to *V. velutina* and concluded *auraria* was a distinct species; however, *auraria* could equally well be a color form of *V. velutina* and *nigrithorax* a distinct species. Considering the fact that *Vespa* species often represent considerable local color variation, taxonomic conclusions such as Archer made should be based

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on morphological characters.

We reexamined part of the material of Nguyen and Carpenter (2002) and additional material collected in as well as outside Viet Nam. We have been able to produce a key to Vietnamese species of the Vespinae based only on morphological characters as presented in this paper. In this paper, we also discuss the taxonomic problems prevailing around the three pairs of *Vespa* species mentioned above and record *Vespula koreensis* (Radoszkowski, 1887) in the Vietnamese vespine fauna.

MATERIALS AND METHODS

Specimens examined are deposited in the Institute of Ecology and Bioresources, Hanoi (IEBR); the American Museum of Natural History, New York (AMNH); Natural History Collection, Ibaraki University, Mito (IUNH); Systematic Entomology, Hokkaido University, Sapporo (SEHU); Museum Zoologicum Bogoriense, Bogor (MZB); and National Science Museum, Tokyo (NSMT). Specimens for which depositories are not indicated are housed in the IEBR or IUNH as long-term loans. Morphological as well as color characters were observed on pinned and dried specimens under a stereoscopic dissecting microscope.

In the section listing material examined, the specimens listed in Nguyen and Carpenter (2002) are not given, except for *V. velutina* for which Nguyen and Carpenter (2002) listed some specimens under "*Vespa auraria*". We also examined specimens from various localities outside Viet Nam for comparison, but they are not listed except for *V. velutina*. The specimens examined are listed by province in Viet Nam (given in bold) or by country. Abbreviations are as follows: NP, National Park; ISD-c, collectors of the Insect Systematic Department of the IEBR; NL, Lien Thi Phuong Nguyen.

RESULTS AND DISCUSSION

Key to the species of subfamily Vespinae occurring in Viet Nam

The present key is based primarily on morphological characters. Color characteristics are also given, but they may not be applicable to some local forms occurring outside of Viet Nam.

1. Ocelli enlarged; posterior ocelli closer to inner eye margin than to each other (Fig. 1A). Vertex short; distance from the posterior ocellus to posterior margin of vertex nearly the same as or only slightly longer than that between posterior ocelli (Fig. 1A)2, genus *Provespa*
 - Ocelli not prominently enlarged; posterior ocelli closer to each other than to inner eye margin (Fig. 1B,C), or if the ocelli are enlarged (*Vespa binghami*) then vertex long, with posterior ocelli more than twice as far from the posterior margin of vertex as from each other 3
2. Female: apical margin of clypeus distinctly emarginate medially, with lateral angles prominent and slightly projecting. Scutum longer than wide. Male: apical margin of clypeus distinctly, but shallowly emarginate in the middle; antennal flagellum without tyloides.
 - Clypeus brownish yellow *Provespa nocturna* van der Vecht, 1935
 - Female: apical margin of clypeus only shallowly emarginate medially, with lateral angles not prominent or projecting. Scutum nearly as wide as long. Male: apical margin of clypeus scarcely emarginate, almost straight; antennal flagellum with tyloides.

- Clypeus pale yellow *Provespa barthelemyi* (du Buysson, 1905)
3. Pronotal carina and pretegular carina absent. Vertex short; distance from posterior ocellus to posterior margin of vertex slightly shorter than or equal to distance between posterior ocellus (Fig. 1B). Prestigma subequal in length to pterostigma4, genus *Vespula*
 - Pronotal carina and pretegular carina present. Vertex long; distance from posterior ocellus to posterior margin of vertex more than twice that between posterior ocelli (Fig. 1C). Length of prestigma three times that of pterostigma (Fig. 1D)5, genus *Vespa*
 4. Female: punctures on scutum dense, with inter-puncture distance equal to puncture diameter, denser on the lateral margins; propodeum rugose, with punctures between and interrupting the rugae. Male: propodeum rugose, lacking punctures *Vespula koreensis* (Radoszkowski, 1887)
 - Female: punctures on scutum less dense, with inter-puncture distance greater than puncture diameter; propodeum not rugose, only punctate. Male: propodeum punctate, lacking rugae *Vespula orbata* (du Buysson, 1902)
 5. Female; antenna with ten flagellomeres; metasoma six segmented 6
 - Male; antenna with 11 flagellomeres; metasoma seven segmented 16
 6. Anterior margin of clypeus with broad and rather deep median emargination, lateral edges of emargination forming broadly rounded lobes, with median bluntly triangular tooth (Fig. 1E).
 - Clypeus, vertex, scutellum and metanotum orange; fifth and sixth metasomal terga black. ... *Vespa analis* Fabricius, 1775
 - Anterior margin of clypeus more or less emarginated, without median tooth 7
 7. Ocelli large; posterior ocelli closer to inner eye margin than to each other. *Vespa binghami* du Buysson, 1905
 - Ocelli normal sized; posterior ocelli closer to each other than to inner eye margin. (Fig. 1C) 8
 8. Pretegular carina complete, crossing spiracular operculum. Center of the clypeus covered by coarse and large punctures, with distance between punctures less than puncture diameter 9
 - Pretegular carina incomplete, only extending to or only slightly beyond center of spiracular operculum. Center of the clypeus usually covered by small punctures, with inter-puncture distance more than puncture diameter 14
 9. Clypeus with bluntly triangular tooth on each side of the apical emargination (Fig. 1F,G) 10
 - Clypeus with short, broadly rounded lobe on each side of the apical emargination (Fig. 1H) 13
 10. Head enlarged and swollen behind eyes; in lateral view gena more than 1.8 times eye width. 11
 - Head not swollen behind eyes; gena less than 1.4 times eye width 12
 11. Pronotum with median impression (Fig. 1I). First metasomal tergum short, less than half as long as wide in dorsal view.

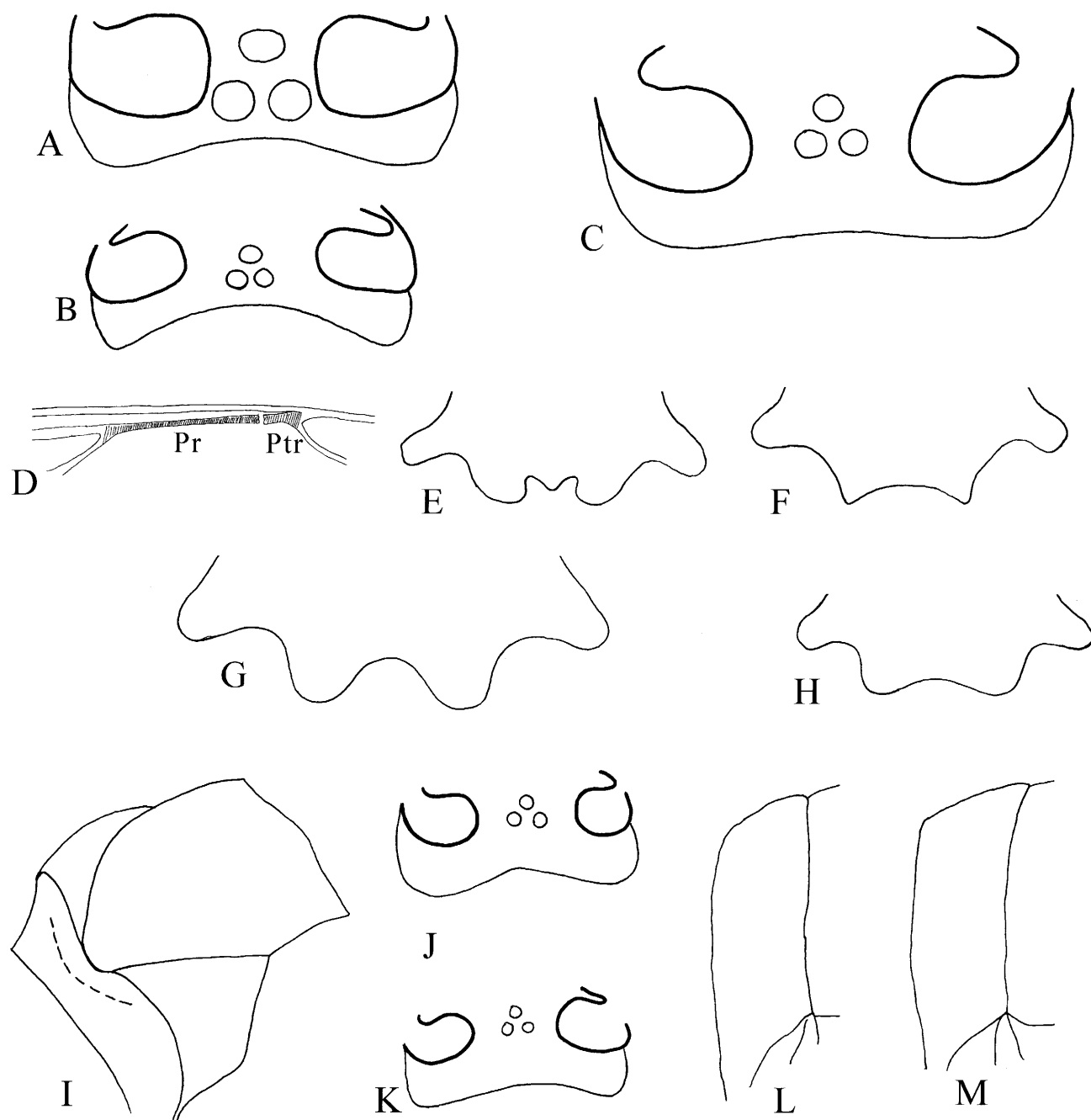


Fig. 1. Female morphological characters separating Vietnamese vespine species. (A–C) Dorsal view of head of *Provespa nocturna* (A), *Vespula koreensis* (B), and *Vespa velutina* (C). (D) Part of forewing of *Vespa bicolor*. pr, prestigma; ptr, pterostigma. (E–H) Apical part of clypeus of *Vespa analis* (E), *V. ducalis* (F), *V. mandarinia* (G), and *V. velutina* (H). (I) Pronotum and scutum of *Vespa mandarinia*. (J–K) Head in dorsal view of *Vespa basalis* (J) and *V. bicolor* (K). (L–M) Lateral view of first metasomal segment of *Vespa bicolor* (L) and *V. velutina* (M).

- Third to fifth metasomal terga with either a narrow or broad apical orange band; sixth tergum largely orange *Vespa mandarinia* Smith, 1805
- Pronotum without such a median impression. First metasomal tergum long, about as long as or longer than half of its own apical width in dorsal view. Third to sixth metasomal terga black.....
..... *Vespa soror* du Buysson, 1905
- 12. Disk of scutellum weakly swollen dorsally.

- Vertex and frons with strong yellow hairs; second metasomal tergum orange-yellow with a broad black band. *Vespa ducalis* Smith, 1852
- Disk of scutellum nearly flat. Vertex and frons with strong black hairs; second metasomal tergum entirely orange-yellow..... *Vespa tropica* (Linnaeus, 1758)
- 13. Scutum, vertex, and propodeum with distances between punctures greater than puncture diameter. Ventrolateral

- part of pronotum rugose, with transverse striae.
Vertex yellow-brown; second metasomal tergum black
..... *Vespa mocsaryana* du Buysson, 1905
- Scutum, vertex, and propodeum with distances between punctures less than puncture diameter. Ventrolateral part of pronotum not rugose.
Vertex black; second metasomal tergum orange-yellow
..... *Vespa affinis* (Linnaeus, 1764)
14. First metasomal tergum in dorsal view about as long as or longer than half of its own apical width. Punctures on central part of clypeus small, separated by two or three puncture diameters. Posterior margin of head in dorsal view distinctly concave medially (Fig. 1J).
Second to fifth metasomal terga entirely black; part of the first tergum not black ... *Vespa basalis* Smith, 1852
 - First metasomal tergum less than half as long as wide in dorsal view. Punctures on central part of clypeus larger, separated by one puncture diameter or less. Posterior margin of head in dorsal view barely concave (Fig. 1K).
Second to fifth metasomal terga not entirely black .. 15
 15. Ventrolateral part of pronotum smooth. First metasomal tergum in lateral view with anterior declivity sometimes weakly convex; anterodorsal angle between anterior declivity and dorsal face more obtuse, and often weakly rounded (Fig. 1L).
Vertex black. Metanotum yellow; first and second metasomal tergum yellow, with at most a black apical band
..... *Vespa bicolor* Fabricius, 1787
 - Ventrolateral part of pronotum rugose, with transverse striae (sometimes less distinct in worker). First metasomal tergum in lateral view with anterior declivity nearly flat; anterodorsal angle between anterior declivity and dorsal face prominent (Fig. 1M).
Vertex yellowish orange to orange, but often black. Metanotum black; first and second metasomal tergum black, with at most a yellow apical band... *Vespa velutina* Lepeletier, 1836
 16. Apical margin of seventh metasomal sternum convex (Fig. 2A) 17
 - Apical margin of the seventh metasomal sternum straight or concave 18
 17. Ocelli large; posterior ocelli nearer to inner eye margin than to each other.....
..... *Vespa binghami* du Buysson, 1905
 - Ocelli normal size; posterior ocelli nearer to each other than to inner eye margin *Vespa basalis* Smith, 1852
 18. Pretegular carina complete 19
 - Pretegular carina incomplete 25
 19. Head strongly swollen behind eyes; in lateral view gena more than 1.3 times eye width 20
 - Head not swollen behind eyes; in lateral view gena less than 1.2 times eye width..... 21
 20. Pronotum with median impression. First metasomal tergum short, less than half as long as wide in dorsal view.
Fifth and sixth metasomal terga with either a narrow or broad apical orange band; seventh tergum largely orange
..... *Vespa mandarinia* Smith, 1805
 - Pronotum without such a median impression. First metasomal tergum relatively long, about as long as or longer than half of its apical width in dorsal view.
Fifth to seventh metasomal terga black.....
..... *Vespa soror* du Buysson, 1905
 21. Apical margin of seventh metasomal sternum only shallowly emarginate (Fig. 2B).
Second metasomal tergum orange-yellow, with a broad black band. *Vespa ducalis* Smith, 1852
 - Apical margin of seventh metasomal sternum with deep median emargination..... 22
 22. Apical margin of sixth metasomal sternum shallowly emarginate (Fig. 2C).
Second metasomal tergum entirely orange-yellow.....
..... *Vespa tropica* (Linnaeus, 1758)
 - Apical margin of sixth metasomal sternum deeply emarginate (Fig. 2D,E)..... 23
 23. Eye separated from clypeal border by gap on both sides, or at least on one side (Fig. 2F).
Clypeus, vertex, scutellum and metanotum orange; fifth and sixth metasomal terga black
..... *Vespa analis* Fabricius, 1775
 - Both eyes touching clypeal border (Fig. 2G)..... 24
 24. Punctures on vertex behind ocelli and on scutum large, with distances between punctures less than puncture diameter. Ventrolateral part of pronotum not rugose.
Second metasomal tergum largely or entirely orange-yellow..... *Vespa affinis* (Linnaeus, 1764)
 - Punctures on vertex behind ocelli and on scutum small, with distances between punctures greater than puncture diameter. Ventrolateral part of pronotum rugose.
Second metasomal tergum black, with at most narrow apical yellow to reddish-brown band.....
..... *Vespa mocsaryana* du Buysson, 1905
 25. Ventrolateral part of pronotum rugose, with transverse striae. First metasomal tergum in lateral view with anterodorsal angle between anterior declivity and dorsal face prominent.
Vertex yellow; metanotum black; first and second metasomal terga black, with at most yellow apical bands
..... *Vespa velutina* Lepeletier, 1836
 - Ventrolateral part of pronotum smooth. First metasomal tergum in lateral view with anterodorsal angle between anterior declivity and dorsal face more obtuse and often weakly rounded.
Vertex black; metanotum yellow; first and second metasomal terga yellow, with at most black apical bands.
..... *Vespa bicolor* Fabricius, 1787
- Provespa barthelemyi* (du Buysson, 1905)**
- This species is distributed from India in the west to the Malay Peninsula in the east (Carpenter and Kojima, 1997), and is supposed to occur throughout Viet Nam (Nguyen and Carpenter, 2002).
- Material examined.** **Phu Tho:** 1 ♂ 3 ♀, Xuan Son NP, 600 m, light trap, 16.vi. 2004, NL; **Vinh Phuc:** 6 ♀ 1 ♂ (IEBR), Tam Dao NP, 800 m, [6 ♀, 12.v.2003, light trap; 1 ♂, 03.vii.2003], NL; 3 ♀ (IUNH), Trai Trau, Mê Linh, 10.iii.2005, F. Saito; **Quang Nam:** 3 ♀, Ngoc Linh Mt., Lo Xo, 100 m, [1 ♀, 31.iii.2004; 2 ♀, 14–20.iv.2004], X.H. Le.
- Provespa nocturna* van der Vecht, 1935**
- This species of the nocturnal genus *Provespa* is common in Sumatra and Borneo, while less common in conti-

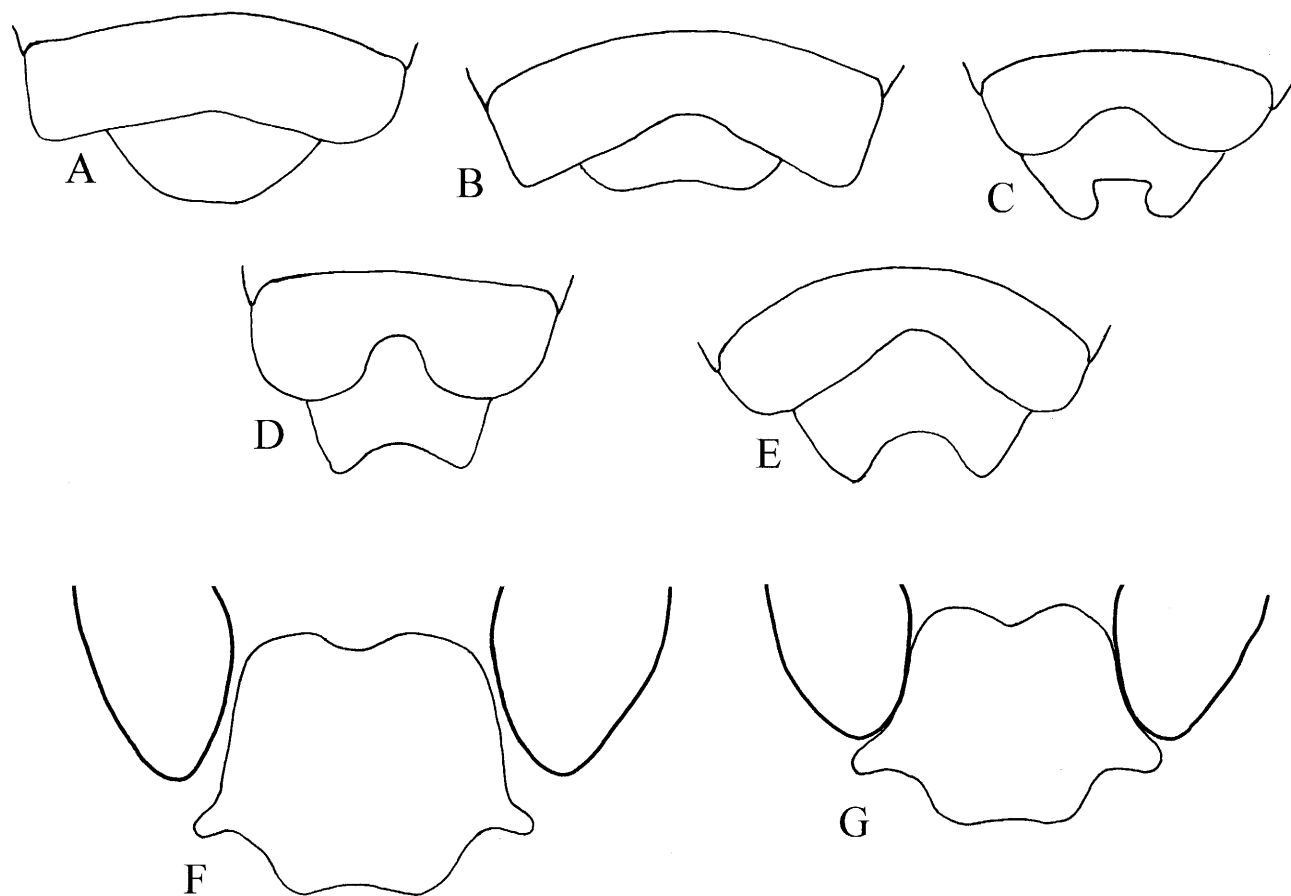


Fig. 2. Male morphological characters of Vietnamese *Vespa* species. (A–E) Sixth and seventh metasomal sterna of *V. basalis* (A), *V. ducalis* (B), *V. tropica* (C), *V. affinis* (D), and *V. analis* (E). (F–G) Clypeus and ventral parts of eyes of *V. mandarinia* (F) and *V. affinis* (G).

mental Southeast Asia, having been recorded from the Malay Peninsula and Viet Nam (van der Vecht, 1957; Carpenter and Kojima, 1997). Van der Vecht (1957: 9) recorded a worker deposited in the Museum national d'Histoire naturelle in Paris, with data "Hoa Binh (1929, leg. A. de Cooman)", that is the only distribution record or specimen available for Viet Nam.

***Vespa affinis* Linnaeus, 1764**

This species, representing many local color forms (Bequaert, 1936; van der Vecht, 1957; Das and Gupta, 1989; Archer, 1997), is widely distributed from India in the west, through the Indo-Papuan Islands, to New Britain and New Ireland in the east, and to Ishigaki Island of the Ryukyus in the north (Carpenter and Kojima, 1997). This species occurs throughout Viet Nam (Fig. 3A), and the color pattern of Vietnamese specimens agrees with that referred to by van der Vecht (1957: 28) for the wasps in Indo-China and Sumatra.

Material examined. **Thai Nguyen:** 17 ♀ 1 ♂, Cat Ne, Dai Tu, 23.x.2004, ISD-c; 2 ♀, Than Xa, Vo Nhai, 15.x.2004, ISD-c; **Vinh Phuc:** 2 ♀ (IEBR), Tam Dao NP, 800 m, [1 ♀, 02–04.vii.2003; 1 ♀, 27.viii.2004], NL; 1 ♀ (IEBR), Tay Thien Mt., 200 m, 26.viii.2004, NL; **Hai Phong:** 1 ♀, Cat Ba, 10.v.2003, NL; **Nghe An:** 1 ♀, Pu Huong NP, Chau Cuong, Quy Hop, 19.vii.2004, ISD-c; 2 ♀ (IEBR), Mon Son, Con

Cuong, 22–24.vii.2004, NL; **Ha Tinh:** 1 ♀, Son Kim, Huong Son, 500 m, 7.v.2004, NL; 2 ♀, Son Tay, Huong Son, 19–27.v.2004, X.L Truong; **Quang Tri:** 9 ♀, [1 ♀, Hong Thuy; 3 ♀, Ta Rut; 5 ♀, Huc Nghi], Dakrong, 16–18.vii.2004, ISD-c; **Quang Nam:** 12 ♀, Phuoc Xuan, Phuoc Son, 31.vii.2004, ISD-c; 9 ♀, Phuoc Hiep, Phuoc Son, 300 m, 30.vii.2004, ISD-c; **Phu Yen:** 1 ♀, Tuy Hoa, 6.xii.2003, NL; **Kien Giang:** 19 ♀ (IEBR), Phu Quoc NP, 1–6.xii.2003, T.H. Nguyen; 2 ♀, U Minh Thuong NP, 01.xii.2003, NL

***Vespa analis* Fabricius, 1775**

This species also has many local color forms and is distributed widely from India to Lombok of the Lesser Sunda Islands, and to Japan and Amur and Primor'ye of Russia in the north.

In Viet Nam, this species has two distinct color variations, both having been collected in northern Viet Nam (Fig. 3A). One agrees with the color form that van der Vecht (1957:12) referred to under a subspecies, *nigrans* du Buysson, 1903, for the specimens from continental Asia including the Malay Peninsula. The other has the clypeus and vertex colored orange-yellow, the first and second metasomal terga being orange with a black band which extends one-third the distance across the tergum, and the entire part of the third to sixth metasomal terga colored black. This color pattern has not been previously reported.

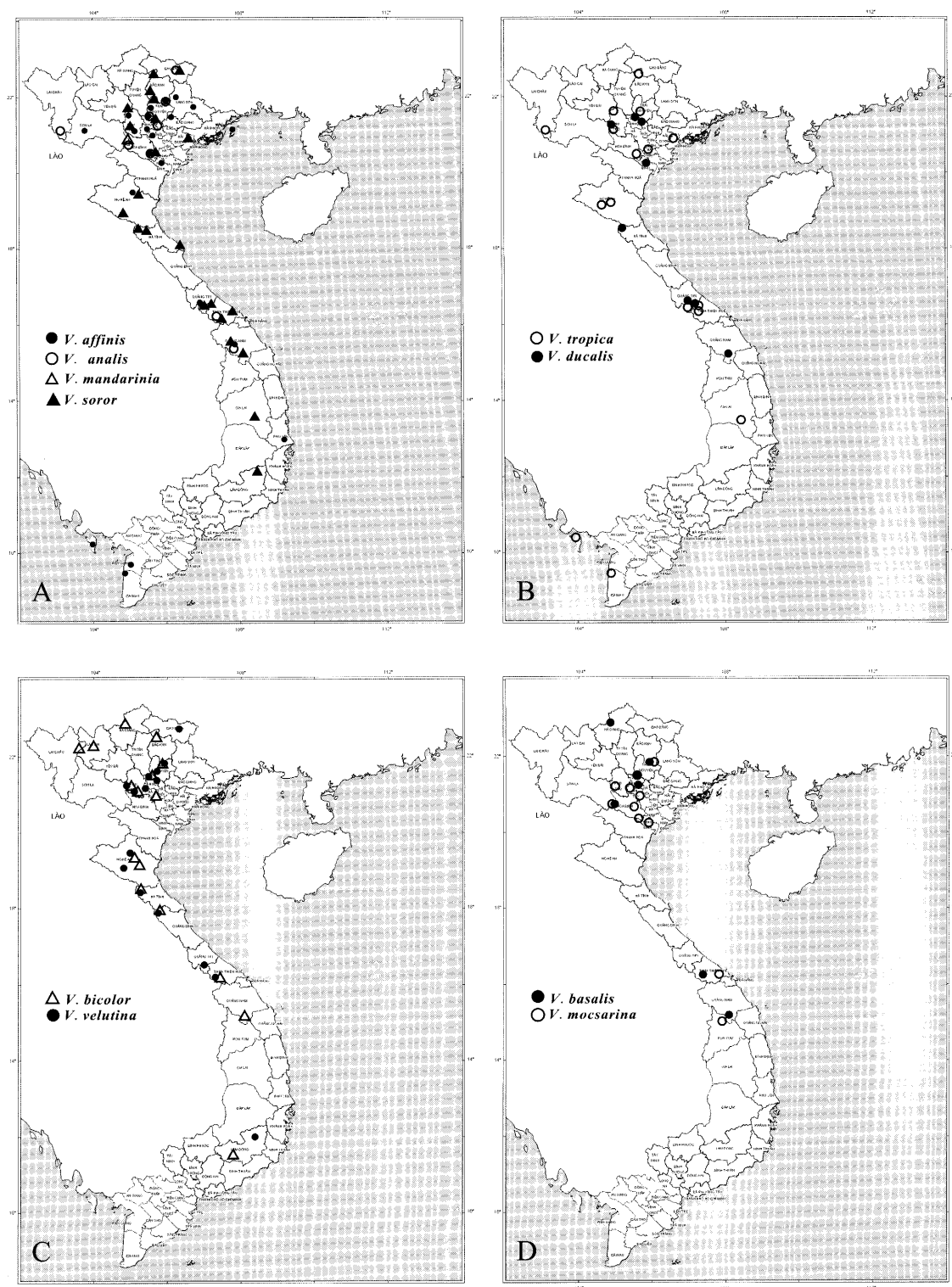


Fig. 3. Maps showing collection records of *Vespa* species in Viet Nam. (A) *V. affinis*, *V. analis*, *V. mandarinia*, and *V. soror*. (B) *V. ducalis* and *V. tropica*. (C) *V. bicolor* and *V. velutina*. (D) *V. basalis* and *V. mocsaryana*.

Material examined. **Cao Bang:** 1 ♀, along Bang Giang River, 21.viii.2001, X.L. Truong; **Lai Chau:** 1 ♀, Dien Bien, 1000 m, 13.vii.2001, ISD-c; **Thai Nguyen:** 1 ♀, Than Xa, Vo Nhai, 17.x.2004, ISD-c; **Vinh Phuc:** 5 ♀, Tam Dao NP, 800 m, 03.vii.2003, NL; **Hoa Binh:** 1 ♀, Lac Thinh, Yen Thuy,

1.v.2002, V.T. Hoang; **Quang Tri:** 5 ♀, [3 ♀, Hong Thuy; 1 ♀, Ta Rut; 1 ♀, Huc Nghi], Dackrong, 16–18.vii.2004, ISD-c; **Thua Thien Hue:** 2 ♀, A Roang, A Luoi, 700 m, 23.vii.2004, ISD-c; **Quang Nam:** 1 ♀, Ngoc Linh Mt., 1500 m, 28.iii.2004, X. H. Le; 6 ♀, Lo Xo, Phuoc Son, 500 m, 29.vii.2004, ISD-c.

***Vespa basalis* Smith, 1852**

This species is widely distributed in Pakistan, northern India, Taiwan, southern China, continental Southeast Asia, and Sumatra (Das and Gupta, 1989; Carpenter and Kojima, 1997). Although this distribution pattern indicates that the species occurs throughout Viet Nam, available collection records are restricted to northern and central Viet Nam (van der Vecht, 1957; Nguyen and Carpenter, 2002) (Fig. 3D).

Material examined. **Ha Giang:** 1 ♀ (AMNH), 22°46.15'N 104°49.38'E, 1170 m, 9.ix.2000, C. Johnson, sweep; 1 ♀ (AMNH), 22°46.15'N 104°49.38'E, 1420 m, 19–20.ix.2000, C. Johnson, mercury vapor lamp; 1 ♀ (AMNH), 22°46.19'N 104°49.46'E, 1210 m, 22.ix.2000, C. Johnson, AMNH Malaise trap; **Thai Nguyen:** 14 ♀, Than Xa, Vo Nhai, 15.x.2004, ISD-c; **Vinh Phuc:** 1 ♀, Tam Dao NP, 800m, 12.v.2003, NL; **Hoa Binh:** 1 ♀, Pa Co, Mai Chau, 1100 m, 28.iv.2002, V. T. Hoang; **Thanh Hoa:** 1 ♀, Lung Cao, Ba Thuoc, 500 m, 12.vi.2003, X. H. Le; Thua Thien Hue: 1 ♀, A Roang, A Luoi, 700 m, 21.vii.2004, ISD-c; **Quang Nam:** 6 ♀, Ngoc Linh Mt., Lo Xo, 100 m, 14–20.iv.2004, X.H. Le.

***Vespa bicolor* Fabricius, 1787**

This species is known to occur in northern India, Nepal, Bhutan, southern China, and continental Southeast Asia (Das and Gupta, 1989; Carpenter and Kojima, 1997).

Material examined. **Ha Giang:** 3 ♀ (AMNH), 22°46.15'N 104°49.38'E, 1170 m, 9.ix.2000, C. Johnson, sweep; 1 ♀ (AMNH), along trail ~1400 m, 9.ix.2000, T. Nguyen; 1 ♀ (AMNH), 22°46.19'N 104°49.46'E, 1316–1470 m, 9–15.ix.2000, C. Johnson, AMNH Malaise Trap; 1 ♀ (AMNH), 22°46.36'N 104°49.00'E, 1316–1810 m, 10–15.ix.2000, C. Johnson, AMNH Malaise Trap, 4 ♀ (AMNH), 22°46.19'N 104°49.46'E, 1210 m, 23.ix.2000, C. Johnson, AMNH Pitfall Trap #1; 2 ♀ (AMNH), 22°46.36'N 104°49.00'E, 1780m, 23.ix.2000, C. Johnson, AMNH Pitfall Trap #3; **Lai Chau:** 1 ♀ (NSMT), Phan Si Pang Mt., 1950–1970 m, Hoang Lien Son Mts., 13.v.1995, A. Saito; **Lao Cai:** 1 ♀, Sa Pa Mt., Sa Pa, 1300m, 10.vi.2004, D.L. Khuat; **Thai Nguyen:** 1 ♀, Than Xa, Vo Nhai, 16.x.2004, ISD-c; **Phu Tho:** 4 ♀, Xuan Son NP, 500 m, 6–9.ix.2003, X.L. Truong; **Vinh Phuc:** 13 ♀, Tam Dao NP., 800 m, [11 ♀, 02–04.vii.2003; 2 ♀, 12.v.2004], NL; 5 ♀, Tay Thien Mt., 200 m, 26.viii.2004, NL; **Nghe An:** 1 ♀, Pu Huong NP, Chau Cuong, Quy Hop, 19.vii.2004, ISD-c; **Ha Tinh:** 1 ♀, Cau Treo, Huong Son, 30.v.2004, NL; **Thua Thien Hue:** 1 ♀, A Roang, A Luoi, 25.vii.2004, ISD-c; **Quang Nam:** 4 ♀, Ngoc Linh Mt., 1500 m, 28.iii.2004, X.H. Le; **Lam Dong:** 2 ♀, Blao, Bao Loc, 500 m, 28.xi.2003, NL.

***Vespa binghami* du Buysson, 1905**

This species has been recorded from India (West Bengal, Assam, Meghalaya), Bhutan, Myanmar, Thailand, Laos, China (Xizang, Sichuan, Yunnan, Jiangsu, Shanghai), Korea, and Primor'ye and Sakhalin in Russia (Carpenter and Kojima, 1997). Nguyen and Carpenter (2002: 206) mentioned that “the presence of this species in Viet Nam, while possible, is not documented”, and no specimens were available for the present study.

***Vespa ducalis* Smith, 1852**

Smith (1852) described *Vespa ducalis* from “Tein-tung, near Ning-po-foo” [Probably Teintung near Ningbo, 29°47'N,

121°46'E]. Bequaert (1936) treated *ducalis* as a variety of *V. tropica*, and van der Vecht (1959) and Das and Gupta (1984, 1989) treated it as a subspecies of *V. tropica*. Archer (1989, 1991a, b) reinstated the species status of *ducalis*. However, as mentioned in the INTRODUCTION, his reasoning for treating *ducalis* as a different species from *tropica* can be justified only when typical color forms of both taxa co-occur or when there are stable differences. We examined specimens from various localities and found the morphological differences mentioned in the key to support Archer's treatment. We have collected *V. ducalis* in northern and central Viet Nam, but not in the southern region (see also Nguyen and Carpenter 2002) (Fig. 3B).

Material examined. **Phu Tho:** 2 ♂, Xuan Son NP, 500 m, 9.xii.2003, X.L. Truong; 2 ♀, 300m, 16.x.2004, X.H. Le; **Vinh Phuc:** 8 ♀, Tam Dao NP, 800 m, [1 ♀, 27.viii.2004; 7 ♀, 3.vii.2003], NL; **Quang Tri:** 1 ♀, Huc Nghi, Dakrong, 18.vii.2004, ISD-c.

***Vespa mandarinia* Smith, 1852**

This species is widely distributed in continental Asia from India to China and Korea, and Primor'ye of Russia, and Taiwan and Japan (including the northern islands of the Ryukyus) (Carpenter and Kojima, 1997; Nguyen and Carpenter, 2002). In Viet Nam, the species has so far been recorded only from one locality in the northern region and seems to be much less common than its closely related species, *V. soror* du Buysson, 1905 (see also Nguyen and Carpenter, 2002) (Fig. 3A).

Archer (1989) treated *mandarinia* and *soror* as different species, and he (Archer, 1991a: 163) mentioned the reasoning for this treatment, that “... *soror* ... is sympatric with *V. mandarinia magnifica* in northern Laos and parts of southern China but retains a distinct colour form ...” This brought confusion to the taxonomy of *mandarinia-soror*, because the typical color form of *V. mandarinia* may occur in northern Laos and southern China. Later he (Archer, 1995: 48) mentioned that “Archer (1991a) showed that *V. mandarinia soror* was sympatric ... with *V. m. mandarinia* ...” Both *V. mandarinia* and *V. soror* were described from southwestern China (“Tein-tung, near Ning-po-foo” and “Kiangsi”, respectively); thus the sympatric occurrence of their typical color forms is apparent. Our finding of morphological differences has supported Archer's treatment. Van der Vecht (1957: 15, 16) listed two color forms from Indo-Malayan areas, and Das and Gupta (1989: 212, 213) add one color form from Burma. The color pattern of Vietnamese specimens agrees with that referred to by Das and Gupta (1989) under the subspecies *bellona* Smith, 1871, for the specimens from Yunnan, north Myanmar, and Bhutan; that is, the mesosoma is largely yellowish brown.

No specimens additional to Nguyen and Carpenter (2002) were available to us.

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

This species is widely distributed in the northeastern part of India, continental Southeast Asia, China, and Sumatra (van der Vecht, 1957; Das and Gupta, 1989; Carpenter and Kojima, 1997). The species is known from northern and central Viet Nam (van der Vecht, 1957; Nguyen and Carpenter, 2002) (Fig. 3D).

We recognized two color variations in the Vietnamese populations. The northern population has a color pattern agreeing with that given in Das and Gupta (1989), viz. the female sixth metasomal tergum is entirely black. In contrast, specimens collected in the central part of Viet Nam have the sixth tergum entirely or partly orange-yellow.

Material examined Thai Nguyen: 4 ♀, Than Xa, Vo Nhai, 16.x.2004, ISD-c; **Phu Tho:** 2 ♀, Xuan Son NP, [1 ♀, ix.2000, ISD-c; 1 ♀, 500 m, 9.xii.2003, X.L. Truong]; **Hoa Binh:** 1 ♀, Pa Co, Mai Chau, 1100 m, 28.iv.2002, V.T. Hoang; **Ninh Binh:** 1 ♀, Cuc Phuong NP, 7.v.2002, V.T. Hoang; **Thua Thien Hue:** 2 ♀, Bach Ma NP, 700 m, 4.xi.2001, ISD-c; **Kon Tum:** 1 ♀ (IEBR), Lo Xo, Ngoc Linh, 14–20.iv.2004, X.H. Le.

Vespa soror du Buysson, 1905

Vespa soror has so far been recorded in southern China, Thailand, Laos and Viet Nam (Das and Gupta, 1989; Carpenter and Kojima, 1997). The species may occur throughout Viet Nam (Fig. 3A) and seems to be much more common than its closely related species, *V. mandarinia* (see also Nguyen and Carpenter, 2002).

Material examined. Cao Bang: 2 ♀, along Bang Giang river, 200 m, 21.viii.2001, X.L. Truong; **Thai Nguyen:** 7 ♀, Than Xa, Vo Nhai, 18.x.2004, ISD-c; **Phu Tho:** 1 ♀, Xuan Son NP, 500 m, 9.xii.2003, X.L. Truong; **Vinh Phuc:** 4 ♀, Tam Dao NP, 800m, [1 ♀, 27.viii.2004; 3 ♀, 3.vii.2003], NL; **Nghe An:** 2 ♀, Pu Huong NP, Chau Cuong, Quy Hop, 19.vii.2004, ISD-c; 4 ♀ (IEBR), Mon Son, Con Cuong, 22–24.vii.2004, NL; **Ha Tinh:** 7 ♀, Huong Son, Son Tay, 19–27.v.2004, NL; **Thua Thien Hue:** 1 ♀, 28.vii.2002, D.L. Khuat; 1 ♀, Bach Ma NP, 1000 m, 27.vii.2003, X.L. Truong; 1 ♀, A Roang, A Luoi, 25.vii.2004, ISD-c; **Quang Tri:** 20 ♀, [1 ♀, Hong Thuy; 1 ♀, Ta Rut; 18 ♀, Huc Nghi], Dakrong, 16–18.vii.2004, ISD-c; **Quang Nam:** 1 ♀, Ngoc Linh Mt., Lo Xo, 14–20.iv.2004, X.H. Le; 7 ♀, Phuoc My, Phuoc Son, 700 m, 28.vii.2004, ISD-c; 1 ♀, Khau Duc, Phuoc Son, 30.vii.2004, ISD-c.

Vespa tropica (Linnaeus, 1758)

Represented by many local color forms, this species is widely distributed in the Indo-Malayan and Papuan regions, from Afghanistan to New Guinea and its adjacent islands including New Britain (van der Vecht, 1957; Das and Gupta, 1989; Carpenter and Kojima, 1997).

The color pattern of the Vietnamese specimens agrees with that for specimens from continental Southeast Asia and Sumatra (see also van der Vecht, 1957). This species may occur throughout Viet Nam (Fig. 3B).

Material examined Thai Nguyen: 2 ♀, Cat Ne, Dai Tu, 23.x.2004, ISD-c; **Phu Tho:** 2 ♀, Xuan Son NP, [1 ♀, ix.2000, ISD-c; 1 ♀, 400 m, 11.vi.2004, NL]; **Vinh Phuc:** 1 ♀, Tay Thien Mt., 200 m, 26.viii.2004, NL; **Ha Nam:** 1 ♀, Phu Ly, 20.vi.2003, Malaise trap; **Nghe An:** 4 ♀, Pu Mat NP, 200 m, 21–26.vii.2004, NL; **Quang Tri:** 2 ♀, Dakrong, 16–17.vii.2004, ISD-c [1 ♀, Hong Thuy; 1 ♀, Ta Rut]; **Thua Thien Hue:** 1 ♀, A Roang, A Luoi, 700 m, 23.vii.2004, ISD-c.

Vespa velutina Lepeletier, 1836

Archer (1989, 1991a, 1994) treated *auraria* as a species distinct from *velutina*, based on the observation that “*V. velutina auraria* and *V. velutina nigrithorax*... are sympatric

in north-eastern India, Nepal, Assam, northern Burma and parts of western China but remain distinct colour forms”. We examined workers of typical “*nigrithorax*” (specimens from China deposited in the AMNH), “*auraria*” (specimens from Nepal) and “*velutina*” (from Java), as well as several Indonesian color forms, but we were unable to find any morphological characters allowing us to separate these forms. Furthermore, the marking pattern sometimes varies greatly within a given local population. A typical case was found among specimens from northern Viet Nam [listed partly under “*V. auraria*” in Nguyen and Carpenter (2002)], which show color variations intergrading with “*nigrithorax*” and a color form described by van der Vecht (1957: 37, 38) for the specimens from Thailand and Indo-China under the subspecific name “*variana*”. Of 25 workers collected at Tam Dao from 7–9 September 2000, seven have their vertex and mesosoma entirely black or with at most ill-defined, narrow, dark-orange lines along the pronotal carina and at the posterior margin of the scutellum; five have the vertex yellowish orange to orange, sometimes with a black spot among the ocelli, while the mesosoma is nearly entirely black; the remaining 13 specimens have the vertex yellowish orange to dark reddish brown, often with a black spot among ocelli, and the mesosoma has orange or reddish brown marks variously developed as bands along the pronotal carina and on the posterodorsal margin of pronotum, and spots on the scutellum. Similarly, two females from Bali are considerably different in coloration of the vertex and mesosoma. The reasoning of Archer (1989, 1991a, 1994) for treating *V. auraria* as a different species from *V. velutina* is not supported. *Vespa auraria* Smith, 1852, is therefore synonymized under *Vespa velutina* Lepeletier, 1836 (**REVISED SYNONYMY**).

Vespa velutina seems to occur throughout Viet Nam (Fig. 3C).

Material examined. Ha Giang: 1 ♀ (AMNH), 22°46.36N 104°49.00E, 1780 m, 23.ix.2000, C. Johnson, AMNH Pitfall Trap #3; **Cao Bang:** 3 ♀, along Bang Giang river, 200m, 21.viii.2001, X.L. Truong; **Thai Nguyen:** 5 ♀, Cat Ne, Dai Tu, 23.x.2004, ISD-c; 24 ♀, Than Xa, Vo Nhai, 14–19.x.2004, ISD-c; **Phu Tho:** 3 ♂, Xuan Son NP, 500 m, 6–9.xii.2003, X.L. Truong; **Vinh Phuc:** 54 ♀, Tam Dao NP, [25 ♀, 800–1000 m, 7–9. ix.2000; 1 ♀, 800 m, 12.v.2003; 28 ♀, 800 m, 02–04.vii.2003], NL; 1 ♀ (NSMT), Tam Dao Mt., 960–1230 m, 19–21.v.1995, A. Saito; 8 ♀, Tay Thien Mt., 200 m, 26.viii. 2004, NL; 11 ♀, Trai Trau, Mê Linh, 22.viii.2000, NL; **Ha Tay:** 5 ♀, Ba Vi Mt., 800 m, 18.ix.2000, NL; 1 ♀, Ba Vi Mt., 100 m, 1.vi.2001, NL; **Nghe An:** 2 ♀, Pu Mat NP, 200 m, 27.vii.2004; 1 ♀, Pu Huong NP, Chau Cuong, Quy Hop, 19.vii.2004, ISD-c; **Ha Tinh:** 2 ♀, Huong Son, Son Kim, 400 m, 6.v.2004, X.L. Truong; **Quang Tri:** 7 ♀, [2 ♀, Hong Thuy; 5 ♀, Huc Nghi], Dakrong, 16–18.vii.2004, ISD-c; **Thua Thien Hue:** 1 ♀, A Roang, A Luoi, 25.vii.2004, ISD-c; 8 ♀, A Roang, A Luoi, 700 m, 23.vii.2004, ISD-c; **Quang Nam:** 7 ♀, Ngoc Linh Mt., 1500 m, 28.iii.2004; 3 ♀, Lo Xo, Ngoc Linh, 31.iii.2004, X.H. Le; **Lam Dong:** 2 ♀, Lang bian, 2170 m, 1.v.2003, ISD-c; 3 ♂, Da Lat, Dankia, 1950 m, 27.xi.2003, NL. **Nepal:** 1 ♀ (SEHU), Berrawate, 12.ix.1975, S. Takagi; 1 ♀ (SEHU), Ghora Tobela, Syabru, 30.ix.1975, S. Takagi; 1 ♀ (SEHU), Syabru, 20.ix. 1975, S. Takagi. **Taiwan:** Hualien: 1 ♀ (SEHU), Taroko, 20.x. 1976, Sk. Yamane; Nantou: 2 ♀ 10 ♂

(SEHU), Puli, [1 ♂, 12.xi.1972; 1 ♀, Puli, 28.x.1976; 2 ♀, 12.xi.1972; 9 ♂, 12.xi. 1972], S. & Sk. Yamane; Nantou: 1 ♀ (SEHU), Wushe, 10.v. 1980, S. Aoki. **China:** 9 ♀ + nest (AMNH), Yen Ching Kao, i.1922, W. G.; 21 ♀ (AMNH), Futsing, Fukien, vii.1938 and viii.1938, H. Caldwell; 7 ♀ (AMNH), Wah-hsien, Sichuan, ix.1921; 5 ♀ (AMNH), Mt. Omei, Sichuan, D. Sage Jr. 17.vii. 1938, 22.vii.1938, 7.viii.1938, 17.viii.1938, and 18.viii.1938; 1 ♀ (AMNH), Chengtu, Sichuan, 2.ix.1938, D. Sage Jr.; 11 ♀ (AMNH), Yeping, vii.1916, 16.iv.1917, 7.vii.1917, 10.vii. 1917, 13.vii. 1917, 19.viii.1917, 1.ix.1917, 13.ix.1917, 21.iv. 1920, 19.viii.1920 and 31.viii.1920; 2 ♀ (AMNH), Peking, vii.1921, viii.1921. **Sumatra:** 8 ♀ (MZB, paratypes of *V. velutina karnyi* van der Vecht, 1957), Atjeh [=Ache]; 5 ♀, 1 ♂ (MZB, paratypes of *V. velutina karnyi* van der Vecht, 1957), Mt. Tanggamus, Lampong Districts. **Java:** 38 ♀, 2 ♂ (MZB), 6°44'S 106°32'E, Chikaniki, Gunung Halimun NP, iii.2000–xii.2001; 4 ♀ (MZB) Cibodas, 15–16.vi.1994, W. A. Noerdjito. **Bali:** 2 ♀ (MZB), Batoe-Meringgit, central Bali, x.1928, Franck. **Flores:** 1 ♀ (MZB, paratype of *V. v. floresiana* van der Vecht, 1957); 9 ♀ (MZB), Rana Mese, 1300–1500 m, 6–10.iv.1958, A. M. R. Wegner. **Sumba:** 11 ♀ (MZB, paratypes of *V. v. sumbana* van der Vecht, 1957), Bühler & Sutter [4 ♀, Mau Maru, 18–22.vii.1949; 2 ♀, Baing, 23.vi.1949; 4 ♀, Rua, 29.viii-1.ix.1949; 1 ♀, Pogobina, 17.xi. 1949]; 1 ♀ (MZB), Wanggameti Forest, 700 m, 5–28.ii.1995, H. Sutrisno. **Timor:** 12 ♀ (MZB, paratypes of *V. v. timorensis* van der Vecht, 1957), Kupang, v.1940.

Vespula koreensis (Radoszkowski, 1887)

This is a new record for Viet Nam. This species is widely distributed from India in the west to Korea, Amur, and Primor'ye of Russia in the east (Das and Gupta, 1989; Carpenter and Kojima, 1997). Two female (worker) specimens from northern Viet Nam were available for the present study.

The specimens have the following color pattern: head and mesosoma black, with the following parts yellow: mandible except for nearly black teeth and margins, clypeus (specimen from Than Xa with a large, ill-defined, pale brown spot dorsomedially and a small, pale brown spot on each side of the median spot), gena, frons below level of upper margin of eye emargination (interrupted by black lines extending from vertex to antennal sockets in specimen from Than Xa), dorsal face of pronotum (in specimen from Than Xa, pronotum black, with narrow, yellow band along posterodorsal margin), anterior bands on scutellum and metanotum, large scrobal spot, and paired, large spots on posterior face and a small spot on each lateral face of propodeum (united in specimen from Than Xa). All legs yellow, but femora and tibiae partly bright brown. Metasoma black; first to fifth terga with a narrow, yellow apical band; sixth tergum black or dark brown, with apical margin dull yellow; anterior face of first tergum largely dark, reddish brown; second to fifth sterna black or dark brown, with a yellow apical band; sixth sternum dark brown. Wings hyaline, pale ferruginous; veins brown; stigma pale brown.

Material examined. **Thai Nguyen:** 1 ♀, Than Xa, Vo Nhai, 14.x.2004, ISD-c; **Phu Tho:** 1 ♀, Xuan Son NP, 627m, 13.vii.2004, NL.

Vespula orbata (du Buysson, 1902)

This species occurs in India, Nepal, Myanmar, and Viet Nam (Carpenter and Kojima, 1997; Nguyen and Carpenter, 2002). In Viet Nam, this species has been found only in high mountainous areas in the northern and central regions.

Material examined. **Ha Giang:** 1 ♀ (AMNH), 22°46.15'N 104°49.38'E, 1170 m, 9.ix.2000, C. Johnson, sweep; 1 ♀ (AMNH), along trail ~ 1400m, 9.ix.2000, T. Nguyen; 1 ♀ (AMNH), 22°46.07'N 104°49.51'E, 1170 m, 22.ix.2000, C. Johnson, AMNH Aerial Malaise Trap #1; **Quang Nam:** 1 ♀, Ngoc Linh NP, 1500 m, 31.iii.2004, X.H. Le.

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