

## THE COMMON ORIENTAL HORNETS, *VESPA TROPICA* AND *VESPA AFFINIS*, AND THEIR COLOR FORMS.

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Perhaps the most common Hornets of the Oriental and Indo-Malayan regions are the large black or fuscous wasps with the second or first and second abdominal segments partly or wholly orange or orange-yellow. In most collections these wasps stand as *Vespa cincta* and *Vespa affinis*, the latter being often regarded as a variety of the former. A study of structure, however, discloses that two quite distinct species are commonly confused under these names. This fact, unfortunately, was not recognized by R. DU BURSSON, when he wrote his monograph of the Vespinae (1905). At the Paris Museum, he placed specimens of both species under *V. cincta* var. *affinis*, as well as under *V. cincta*. J. PÉREZ (1910) first noticed the confusion, when he described his *V. indosinensis* as distinct from *V. cincta*; and more recently (1922), S. LEEFMANS suggested that two distinct species were possibly united under *V. cincta* and its varieties.

The oldest name for the more common of the two species appears to be *Vespa tropica* (LINNAEUS). If structural characters alone are recognized as binding for the delimitation of species, as I have done consistently in my work with Diptera, several other so-called "species" of DU BURSSON'S monograph should be regarded merely as color forms, or "races", of *V. tropica*.

The second species is perhaps rarer, although, owing to the persistent confusion with *V. tropica*, it is as yet impossible to gain a clear idea of its distribution. I have reached the conclusion that it was the insect originally described by LINNAEUS as *Apis affinis* and later called *Vespa affinis* by FABRICIUS.

I have endeavored to unravel the several forms of these two Hornets, in so far as feasible with museum material. Entomologists residing in India, the Orient, or the East Indies should take up their study in the field and, among other points, enlighten us about possible ethological differences between the two species.

I have studied material belonging to the Musée Royal d'Histoire Naturelle de Belgique, Brussels (Brux. M.), the American Museum of Natural History (A.M.N.H.), the United States National Museum (U.S.N.M.), the Philadelphia Academy of Sciences (Phila. Ac.), the Museum of Comparative Zoölogy, Cambridge, Mass. (M.C.Z.), Rijksmuseum van Natuurlijke Historie, Leiden

(Leid. M.), the Department of Entomology, Philippine College of Agriculture (Phil. Agri.), the Philippine Bureau of Science (Phil. B. Sci.), the Paris Museum (Par. M.), the Zoologisches Museum, Berlin (Berl. M.), and the Deutsches Entomologische Institut, Berlin-Dahlem (D.E.I.). Interesting specimens were also received from Dr. KEIZO YASUMUTSU (Kyushu Imperial University, Fukuoka, Japan), Mr. C. F. CLAGG, Mr. W. E. HOFFMANN (Lingnan University, Canton, China), and Mr. J. L. GRESSITT. Dr. J. VAN DER VECHT sent me a list of the specimens in the collections of the Leiden Museum. He also examined for me the type of *Vespa unicolor* at Oxford and called my attention to LEEFMANS' account of the habits of *V. affinis*; I am under further obligations to Dr. VAN DER VECHT for arranging for the publication of additional specimens from various localities, recognized by him at the Zoological Museum, Buitenzorg. These I have not examined myself and are therefore listed in a special paragraph under "Additional specimens (Buit. M.)."

**Ethology.** — The nesting habits and behavior of *V. tropica* and *V. affinis* have been little studied thus far. The few published accounts, referring as a rule to *V. cincta*, disagree in at least one important particular, which may possibly be due to the confusion of two species.

A first group of observers, who described nests of "*V. cincta*" placed inside hollows, probably dealt with true *Vespa tropica*<sup>1</sup>). G. A. J. ROTHNEY (1903), in Barrackpore, Bengal, saw a nest, built in a large square flower-pot, which was added to year after year, the colony seemingly being perennial. According to J. C. KONINGSBERGER (1908; in Java, where *V. affinis* is not known) and W. S. BRISTOWE (1932; in Siam), *V. tropica* generally nests in hollow trees, occasionally in houses. H. MAXWELL-LEFROY and F. M. HOWLETT (1909) state that, in the plains of India, "It is found generally in thick forest. It makes its nests in the holes of big fig and other forest trees and has been observed to attack the nests of *Polistes hebraeus* and carry off the larvæ from the cells, the *Polistes* making no opposition." H. LUCAS (1891) describes the larva taken from a nest in Penang. W. S. BRISTOWE relates that both the Laos and the Siamese are very fond of the grubs of this hornet.

There are also accounts of aërial nests referred to "*V. cincta*" and it may be suggested that these observations were perhaps really based upon *Vespa affinis*, a form of which (var. *continentalis* J. BEQUAERT), homeochromic with typical *V. tropica*, is by no means rare in India. B. CHOPRA (1925) describes and figures an unusually large nest found attached to the stem of a small tree in a garden near Calcutta. It was fixed at a height of about 4 feet from

<sup>1</sup>) C. HORNE's (1870) account unfortunately is unreliable since it refers jointly to *V. orientalis* and *V. tropica*. He states that, in the North-West Provinces of India, these Hornets build „nests of prepared earth, strongly impregnated with some viscid substance, probably derived from the gum of a tree." The cells are regular hexagons and built from an hexagonal groundplan. The whole structure often reaches a large size and the outside is covered with a coating of loose paper. The nest is placed in some hollow, frequently in the mud walls of houses. The wasps work at night as well as during the day. The painful sting induces considerable inflammation and is believed sometimes to cause death. [*V. orientalis* is known often to mix clay with the paste for its cells; but the habit has not been recorded for *V. tropica*.]

the ground. It is said to have been first noticed in March, when it was quite small; in May it was the size of a man's head and toward the end of October of the same year it had attained its maximum size, about 109 cm in length and over 64 cm in greatest width near its base. It was perfectly pear-shaped, broadest below and gradually tapering to the upper end. It was principally attached near the base to the tree-trunk on one side, but it was also fixed to a fairly stout branch at the apex; while a number of small branches passing right through it gave it additional support. The outer envelope of papery material had the usual appearance of that of other Hornet nests, but was strong enough to withstand successfully the full force of the monsoon for a whole season. The nest was completely enclosed except for two nearly circular openings on the two sides near the base, both serving as entrance and exit. The inside of the nest is described as follows: "On breaking open the envelope on one side we see tiers of combs lying horizontally one above the other, and supported by short vertical pillars formed in between respective tiers. The combs consist of a very large number of cells and are the habitations of thousands of adults and young members of this vast colony. The lower three or four tiers of combs are seen to be full of larvæ and pupæ, while the upper ones which appear deserted, are evidently used by the adults. The cells housing the pupæ are covered at their mouths with silken caps. The combs are not attached to the envelope, but there is a large amount of space left between the two, so that access is available to each comb all round. The envelope, especially in its upper parts, is several layers thick, and in its structure contains a network of air-pockets which give the appearance of tunnel-like passages connecting the upper tiers with the general space round the basal combs" <sup>2)</sup>. J. CARL (1934) also records observing an aerial, openly exposed nest of "*V. cincta*", in the Nilgiris, southern India. When he found it in the dry and cool season (December), the envelope had suffered much from weathering. The nest contained nevertheless a few unaggressive wasps, mostly workers. According to CARL, this indicates a resting period in a perennial colony, a point which should be very carefully investigated. An earlier observation, by G. A. J. ROTHNEY (1877), also suggests that *V. tropica* or *V. affinis* may perhaps start a new nest either by several fecundated females, or queens, working in unison, or by a swarm consisting of a queen and a number of workers. He observed in Barrackpore, Bengal, a young nest of "*V. cincta*" started in a rose bush and attended by about seven wasps. M. MAINDRON's observations (quoted by R. DU BUYSSON, 1905) of large aerial nests of "*V. cincta*", which he saw near Menoekwari, in Mansinam Island, Doré Bay, N. New Guinea, almost certainly refer to one of the varieties of *V. affinis*. Moreover, R. DU BUYSSON (1905, p. 535, Pl. XIII) also describes and figures a large aerial nest of "*V. cincta* var. *affinis*", sent to the Paris Museum from Penang, Malacca. It was pear-shaped, 65 cm long

<sup>2)</sup> The figure of the nest with part of the envelope removed on one side, shows about nine tiers of cells in the lower, swollen half, while the narrower, upper half seems to be filled entirely with a sponge-like mass of paper layers and air-pockets. The purpose of this arrangement is not clear.

and 52 cm in greatest width, and contained twelve combs, some of the cells being differentiated for the rearing of queens. The pillars connecting the combs were oval or elliptic, not circular in cross-section. The nest, broadly fixed to a tree branch at the upper end, was built of brown paper, zoned with yellowish. The envelope was almost simple, remarkably thick, yet very fragile. At Padang, Sumatra, S. LEEFMANS (1922) observed two nests undoubtedly built by *V. affinis* (called by the author *V. cincta* var. *c*). One of these was placed inside the hollow wooden wall of a house and was not examined. The other, hung up in a citrus tree, was carefully studied. After being allowed to grow for several months, it had reached upon removal 35 cm in height and 25 cm in greatest width. At the upper end it was attached to three ramifications of a branch. The outer envelope, mostly of a whitish color, consisted of a number of paper layers, as many as five at the top, some partly fused. The outer layer formed a series of broad channels, never used by the wasps, but probably built for ventilation purposes. The one exit hole, measuring 3.5 by 5 cm, was placed laterally near the lower end. The nest contained five combs of cells measuring successively in diameter 8 cm (lowermost comb), 18 cm, 21 cm, 15 cm, and 10 cm (uppermost comb), the individual cells being 7 to 8 mm wide. The combs were connected by means of a number of paper pillars, in some cases fused into a wall with passage ways. From this nest 215 workers and 10 queens were taken. LEEFMANS' account is illustrated with three excellent photographs.

Heterochromy and Homeochromy. — Like most common and widespread structural species of Diploptera, both *V. tropica* and *V. affinis* exhibit a high degree of heterochromy. They vary from wholly or almost wholly black to extensively or mostly ferruginous and orange-yellow. Thus a number of color forms may be distinguished, some of which were at one time regarded as valid species. While some of these variations are well defined, others are connected by so many transitional specimens that their limits must needs be arbitrary. Usually, but by no means always, the better-marked color forms are more or less geographically segregated. Examples of such precinctive forms are: *V. tropica* var. *eulemoides* in the Andaman Islands; *V. tropica* var. *anthracina* and *V. tropica* var. *philippinensis* in the Philippines; *V. tropica* var. *loochooensis* in the Loo Choo Archipelago; *V. tropica* var. *haematodes*, *V. tropica* var. *ducalis* and *V. affinis* var. *continentalis* in southern Asia (from India to southern China); *V. tropica* var. *trisinata* in the Malay Archipelago; *V. tropica* var. *deusta* in the Philippines, Celebes, Moluccas and New Guinea; *V. affinis* var. *alduini* in the Moluccas, New Guinea and Bismarck Archipelago; *V. tropica* var. *soror* in Formosa, Southern China and Tonkin; *V. tropica* var. *pulchra* in Japan and northern China; *V. affinis* var. *hainanensis* in Hainan; and *V. affinis* var. *picea* in New Guinea. *V. tropica* var. *eulemoides* is the only form of the species known from the Andamans. In all other cases listed above, however, two or more of the color forms of the same structural species are found in the same area and often in the same locality, so that they are not, strictly speaking, "geographical races". To claim that in such cases the several

color forms of the same species are "ecologically" segregated, is a mere surmise which, with the data now available, could be neither proven nor disproven.

A few of the forms of *V. tropica* and *V. affinis* are homeochromic, superficially resembling each other. Such pairs of parallel variations are, for instance: *V. tropica* var. *haematodes* and *V. affinis* var. *continentalis*; and *V. tropica* var. *trisinata* and *V. affinis* var. *indosinensis*. In both these cases, the two members of each pair occur together over at least part of their range, so that there might be some justification for regarding them as "mimics". Homeochromy in some cases extends also to other insects. H. M. PENDLEBURY (1927) states that, in Malacca, "*V. cincta*" is "mimicked" by a syrphid fly, *Milesia vespoides* WALKER. In the Philippines, *V. tropica* var. *deusta* is homeochromic with *Sceliphron luzonensis* ROHWER, a peculiar color form of *Polistes tenebricosus*, *Eumenes pyriformis* var. *philippinensis* J. BEQUAERT, *Odynerus haemorrhoidalis* var. *ater* (H. DE SAUSSURE) and other wasps. Typical *V. tropica* is homeochromic with *Polistes tenebricosus* var. *hoplites* DE SAUSSURE.

### *Vespa tropica* (LINNAEUS).

Structural Characters. — *Queen and Worker.* — Head (Fig. 1A) moderately swollen behind the eyes, the outer orbit at its widest nearly one and one-half times the width of an eye in profile; occipital margin of vertex straight or very

slightly curved inward; oculo-malar space about the length of the fifth antennal segment; inter-antennal shield semi-elliptical, with bluntly keeled sides; inner orbits about as far apart at the clypeus as on the vertex. Ocelli of normal size, placed close together; the posterior pair about twice as far from the inner orbits as from each other. Clypeus coarsely punctate; anterior margin with a broad, arcuate, median excision, without even a trace of tooth in the middle; the apical edges narrow, bluntly triangular and somewhat bent up-

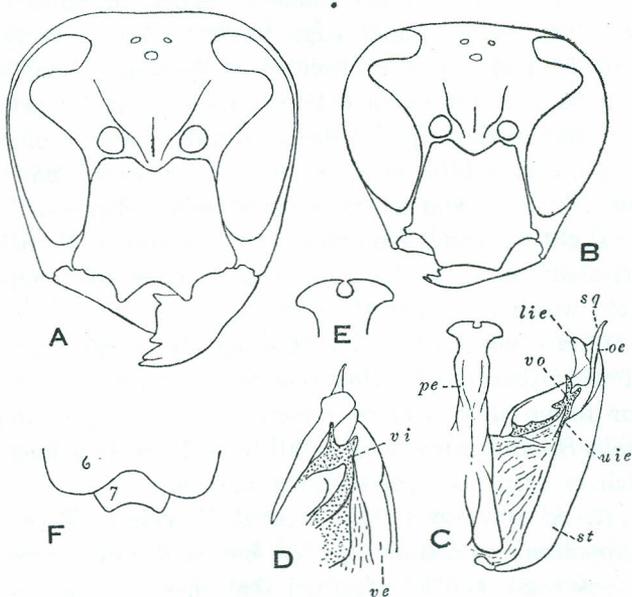


FIG. 1 — *Vespa tropica* (LINNAEUS): A, head of female; B, head of male; C, male genitalia from above (*ve*, valva externa; *st*, stipes; *oe*, outer edge; *uie*, upper or dorsal inner edge; *lie*, lower or ventral inner edge; *sq*, squama); D, inner view of apex of valva externa and interna; E, apex of penis; F, sixth and seventh abdominal sternites of male.

ward. Fore femora swollen, conspicuously flattened or slightly excavated beneath; the flattened area limited on the outer side by a strong, blunt ridge. Lower, vertical area of pronotum with strong, transverse ribs. Venation: first intercubitus more or less curved; third submarginal cell equally wide above and below, or slightly wider at the radius. Punctures of vertex and thorax of medium strength and rather sparse, the punctures smaller than the intervals; those of the abdomen very scattered. Body thickset; first abdominal tergite not or scarcely narrowed basad. Very large, the fore wing 20 to 30 mm long.

*Male.* — Like the female, except as follows. Oculo-malar space about half the length of the fourth antennal segment. Clypeus (Fig. 1B) about as long in the middle as wide; its sides nowhere touching the eyes, from which they are separated by exceedingly narrow extensions of the inner orbits; anterior margin almost straight, the apical edges bluntly rounded off. Tyloides on the under side of the antennæ rather low, absent on the third segment; fourth segment, as a rule, with only the basal tyloide distinct; thirteenth segment slightly longer than twelfth. Apex of sixth abdominal sternite (Fig. 1F) with a broad, semi-elliptical excision, rather variable in depth and with the edges curving gradually toward the sides of the hind margin. Seventh tergite straight or faintly curved inward at the apical margin. Apical edges of seventh sternite forming short and broad, rounded, slightly projecting lobes, connected by the slightly curved or almost straight hind margin. Genitalia (Fig. 1 C-E): outer edge of stipes (of valva externa) evenly rounded; upper (or dorsal) inner edge very obtuse; lower (or ventral) inner edge produced into a very broad lobe, irregularly rounded off at apex and provided on the ventral side with a prominent, oblique crest; squama (of valva externa) slender, acute, extending beyond the lower inner edge of the stipes; volsella of valva interna much shorter than the valva externa, deeply bifid at apex, the ventral branch narrow, digitiform, the dorsal branch broader and shorter; penis broad, depressed, the shaft parallel-sided, only slightly expanded in apical third; two apical branches broad, hatchet-shaped with sharp inner angles and arcuate outer edge, separated by a rectangular notch, which is deeper than wide.

I have not succeeded in finding structural characters, in female, worker, and male that would allow one to recognize several valid species among the color forms of *V. tropica* (*cincta* of authors), *V. deusta* LEPELETIER and *V. ducalis* SMITH. In my opinion, all these Hornets belong to one structural species, which is extremely polymorphic in color.

R. DU BUYSSON (1905) treated *V. cincta*, *V. deusta*, *V. ducalis* and *V. philippinensis* as distinct species; but he did not know the males of *deusta* and *philippinensis*, and he admitted that these two, at any rate, were perhaps not separable from his *V. cincta*. The male of *V. ducalis* he attempted to separate in his key. At couplet 3, the statement "6e sternite abdominal très profondément échancré" leads to *V. cincta*; the alternative, "6e sternite abdominal légèrement sinué", to *V. ducalis*. In the more detailed description of the male of *V. ducalis*, however, the 6th sternite is said to be "profondément échancré." Males of *V.*

*ducalis* I have seen have the terminal sternites of the abdomen like those of *V. tropica*.

The difference in the texture of the pilosity used by du Buysson as a specific character is, I believe, due to an illusion. All the several forms here grouped under *V. tropica* have, in addition to the erect, sparse pile, a dense covering of shorter, appressed pubescence. Over the black areas this is black and, in perfectly clean and fresh specimens has a velvety sheen. Over the orange or yellow areas, it is yellow and more or less golden.

Key to the Color Forms of *V. tropica*.\*

1. Thorax and abdomen wholly or almost wholly black; at most a narrow yellow line at the apex of the second, or more rarely of the first and second tergites; sternites wholly or almost wholly black. Head uniformly black ..... 2.  
 Thorax and abdomen, or abdomen only, extensively marked with yellow or orange-yellow; one or more of the tergites almost entirely of that color or with broad apical bands ..... 3.
2. Wings uniformly yellowish-russet, only slightly darker close to the costa  
     var. *deusta* LEPELETIER.  
 Wings very strongly infuscated (almost black) in the basal half; apical portion yellowish-russet ..... var. *anthracina* J. BEQUAERT.
3. Abdomen almost entirely orange-yellow; first tergite black or brownish-black, with a yellow apical fascia; head ferruginous; thorax black, blotched with ferruginous; wings infuscate basally, more yellowish apically ..... var. *eulemoides* R. DU BUYSSON.  
 Orange or yellow color of abdomen either restricted to some of the segments or forming transverse fasciæ ..... 4.
4. Broad yellowish brown apical fasciæ on tergites one to five, the sixth entirely of that color; basal yellowish-brown fasciæ, narrowly interrupted medially, on first and second tergites ..... var. *esaki* SONAN.  
 At least fifth and sixth tergites entirely black ..... 5.
5. First three or four abdominal tergites with yellow apical fasciæ or mostly orange-yellow. Wings rather uniformly yellowish-russet, darker toward base and along costa ..... 6.  
 Orange-yellow color of abdomen restricted dorsally to the second or first and second tergites ..... 9.
6. Head and thorax black; first three tergites mostly or extensively orange-yellow (rarely the fourth with apical fascia); sternites almost wholly black ..... var. *philippinensis* H. DE SAUSSURE.  
 Head mostly or wholly orange-yellow or ferruginous. Thorax more or less marked with yellow or ferruginous; some of the sternites margined with yellow ..... 7.
7. First and second tergites black with a broad apical yellow fascia; their base either entirely black or more or less ferruginous or orange-yellow,

in which case these tergites are tri-colored; third and sometimes fourth tergites with an apical yellow fascia; thorax without or with few pale markings; scutellum black or blotched with ferruginous.

var. *pulchra* (R. DU BUYSSON).

Second tergite bicolored, mostly ferruginous with a broad, yellow, apical fascia; rarely with a darker line faintly separating these two colors; thorax with rather extensive yellow or ferruginous markings; scutellum and postscutellum almost entirely of that color ..... 8.

8. Third tergite and sternite narrowly margined with yellow, the band of the tergite not reaching the sides. Horizontal face of first tergite usually ferruginous at base, broadly yellow at apex, rarely with an intervening black streak; rarely the base somewhat yellowish. var. *ducalis* SMITH.

Third tergite and sternite broadly margined with yellow, the bands of sternite and tergite meeting on the sides. Horizontal face of first tergite broadly yellow at base and apex, the intervening area ferruginous and divided by a narrow black band from the apical yellow area.

var. *lochooensis* J. BEQUAERT.

9. Head mostly or wholly orange-yellow or yellow or ferruginous; first and second tergites with orange or ferruginous base and a broad, apical, yellow fascia, the two separated by a narrow and often ill-defined or interrupted, black cross-band; second sternite yellow at apex and more or less blotched with ferruginous; thorax rather extensively yellow or ferruginous; scutellum and postscutellum often mostly orange-yellow; wings uniformly yellowish-russet ..... var. *soror* R. DU BUYSSON.

Head either entirely black or partly or wholly reddish; first and second tergites, or the second only, almost entirely and uniformly yellow or orange-yellow; wings conspicuously infuscated in basal half, yellowish-russet in apical portion ..... 10.

10. Only the second tergite and sternite mostly or wholly orange or orange-yellow; the first tergite rarely with small yellowish spots or narrow yellow border ..... 11.

In addition to the second segment, the first mostly orange-yellow (at least along the hind margin). Head, antennæ and thorax wholly or almost wholly black ..... var. *tresignata* PÉREZ.

11. Head, antennæ and thorax wholly or almost wholly black.

typical *V. tropica* (LINNAEUS).

Head and antennæ mostly dark blood-red or ferruginous; pronotum and scutellum usually more or less reddish or ferruginous.

var. *haematodes* J. BEQUAERT.

Distribution. — In its several color forms, the structural species *V. tropica* covers the entire Oriental and Indo-Malayan regions, from Ceylon, Bombay and Punjab, in the west, to Korea, southern Manchuria and Japan in the northeast, and to New Guinea and the New Britain Archipelago in the

south-east. It occurs in all the islands of the East Indian Archipelago, as well as in the Andamans. There are no reliable records from Australia and the Solomon Islands, where the Vespinae are apparently entirely lacking.

*V. tropica*, typical form.

*Sphex tropica* LINNAEUS, 1758, Syst. Nat., 10th Ed., I, p. 571 ("in Indiis"); 1764, Mus. Ludov. Ulricaee, p. 408; 1767, Syst. Nat., 12th Ed., I, pt. 2, p. 945; 1768, Iter in Chinam, p. 4; 1768, Amoenitates Academicae, VII, p. 501 (Java). SULZER, 1776, Abgek. Gesch. Ins., I, p. 192; II, p. 54, Pl. XXVII, fig. 5. GMELIN, 1790, in LINNAEUS' Syst. Nat., 13th Ed., I, pt. 5, p. 2730. G. SHAW, 1806, General Zoology, VI, pt. 2, Pl. XCIII\*, fig. "*tropica*".

*Vespa tropica* W. A. SCHULZ, 1912, Berlin. Ent. Zeitschr., LVII, p. 57 (♀ type).

*Vespa cincta* FABRICIUS, 1775, Syst. Entom., p. 362 (Malabar); 1781, Spec. Insect., I, p. 458; 1787, Mantissa Insect., I, p. 287. RÖMER, 1789, Genera Insect., p. 60, Pl. XXVII, fig. 5. GMELIN, 1790, in Linnaeus' Syst. Nat., 13th Ed., I, pt. 5, p. 2748. OLIVIER, 1791, Encyclop. Méthod., Insectes, VI, p. 676. FABRICIUS, 1793, Ent. Syst., II, p. 253. DONOVAN, 1800, Epitome Nat. Hist. Ins. India, Pl. LVII. FABRICIUS, 1804, Syst. Piezat., p. 253. JURINE, 1807, Nouv. Méthod. Class. Hym., p. 168 (♀). LATREILLE, 1809, Gen. Crust. Ins., IV, p. 142. LAMARCK, 1817, Hist. Nat. An. sans Vert., IV, p. 88; 1835, *Ibidem*, 2nd Ed., IV, p. 305. LEPELETIER, 1836, Hist. Nat. Ins. Hym., I, p. 505 (♀). BLANCHARD, 1840, Hist. Nat. Ins., III, p. 397, Pl. VI, fig. 6. WESTWOOD, 1842, in DONOVAN'S Nat. Hist. Ins. India, 2d Ed., p. 89, Pl. LVII, fig. 1. H. DE SAUSSURE, 1853-1855, Et. Fam. Vesp., II, p. 152 (♀). F. SMITH, 1857, Cat. Hym. Brit. Mus., V, p. 118; 1858, Jl. Proc. Linn. Soc. London, Zool., II, p. 116. HORNE, 1870, Trans. Zool. Soc. London, VII, pt. 3, p. 172. ROTHNEY, 1877, Ent. Mo. Mag., XIII, p. 254; 1877, *Ibidem*, XIV, p. 92. GRIBODO, 1884, Ann. Mus. Civ. Genova, XXI, p. 354 (♀). H. LUCAS, 1891, Ann. Soc. Ent. France, LX, Bull. Séances, p. cxviii. DALLA TORRE, 1894, Cat. Hym., IX, p. 140. BINGHAM, 1897, Fauna Brit. India, Hym., I, p. 402, fig. 125 (♀). CAMERON, 1901, Proc. Zool. Soc. London, II, p. 29; 1904, Jl. Straits Br. R. Asiat. Soc., XLI, p. 120. ROTHNEY, 1903, Trans. Ent. Soc. London, pp. 107 and 114. DALLA TORRE, 1904, Gen. Insect., Vespidae, p. 64. ASHMEAD, 1904, Proc. U. S. Nat. Mus., XXVIII, p. 151. R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 3, pp. 490, 495 and 530 (♀ ♂ ♂), Pl. V, fig. 8. CAMERON, 1905, Tijdschr. v. Entom., XLVIII, p. 67. KONINGSBERGER, 1908, Tweede Overzicht Schadel. Nuttige Ins. Java, p. 101. KUROIWA, 1908, Prov. List Hym. Coll. Loochoo, p. 6. MAXWELL-LEFROY and HOWLETT, 1909, Indian Insect Life, p. 216. MATSUMURA and UCHIDA, 1926, Insecta Matsumurana, I, pt. 1, p. 33. PENDLEBURY, 1927, Proc. Ent. Soc. London, I, pt. 3, p. 39. J. BEQUAERT, 1928, Bull. Brooklyn Ent. Soc., XXIII, p. 61. A. v. SCHULTHESS, 1932, Mém. Mus. R. Hist. Nat. Belgique, Hors Série, IV, pt. 5, p. 38. BRISTOWE, 1932, Trans. Ent. Soc. London, LXXX, p. 403. CARL, 1934, Rev. Suisse Zool., XLI, p. 683. A. v. SCHULTHESS, 1935, Rev. Suisse Zool., XLII, p. 298. Not *Vespa cincta* DEGEER, 1773, nor of DRURY, 1773<sup>3)</sup>.

*Vespa crabro cincta* CHRIST, 1791, Naturgesch. d. Insect., p. 219.

*Vespa crabro tenebrionis* CHRIST, 1791, Naturgesch. d. Insect., p. 216, Pl. XVIII, fig. 4 (without locality).

<sup>3)</sup> The references here listed under *V. cincta* undoubtedly refer in part to some of the varieties of *V. tropica* or even of *V. affinis*. It seems impossible to sort out those that were only based on the typical form of the species.

The typical form of *V. tropica* occurs over much of the Oriental and Indo-Malayan regions, from India to southern China and the Loo Choo Islands and in the Malay Archipelago as far east as Lombok and Amboina. I can find no reliable record from New Guinea, although the var. *tresignata* occurs there. The specimen seen by R. DU BUYSSON from "Nouvelle-Hollande" must have been wrongly labelled, since no species of *Vespa* is known to occur in Australia. I also attribute to erroneous labelling DU BUYSSON'S records from Brazil and Peru. So far as I know, local students of wasps (such as H. and R. VON IHERING, A. DUCKE, SCHROTKY, DE WINKELRIED BERTONI, etc.) never observed any species of *Vespa* in South America.

I have seen many specimens of typical *tropica* from Tenasserim, Assam, Sikkim, Tonkin, Indo-China, Siam, Penang, Sumatra (Penda Siroen, Soengai Maroewai, 1 ♀, Prince Leopold of Belgium, May 13, 1931; etc.), Nias, Banka, Billiton, Java, Madoera, Lombok and Borneo. It is particularly common in Sumatra, Java and Borneo. I have seen two specimens from the Soeloe (or Jolo) Archipelago (Doedahoe, Jolo Id.; and Bungao Id.); but this form is unknown from the Philippines proper.

W. A. SCHULZ, who examined LINNAEUS' type of *Sphex tropica* at the Zoological Museum in the University of Upsala, found that it was a female of the Hornet generally called *V. cincta* FABRICIUS, and not a Psammocharid, as DAHLBOM believed evidently through a confusion with *Sphex tropica* FABRICIUS. Moreover, the species is clearly recognizable from LINNAEUS' more detailed description in Mus. Ludov. Ulricæ (1764), which mentions, for instance, "corpus magnitudine crabronis.... Oculi lunati.... Antennæ subclavatæ." In a later work (1768), LINNAEUS even states that his *Sphex tropica* has "alae complicatae Vespæ." The description of 1764 also leaves no doubt as to which color form must be regarded as typical for the species, since it reads: "Caput atrum.... Thorax niger.... Abdomen nigrum.... Segmentum secundum.... ferrugineum supra et infra." Both SULZER (1776) and SHAW (1806) figure a Hornet as "*Sphex tropica*"; but P. L. MÜLLER'S figure of that name is a Psammocharid (1790, in LINNAEUS' Vollst. Natursyst., V, pt. 2, p. 872, Pl. XXVI, fig. 16).

*Sphex tropica* FABRICIUS (1775, Syst. Entom., p. 350. — America) is not LINNAEUS' species. As shown by the type in the University Museum at Kiel, it is an American Psammocharid, which, Mr. N. BANKS tells me, has not yet been properly recognized. In any case, this insect will have to be renamed, according to the rules. FABRICIUS' species is figured by P. L. MÜLLER (1790) as *Sphex tropica* (see above).

#### *V. tropica* var. *haematodes*, new variety.

*Female, Worker and Male.* — Agrees in most respects with *V. tropica*, except that head and antennæ are mostly or entirely dark blood-red or ferruginous; pronotum dorsally and scutellum ferruginous or reddish; mesonotum anteriorly as a rule with two short, ferruginous lines or triangular spots; legs also often

partly reddish-brown; in some specimens the apex of the first tergite is very narrowly yellow.

**Specimens Examined.** — INDIA: Kooloo, one female *holotype* and one female paratype (M. M. CARLETON — M.C.Z.); Amballa, one female paratype (M. M. CARLETON — M.C.Z.); Lahore, two female paratypes (BruX. M.); Tranquebar (Berl. M.); Arrarabad (Berl. M.); Basin of the Beas River, Sub-Himalayas, one female paratype (M. M. CARLETON — M.C.Z.). — CEYLON: Nalanda, two female paratypes (W. HORN — M.C.Z. and D.E.I.). — BURMA: Pegu, one female paratype (C. H. CARPENTER — M.C.Z.). — SIKKIM: (Berl. M.). — ANNAM: (Berl. M.). — CHINA: three female paratypes and one male *allotype*, without more definite locality (M.C.Z.); Amoy, one worker and three female paratypes (BUDDING — Leid. M.); Pingshiang, Kiangsi, one female paratype (M.C.Z.); Canton (Berl. M.); Hainan (Berl. M.); Ta Hian, Hainan; Dwa Bi, Hainan; Liamui, Hainan; Ta Hau, Hainan (all J. L. GRESSITT — M.C.Z.).

I suspect that FABRICIUS' (1775) description of *V. cincta* was based upon a specimen of the var. *haematodes*, since he says "Thorax niger, maculis duabus utrinque ante alas scutelloque obscuris" and "antennis fuscis." He describes the head as "nigrum", but may well have overlooked the blood-red color. FABRICIUS' name is not available for this variety in any case, since it is pre-occupied by *Vespa cincta* DRURY, 1773, and *Vespa cincta* DEGEER, 1773. The variety "minor thorace immaculato", supposedly from the Cape of Good Hope (by error), mentioned by FABRICIUS, is now in the Banksian Collection, at the British Museum. When I saw it, some years ago, I referred it to typical *V. tropica*; but I was not aware then of the true characters of the species, and the specimen may well have been *V. affinis* var. *alduini* GUÉRIN.

The var. *haematodes* is connected with typical *tropica* by individuals in which the thorax is completely black, but the head has a few ferruginous blotches. Such specimens I have seen from Hanoi, Indo-China (where the typical form appears to be more common), southern China and Siam.

### *V. tropica* var. *tresignata* PÉREZ.

*Vespa affinis* var. *tresignata* PÉREZ, 1910, Actes Soc. Linn. Bordeaux, LXIV, p. 8 (8 ♀; Timor).

This form was described as follows: "First segment wholly black anteriorly and on the sides; the dorsal yellow area of first tergite ragged on the sides and cut by three small black lines, one anterior and median, the other two lateral and transverse." One female from New Guinea fits this description perfectly. In other specimens from the same region the black side markings, cutting the yellow area of the first tergite, are much reduced and the median black line is lacking. This leads to specimens having the first tergite almost wholly orange-yellow, except for the black base. At the other extreme of variation, forming the passage to typical *V. tropica*, is the form from the Banda Islands, which PÉREZ described (but did not name) as follows (1910, *Ibidem*,

p. 8): "The yellow of the first tergite reduced to an apical band, shortened and narrowed on the sides; that of the second segment broadly sinuate anteriorly, shortened on the sides, and provided on each side with a small black, transverse spot, as is seen, more or less vaguely, in the other varieties." This form is homeochromic with *V. affinis* var. *continentalis* and is perhaps worthy of a name. In all specimens of *tresignata* seen, head, antennæ, thorax and legs are uniformly black.

Specimens Examined. — SUMATRA: (Berl. M.). — NIAS: (Berl. M.). — JAVA: (Berl. M.). — SOEMBA: (Berl. M.). — TIMOR: (Berl. M.; Leid. M.). — WETTER ISLAND: (SCHÄDLER — Leid. M.). — BORNEO: (Leid. M.). — CELEBES: Makassar (M.C.Z.); Latimodjong Mts., Bontoe Batoe District, 4500 to 6500 ft. (C. F. CLAGG — M.C.Z.); Tondano-Menado (VAN BRAEKEL — BRUX. Mus.); Soemlata (SCHRÖDER — Leid. M.); Gorontalo (ROSENBERG — Leid. M.); Tomohon (BERRENDSEN — Leid. M.). SALAYER ISLAND (Berl. M.). — BANDA: (ROSENBERG — Leid. M.). — AMBOINA: Haroeko (HOEDT — Leid. M.). — HALMAHERA: Ternate (BERNSTEIN — Leid. M.). — BATJAN: (BERNSTEIN — Leid. M.). — CERAM: (Berl. M.); Manipo (HOEDT — Leid. M.). — OBI: (BERNSTEIN — Leid. M.). — WAIKOE: (BERNSTEIN — Leid. M.). — AROE: (ROSENBERG — Leid. M.). — NEW GUINEA: Fakfak (PALMER — Leid. Mus.); Sakoemi (Prince LEOPOLD of Belgium — BRUX. M.); Bongu, K. Wilhelmsland (U.S.N.M.); Arfak Mts. (Berl. M.); Mt. Misim, Morobe District (H. STEVENS — M.C.Z.). — YULE ISLAND: (M.C.Z.). — NEW BRITAIN: (Berl. M.). — NEW POMERANIA: (Berl. M.).

Additional specimens. — SOEMBA: Kananggar and Kambera, 4-700 m (E. & NE. Soemba), Laora, 100 m (N.W. Soemba) (K. W. DAMMERMAN — Buit. M.). — N. CELEBES: 1908 (Buit. M.). — N. CERAM: Koea River, Taloearang (DENIN — Buit. M.). — NEW GUINEA: Mamberamo River, Pionierbivak (W. C. VAN HEURN — Buit. M.).

Specimens named "*V. affinis*" or "*V. cincta* var. *affinis*" in collections, are either true *V. affinis* (LINNAEUS) or *V. tropica* var. *tresignata*, these two forms having been steadily confused. Many of the published records of "*V. affinis*" were undoubtedly based upon specimens of the var. *tresignata*. This is, for instance, the case for the wasps from Sakoemi, New Guinea, recorded by A. v. SCHULTHESS (1932) as *V. cincta* subsp. *affinis*, which I have seen at the Brussels Museum.

### *V. tropica* var. *eulemoides* R. DU BUYSSON.

*Vespa eulemoides* R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 3, pp. 491 and 530 (♂?; Port Blair, Andaman Islands).

Specimens Examined. — ANDAMAN ISLANDS, sixteen females and workers (BINGHAM — Berl. M.).

This wasp, peculiar to the Andamans, is an extreme xanthic color form of *V. tropica*, connected with the var. *affinis* by means of the var. *philippinensis*.

***V. tropica* var. *deusta* LEPELETIER.**

*Vespa deusta* LEPELETIER, 1836, Hist. Nat. Ins. Hym., I, p. 506 (♂; locality unknown).

H. DE SAUSSURE, 1853-1855, Et. Fam. Vesp., II, p. 149 (♀). F. SMITH, 1857, Cat. Hym. Brit. Mus., V, p. 121. KIRSCH, 1878, Mitth. Zool. Mus. Dresden, III, p. 381 (♂ ♀). DALLA TORRE, 1894, Cat. Hym., IX, p. 145; 1904, Gen. Insect., Vespidae, p. 65. ASHMEAD, 1904, Proc. U.S. Nat. Mus., XXVIII, p. 151. R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 3, pp. 489 and 528 (♂ ♀). MEADE-WALDO, 1915, Repts. Brit. Ornithol. Union Exp. Dutch New Guinea, I, pt. X, p. 15 (♀). F. X. WILLIAMS, 1919, Hawaiian Sugar Planters' Assoc. Expt. Sta., Ent. Ser., Bull. No. 14, p. 165, fig. 95 (♀); 1928, Philippinê Jl. Sci., XXXV, p. 78<sup>4</sup>).

*Vespa unicolor* F. SMITH, 1863, Jl. Proc. Linn. Soc. London, Zool., VII, p. 44 (♀; Boeroe).

DALLA TORRE, 1894, Cat. Hym., IX, p. 157; 1904, Gen. Insect., Vespidae, p. 66. R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 4, p. 620.

Specimens Examined. — PHILIPPINE ISLANDS: Manila (R. C. Mc GREGOR — M.C.Z.; Berl. M.); Los Baños, Luzon (Phil. Agri.; Phil. B. Sci.); Mt. Maquiling, up to 1000 m, Luzon (Phil. Agri.); Mt. Banahao, Laguna, Luzon (Phil. B. Sci.); Rizal, Novaliches, Luzon (W. SCHULTZE — Phil. B. Sci.); Calapan, Mindoro (P. DE MESA — M.C.Z.); Lubang (P. DE MESA — M.C.Z.); Mindanao (BRUX. M.); Mt. Halcon, Mindoro (E. D. MERRILL — Phil. B. Sci.); Puerto Galera, Mindoro (S. M. CENDAÑA — Phil. Agri.); San Juan, La Union, Luzon (J. FONTANILLA — Phil. Agri.); Zamboanga, Mindanao (M.C.Z.); Bayombong, Luzon (Phil. Agri.). — BOEROE: (HOEDT and BERNSTEIN — Leid. M.).

Additional specimens. — BOEROE: (DENIN — Buit. Mus.); Kajeli Bay (ZADELHOFF 1928 — Buit. Mus.).

This variety is known from the Philippines, Celebes, Boeroe Island (one of the Moluccas) and Dutch New Guinea (Setakwa River; recorded by MEADE-WALDO). R. DU BUYSSON's record from Sumatra appears to me open to doubt.

The queens and males usually have narrow yellow apical margins on the first and second tergites, or on the second only; these margins are often lacking in the workers.

*V. unicolor* is identical with *deusta*, which I have seen from Boeroe. SMITH's description agrees with my specimens of *deusta* and Dr. J. VAN DER VECHT, who recently saw SMITH's type at the Oxford University Museum, writes me that it is a uniformly black form of *V. tropica*. It should be noted that SMITH did not compare *unicolor* with true *deusta*. He states that in *deusta*, "the eyes extend to the base of the mandibles", which is erroneous.

***V. tropica* var. *anthracina*, new variety.**

*Female, Worker and Male.* — This form is much like the var. *deusta* in appearance, but differs strikingly in the color of the wings, which are blackish-brown to black in the basal two-thirds, ferruginous-subhyaline in the apical third, the two areas gradually fusing. In addition, the body is, as a rule, wholly

<sup>4</sup>) Some of the references listed for *deusta* may have been based in part upon specimens of the var. *anthracina*.

black, although exceptionally there are two short, orange lines along the apical margin of the second tergite. Two females, at the Berlin Museum and the M.C.Z., have not only an apical band, but also two small orange transverse spots on the second tergite and the second sternite spotted.

**Specimens Examined.** — PHILIPPINE ISLANDS: Sibuyan, one worker *holotype*, one worker paratype, and one male, *allotype* (F. C. BAKER — U.S. N.M.); Puerto Princesa, Palawan, worker paratypes (R. C. MCGREGOR — U.S.N.M.; Phil. B. Sci.; M.C.Z.); Palawan, one female paratype (DOHERTY — Berl. M.); Palawan-Backuit, three worker paratypes (Prince LEOPOLD of Belgium — Brux. M.); Mindanao, worker paratypes (U.S.N.M.); Zamboanga, Mindanao, queen and worker paratypes (U.S.N.M.) M.C.Z.); Dapitan, Mindanao, worker paratypes (U.S.N.M.); Surigao, Mindanao, two worker paratypes (F. C. BAKER — U.S.N.M.); Calian, Davao Prov., Mindanao, three queen paratypes (C. F. CLAGG — M.C.Z.); Lawa, Davao Prov., Mindanao, one queen paratype (C. F. CLAGG — M.C.Z.); Culasi, Panay, one female paratype (MCGREGOR); two female paratypes, without more definite locality (Brux. M.).

At the U. S. National Museum I found, in the F. C. BAKER Collection, many specimens of this form placed under the MS name "*Vespa deusta* var. *anthracina* GRIBODO." This name I have retained because most likely it was used in GRIBODO's collection and may have been distributed by him to other Museums.

The var. *anthracina* is known only from the Philippines, where it appears to be as common as the var. *deusta*, with which it has been thus far confused.

#### *V. tropica* var. *philippinensis* H. DE SAUSSURE.

*Vespa philippinensis* H. DE SAUSSURE, 1853-1855, Et. Fam. Vesp., II, p. 148 (♂; Philippines). F. SMITH, 1860, Jl. Proc. Linn. Soc. London, Zool., V, p. 131; 1863, *Ibidem*, VII, p. 44. DALLA TORRE, 1894, Cat. Hym., IX, p. 152; 1904, Gen. Insect., Vespidae, p. 65. R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 3, pp. 489 and 529 (♀).

**Specimens Examined.** — PHILIPPINE ISLANDS: Surigao, Mindanao, one worker and one male (F. C. BAKER — U.S.N.M.); Ubay, one female (SEMPER — Par. M.); Luzon, one female (Berl. M.); Mauo River, Samar Island (Prince LEOPOLD of Belgium — Brux. M.); Samar Island (F. C. BAKER); Oquendo, Samar Id. (Phil. B. Sci.); Negros (Prince LEOPOLD of Belgium — Brux. M.); Canlawan, Negros, one female and one male (C. S. BANKS — Phil. B. Sci.); Maa, Negros Occidental (C. S. BANKS — Phil. B. Sci.); Los Baños, Luzon (C. P. DOLORES — Phil. B. Sci.).

This form is widespread in the Philippines, but apparently rather rare. SMITH's (1860 and 1863) records from Boeroe and Amboina need confirmation.

#### *V. tropica* var. *ducalis* F. SMITH.

*Vespa ducalis* F. SMITH, 1852, Trans. Ent. Soc. London, (2) II, p. 39 (♂ ♀ ♂; Tein-tung naar Ning-po-foo, China). H. DE SAUSSURE, 1853-1855, Et. Fam. Vesp., II, p. 151 (♂ ♀ ♂). F. SMITH, 1857, Cat. Hym. Brit. Mus., V, p. 121; 1872, Trans.

Ent. Soc. London, pt. 2, p. 197. DALLA TORRE, 1894, *Cat. Hym.*, IX, p. 145. BINGHAM, 1897, *Fauna Brit. India, Hym.*, I, p. 401 (♀♂). R. DU BUYSSON, 1903, *Bull. Mus. Hist. Nat. Paris*, IX, p. 127. DALLA TORRE, 1904, *Gen. Insect., Vespidæ*, p. 65. R. DU BUYSSON, 1905, *Ann. Soc. Ent. France*, LXXIII, (1904), pt. 3, pp. 518 and 627 (♀♂), Pl. XIII (nest). MAXWELL-LÉFROY and HOWLETT, 1909, *Indian Insect Life*, p. 216.

Specimens Examined. — CHINA: Tsing-Tau (Berl. M.); Canton (Berl. M.); Hongkong (Berl. M.); Yen-Ping, one female, Tcheng-Ting-Fou, Tche-ly, one worker; Foochow, one female (C. R. KELLOGG — M.C.Z.); Ping-shiang, Kiangsi (KREYENBERG); southeastern Ngan-Hoei (Par. M.); Tse-Kou, Yunnan (Par. M.). — SIAM: (Par. M.). — SIKKIM: (Berl. M.).

Originally described from southern China (not northern China as erroneously given by SMITH), this form has also been recorded from northern India (Nepaul, Assam), Burma, Siam and Tonkin.

Published records of "*ducalis*" from Formosa were based upon specimens of the var. *soror* R. DU BUYSSON; those from Japan, northern China and Manchuria are referable to the var. *pulchra* R. DU BUYSSON, and those from the Loo-Choo Islands to the var. *lochooensis* J. BEQUAERT.

An aberrant specimen from Sikkim, at the Berlin Museum, has the first tergite ferruginous anteriorly, black in the middle, and narrowly yellow at apex; the second tergite is broadly yellow at apex, otherwise black with a dull russet band broadly interrupted in the middle; the third tergite has an apical yellow band. Other specimens from Sikkim have the more usual *ducalis* color markings.

#### *V. tropica* var. *lochooensis*, new variety.

*Vespa ducalis* KUROIWA, 1908, *Prov. List Hym. Coll. Loochoo*, p. 6. Not of F. SMITH, 1852.

*Female or Worker.* — Head mostly dull yellow, with most of the mandibles and a broad, diffuse spot on the frons near the ocelli, chestnut-brown; the apical portion of the mandibles black. Antennæ chestnut-brown, the scape yellow beneath. Thorax black; prothorax, tegulæ and scutellum blotched with ferruginous-brown; anterior edge of pronotum and postscutellum yellow, the hind part of the scutellum also somewhat yellowish. First abdominal segment ferruginous, the horizontal portion of the tergite broadly yellow at the base, then with a ferruginous cross-band, broadly yellow at apex, the apical yellow portion separated from the ferruginous area by a narrow blackish streak which does not reach the sides and is more or less divided in the middle. Second segment with basal two-thirds ferruginous, apical third yellow; no intervening black area. Third segment black with a broad and continuous yellow apical fascia. Succeeding segments black, the fourth sternite with a narrow, more or less distinct, apical yellowish band. Legs brownish-black, blotched with ferruginous, the fore tibiæ yellowish on the outer side. Wings as in the var. *ducalis*.

**Specimens Examined.** — JAPAN: Saitama, Konshu, one female (T. FUKAI); Kanagawa, one worker and one male; Oshima Island, one female (S. YAMAMOTO); Tottori, Konshu, one female (S. YAMAMOTO); Tokio (L. GRESSITT — M.C.Z.); Kofou (Par. M.); Yokohama, cotypes (Par. M.). — CHINA: Tche-ly (Par. M.). — MANCHURIA: two workers sent by K. YASUMATSU.

The var. *pulchra* is distributed over Japan, Korea, Manchuria, northern China and the Ussuri district of eastern Siberia. It varies much in the extent of yellow on the four anterior tergites, especially that of the fourth which may be entirely black or have a very narrow or a rather broad apical fascia. One specimen, from Tokyo, has the bases of first and second tergites entirely black; usually, though, these bases bear an orange or ferruginous-yellow fascia, which is sometimes interrupted in the middle. SONAN's *V. matsumurai* hardly differs from DU BUYSSON's Japanese specimens of *pulchra*.

### *V. tropica* var. *esakii* SONAN.

*Vespa esakii* SONAN, 1925, Trans. Nat. Hist. Soc. Formosa, XXV, p. 371, figs. 4-6 (♀; Izuhara in Tsushima Islands, between Japan and Korea).

This form, known only from the type locality, is evidently very closely related to the var. *pulchra*, from which it differs only in having an orange apical fascia on the fifth tergite also and the sixth tergite entirely of that color. I have not seen it; but the description leaves little doubt that it is a color form of *V. tropica*. It is homeochromic with *V. mandarinia* var. *magnifica* SMITH.

### *Vespa affinis* (LINNAEUS).

**Structural Characters.** — *Queen and Worker.* — Oculo-malar space (Fig. 2A) about half the length of the sixth antennal segment; inter-antennal shield triangular, with more sharply keeled sides. Posterior ocelli about one and one-half times as far from the inner orbits as from each other. Anterior margin of clypeus with a rather narrow but deep, arcuate, median excision; the apical edges low, very broad, evenly arcuate, passing gradually into the median excision, but ending abruptly on the outer side. Fore femora swollen, but not conspicuously flattened beneath and without strong, blunt ridge on the outer side.

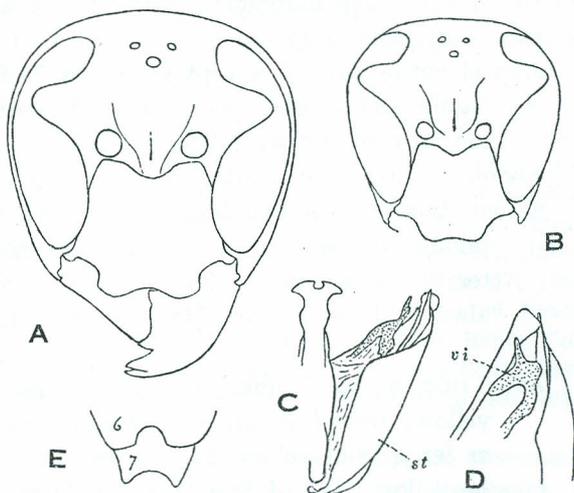


Fig. 2. — *Vespa affinis* (LINNAEUS); A, head of female; B, head of male; C, male genitalia from above (lettering as in Fig. 1); D, inner view of apex of valva externa and interna; E, sixth and seventh abdominal sternites of male.

Venation: first intercubitus usually straight. Punctures of vertex, thorax and abdomen of medium strength, but very close together, producing a more coarsely granulose sculpture (the contrast with *V. tropica* is especially sharp on propodeum and postscutellum). Body more slender, the first abdominal tergite markedly narrowed basad. Smaller, the fore wing 15 to 23 mm long. The remainder as in *V. tropica*.

*Male*. — Oculo-malar space (Fig. 2B) about one-half the length of the seventh antennal segment. Clypeus slightly wider than long; its sides touching the eyes over about the lower half; anterior margin slightly curved inward (more so than in *V. tropica*), the apical edges very broadly rounded off. Tyloides on the under side of antennæ quite pronounced; a pair present on fourth segment; third segment also with a tyloide near apex; thirteenth segment hardly or not longer than twelfth. Sixth abdominal sternite (Fig. 2E) at apex with a rather narrow, semi-circular excision, the edges of which form sharp angles with the sides of the hind margin. Seventh tergite with a short, sharp, median, apical notch. Apical edges of seventh sternite much produced, bluntly triangular, the hind margin forming a deep, even, bow-like inward curve. Genitalia (Fig. 2C-D) essentially as in *V. tropica*, the slight differences shown in the drawings being largely due to the different position and spreading of the parts; squama short, acute, barely extending beyond the lower inner edge of the stipes; volsella of valva interna not bifid, ending ventrally in a narrow, digitiform lobe, dorsally in a blunt angle; penis shaped much as in *V. tropica*, but the shaft relatively shorter and slightly expanded in its apical third.

*V. affinis* is almost as variable in color as *V. tropica*. Names are available for four of the six color forms recognized in the subjoined key. All forms are rather poorly defined and connected by transitional specimens; and some are perhaps only extreme individual variations, in which case they should not be recognized in nomenclature.

1. Almost entirely black, except for a few ferruginous blotches on head and tegulæ and a small, poorly defined ferruginous spot on each side near the base of the second tergite ..... var. *picea* R. DU BUYSSON.  
Abdomen extensively marked with orange-yellow ..... 2.
2. Second tergite with two large, orange-yellow spots, which touch on the middle line or tend to fuse and are often blotched with brown; first tergite either wholly black or more or less orange-yellow basally, always black at apex. Head more or less ferruginous. Thorax black.  
var. *alduini* GUÉRIN.  
As a rule, at least apical margin of first tergite marked with orange-yellow; second tergite and sternite entirely or mostly orange-yellow or ferruginous-yellow; rarely also the third tergite of that color ... 3.
3. Orange-yellow color of first tergite reduced to a narrow apical margin or almost lacking; remainder of first tergite either black or slightly dull ferruginous. Head black or ferruginous. Thorax and legs black or reddish ..... var. *continentalis* J. BEQUAERT.

- First tergite extensively orange-yellow; the base bright ferruginous-red or black ..... 4.
4. Thorax wholly black or with very faint ferruginous blotches on the pronotum. Head black or more or less dull ferruginous. Legs mostly black.  
var. *indosinensis* PÉREZ.
- Head and antennæ mostly bright ferruginous-red; mesonotum either black or blotched with ferruginous ..... 5.
5. Only first and second tergites orange-yellow; usually base of first extensively ferruginous ..... typical *V. affinis* (LINNAEUS).  
Third tergite also extensively orange-yellow. var. *hainanensis* J. BEQUAERT.

Distribution. — The structural species *V. affinis* appears to occur throughout most of southern Asia and the Malay Archipelago, though not as widely as *V. tropica*. It is known definitely from western India (Mangalore; Bombay; Calcutta; Himalaya) and Ceylon in the west, to Central China (Kiangsi and Fokien), Formosa and the Loo-Choo Islands in the northeast, and to New Guinea in the southeast. It does not, however, occur in all the East Indian islands. As was pointed out to me by Dr. J. VAN DER VECHT, it is unknown in Java. It does not reach Japan.

*V. affinis*, typical form.

- Apis affinis* LINNAEUS, 1764, Mus. Ludov. Ulricae, p. 417 ("In calidis regionibus").  
DALLA TORRE, 1896, Cat. Hym., X, p. 586.
- Vespa affinis* FABRICIUS, 1787, Mantissa Insect., I, p. 287 (China; described as a new species). GMELIN, 1790, in Linnaeus' Syst. Nat., 13th Ed., I, pt. 5, p. 2748. OLIVIER, 1791, Encyclop. Méthod., Insectes, VI, p. 677. FABRICIUS, 1793, Entom. Syst., II, p. 253; 1804, Syst. Piezat., p. 254. LATREILLE, 1806, Gen. Crust. Ins., IV, p. 142, JURINE, 1807, Nouv. Méth. Class. Hym., p. 168 (♀♂). LEPELETIER, 1836, Hist. Nat. Ins. Hym., I, p. 506 (♀). H. DE SAUSSURE, 1853-1855, Et. Fam. Vesp., II, p. 154. F. SMITH, 1857, Cat. Hym. Brit. Mus., V, p. 118; 1857, Jl. Proc. Linn. Soc. London, Zool., II, p. 116; 1858, *Ibidem*, III, p. 23; 1861, *Ibidem* VI, p. 59; 1863, *Ibidem*, VII, p. 43; 1865, *Ibidem*, VIII, p. 89. GRIBODO, 1884, Ann. Mus. Civ. Genova, XXI, p. 355 (♀). DALLA TORRE, 1894, Cat. Hym., IX, p. 136. CAMERON, 1901, Proc. Zool. Soc. London, I, p. 241. ROTHNEY, 1903, Trans. Ent. Soc. London, p. 107. W. A. SCHULZ, 1912, Berlin. Ent. Zeitschr., LVII, p. 57 (type).
- Vespa cincta* var. *affinis* R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 3, p. 534 (♀♂♂). CAMERON, 1905, Tijdschr. v. Entom., XLVIII, p. 67; 1906, Nova Guinea, V, Zool., pt. 1, p. 59; 1911, *Ibidem*, IX, Zool., pt. 2, p. 186. PÉREZ, 1910, Actes Soc. Linn. Bordeaux, LXIV, p. 7. MEADE-WALDO, 1915, Repts. Coll. Brit. Ornith. Union Exp. Dutch New Guinea, I, pt. X, p. 15. A. v. SCHULTHESS, 1932, Mém. Mus. R. Hist. Nat. Belgique, Hors Série, IV, pt. 5, p. 38; 1935, Rev. Suisse Zool., XLII, p. 298.
- Vespa formosana* SONAN, 1927, Trans. Nat. Hist. Soc. Formosa, XVII, p. 125 (Formosa); 1929, *Ibidem*, XIX, pp. 137 and 145 (♀♂♂). ESAKI, 1932, Iconogr. Insect. Japon., p. 304, fig. (♀).
- Vespa bicolor* MATSUMURA, 1911, Thousand Insects of Japan, Suppl. III, p. 103, Pl. XXXVIII, fig. 12. Not of FABRICIUS 1787.
- Vespa cincta* var. *c* LEEFMANS, 1922, De Tropische Natuur, XI, p. 125, figs. 1-4 and 6-8 (nest).

Some of the foregoing references cover also specimens of the var. *indosinensis* PÉREZ; while others were based, in part at any rate, upon specimens of *V. tropica* var. *tresignata* PÉREZ, which in color resembles typical *V. affinis* and its var. *indosinensis*.

Specimens Examined. — CHINA: Pingshiang, Kiangsi (KREYENBERG); Loh Hong (C. W. HOWARD); Canton (C. W. HOWARD); Paak Shui Kong (C. W. HOWARD); White Cloud (C. W. HOWARD); Amoy (S. F. LIGHT); Kaichek, Hainan (C. F. LIGHT); Foochow (GIST GEE and C. R. KELLOGG); Hainan Island (2 miles S.W. of Nodoo, June 28, 1929; S. of Nodoo, July 9, 1929; and Woh-Hau-Chuen, E. of Nodoo, July 3, 1929 (W. E. HOFFMANN). — LIAMUI; Ta Hau; Ta Hian; Dome Mt.; Hoihow; Dwa Bi; Nodoo (J. L. GRESSITT). — FORMOSA: Takao (SAUTER — Leid. M.); Hu Sia. — LOO CHOO ARCHIPELAGO: Iriomote Island (L. GRESSITT). — CEYLON: (W. McM. WOODWORTH). — INDIA: Calcutta (BRUNETTI); Himalaya (FELDER — Leid. M.). — NORTHERN SUMATRA: (G. FAIRCHILD). — BORNEO: Balikpapan (Prince LEOPOLD of Belgium. — BRUX. M.). — CELEBES: Toli-Toli (BRUX. M.). — MOLUCCAS: Ternate (Prince LEOPOLD of Belgium — BRUX. M.). — BATJAN (BRUX. M.). — SOELOE (or Jolo) ARCHIPELAGO: Bongao Id. near Tawi Tawi (A. DUYAG — Phil. B. Sci.).

Additional specimens. — N. CELEBES: 1908 (Buit. M.). — TALAUD: Karakelang, Beo, 1920 (ERIE — Buit. M.). — OBI: Laiwoei (DENIN — Buit. M.). — NEW GUINEA: Hollandia (K. GJELLERUP — Buit. M.); Mamberamo River, Prauwen bivak (W. C. VAN HEURN — Buit. M.).

W. A. SCHULZ (1912) examined the type of *Apis affinis* at the Zoological Museum of the University of Upsala. He recognized that it was a *Vespa*, identical with FABRICIUS' *Vespa affinis*, which he regarded as a color variety of *V. tropica* (LINNAEUS). There are several statements in LINNAEUS' original description which make the identification certain. He says "Caput... obscure testaceum... Labium [= clypeus] obtusum... Thorax... obsolete testaceus... Segmenta 1.2. [of abdomen]... corpori [= head and thorax] concoloria, secundo tamen pallidior... Segmenta reliqua nigra. Pedes obsolete ferruginei... Affinitas facie et habitu antecedentis *Sphegus tropicae*,<sup>6)</sup>... licet color alius et magnitudo inferior..." These characters are not found in the form of *V. tropica* having the two basal tergites orange-yellow (var. *tresignata* PÉREZ). All the specimens of that form I have seen have the head and thorax entirely black and, moreover, are of the size of typical *V. tropica*.

Specimens with the thorax almost completely ferruginous-red are common in Formosa, where they were described by SONAN as *V. formosana*. Since this coloration is found also in China and even in Ceylon, and since it is connected by many intermediate stages with the more usual form, in which the mesonotum is entirely black, I do not give *formosana* even varietal rank. Moreover, LINNAEUS' type appears to have been a wasp with the thorax mostly ferruginous.

<sup>6)</sup> From this statement it would seem that LINNAEUS intended his "*affinis*" to follow *Sphegus tropica*, but that through an oversight it was inserted after his "*Apis tropica*".

It is interesting to note that typical *affinis* occurs in the western part of the Soeloe Archipelago, but is unknown from the Philippines proper.

***V. affinis* var. *hainanensis***, new variety.

*Female or Worker.* — Head and antennæ ferruginous-red; only the upper margin of clypeus and teeth of mandibles black. Thorax ferruginous-red; mesonotum, anterior half of mesopleura, upper half of metapleura, hind half of postscutellum, and middle of propodeum black. Legs fuscous; femora more reddish on the inner side and more blackish on the outer side. Wings rather uniformly tinged with ferruginous. First abdominal tergite orange-yellow with ferruginous base; second orange-yellow; third more brownish orange-yellow, with a black base and an apical infuscate cross-band which on each side ends far from the lateral margins in an anterior expansion. Second sternite diffusely yellowish in apical half.

CHINA: Hainan Island, one female or worker *holotype* (2 miles south of Nodoa, June 25, 1929; W. E. HOFFMANN — M.C.Z.).

This peculiar variation somewhat parallels in color *V. tropica* var. *philippinensis*. PÉREZ (1910) describes a similar specimen, from Cochinchina, as a variation of his *V. indosinensis*.

***V. affinis* var. *indosinensis*** PÉREZ.

*Vespa unifasciata* OLIVIER, 1791, Encyclop. Méthod., Insectes, VI, p. 677 ("Indes orientales"). Not *Vespa unifasciata* GMELIN, 1790.

*Vespa nigripennis* H. DE SAUSSURE, 1853-1855, Et. Fam. Vesp., II, p. 156 (no sex; Philippines). F. SMITH, 1857, Cat. Hym. Brit. Mus., V, p. 121. DALLA TORRE, 1894, Cat. Hym., IX, p. 150; 1904, Gen. Insect., Vespidae, p. 65. ASHMEAD, 1904, Proc. U.S. Nat. Mus., XXVIII, p. 151. R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 4, p. 620. Not *Vespa nigripennis* DEGEER, 1773.

*Vespa indosinensis* J. PÉREZ, 1910, Actes Soc. Linn. Bordeaux, LXIV, p. 8 (♂ or ♀; Cochinchina; Annam; Malacca; northern Celebes; India; type locality not designated).

**Specimens Examined.** — INDO-CHINA: Hanoi (W. DEMANGE). — FEDERATED MALAY STATES: Penang; Singapore. — SUMATRA: Medan (G. FAIRCHILD; v. D. MEER MOHR); Padang (Prince LEOPOLD of Belgium — Brux. M.); Tandjong Bringin Est., Langkat (JOURIN); Poeloe Weh (BUI TENDLIK — Leid. M.); Tandjong Morawa, Serdang (B. HAGEN — Leid. M.); Solok (P. STOLZ — Leid. M.); Palembang (WIENECKE — Leid. M.); Sawahloentoe, Padangsche Bovenlanden (Mej. DELPRAT — Leid. M.). — SIMALOER: Kaloeng and Sibolga (E. JACOBSON). — NIAS: (KLEI WEG DE ZWAAN — Leid. M.). — ENGGANO ISLAND: (WIENECKE — Leid. M.). — BANKA: (BUDDING — Leid. M.). — BORNEO: (SCHWANNER — Leiden M.). — PHILIPPINE ISLANDS: Zamboanga, Mindanao (M.C.Z.); Mauo River, Samar Id.; Palawan-Backuit (Prince LEOPOLD of Belgium — Brux. M.), Puerto Princesa, Palawan (R. C. MCGREGOR — Phil. Bur. Sci.); Iwahig, Palawan (C. M. WEBER — Phil. Bur. Sci.); Dumaran Id. (W. SCHULTZE — Phil.

Bur. Sci.). — CELEBES: Toli-Toli (H. FRUHSTORFER); Gorontalo (ROSENBERG — Leid. M.); Bolaäng Mongondow (W. KAUDERN — Leid. M.); Tomohon (BERENDS TEN KATE — Leid. M.). — HALMAHERA: northern part (BERNSTEIN — Leid. M.). — TERNATE: (T. BARBOUR; BERNSTEIN — M.C.Z.; Leid. M.). — AMBOINA: (Prince LEOPOLD of Belgium. — BRUX. M.; HOEDT. — Leid. M.). — SALAWATTI: (BERNSTEIN — Leid. M.). — AROE: (ROSENBERG — Leid. M.). — WAIGEEOE: (Mts. DE BEAUFORT). — NEW GUINEA: Manokwari; Mianorwoo (T. BARBOUR).

Additional Specimens. — SUMATRA: Atjeh, Singkel (M. E. WALSH — Buit. M.); Padang (C. BODEN KLOSS & H. SMEDLEY — Buit. M.). — MENTAWAI ARCHIP.: Siberoet & Sipora (C. BODEN KLOSS & H. SMEDLEY — Buit. M.). — Strait Soenda: Sebesi (K. W. DAMMERMAN — Buit. M.).

*V. affinis var. continentalis*, new variety.

*Female and Worker.* — Head black or more or less ferruginous-red or reddish-brown; mandibles always black. Thorax and legs black, or the thorax more or less ferruginous; tegulae somewhat reddish. Abdomen black or somewhat ferruginous on first tergite, with the second tergite almost entirely and the second sternite extensively orange-yellow; first tergite with a narrow and irregular yellow apical margin, often effaced on the sides and interrupted medially. Wings blackish-brown in basal half, much clearer and russet in apical half.

Specimens Examined. — INDIA: Mangalore, female *holotype* (J. C. BRIDWELL — U.S.N.M.); Shembaganur near Madura, two worker paratypes; three worker paratypes without more definite locality (C. V. PIPER — U.S.N.M. and M.C.Z.) — TENASSERIM: Papun, several worker paratypes (BINGHAM — Berl. M.). — CEYLON: Colombo, one worker paratype (Berl. M.); Negombo, two female paratypes (W. HORN — M.C.Z. and D.E.I.); Kandy, one female paratype (W. HORN — M.C.Z.); eight worker or female paratypes without more definite localities (Berl. M.). — SIAM: Trong, Lower Siam (W. L. ABBOTT — U.S.N.M.).

The specimens from Ceylon differ from most of those from continental India in being extensively reddish on the thorax. It seems hardly possible to separate them as a distinct variety, since the specimens from Tenasserim show somewhat the same type of coloration.

*V. affinis var. alduini* GUÉRIN.

*Vespa alduini* GUÉRIN-MÉNEVILLE, 1851, in DUPERREY, Voyage de la Coquille, Zool., Atlas, Insectes, Hymén., Pl. IX, fig. 6 (1838, Texte, II, pt. 2, 1st Div., p. 264, as a synonym of *V. bimaculata*). H. DE SAUSSURE 1853-1855, Et. Fam. Vesp., II, p. 154 (♂). F. SMITH, 1863, Jl. Proc. Linn. Soc. London, Zool., VII, p. 43. J. BEQUAERT, 1926, Ent. Mitt., Berlin, XV, p. 192.

*Vespa cincta var. alduini* R. DU BUYSSON, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pt. 3, p. 536 (♀).

*Vespa bimaculata* GUÉRIN-MÉNEVILLE, 1838, in DUPERREY, *Voyage de la Coquille*, Zool., II, pt. 2, 1st Div., p. 264 (no sex given; Boeroe Island; substitute name for *V. alduini*). DALLA TORRE, 1894, *Cat. Hym.*, IX, p. 139; 1904, *Gen. Insect.*, Vespidae, p. 64. Not *Vespa bimaculata* FOURCROY, 1785, nor of OLIVIER, 1791.

GUÉRIN gave the type locality as "Buru" (Boeroe), one of the Moluccas, and DE SAUSSURE's statement that the type, which he saw in GUÉRIN's collection, came from Java, was due to an oversight. I have found no evidence as yet of the var. *alduini* or any of the forms of *V. affinis* occurring in Java. The var. *alduini* does not extend west of the Moluccas <sup>7</sup>).

Specimens Examined. — BOEROE, one female (KUHN — U.S.N.M.). — CERAM: Jilo, two females (C. RIBBLE); Wahaai, several females (T. BARBOUR — M.C.Z.) — TERNATE: (Par. M.). — AMBOINA: (Par. M.; Brux. M.). — NEW GUINEA: Kaimana (Prince LEOPOLD of Belgium — Brux. M.). — BISMARCK OR NEW BRITAIN ARCHIPELAGO: Ralum (DAHL — Berl. M.).

Additional Specimens. — BOEROE: long series (DENIN — Buit. M.). — AMBOINA: one worker (Buit. M.). — CERAM: Watai, long series (DENIN — Buit. M.). — KEI: one worker (H. C. SIEBERS — Buit. M.).

#### *V. affinis* var. *picea* R. DU BUYSSON.

*Vespa cincta* var. *picea* R. DU BUYSSON, 1905, *Ann. Soc. Ent. France*, LXXIII, (1904), pt. 3, pp. 488 and 537 (♀ New Guinea: Tupuseleia; Yule Island; Kapa-Kapa; type locality not designated). CAMERON, 1911, *Nova Guinea*, IX, Zool., pt. 1, p. 186.

The var. *picea* is evidently the extreme melanic variation of *V. affinis*, being entirely black, except for a few ferruginous blotches on head and tegulae and a small, poorly defined ferruginous spot on each side near the base of the second tergite. The spots of the second tergite sometimes disappear entirely. There is, moreover, only a step from this to the var. *alduini* GUÉRIN. That it is a color variation of *V. affinis* and not of *V. tropica* is clear from DU BUYSSON's statement: "Le clypeus a les angles antérieurs arrondis," as well as from one of the cotypes which I saw at the Paris Museum.

Specimens Examined. — NEW GUINEA: Tupuseleia, worker cotype (Par. M.); Bivak Island, four workers (Lorenz Exp. — *Natura Artis Magistra* Mus., Amsterdam); Noord Rivier, southern New Guinea, three workers (Lorenz Exp. — *Ibidem*); van Weelskamp, southern New Guinea, two workers (Lorenz Exp. — *Ibidem*).

This form is apparently peculiar to New Guinea.

<sup>7</sup>) Moreover, the Expedition of "La Coquille" did not visit Java.