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Description of *Apechthis cantika* sp. n. from Sulawesi Is., Indonesia with redescription of the holotype of *A. taiwana* Uchida (Hymenoptera, Ichneumonidae, Pimplinae)

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Abstract

Apechthis cantika **sp. n.** (Ichneumonidae: Pimplinae) is described from the island of Sulawesi, Indonesia. This is the first known representative of the genus in Indonesia and also the southernmost record of *Apechthis* in the Oriental region, extending the known distribution far southwards. Discovery of a second yellow *Apechthis* in the Oriental region, following *A. taiwana* Uchida, suggests that the genus suddenly changes its body colour entirely from black to yellow towards the equator, independently in both the Oriental and Neotropical regions. The holotype of *A. taiwana*, apparently closely related to *A. cantika* **sp. n.**, is also redescribed for comparison.

Keywords

Body colour, convergence, hamuli, Oriental region, parasitoid wasp, taxonomy, yellow body

Introduction

The genus *Apechthis* is a small taxon of the tribe Pimplini, subfamily Pimplinae, containing 16 described species from the Holarctic, Oriental and Neotropical regions (Yu et al. 2012). Individual species seem to have relatively wide distributions compared to related genera (e.g. *Pimpla* Fabricius, 1804, *Itoplectis* Förster, 1869, and *Xanthopimpla* Saussure, 1892), whereas sympatric species are relatively fewer than other Pimplini. Species of *Apechthis* are known as solitary idiobiont endoparasitoids of lepidopteran pupae, including important forest and agricultural pests (Iwata 1961; Cole 1967; Wahl 1993).

Body colouration, an important set of characters in morphological identification, also strongly relates to biological functions, such as thermoregulation, crypsis or warning mimicry in bumblebees (Williams 2007). As seen in bumblebees, body colour pattern reflecting geographical region or environment also reflects phylogeny, in association with biogeography and biological functions.

Body colour within *Apechthis* shows two patterns, i.e. predominantly black or yellow, seemingly with some trend in its distribution. Most of the yellow species are found in the Neotropical region (Cresson 1865, 1870; Blanchard 1936) whereas in other regions, only one yellow species, *A. taiwana* Uchida, 1928, has been recorded from Southern China and Taiwan in the Oriental region (Uchida 1928). We expected that if *Apecthis* species were found in Southeast Asia, those species would be yellow.

We had an opportunity to collect on Sulawesi Island, Indonesia in 2011, resulting in acquisition of an undescribed yellow *Apechthis* species (Figs 1–4), caught in a Malaise trap at *c.* 2000m elevation on Mt. Lompobattang (alt. 2,870m), southern Sulawesi. In this paper, we record this genus from Sulawesi Island for the first time, describe this new, yellow species as *Apechthis cantika* sp. n., and discuss the distribution of body colour trends and asymmetric numbers of hamuli in wings found in two Oriental species. The holotype of *A. taiwana*, apparently closely related to *A. cantika* sp. n., is also redescribed for comparison.

Materials and methods

Within range of vision, Mt. Lompobattang has been cultivated up to *c.* 1700m, coexisting with natural forest, and has a meadow from *c.* 1800 to 1900m. There is a huge cloud forest starting from *c.* 1900m with several creeks but seemingly fewer insects flying. We deployed Malaise traps at four altitudes each, such as 700, 1400, 1700 and 2000m, for about 40 days. Unfortunately, the traps at 700 and 1700m were stolen or destroyed by local people. The trap at 2000m, the only trap which caught *A. cantika* sp. n., had been deployed inside the cloud forest alongside the creek.

Observation and drawings were made by stereomicroscope (Nikon SMZ800) and light microscope (Nikon eclipse 50i). Male terminalia were treated with 10% KOH at about 20ºC for 24 hours then washed in distilled water and observed in 70% ethanol. Digital images were edited using Adobe Photoshop® CS3.

Morphological terminology mainly follows Gauld (1991). We referred to Snodgrass (1941) and Eady (1968) for male genitalia and microsculpture descriptions, respectively. The following abbreviations were used: minimum length of ocello-ocular line (OOL), minimum length of postocellar line (POL), maximum diameter of posterior lateral ocellus (OD), and character states of the holotype (HT). Ovipositor length is expressed as the length of the ovipositor sheaths (i.e. the length of the ovipositor beyond the hypopygium).

The specimens examined in this study are deposited in the following collections: the Ehime University Museum, Matsuyama, Japan (EUM), the Kanagawa Prefectural Museum of Natural History (KPMNH), the Indonesian Institute of Sciences, Bogor, Indonesia (LIPI), and the Hokkaido University Museum, Sapporo, Japan (SEHU).

Taxonomy

Genus *Apechthis* Förster, 1869
http://species-id.net/wiki/Apechthis

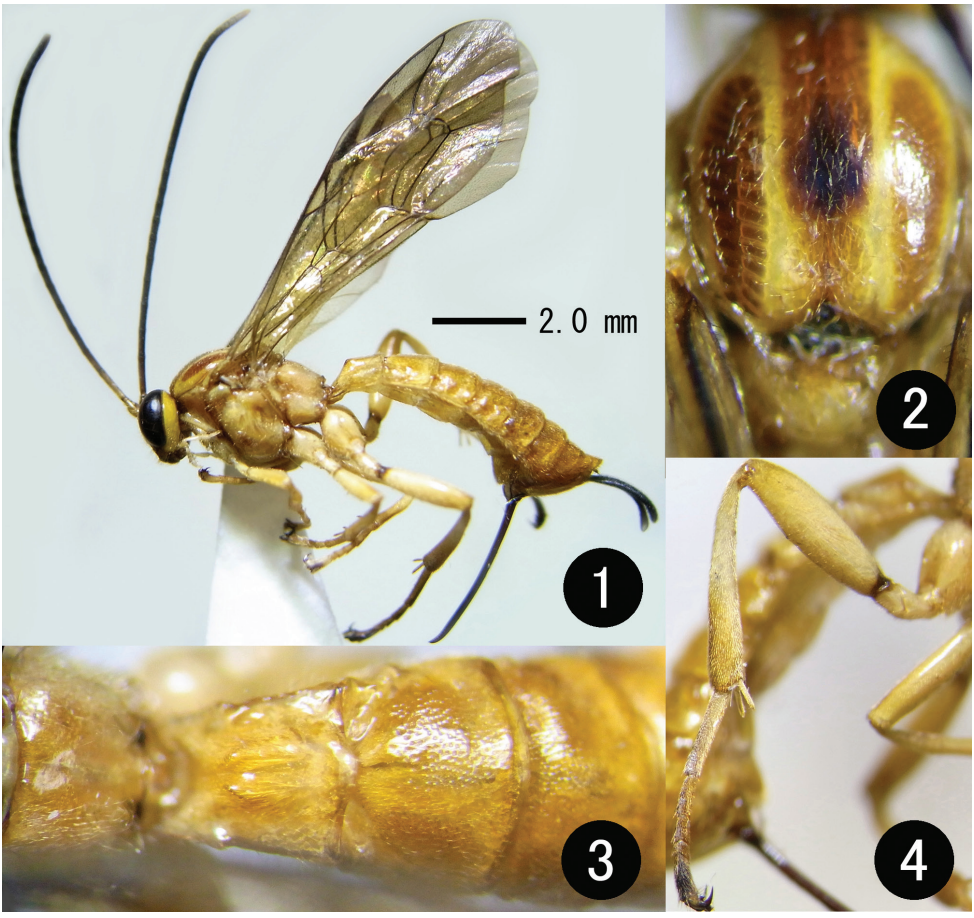
Ephialtes Schrank, 1802: 316. Name suppressed. [Type species: *Ichneumon compunctor* Linnaeus, 1758]
Apechthis Förster, 1869: 164. [Type species: *Ichneumon rufatus* Gmelin, 1790]
Apechtis Thomson, 1889: 1410. Emendation.
Parapechthis Blanchard, 1936: 404. [Type species: *Parapechthis bazani* Blanchard, 1936]
Taiwatheronia Sonan, 1936: 256. [Type species: *Taiwatheronia mahasenae* Sonan, 1936 (= *Apechthis taiwana* Uchida, 1928)]

Remarks. Morphologically, this genus can easily be distinguished from other genera of Pimplini by the yellow face of the male, the mandibular teeth of equal length, the strongly notched inner margin of the eye, the non-divided clypeus (Fig. 5), and the hook-like (apically down-curved) ovipositor tip (Fig. 16) (Townes 1969).

***Apechthis cantika* Watanabe & Takasuka, sp. n.**
urn:lsid:zoobank.org:act:E9D47938-E070-474D-9D13-A5421F10BAAF
http://species-id.net/wiki/Apechthis_cantika
Figs 1–16, 18–22

Diagnosis. Propodeum largely smooth medially, without median longitudinal carinae (Figs 3, 14); metasomal tergite I with pair of strongly convex keels and strongly angulate in lateral view (Figs 1, 15); all tarsal claws with basal tooth (Figs 10–12); male flagellum with longitudinal ridge on flagellomere VI to basal half of IX (Fig. 6); metasoma entirely yellow (Figs 1, 3).

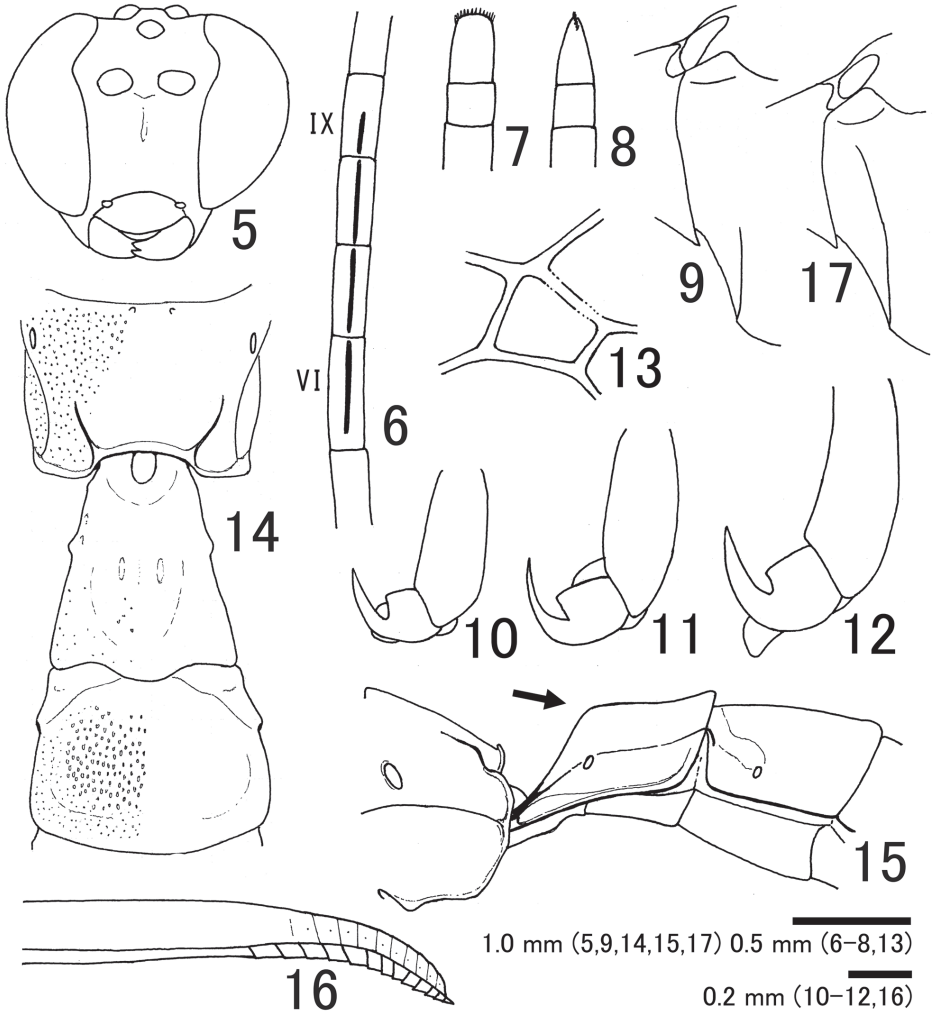
Description. Female: body 10.0–12.0 (HT: 12.0) mm long, fore wing 10.0–12.0 (HT: 12.0) mm long. Head polished, punctate, 0.5 times as long as wide in dorsal



Figures 1–4. Holotype of *A. cantika* **sp. n. 1** habitus, lateral view **2** mesonotum, dorsal view **3** T1-T2, dorsal view **4** right hind leg, lateral view.

view; clypeus 0.6 times as long as wide, flat, smooth, finely punctate along apical margin and supraclypeal suture; face 0.7 times as long as wide, finely punctate, medially with weak longitudinal convexity (Fig. 5); frons smooth, weakly concave above antennal sockets; malar space 0.2 times as long as basal width of mandible; basal portion of mandible flat; vertex and gena minutely and finely punctate; OOL/OD 0.7; POL/OD 1.0; antenna with 25–27 (HT: 27) flagellomeres, terminal segment with columnar projections (Figs 7, 8); flagellomere I 1.3 times as long as flagellomere II.

Mesosoma polished, sparsely punctate; pronotum laterally largely smooth; mesoscutum finely, densely punctate; anterior half of mesopleuron strongly convex; upper end of epicnemial carina reaching lower apex of pronotum (Fig. 9); episternal scrobe large; lower division of metapleuron largely smooth excluding along pleural carina; propodeum smooth medially, sparsely punctate laterally, with pleural carina and posterior part of lateral longitudinal carina (Figs 3, 14, 15); lateromedian longitudinal carina present only as basal tubercle (Figs 3, 14); other carinae absent.



Figures 5–17. Holotypes (female) of *A. cantika* **sp. n.** (**5**, **7–16**) and *A. taiwana* Uchida (**17**), paratype (male) of *A. cantika* **sp. n.** (**6**) **5** Head, frontal view **6** left flagellum, lateral view **7**, **8** apex of flagellum, dorsal (**7**) and lateral (**8**) views **9**, **17** anterior half of mesopleuron, lateral view **10–12** left fore- (**10**), mid- (**11**) and hind (**12**) tarsal claw, lateral view **13** fore wing areolet **14**, **15** propodeum and metasomal tergites I and II, dorsal (**14**) and lateral (**15**) views; **16** apex of ovipositor, lateral view.

Legs: claws of all legs with basal tooth (Figs 10–12); hind femur 3.5 times as long as deep.

Wings: fore wing with vein *Cu-a* distad to vein *Rs+M* by 0.4–0.5 (HT: 0.5) times length of vein *Cu-a*, with rectangular areolet receiving vein 2*m-cu* near apical 1/3 (Fig. 13); hind wing with distal abscissa of vein *Cu*1 much closer to vein 1*A* than to vein *M*, basal abscissa of vein *Cu*1 0.5 times length of vein *cu-a*; 9 (left) or 11 (right) distal hamuli.

Metasoma polished, punctate; tergite I 1.1–1.2 (HT: 1.1) times as long as maximum width, smooth, with pair of strong median convexities (Figs 1, 3, 14, 15), con-

vexity nearly angulate in lateral view (Figs 1, 15); tergite II 0.8 times as long as maximum width, anterior 1/5, gastrocoeli and posterior margin smooth (Figs 3, 14); tergites III to VII punctate excluding posterior margin; lower valve of ovipositor with 13 teeth (Fig. 16); ovipositor sheath 0.8 times as long as hind tibia.

Colour (Figs 1-4). Body yellow, except for: apex of mandible, dorsal surfaces of scape and pedicel, flagellomere I and II, small median spot on mesoscutum, pair of small spots on posterior margin of propodeum, apices of claws (including teeth) of legs, base of hind femur, wing veins including stigma, ovipositor, ovipositor sheath excluding apex black; posterior part of vertex, scuto-scutellar groove, apex of hind tibia, hind tarsus excluding base of first segment blackish-brown; above antennal socket on frons, ocellar area, three longitudinal stripes on mesoscutum (these stripes sometimes darkened), small areas near epicnemial carina, epistomal scrobe, subalar prominence brown; wings yellowish-hyaline.

Male: similar to female, except following characters: body 8.0–9.0 mm long, fore wing 8.0–8.5 mm long; clypeus 0.5–0.6 times as long as wide; face slightly wider, 0.7–0.8 times as long as wide; OOL/OD 1.0; POL/OD 0.7; flagellum with longitudinal ridge on flagellomere VI to basal half of IX (Fig. 6); tergite I 1.2–1.3 times as long as maximum width; tergite II 1.0 times as long as maximum width; and 8 (left) or 9 (right) distal hamuli.

Male terminalia: subgenital plate elongate, with acute apex, apico-lateral area without setae (Fig. 18); paramere with membranous inner surface, apex covered with dense setae and ventral margin with very dense, long setae near apex (Figs 19-21); apical margin of paramere sharp, apex not projecting beyond apex of aedeagus (Figs 19, 20); aedeagus weakly widened apically, with basal apodeme slightly shorter than penis valve (Fig. 22).

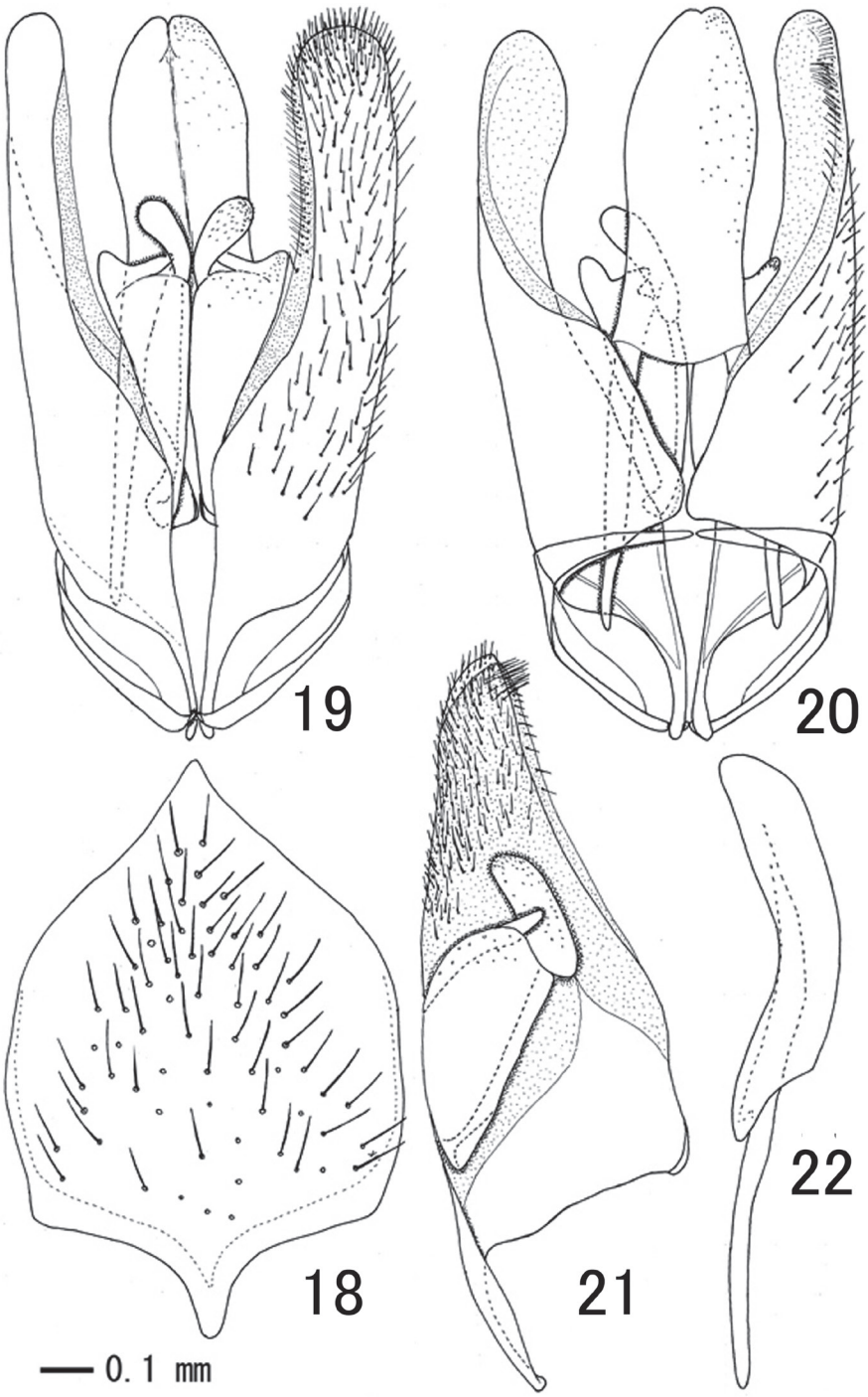
Colouration similar to female but brown areas somewhat darker.

Type series. Holotype: Female, Mt. Lompobatang, Gunung, South Sulawesi Prov., INDONESIA, 1977m alt., 14.xii–21. i.2011, Keizo Takasuka leg. (Malaise trap, 5°23'26.74"S, 119°56'1.14"E) (LIPI). Paratypes: 1 female and 2 males, same data as holotype (1 male in LIPI; 1 female and 1 male in EUM).

Distribution. Indonesia (Sulawesi).

Etymology. The specific name is derived from the Indonesian word "*cantik*", meaning "beautiful".

Remarks. This species can easily be distinguished from most other *Apechthis* species by its yellow body without dark areas on the metasomal tergites (Figs 1-4), and from all yellow Neotropical species by the keel on the first metasomal tergite being strongly angulate in lateral view (Figs 1, 15 arrow) (weaker or not angulate in the Neotropical species). Although this species morphologically much resembles *A. taiwana*, it can be distinguished by the upper end of the epicnemial carina reaching the lower apex of the pronotum (Fig. 9) (in *taiwana* it extends dorsally, reaching the middle of the pronotum: Fig. 17), smoother metasomal tergites I and II (Figs 3, 14) (*taiwana* relatively densely punctate: Fig. 24), and the entirely yellow metasoma (Figs 1, 3) (*taiwana* with conspicuous black or brown areas: Figs 23, 24). This species is also the southernmost representative of *Apechthis* in the Oriental region.



Figures 18–22. Male genitalia and subgenital plate of *A. cantika* **sp. n.** (paratype) **18** subgenital plate, ventral view; **19**, **20** genital capsule, ventral (**19**) and dorsal (**20**) views **21** left paramere, inner aspect **22** aedeagus, lateral view.

Although the columnar projections on the terminal antennal segment of females (Figs 7, 8) was pointed out as a synapomorphy in Pimplini (Gauld et al. 2002), relating to host-searching behaviour (Broad and Quicke 2000), it is also shared with the male of *A. cantika* sp. n. and thus this structure may serve other functions.

Asymmetric numbers of hamuli in "left" and "right" wings were observed in two Oriental species, *A. cantika* sp. n. (L<R: 2 females and 2 males, asymmetry at a rate of 100%) with stable numbers of hamuli and *A. taiwana* (L>R: 1 female, holotype, asymmetry at a rate of 100%, see following description). But in two Palaearctic species collected from Japan, *A. capulifera* (Kriechbaumer, 1887) (19 females and 9 males deposited in KPMNH, asymmetry at a rate of ca. 47%) and *A. rufata* (Gmelin, 1790) (18 females and 12 males deposited in KPMNH, asymmetry at a rate of ca. 47%), although asymmetric hamuli numbers are also found in approximately half of specimens, both the side of asymmetry and numbers of hamuli are unstable, not supporting the apparently stable asymmetry trend observed in the Oriental species, but based on small numbers of specimens.

Apechthis taiwana Uchida, 1928

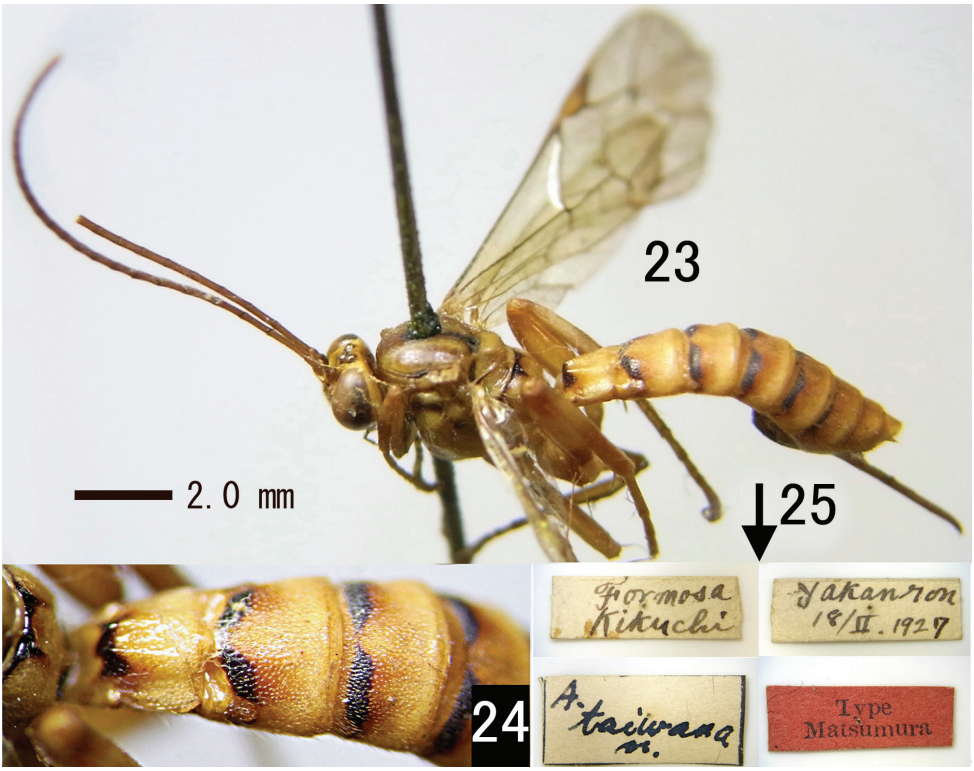
http://species-id.net/wiki/Apechthis_taiwana
Figs 17, 23, 24

Apechthis taiwana Uchida, 1928: 49.
Taiwatheronia mahasenae Sonan, 1936: 256.

Remarks. Although this species also has a yellow body and is found in the Oriental region, China and Taiwan (Yu et al. 2012), indicating a close relationship with *A. cantika* sp. n., published descriptions are unsatisfactory for identification and comparison with undescribed species. We thus redescribe the holotype of *A. taiwana* below.

Redescription of holotype. Female: body 10.5 mm long, fore wing 10.0 mm long. Head polished, punctate, 0.6 times as long as wide in dorsal view; clypeus 0.6 times as long as wide, flat excluding weakly concave apical half, smooth, finely punctate along apical margin and supraclypeal suture; face 0.7 times as long as wide, finely punctate, medially with weak longitudinal convexity; frons smooth, weakly concave above antennal sockets; malar space 0.2 times as long as basal width of mandible; basal portion of mandible flat; vertex and gena minutely and finely punctate; OOL/OD 0.6; POL/OD 1.1; antenna with 25 flagellomeres, terminal segment with columnar projections; flagellomere I 1.3 times as long as flagellomere II.

Mesosoma polished, sparsely punctate; pronotum laterally largely smooth; mesoscutum finely, densely punctate; anterior half of mesopleuron strongly convex; upper end of epicnemial carina reaching half height of pronotum (Fig. 17); episternal scrobe large; lower division of metapleuron largely smooth except along pleural carina; propodeum smooth medially, densely punctate laterally, with pleural carina and posterior part of lateral longitudinal carina; lateromedian longitudinal carina present only as basal tubercle; other carinae absent.



Figures 23–25. Holotype of *A. taiwana* Uchida. **23** habitus, dorso-lateral view **24** T1-T3, dorso-lateral view **25** labels.

Legs: claws of all legs with basal teeth; hind femur 3.0 times as long as deep.

Wings: fore wing with *Cu-a* distad *Rs+M* by 0.4 times length of *Cu-a*, with rectangular areolet receiving 2*m-cu* near apical 1/3; hind wing with distal abscissa of *Cu*1 much closer to 1*A* than to *M*, basal abscissa of *Cu*1 0.3 times as long as *cu-a*; 11 (left) or 10 (right) distal hamuli.

Metasoma polished, densely punctate (Fig. 24); tergite I 1.1 times as long as maximum width, with pair of strong median convexities, convexity nearly angulate in lateral view; tergite II 0.8 times as long as maximum width, gastrocoeli and posterior margin smooth; posterior margin of tergites III to VII smooth; lower valve of ovipositor with at least 10 teeth (apex concealed by dirt); ovipositor sheath 0.9 times as long as hind tibia.

Colour (Figs 23, 24). Yellow; apex of mandible, small median spot on posterior margin of mesoscutum, scuto-scutellar groove, small spot on mesopleuron near subtegular ridge and episternal scrobe, anterior margin of propodeum, pair of small spots on posterior margin of propodeum, apices of claws (including teeth) of legs, wing veins excluding stigma, anterior band of metasomal tergite I, pair of anterior spots on tergites II to VI and ovipositor sheath (apex concealed by dirt) black; antenna, ocellar triangle, three longitudinal stripes on mesoscutum, submetapleural carina, base of mid

femur, apex of hind coxa, base and apex of hind femur, base and apical half of hind tibia, stigma excluding black margins, tarsal claws, ovipositor brown; each black area more or less framed by brown area; wings yellowish-hyaline.

Specimen examined. Holotype (Fig. 25): Female, "Formosa, Kikuchi" (label 1), "Yakanron, 18/II. 1927" (label 2), "A. taiwana n." (label 3), "Type Matsumura" (label 4), apical parts of right antenna and left hind tarsus, and left fore wing lost (SEHU).

Discussion

In terms of body colour, *Apechthis* species show two conspicuous patterns, black or yellow (Figs 1–4). Although the black species usually have conspicuous yellow mark(s) on the mesoscutum and scutellum, there are no noticeable intermediate patterns between basically yellow and black in any species. Black species are mainly Holarctic and Himalayan (Townes and Townes 1960; Gupta and Tiker 1966; Kasparyan 1973), ranging from the temperate to arctic regions, whereas yellow species, including *A. cantika* sp. n., are Oriental (Uchida 1928) and Neotropical (Cresson 1865, 1870; Blanchard 1936), ranging from the subtropical to tropical zones, with a trend more or less reflecting latitude (Fig. 26). The distribution of yellow *Apechthis* in the Oriental region extends much further south than previously recognised with the discovery of *A. cantika* sp. n. on Sulawesi, being the second yellow *Apechthis* in the Oriental region, along with *A. taiwana* (Fig. 23). Although the yellow species of the genus are biased obviously toward the tropical zone, they can easily be separated into Oriental and Neotropical groups by the shape of the keel on the first metasomal tergite, clearly reflecting biogeographical regions. Several reasons for the change in colour pattern in *Bombus* Latreille,

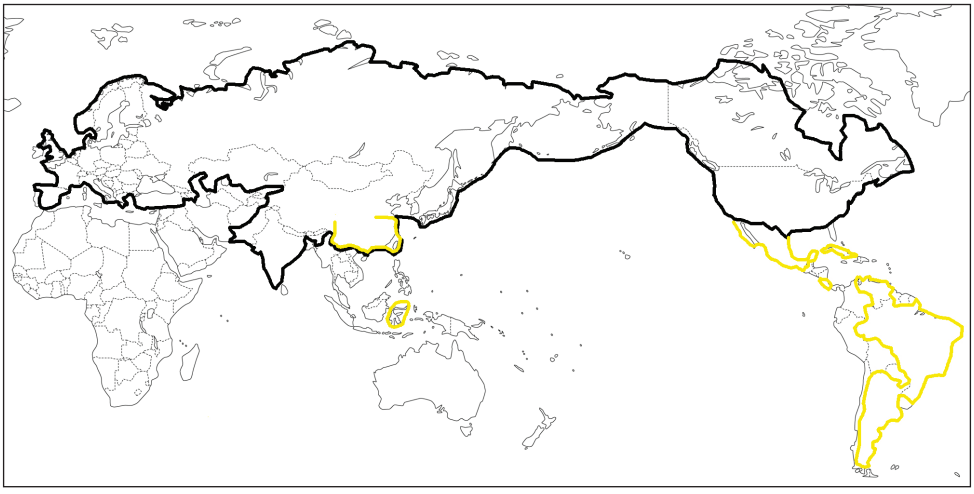


Figure 26. Distribution of predominantly black and predominantly yellow species of *Apechthis* at the country scale, based on Yu et al. (2012). Note that some countries or regions which have no recorded *Apechthis* are included in the distribution ranges for convenience, based on records from adjacent countries.

1802 (bumblebees, Apidae) ranging from paler to darker depending more or less on biogeography, are thermoregulation, in which the darkest bumblebees are associated primarily with the tropics, and crypsis in grasslands in which the palest bumblebees are associated with intermediate northern latitudes (Williams 2007). Although we do not know the reasons for the drastic change in colour suddenly from black to yellow in *Apechthis* (conceivably thermoregulation), because the direction of colour pattern is reversed in *Bombus* and *Apechthis*, we could say at least that it would have occurred both in the Oriental and Neotropical regions independently (i.e. convergence). However, Dr Ilari Sääksjärvi (University of Turku) advised us that several undescribed species which do not obey this pattern have been found in the Neotropical region, making the discussion a little more complicated (Sääksjärvi pers. comm.). Therefore, a global-scale discussion of colour pattern in *Apechthis* should be advanced by future studies both in the Neotropical and Oriental regions.

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