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## Research article

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# A revision of *Ichneumonopsis* Hardy, 1973 (Diptera: Tephritidae: Dacinae: Gastrozonini), Oriental bamboo-shoot fruit flies

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**Abstract.** *Ichneumonopsis* Hardy, 1973, a genus of oriental fruit flies, is revised and two new species, *I. hancocki* sp. nov. (from Peninsular Malaysia) and *I. taiwanensis* sp. nov. (from Taiwan), are described. A key to the three species of *Ichneumonopsis* is presented. In northern Thailand larvae of *I. burmensis* Hardy, 1973 develop in bamboo shoots of *Pseudoxytenanthera albociliata* (Munro) Nguyen and *Dendrocalamus strictus* (Roxburgh) Nees (Poaceae), not *Melocalamus compactiflorus* as previously reported. The recently discovered association of *I. burmensis* with bamboo substantiates our previous assumption assigning *Ichneumonopsis* to the primarily bamboo-inhabiting tribe Gastrozonini. Hence, we synonymize Ichneumonopsidini under Gastrozonini (syn. nov.).

**Keywords.** New species, new records, distribution, key, bamboo, *Pseudoxytenanthera*.

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## Introduction

Hardy (1973: 132) erected the monobasic genus *Ichneumonopsis*, with *I. burmensis* as the type species, based on a single male and female collected in the Chin Hills, Myanmar (Burma). He placed *Ichneumonopsis* in the Adramini (Subfamily Trypetinae) because of the reduced cephalic and thoracic chaetotaxy. Hancock (1986) noted that *Ichneumonopsis* differed from typical Adramini by the absence of long hairs on the laterotergite, by having “a narrow anal cell extension” and by having only two

spermathecae in the female. He argued that these characters, combined with the wing pattern and the general reduction of head setae, suggested a relationship with the Dacinae. He considered *Ichneumonopsis* the most primitive genus of the subfamily Dacinae and erected a new tribe, Ichneumonopsidini, with *Ichneumonopsis* as its type and only genus. Drew & Hancock (1994) redescribed *Ichneumonopsis* and presented an updated diagnosis for the genus, retaining it in the Dacinae in the narrow sense (i.e., together with *Dacus* Fabricius, 1805, *Bactrocera* Macquart, 1835 and *Monacrosticus* Bezzi, 1914).

Norrbom *et al.* (1999a: 21) found that *Ichneumonopsis* lacked the synapomorphies of the Dacini in the narrow sense (as Dacina in Norrbom *et al.* 1999a), i.e., the posterodistal lobe of cell bcu was only moderately long and the spermathecae rounded (in Dacini the posterodistal lobe of cell bcu is usually very long and the spermathecae are mulberry-like). They tentatively placed *Ichneumonopsis* in the Gastrozonini (as Gastrozonina in Norrbom *et al.* 1999a) based on its short plumose arista and broad aculeus. Kovac *et al.* (2006), in their catalogue of Gastrozonini, retained *Ichneumonopsis* in the Gastrozonini based on the same characters, although no host or other records that could support this decision were available at that time.

Since all reared Oriental Gastrozonini to date have been reared from bamboo (Hancock & Drew 1999 and subsequent authors), and all reared Afrotropical Gastrozonini have been reared from Poaceae (Hancock 1999; Copeland 2007), host relationships probably provide the best synapomorphy for this group. Kovac *et al.* (2013) reported that *I. burmensis*, a species that is known from Myanmar, India and north Thailand (Radhakrishnan 2000; Kovac *et al.* 2013) and is very rare in collections, is associated with bamboo, indicating that *Ichneumonopsis* belongs to the primarily bamboo-inhabiting tribe Gastrozonini. Nevertheless, Drew & Romig (2013) continued to treat *Ichneumonopsis* as a Dacini, albeit without explanation.

In the present paper we redescribe the genus *Ichneumonopsis* and its type species *I. burmensis*, for which we also provide precise information on distribution, beyond the data provided by Kovac *et al.* (2013). We also describe *I. hancocki* sp. nov. from Peninsular Malaysia and *I. taiwanensis* sp. nov. from Taiwan. The recent rearing of *I. burmensis* from bamboo for the first time (Kovac *et al.* 2013) has substantiated our previous assumption assigning *Ichneumonopsis* to the primarily bamboo-inhabiting tribe. Therefore, we synonymize here Ichneumonopsidini under Gastrozonini (syn. nov.), and, at least from our point of view, the current tribal assignment of *Ichneumonopsis* now stands on a firm basis.

## Material and methods

Field collecting and observations on *I. burmensis* Hardy, 1973 were conducted in India (Meghalaya) in 1980 (A. Freidberg), in Taiwan in 2000 (C.Y. Lee) and in north-west Thailand between 2008 and 2013 (D. Kovac and A. Freidberg). Three general collecting methods were used: in India adult specimens were collected using a sweep net; in Thailand adults were reared from immature stages collected from the host plants; in Taiwan adult specimens were collected by using colour traps. *Ichneumonopsis* larvae were bred from bamboo shoot internodes of *Pseudoxycatanthera albociliata* (Munro) Nguyen (in Kovac *et al.* 2013 this bamboo was misidentified as *Melocalamus compactiflorus* (Kurz) Benth) and from thin shoots of *Dendrocalamus strictus* (Roxburgh) Nees. Bamboo shoots suspected to contain larvae of *Ichneumonopsis burmensis* were cut off, transferred to the laboratory and inspected for larvae. Internodes containing larvae of *I. burmensis* were partly enwrapped with moist tissue and kept in plastic containers. Puparia were transferred to separate containers equipped with moist tissue.

Measurements are based on three specimens whenever available. Terminology follows McAlpine (1981) and White *et al.* (1999). Specimens, including type specimens, are deposited in the following collections (curator's name in parentheses):

BMNH	= Natural History Museum, London, UK (Mr N. Wyatt)
CAS	= California Academy Scientific Collections, San Francisco, California, USA (Dr B. Fisher)
SMF	= Senckenberg Museum, Frankfurt am Main, Germany (Dr D. Kovac)
SMNHTAU	= Steinhardt Museum of Natural History, Tel Aviv University, Tel Aviv, Israel (Dr N. Dorchin)
NTU	= National Taiwan University (Dr S.-F. Shiao)

## Results

Phylum Arthropoda Siebold, 1848  
 Class Insecta Linnaeus, 1758  
 Order Diptera Linnaeus, 1758  
 Family Tephritidae Macquart, 1835  
 Subfamily Dacinae Schiner, 1864  
 Tribe Gastrozonini Hering, 1947

Genus *Ichneumonopsis* Hardy, 1973

*Ichneumonopsis* Hardy, 1973: 132; type species *Ichneumonopsis burmensis* Hardy, 1973: 133 (by original designation and monotypy).

*Ichneumonopsis* – Hardy 1986: 54, 56 (key to Adramini genera). — Drew & Hancock 1994: 829 (redescription). — Drew & Romig 2013: 403 (South-East Asian fruit flies). — Norrbom *et al.* 1999b: 161. — Radhakrishnan 2000: 203 (first record for India). — Kovac *et al.* 2006: 170 (key to Gastrozonini genera), 184. — Kovac *et al.* 2013: 201 (biology and immature stages).

## Diagnosis

Species of this genus are large, slender and somewhat atypical Gastrozonini that cannot be readily associated with any of the other included genera due to some apomorphic characters that obscure their true relationships. The three included species bear some superficial resemblance to *Enicoptera gigantea* Enderlein, 1911, which is even larger, but *Enicoptera* Macquart, 1848 clearly differs from all other Gastrozonini genera, including *Ichneumonopsis*, in the peculiar and unique wing venation, e.g., it is characterized by veins  $R_1$  and  $R_{2+3}$  joining each other for a short distance just before meeting the costa.

Having several conspicuous autapomorphies, *Ichneumonopsis* is so distinctive that in Hardy's (1973: 76) key to Trypetinae genera (including 50 genera), it keys out in just four steps (couplets 1, 2, 46 and 47). The original description itself is rather brief, dealing almost entirely with key characters that have weak relevance here since they refer to adramine genera. In any case, Hardy's (1973: 132) assignment of *Ichneumonopsis* to the Adramini is clearly incorrect.

Kovac *et al.* (2006: 170) included *Ichneumonopsis* in their key to Gastrozonini, which treats 27 genera, but *Ichneumonopsis* keyed out in couplet 1. The characters used in this key, although based only on the type species, can be viewed as the minimum information for a diagnosis of *Ichneumonopsis* within the Gastrozonini. They are: "Extremely wasp-like species, with petiolate abdomen, spinose forefemur and dimidiate wing pattern; chaetotaxy reduced: one (but updated to 0–2 in the Redescription below) setula-like frontal seta, one small orbital seta and one scutellar seta present; ocellar, dorsocentral, acrostichal, intra-alar, postpronotal and pleural setae, except one anepisternal seta, lacking." The following generic description, based on the type species plus the two newly described species, incorporates all characters available from the literature plus additional characters that we think are useful in separating this genus from other Gastrozonini.

## Redescription

Extremely ichneumonid-like species, with elongate body and antennae, petiolate abdomen (Figs 20–21), contrasting dark (brown or black) and yellow or white markings on all body parts, and usually dimidiate wing pattern (anterior 0.4 of wing yellow, remaining part hyaline (Fig. 18), although in *I. taiwanensis* sp. nov. (Fig. 19) there are additional dark areas on posterior half of wing); sexes not conspicuously dimorphic. Chaetotaxy reduced, with many major setae lacking or small, setula-like; one pair of (apical) scutellar setae present; entire body with pale (mostly yellow, sometimes brown or blackish) setulae not strongly contrasted with background. Microtrichia indistinct.

### Head (Figs 5–6)

**STRUCTURE.** Distinctly higher than long, with high and transversely convex face and narrow and shallow antennal fovea (groove), frons sloping, frontofacial angle about 100°–120°; gena high, about 0.33 times as high as eye; occiput rather flat dorsally, swollen ventrally; antenna longer than face, with all three segments at least somewhat elongate, including scape which is distinctly porrect, with 1<sup>st</sup> flagellomere about 4–5 times as long as high, rounded apically; arista short plumose, plumosity about as wide as 1<sup>st</sup> flagellomere height.

**COLOURATION.** Primarily yellow, with black or blackish parts as follows: orbital plate, ocellar triangle, both sometimes united, irregular spot on anterior part of frons, genal spot, small spot laterally on face at mid-height, small spot around and ventral to base of lateral vertical seta, and long vertical spot extending over most of ventral part of occiput to genal margin, latter sometimes indistinct. In addition, face almost entirely black or with elaborate pattern of numerous small spots; these spots variable in number and expression, often asymmetrical, sometimes lacking.

**CHAETOTAXY AND VESTITURE.** Frontal setae 0–2, if present then small (anterior frontal) or setula-like, barely distinguishable from adjacent setulae; anterior orbital seta small but distinct; posterior orbital seta present or lacking, if present, then small, setula-like and barely distinguishable from adjacent setulae; medial and lateral vertical setae present; ocellar seta lacking; postocellar seta indistinguishable from adjacent setulae; genal seta present; postocular setae tiny, inconspicuous. Setulae mostly fine and rather sparse, more spine-like and blackish around occipital foramen.

### Thorax (Figs 7–9)

**STRUCTURE.** Scutum narrow, length to width ratio 1.33–1.40; scutellum small, about 0.22–0.27 times as long as scutum ( $n = 7$  for both ratios); clear overlap between the three species, moderately convex.

**COLOURATION.** Mostly yellow, with complex dark (brown to black) pattern. Scutum generally with five longitudinal brown to black vittae, including (single) median, (pair) dorsocentral and (pair) notopleural vittae, the latter vitta not extending along entire scutum, the former two vittae often entire, connected across posterior margin, hence scutum without distinct yellow or white prescutellar markings; postpronotal lobe mostly yellow, sometimes slightly dark (brown to black anteriorly); scutellum entirely yellow; pleural pattern complex; see description of *I. burmensis* for details. Subscutellum and mediotergite mostly yellow to brownish, laterally and dorsally brown.

**CHAETOTAXY AND VESTITURE.** Notopleural setae 2, postsutural supra-alar, postalar, anepisternal and one pair (apical) scutellar setae present; scapular, postsutural dorsocentral and katapisternal setae present or absent, scapular setae entirely lacking in the two specimens of *I. hancocki* sp. nov., but present in the two other species, although median pair lacking in all specimens of *I. taiwanensis* sp. nov. and sometimes also in *I. burmensis*. Lateral pair variable in size but usually distinct in the two latter species. Presutural dorsocentral, postpronotal, acrostichal and intra-alar setae lacking, median part of scutum with 10–16,

but usually not less than 12 rows of setulae, although in *I. sp. nov.* scutum presuturally appears to have sparser setulae.

#### **Legs** (Figs 13–17)

STRUCTURE AND CHAETOTAXY. Elongate, without overt features except spinose femora in both sexes. In two species (*I. burmensis* and *I. taiwanensis sp. nov.*) only forefemur spinose, with single row of 2–5 blackish spines ventrally on distal half, and other femora without any spines or setae, only setulae, whereas in *I. hancocki sp. nov.* all femora spinose, in two rows and much more extensively; midtibia with one apicoventral spine.

COLOURATION. Pattern complex and variable, with legs comprising whitish, yellowish, brownish and blackish parts. In *I. taiwanensis sp. nov.* legs more uniformly yellow probably due to immersion in alcohol. In extremely dark specimens of *I. burmensis* dark pattern is as follows: coxae entirely or partly blackish; trochanters entirely blackish; forefemur with incomplete narrow blackish ring at base and another preapically, both slightly interrupted ventrally; foretibia blackish; foretarsus blackish except basitarsus mostly whitish, blackish only apically; midfemur with incomplete blackish ring at apical 0.4; midtibia as foretibia, and midtarsus as foretarsus; hindfemur as in forefemur, but rings broader, each about 0.33 times as long as femur; hindtibia brownish-yellow; hindtarsus as in foretarsus.

#### **Wing** (Figs 18–19)

VENATION. Longitudinal veins generally straight, not sinuous; pterostigma about 6–8 times as long as wide; posterodistal lobe of cell bcu slightly shorter than, equal to, or about 1.5 times as long as distal section of vein  $A_1+Cu_2$ ; stump crossvein present in cell  $r_1$ , either indicated as fold or developed as vein, more or less aligned half way between crossveins R-M and DM-Cu; crossvein R-M aligned with, or slightly basal to, middle of cell dm; crossvein DM-Cu slightly oblique anterodistally; costal spine lacking; vein  $R_{4+5}$  dorsally with sparse small fine setulae to about level of crossvein DM-Cu.

PATTERN. Either dimidiate (in *I. burmensis* and *I. hancocki sp. nov.*), with anterior 0.4 of wing yellowish to brownish, with posterior margin of coloured area often brown, particularly over vein  $R_{4+5}$ , extending posteriorly only to vein  $R_{4+5}$  or slightly beyond, and without spots or bands, or pattern type extended dimidiate (in *I. taiwanensis sp. nov.*), with additional dark spots on posterior 0.6 of wing, especially over crossvein DM-Cu and distalmost section of vein M; cell bcu yellowish in all species.

#### **Abdomen** (Figs 20–21)

STRUCTURE. Strongly elongate, petiolate; syntergite 1+2 about as long as remaining preabdomen, broadened posteriorly, with distal 0.2 narrowed in dorsal view; tergite 6 of female 0.2–0.3 times as long as tergite 5; oviscapae about as long as, or longer than, preabdomen, conical at basal 0.2, remaining part cylindrical.

COLOURATION. Abdomen generally banded, with H-shaped or Y-shaped dark pattern on syntergite 1+2, with dark bifurcation always on T1, sometimes also on T2, posterior margin broadly yellow; remaining tergites with more or less discrete, alternating dark (usually brownish or blackish) and yellow posterior transverse bands.

CHAETOTAXY AND VESTITURE. Without obvious setae or with one or few at posterolateral corner of last tergite (both male and female), or with few setae posterolaterally on some sternites (females); syntergite 1+2 posterolaterally with large patches of short, dense and erect minute setulae in both males and females, arranged in numerous (ca 30) rows and sometimes with longer coarse dark setulae near these (stridulatory organ?).

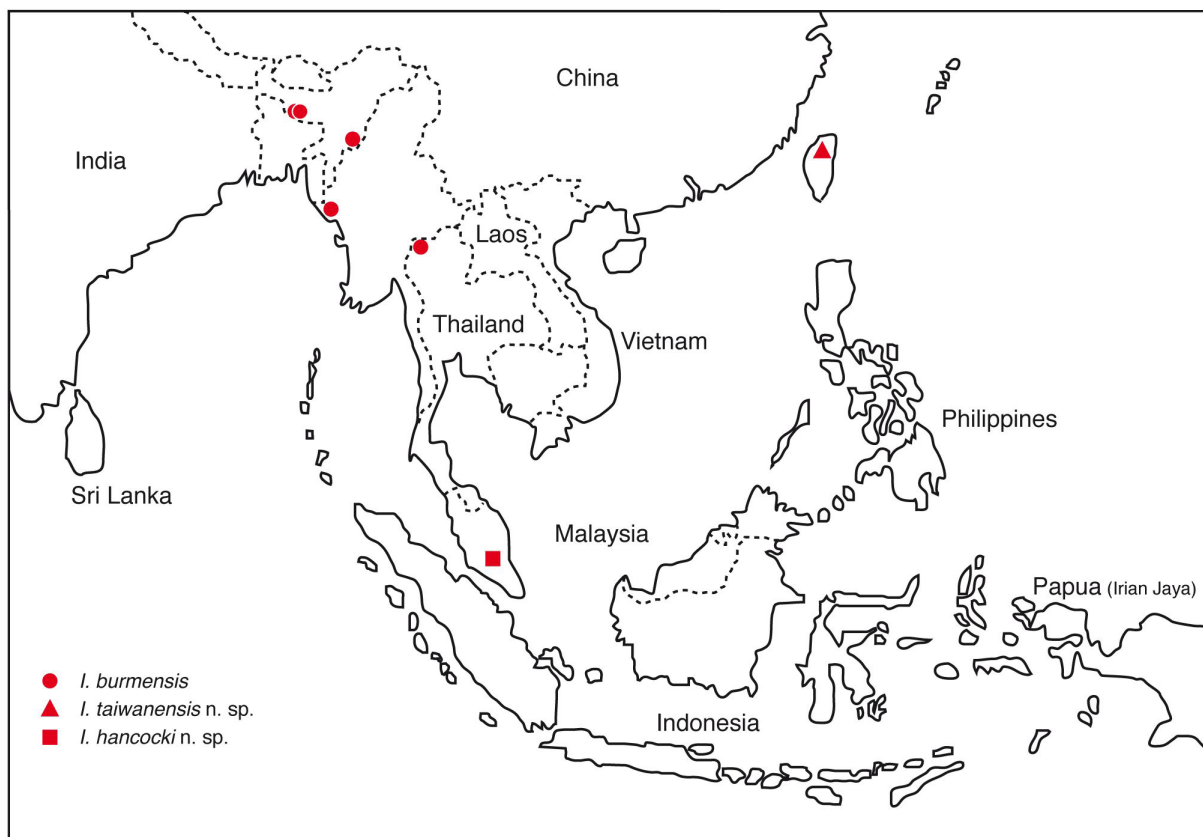
**Terminalia** (based on two species)

**Male** (Figs 22–26)

Epandrium triangular in lateral view, with elongate surstylus, about 10 times as long as wide, and forming 140°–160° with anterior margin of epandrium; surstylus distally with digitiform prolongation more or less aligned with surstylus, about as long as surstylus width at prenisetae level; proctiger (cerci) slightly to distinctly larger than epandrium, with long and thin hair-like setae, longer, denser and darker (brownish) in one species, shorter and sparser in the other; two small prenisetae; hypandrium and ejaculatory apodeme without overt features, the latter narrow, about 3–4 times as long as wide (at widest place, near apex). Phallus about 1.1–1.2 times as long as abdomen; glans with at least four separate sclerotized plates or structures (from base to tip): first sclerite brown, rather flat dome-like at base; second sclerite opposite first sclerite but slightly more distally, yellow, flat, longer than first sclerite, comprising basal lobe; third structure at middle of glans, cochleate, the most complex and conspicuous sclerotization in the glans; finally small curved brown plate at tip of glans.

**Female** (Figs 27–30)

Aculeus flat, about 10 times as long as wide; cercal unit unusually wide, distinctly rounded apically, with or without constriction, with 4 preapical marginal setulae and system of straight or curved longitudinal “canals” crowded toward tip (tip of aculeus illustrated by Hardy 1973: fig. 58e) or extending more proximally; eversible membrane: with 30–40 dense rows of small yellow denticles; denticles rhomboidal, length equal to width, 209–251  $\mu\text{m}$ , average 230  $\mu\text{m}$ ,  $n = 10$ ; denticles occupying basal 0.25–0.30 of length of eversible membrane, which in most of its length lacks denticles and is translucent grey. Spermathecae – 2, spherical or almost spherical (illustrated by Hardy 1973: fig. 58c).



**Fig. 1.** Collecting localities of *Ichneumonopsis* spp.

**Comments**

This genus has been poorly collected and documented except, perhaps, *I. burmensis* (Kovac *et al.* 2013). This situation, as well as the relative wide distribution (Fig. 1), attests to the possibility that additional species await discovery in the Oriental Region.

**Key to species of *Ichneumonopsis***

1. Dark dorsocentral and median scutal vittae connected via two transverse bands: one at level of supraalar seta and one along scutoscutellar suture; submedian yellow vitta divided into isolated anterior vitta and posterior oval spot; all femora with rows of spines anteroventrally and posteroventrally; scapular setae absent, dorsocentral and katapisternal setae present ..... *hancocki* sp. nov.
- Dark dorsocentral and median scutal vittae connected only via transverse band along scutoscutellar suture; submedian yellow vitta complete from anterior margin of scutum to dark transverse band along scutoscutellar suture; forefemur with about 2–5, usually 3–4, spines posteroventrally, other femora devoid of spines; scapular setae present, dorsocentral and katapisternal setae absent or dorsocentral setula-like ..... 2
2. Wing pattern more extensive than dimidiate (although containing elements of the dimidiate pattern of the other species), including posteriorly: blackish bands over distalmost section of vein M and over crossvein DM-Cu, blackish vein Cu<sub>1</sub> and its immediate vicinity and less discrete blackish spot over distal half of posterodistal lobe of cell bcu; remaining posterior half of wing appearing greyish or hyaline, depending on the light; spur vein (across cell r<sub>1</sub>) brownish and in greyish-black spot ..... *taiwanensis* sp. nov.
- Wing pattern dimidiate, with dark pattern restricted to anterior half of wing, extending slightly into cells br and r<sub>4+5</sub>; no discrete pattern in posterior half of wing, although posterior margin of wing broadly greyish; stump vein usually colourless and not in greyish-black spot ..... *burmensis* Hardy, 1973

*Ichneumonopsis burmensis* Hardy, 1973  
Figs 1–2, 7, 10, 13, 18, 20–23, 25, 27, 31–34

*Ichneumonopsis burmensis* Hardy, 1973: 133.

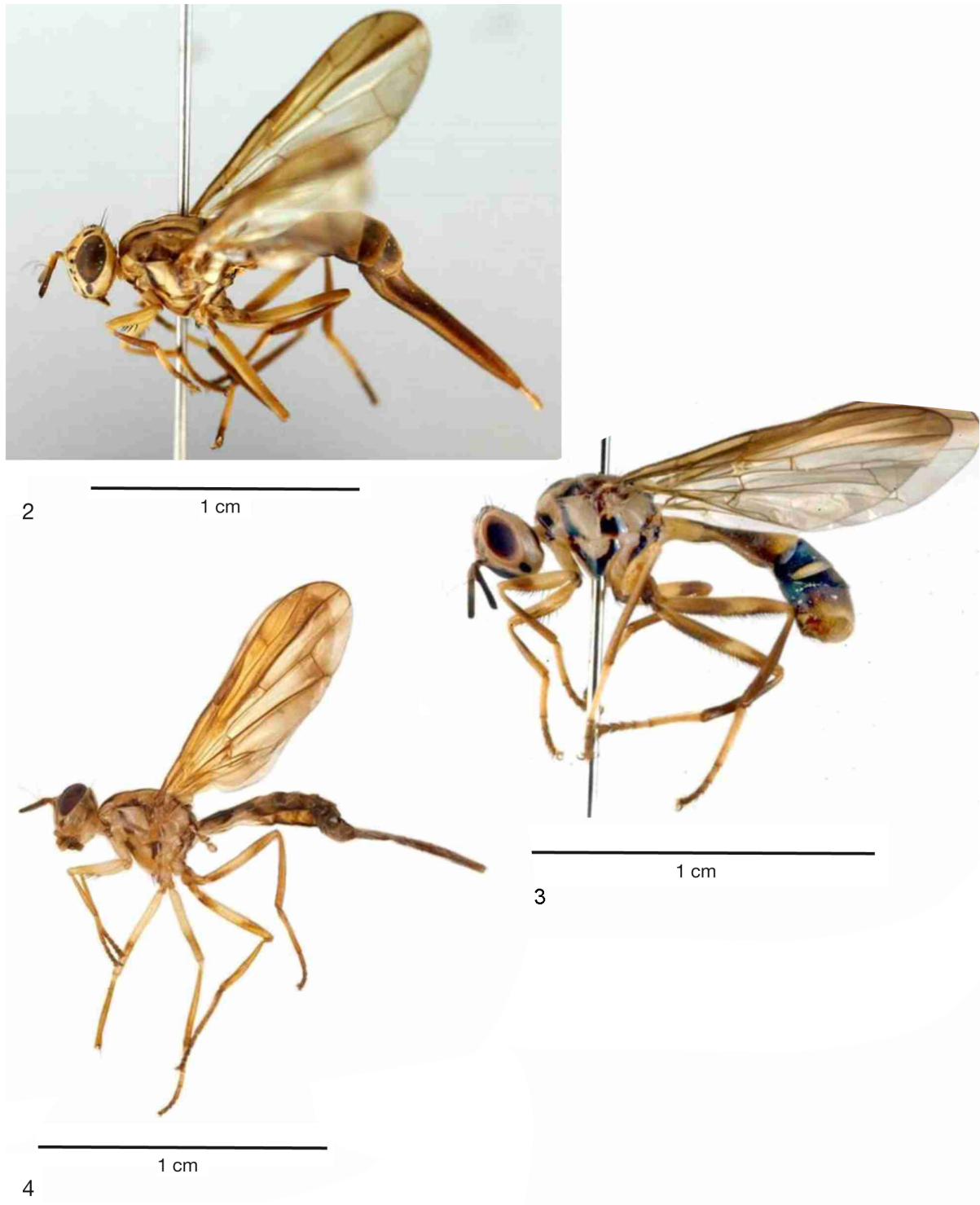
*Ichneumonopsis burmensis* – Hardy 1986: 54, 56 (key). — Drew & Hancock 1994: 830. — Norrbom *et al.* 1999b: 161. — Radhakrishnan 2000: 203 (first record for India). — Kovac *et al.* 2006: 184. — Kovac *et al.* 2013: 117 (biology and immature stages).

**Material examined**

MYANMAR: holotype, ♂, Mt. Victoria, Chin Hills, 1400 m, Apr. 1938, G. Heinrich leg. (BMNH); allotype, ♀, same data as holotype (BMNH).

INDIA: 1 ♀, Manipur, Churachandpur, 915 m, 10 May 1976, S. Biswas leg., no. B 44, Ghorpade Collection Bangalore, purchased by Tel Aviv University, 2002 (SMNHTAU); 1 ♂, 2 ♀♀, Meghalaya, Nongpoh Forest, 25–28 Apr. 1980, A. Freidberg leg. (SMNHTAU).

THAILAND: all specimens were reared by D. Kovac from bamboo shoots of *Pseudoxytenanthera albociliata*, collected in North Thailand, Mae Hong Son, Pangmapha, near Ban Nam Rin, all deposited in SMF or SMNHTAU: larva collected 1 Dec. 2008, adult 22 May 2009 (1 ♂); larva collected Nov. 2008, adult 16 May 2009 (1 ♂, sample 12); alk 29, probe 13, larva collected 21 Nov. 2008, puparium 27 Jan. 2008, adult 17 Mar. 2009 (1 ♀, sample 29); larva collected 31 Nov. 2008, adult 17 Mar. 2009 (1 ♀, sample 2); larva collected Nov. 2008, adult 29 May 2009 (1 ♂, sample 13); larva collected 21 Nov. 2008, adult 29 May 2009 (1 ♂, sample 14); larva collected 21 Nov. 2008, adult 29 May 2009 (1 ♂, sample 14);



**Figs 2–4.** *Ichneumonopsis* spp., habitus. 2. *I. burmensis* Hardy, 1973, ♀. 3. *I. hancocki* sp. nov., holotype, ♂. 4. *I. taiwanensis* sp. nov., holotype, ♀.



larva collected 15 Nov. 2009, puparium 21 Dec. 2009, adult 7 Apr. 2010 (1 ♂, Z56/1/09); larva collected 15 Nov. 2009, adult 30 Apr. 2010 (1 ♂, Z49/2/09); larva collected 15 Nov. 2009, puparium 17 Dec. 2009, adult 30 Apr. 2010 (1 ♀, Z55/1/09); larvae collected 28 Nov. 2009, adults 3 May 2010 (1 ♂, 1 ♀, Z57/2/09); larva collected 28 Nov. 2009, adult 7 May 2010 (1 ♂, Z57/3/09); larva collected 15 Nov. 2012, adult 11 May 2013 (1 ♀, Z68/2/12b).

### Redescription

Hardy's (1973) original description is mostly adequate, requiring only a few comments and a description of the male terminalia (which is lacking in the original description).

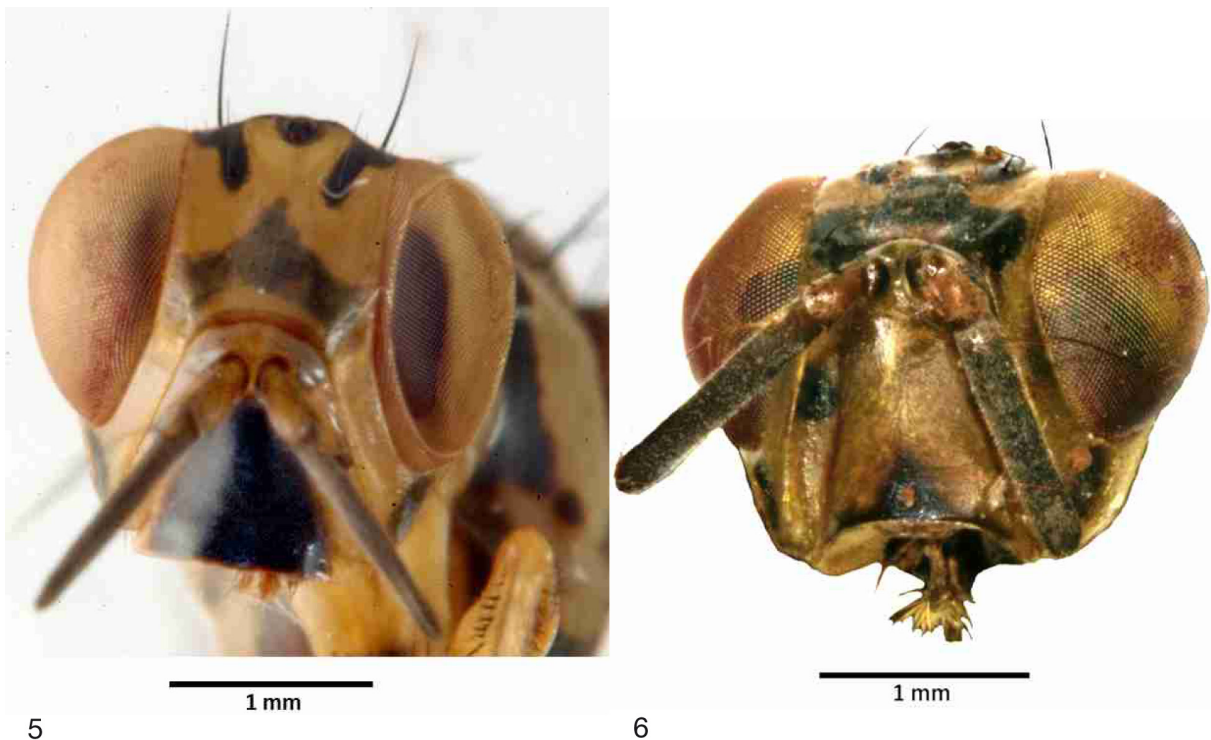
#### Head (Fig. 7)

COLOURATION. Number of lateral facial spots varies between 2 (Hardy 1973: 133, fig. 58b) and 4, spot pattern sometimes asymmetrical; parafacial sometimes with small dark spot in addition to large dorsal spot.

CHAETOTAXY. Tiny frontal seta or enlarged setula sometimes present (more so in females) slightly dorsal to large parafacial spot.

#### Thorax (Figs 7, 10)

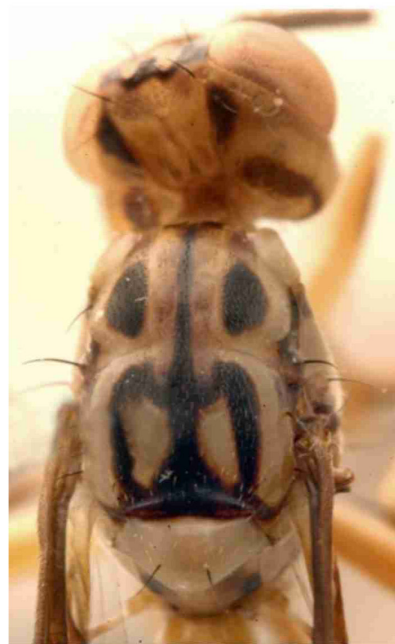
COLOURATION. Scutal pattern (Fig. 7) comprised of vittae best developed in dark specimens (from Thailand): lateral (notopleural) vitta (pair) entirely blackish or brownish centrally; dorsocentral vitta (pair) extending from anterior brown margin of postpronotum as nearly complete vitta (narrowly but distinctly interrupted at transverse suture) to scutoscuteellar suture, and both these vittae connect by blackish transverse band along this suture; median vitta (single) narrower and paler than dorsocentral vitta, extending from scapular setae to scutoscuteellar suture, also connecting to scutoscuteellar band; (pair of) complete yellow submedian bands result, extending from anterior margin of scutum to blackish



**Figs 5–6.** *I. hancocki* sp. nov., head, anterior view. **5.** ♂. **6.** ♀.



7



2 mm

8



2 mm

9

**Figs 7–9.** *Ichneumonopsis* spp., head and thorax, dorsal view. 7. *I. burmensis* Hardy, 1973. 8. *I. hancocki* sp. nov. 9. *I. taiwanensis* sp. nov.

scutoscutellar band, each about as wide as dorsocentral vitta. In paler specimens (from India) dark bands much paler and reduced, mostly less contrasted with yellow background, although brownish-yellow lateral vitta well contrasted with adjacent yellow areas, and narrow median vitta visible throughout its length to or almost to transverse (scutoscutellar) band. Pleural pattern (Fig. 10; best developed in dark specimens) comprised of black vertical or oblique bands and/or spots on whitish or yellowish background as follows: proepisternum black, black extending dorsally to dark area anterior to postpronotum, ventrally to proepimeron (not entirely black), and further “extending” ventrally onto forecoxa dorsobasally; anepisternum with large triangular stripe extending from posterior end of postpronotum and notopleuron to anteroventral corner of anepisternum, just beyond delicate suture extending from near this corner to anepisternal seta; katepisternum with wide “v”-like black pattern, covering most of sclerite except dorsomedially and ventrally where yellowish; posterior arm of “v” “extending over anepimeron, including greater ampulla; narrow sinuous black band extending vertically along posterior half of meron, around anterodorsal margin of spiracle, penetrating into ventral margin of katatergite and reaching base of halter. Postcoxal bridge sclerotized and black. In specimens from India dark pleural pattern mostly brown or dark yellow. Scutellum whitish, narrowly darkened (brownish or blackish) basally; subscutellum pale or dark yellowish, with brownish or blackish lateral and dorsal margins. Calypteres short, slightly bulging anterolaterally.

#### Legs (Fig. 13)

As for genus.

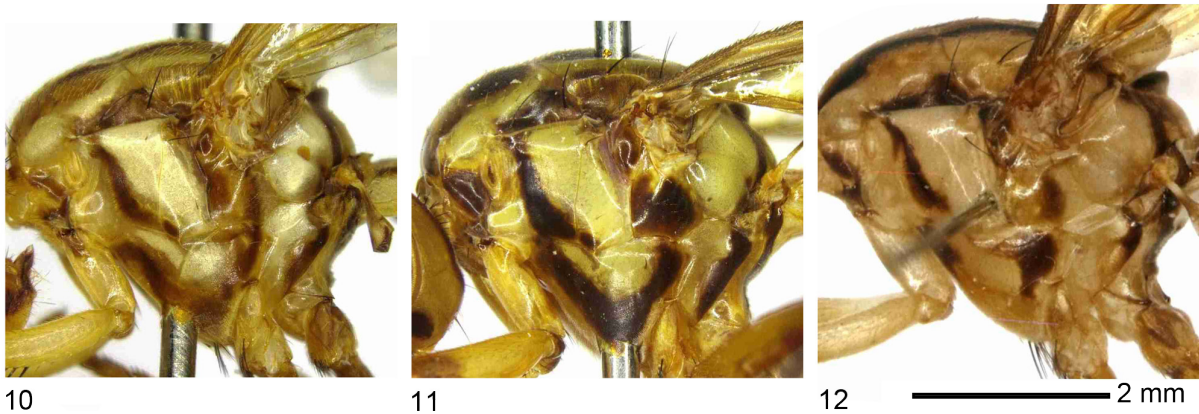
#### Wing (Fig. 18)

Pattern mostly as in Hardy (1973: 133, fig. 58d), with following additions: dark pattern along and posterior to last section of vein  $R_{4+5}$  distinctly darker than adjacent parts of pattern; cell  $bcu$  and surrounding yellowish.

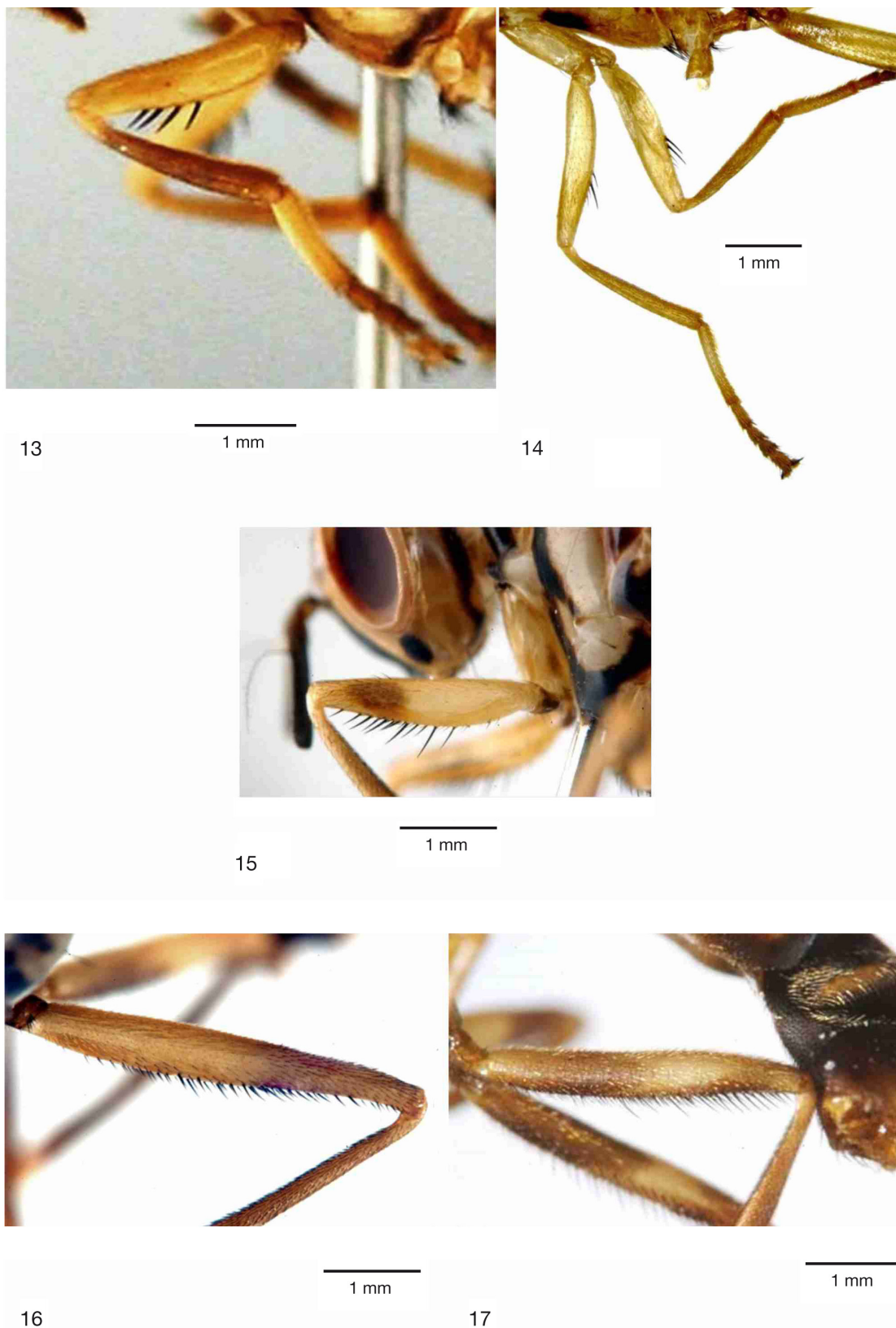
#### Abdomen (Figs 20–21)

TERMINALIA, MALE (Figs 22–23, 25). Digitiform prolongation of surstylus about four times as long as wide; setae on epandrium conspicuous, similar in appearance and density to those on proctiger; non-sclerotized part of glans beyond cochleate sclerotization elongate, about 4 times as long as wide, apically with small sclerotized sclerite about 0.25–0.30 times as long as width of cochleate complex.

TERMINALIA, FEMALE (Figs 27–29). Cercal unit relatively broad, without constriction, with system of longitudinal “canals” crowded toward tip (tip of aculeus illustrated by Hardy 1973: fig. 58e); sensory



**Figs 10–12.** *Ichneumonopsis* spp., thorax, lateral view. **10.** *I. burmensis* Hardy, 1973. **11.** *I. hancocki* sp. nov. **12.** *I. taiwanensis* sp. nov.



**Figs 13–17.** *Ichneumonopsis* spp., legs. **13.** *I. burmensis* Hardy, 1973, foreleg. **14.** *I. taiwanensis* sp. nov., foreleg. **15.** *I. hancocki* sp. nov., foreleg. **16.** *I. hancocki* sp. nov., midleg. **17.** *I. hancocki* sp. nov., hindleg.

setae short, about 0.12–0.16 times as long as width of aculeus at this level; spermathecae illustrated and described by Hardy (1973: fig. 58c), who wrote: “Two small round spermathecae present”. The spermathecae, however, were not found in our dissections.

**Measurements** (length, in mm)

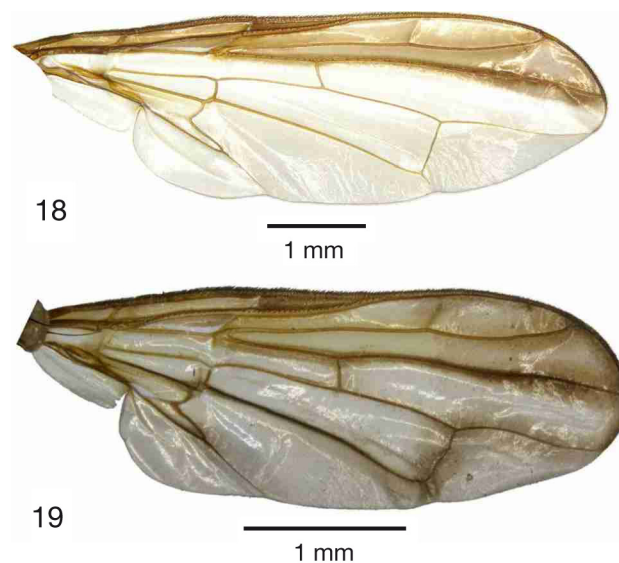
Male: body: 11.5–13.5; wing: 10.0–10.6; female: body, including oviscapae: 18.0–24.1; wing: 10.5–11.8; oviscapae: 6.9–8.5.

**Biology and immature stages** (Figs 31–34)

A detailed biological account of this species was the subject of another publication (Kovac *et al.* 2013). Only the following few relevant comments have been taken from that publication in order to add some perspective to the present one. In north-west Thailand *I. burmensis* larvae were found to develop in shoots of the bamboo *Pseudoxycanthus albociliata* (Munro) Nguyen (Fig. 31). In our study area the bamboo clumps of *P. albociliata* grew in open clearings, at the edges of fields, or in secondary forest at altitudes of 600–1200 m. In addition, we have one, newly reared specimen of *I. burmensis* from a side branch of a bamboo shoot of *Dendrocalamus strictus* (Roxburgh) Nees.

Each infested bamboo shoot usually contained only one internode inhabited by a single *I. burmensis* larva (Fig. 33) which pupariated in a cocoon (Fig. 34). The infested internode was the 4<sup>th</sup>–6<sup>th</sup> internode below the apex. The larvae fed mainly in the lower half of the internode on the white pith found in the internode cavity, and also damaged the bamboo wall at the base of the internode. Due to these feeding activities the apical 4–5 internodes of the bamboo shoot died off and fell to the ground, with the infested internode remaining at the apex of the bamboo shoot (Fig. 32).

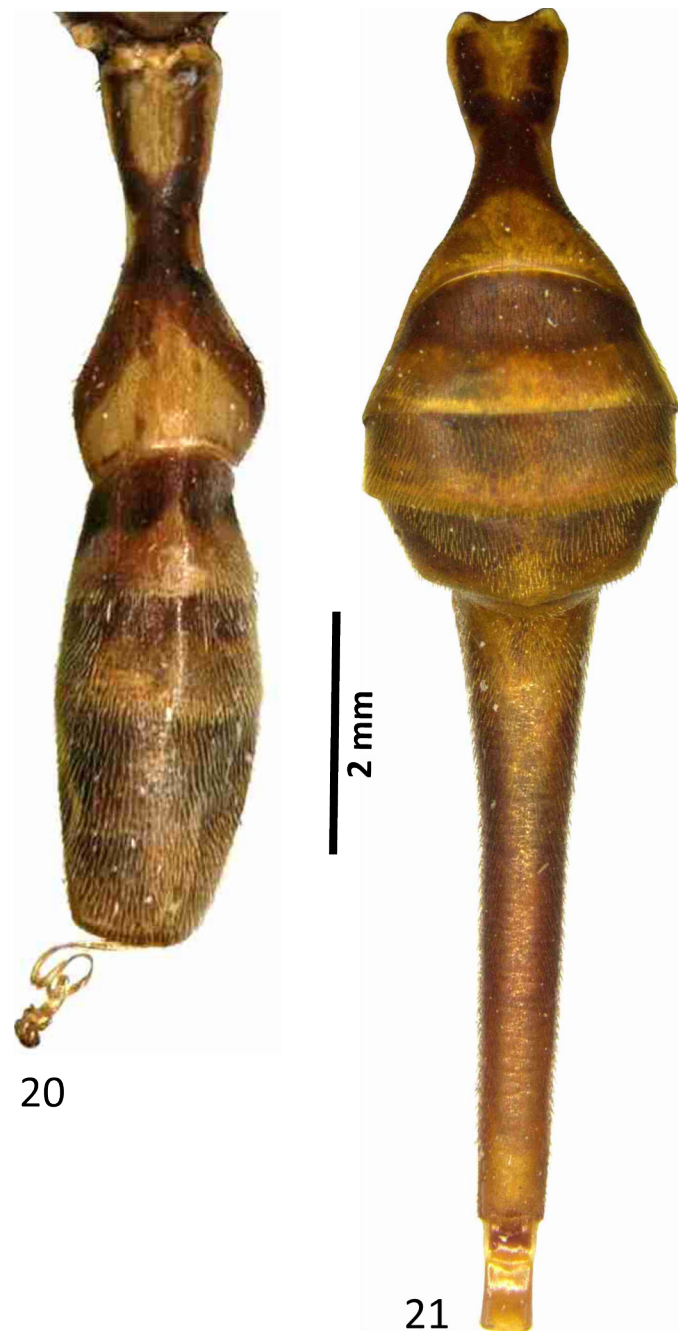
The fully-grown larvae usually moved to the base of the internode cavity, where they created a cocoon by tearing off strips of vascular bundles from the bamboo wall (Fig. 33) and enclosing themselves using finer bamboo particles probably mixed with frass. The larvae pupariated in the cocoon (Fig. 34) and remained there for about three months during the dry season. During that time the upper two-thirds of the infested internode broke off and fell to the ground, but the puparium usually remained in place at the tip of the bamboo shoot. However, sometimes the larvae pupariated in the upper part of the internode and then also fell with it to the ground still enclosed by the internode cavity and the cocoon.



**Figs 18–19.** *Ichneumonopsis* spp., wing. **18.** *I. burmensis* Hardy, 1973. **19.** *I. taiwanensis* sp. nov.

The larvae of *I. burmensis* were found in the field in October and November. They pupariated in November or December and the adults emerged between the end of March and beginning of May. Most (and the largest) shoots of *P. albociliata* appeared between September and November, but smaller shoots also appeared after the start of the rainy season in June and July. Combining the phenological data obtained in India and Thailand, it appears that *I. burmensis* is bivoltine, since the adults were collected or reared from larvae during two distinct seasons, i.e., March – May and October – November.

The bamboo microhabitat of *I. burmensis* is similar to that of the Gastrozonini *Anoplomus rufipes* Hardy, 1973. Larvae of *A. rufipes* also colonized a single internode of a living bamboo shoot, namely the 5<sup>th</sup>–6<sup>th</sup>



**Figs 20–21.** *Ichneumonopsis burmensis* Hardy, 1973, abdomen, dorsal view. 20. ♂. 21. ♀.

internode below the apex (Kovac 2015). However, they generally inhabited a larger bamboo species, *Cephalostachyum pergracile* Munro, and there the infested internodes contained up to 40 larvae. Unlike *A. rufipes* and other Gastrozonini, the larvae of *I. burmensis* did not skip and they pupariated in the internode and not in the soil (thereby removing the need to skip).

### Distribution

India (Meghalaya, Manipur), Myanmar and Thailand (Mae Hong Son).

### Comments

*Ichneumonopsis burmensis* was known from eastern India (Meghalaya, Manipur: Drew & Hancock 1994, Radhakrishnan 2000), western Myanmar (Hardy, 1973) and northwest Thailand (Kovac *et al.* 2013 and the present publication). It is probably more widespread than indicated, and we assume that it occurs at least in countries where the associated bamboo species grows, i.e., in Nepal, India, Bangladesh, Myanmar (eastern and southern parts), Thailand, Laos and Vietnam (Ohrenberger 1999). The Thai population is darker than the Indian population.

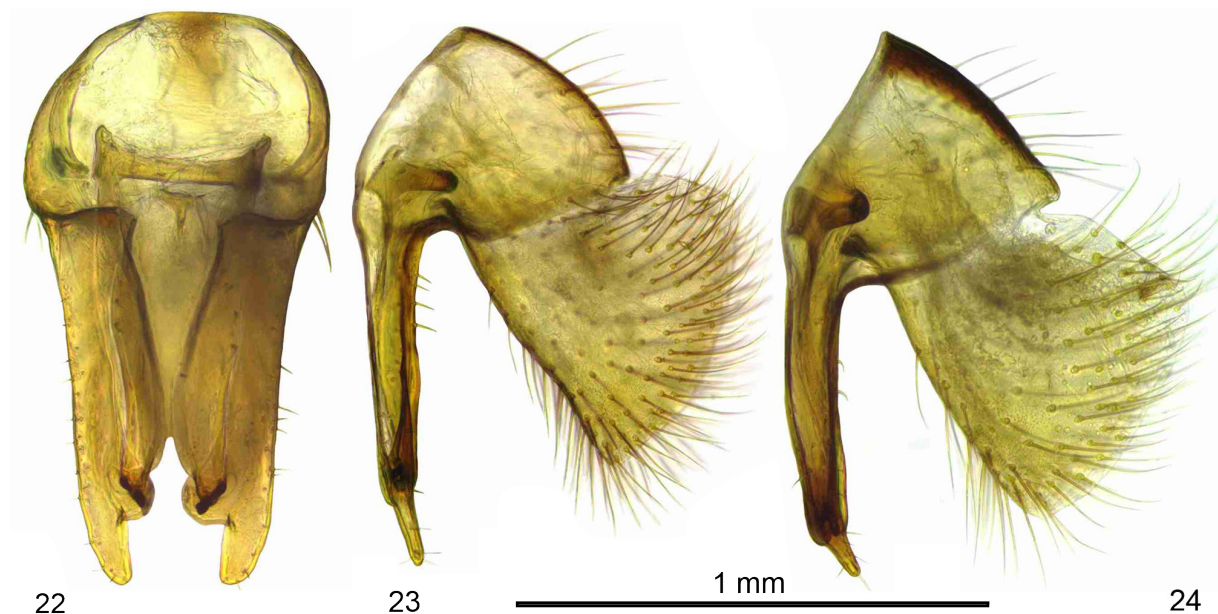
### *Ichneumonopsis hancocki* sp. nov.

[urn:lsid:zoobank.org:act:0189FDE4-39B5-4F52-9C15-7777015C5006](http://urn:lsid:zoobank.org:act:0189FDE4-39B5-4F52-9C15-7777015C5006)

Figs 1, 3, 5–6, 8, 11, 15–17

### Diagnosis

This species is similar to *I. burmensis*, differing from it primarily in its smaller size, darker colouration (e.g., face of male mostly or entirely black, compared with predominantly yellow in *I. burmensis*) and in all three femora being extensively spinose in both sexes (only forefemur with only about four spines in *I. burmensis*). It is also similar to *I. taiwanensis* sp. nov. in its relatively small size, but it differs from this species by the more restricted dimidiate wing pattern and by all femora being spinose (wing pattern extended-dimidiate and only forefemur spinose in *I. taiwanensis* sp. nov.).



**Figs 22–24.** *Ichneumonopsis* spp., epandrium. **22.** *I. burmensis* Hardy, 1973, anterior view. **23.** *I. burmensis* Hardy, 1973, lateral view. **24.** *Ichneumonopsis taiwanensis* sp. nov., lateral view.

### Etymology

This species is named after D.L. Hancock, a friend and prolific tephritidologist, who contributed much to the knowledge on Gastrozonini, including useful revisions of this group (Hancock 1999; Hancock & Drew 1999).

### Material examined

#### Holotype

MALAYSIA: ♂, Selangor, “Old Gombak Road”, on stump of freshly cut bamboo shoot of *Gigantochloa scortechinii*, 17 Oct. 2003, P. Dohm leg., pinned directly and in good condition [M03/1096] (SMF).

#### Paratype

MALAYSIA: 1 ♀, State of Selangor, Ulu Gombak, W Malaysia, 4 Jun. 1970, James E. Tobler leg. [Genus and sp. prob. new, det D.E Hardy 1985. // Related to *Ichneumonopsis*] original label, written with pencil on paper (CAS).

### Description

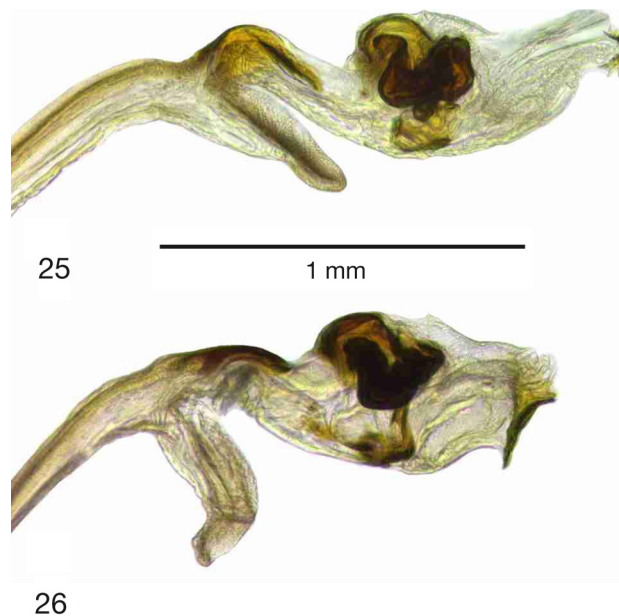
Only differences from *I. burmensis* are noted.

#### Head

COLOURATION. Ocellar and orbital spots united; frontal, genal and occipital dark spots similar to those of *I. burmensis*, although some of these less obvious in female paratype; male face with one lateral spot, and entire large bulging triangular central area black; parafacial spots lacking; female face only with ventral margin blackish, extending slightly dorsomedially as small triangle.

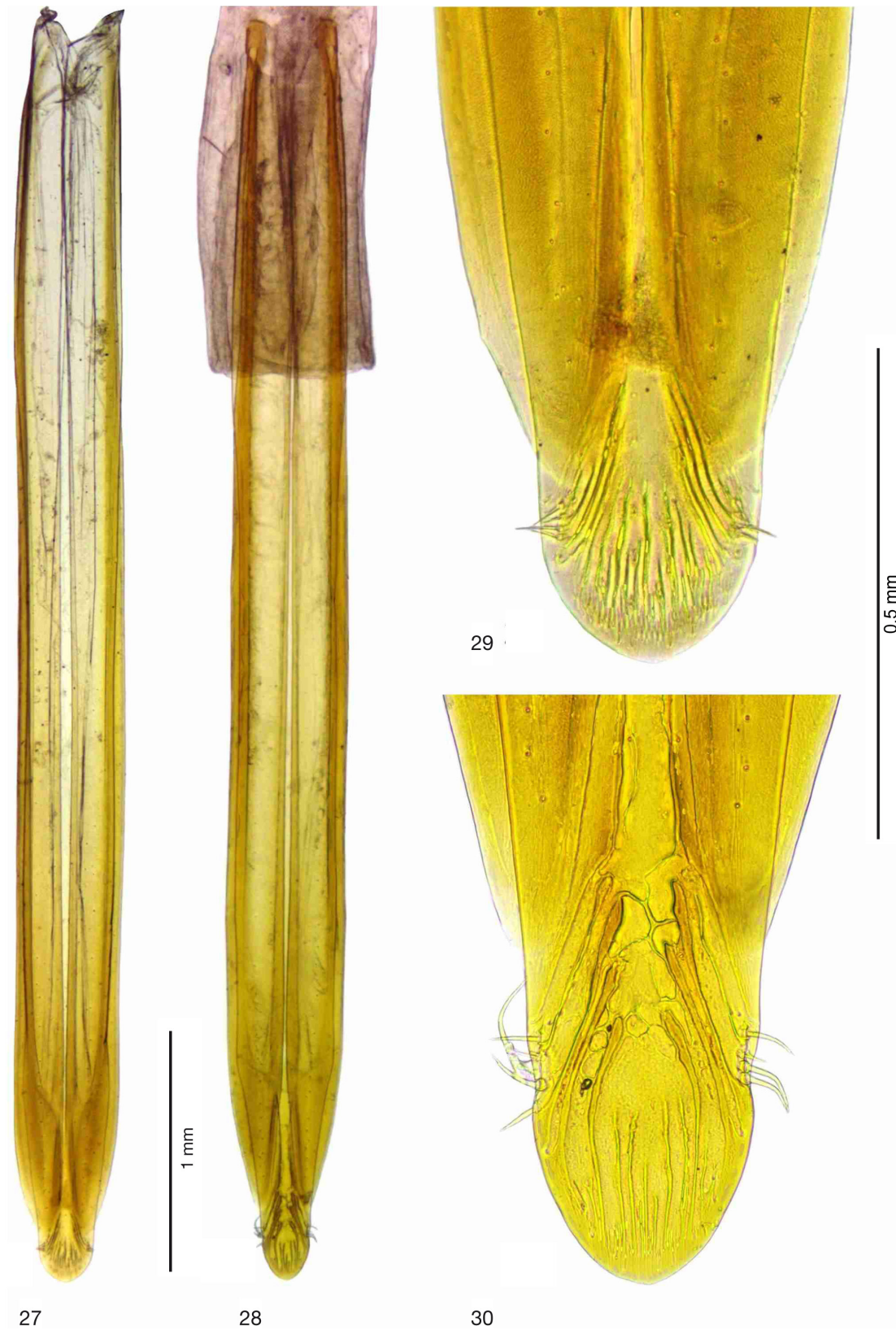
#### Thorax

COLOURATION. Dark dorsocentral vitta divided into two parts: short and wide oval presutural spot clearly separated from postsutural vitta-like section; these sections both unite along scutoscuteellar suture and at level of supra-alar seta, thus enclosing (pair of) yellow oval spots between dorsocentral and median vittae; median vitta distinctly broadened posteriorly, particularly in posterior quarter where it merges



**Figs 25–26.** *Ichneumonopsis* spp., glans. **25.** *I. burmensis* Hardy, 1973. **26.** *I. taiwanensis* sp. nov.





**Figs 27–30.** *Ichneumonopsis* spp., aculeus. **27.** *I. burmensis* Hardy, 1973, entire aculeus. **28.** *I. taiwanensis* sp. nov., entire aculeus. **29.** *I. burmensis* Hardy, 1973, aculeus apex. **30.** *I. taiwanensis* sp. nov., aculeus apex.



31



32



33



34

**Figs 31–34.** *Ichneumonopsis burmensis* Hardy, 1973, biological traits. **31.** Bamboo shoots of the host plant, *Pseudoxytenanthera albociliata*, at the edge of an abandoned field in northern Thailand in November. The shoots are 2–5 m tall and up to 2 cm wide at the base. **32.** Bamboo internode (ca 7 mm wide) infested by an *I. burmensis* larva. The internode is located at the tip of the bamboo shoot, because the apical 4–5 internodes have died and fallen to the ground. **33.** A fully-grown *I. burmensis* larva (length ca 14 mm) that has started to bite off strips of vascular bundles from the bamboo shoot wall (on the right) in order to create a cocoon. **34.** *I. burmensis* puparium (length ca 8 mm) located in the internode cavity at the base of the infested internode. The upper part of the internode has broken off. Side branches growing from the basal bud were partly removed.

with black transverse scutoscutellar band. Pleural pattern as in *I. burmensis*, although dark extension “into” forecoxa lacking and forecoxa entirely yellow.

### Legs

All femora spinose both anteroventrally and posteroventrally (spines mixed with regular setae), although posteroventral row with generally longer spines, and rows of spines denser and longer in male than in female, extending in male along distal half of femur or more, whereas in female extending along distal 0.33 almost to middle of femur. Male (only approximate numbers as spines tend to grade to regular setae): forefemur: 11–12 spines posteroventrally and 9–10 spines anteroventrally; midfemur: 20 and 15, respectively; hindfemur: 20 and 20, respectively; in addition ventral surface of midfemur and hindfemur centrally with additional setae or spines interspaced between two major rows. Female: spines considerably shorter than in male and more difficult to count, especially as tibiae are folded over respective femora, hiding some spines. Female’s numbers appear to be half of male numbers or even fewer. Colouration: forecoxa entirely yellow; forefemur with incomplete brownish ring at distal 0.4; foretibia, and also other tibiae, entirely brown or brownish; foretarsus, and also other tarsi, brownish, except metatarsi yellow; midfemur at nearly distal half with incomplete ring, more distinct at posterior aspect; hindfemur brown to blackish at approximately basal half, more obvious ventrally, with yellow gap dorsally; similar, but smaller and paler incomplete ring at distal 0.33 of femur.

### Wing

VENATION. Posterodistal lobe of cell  $bcu$  1.5–2.0 times as long as vein  $A_1+Cu_2$ .

PATTERN. Marginal band uniformly yellow, not particularly darker around apical section of vein  $R_{4+5}$ .

### Abdomen

As for genus; terminalia not dissected.

### Measurements (length in mm)

Male: body: 11.0; wing: 10.2; female: body, including oviscap: 16.8; wing: 10.0; oviscap: 7.3.

### Distribution

West Malaysia.

### Comments

Being singletons, the holotype and paratype were not dissected. The *I. hancocki* sp. nov. male was collected by Patrick Dohm on a freshly cut bamboo shoot of *Gigantochloa scortechinii*. The bamboo shoot was about 2.5 – 3.5 m high and the upper part of the shoot (ca 80 cm long) was cut off and placed on the ground. The *I. hancocki* sp. nov. male alighted at the cut surface of the upright bamboo stump about half an hour after the apex of the shoot was cut off.

*Ichneumonopsis taiwanensis* sp. nov.

[urn:lsid:zoobank.org:act:D6D4B9D9-4053-4035-B51F-49D7BD3AD822](https://zoobank.org/act:D6D4B9D9-4053-4035-B51F-49D7BD3AD822)

Figs 1, 4, 9, 12, 14, 19, 24, 26, 28, 30

### Diagnosis

This species is similar to *I. burmensis* in having only the forefemur spinose, differing from it primarily in having 2–3 spines (but see Legs below) posteroventrally on forefemur (2–5, usually 4 spines in *I. burmensis*), and in the more extensive wing pattern, extending into the posterior part of the wing (wing pattern dimidiate and restricted to anterior half of wing in *I. burmensis*). *I. taiwanensis* sp. nov. differs

from *I. hancocki* sp. nov. by the more extensive wing pattern, (dimidiate in *I. hancocki* sp. nov.) and by having only the forefemur spinose (all femora spinose in *I. hancocki* sp. nov.).

### Etymology

This species is named after the country where the types were found, Taiwan.

### Material examined

#### Holotype

TAIWAN: ♀, Nantu, Yuchi, colour trap (see Comments), 24 Apr. 2000, C.Y. Lee leg., double mounted, minuten pin on a block of foam and in good condition (most of the right antenna is missing) (NTU).

#### Paratypes

TAIWAN: same collection data as holotype, but different dates and sometimes gender: 1 ♂, 2 ♀♀, 9 Jul. 2000; 1 ♀, 7 May 2000; 1 ♂, 21 May 2000 (NTU, 3 specimens; SMNH-TAU, 1 specimen; SMF, 1 specimen).

### Description

Only differences from *I. burmensis* are noted.

#### Head

COLOURATION. No discrete lateral facial spots present, although ptilinal suture between face and parafacial somewhat blackened, occasionally broadened into indistinct asymmetrical ventral dark spots; parafacial with barely distinct blackish spot aligned slightly ventral to base of antenna.

CHAETOTAXY. Frontal setae 1 or 2, anterior seta moderately long; posterior seta present only in one male, setula-like, barely distinguishable from adjacent setulae.

#### Thorax

COLOURATION. Dark lateral (notopleural) vitta mostly dark brown, slightly brownish centrally; dorsocentral vitta more narrowly interrupted at transverse suture; median vitta short, extending across transverse fissure, about as long as width of yellow gap between both dorsocentral vittae; the two yellow submedian bands united along most of their length. Pleural pattern generally as in *I. burmensis*, although greatly reduced both in intensity and size of dark areas, but all parts of pattern still represented by smaller black or blackish areas (a kind of transition form between dark and pale specimens of *I. burmensis*): katepisternal “v”, for example, reduced into two relatively small black spots comprising apices of arms of “v”, although connecting corner of “v” distinctly yellow, but obvious.

#### Legs

Total number of spines and setulae on forefemur 2–6, total number of only large spines 2–5 (average 3.2). Colouration: varies between entirely yellow, often with some vaguely darker areas, to slightly darker pattern including brownish traces of femoral rings, brownish-yellow tibiae, and brownish three or more tarsomeres.

#### Wing

PATTERN. Similar to that of *I. burmensis*, although more extensive; pattern at anterior half of wing includes dark (greyish-black) spot over spur vein across cell  $r_1$ ; pattern at posterior part of wing comprises mainly blackish band over distalmost section of vein M and arm of this band over crossvein DM-Cu, blackish vein Cu<sub>1</sub> and its immediate vicinity and less discrete blackish spot over distal half of posterodistal lobe of cell bcu; remaining posterior half of wing appearing greyish or hyaline, depending on the light.

**Abdomen**

TERMINALIA, MALE (Figs 24, 26). Digitiform prolongation of surstylus about twice as long as wide; setae on epandrium not conspicuous, shorter, paler and sparser than those on proctiger; non-sclerotized part of glans beyond cochleate sclerotization short, about as long as wide, apically with large sclerotized sclerite about 0.6 times as long as width of cochleate complex of glans.

TERMINALIA, FEMALE (Figs 28, 30). Cercal unit with slight constriction aligned with sensory setae; setae clearly larger than those of *I. burmensis*, about 0.25 times as long as width of aculeus at this level; system of longitudinal “canals” crowded along margin from base to tip.

**Measurements** (length, in mm)

Male: body: 12.4; wing: 10.9; female: body, including oviscape: 13.8–16.8; wing: 8.4–11.5; oviscape: 4.6–6.6.

**Comments**

This species was discovered in Taiwan by Hong-Yih Chang and treated in his dissertation (Chang 2001). Altogether, eleven specimens were collected by C.Y. Lee in the Nantu County (ca 120°50′–20°59′ E, 23°49′–23°66′ N, altitude 650–740 m) by using colour sticky traps. However, only six specimens were found at the Department of Entomology at the National Taiwan University. The specimens were collected near cultivated bamboo areas containing mainly *Dendrocalamus latiflorus* Munro (local name: Ma Bamboo), and some *Phyllostachys makinoi* Hayata (Makino Bamboo) and *P. edulis* (Carrière) J. Houzeau de Lehaie (Mao Bamboo). Like many other species described from Taiwan (Norrbon *et al.* 1999b), this species can be expected to be a Taiwan endemic.

**Discussion**

The accumulation of scientific knowledge and data is usually a gradual and painstaking process, and analysis and conclusions based on the accumulated data constitute further steps in scientific thinking that are often involved in debate and reconsiderations. The current study is no exception, and *Ichneumonopsis* represents an interesting example of biotaxonomy studies and the concurrent debate. Hence, the purpose of this brief discussion is to summarize the current taxonomic status of this genus and to offer additional approaches. Hardy (1973) described *Ichneumonopsis* and placed it in the Adramini. Since then the taxonomic position of *Ichneumonopsis* has become a matter of mini-debate between fruit fly researchers. Hancock (1986), Drew & Hancock (1994) and Drew & Romig (2013) included *Ichneumonopsis* within the Dacini, whereas others (Norrbon *et al.* 1999b; Kovac *et al.* 2006) placed it in the Gastrozonini. None of the above workers supported a return to the Adramini, an assignment recognized by all relevant experts as incorrect. The Dacini constitutes a large group, with ca 700 described spp. (e.g., Drew & Romig 2013; White 2006). It is also a very homogenous group, with several unique and distinctive synapomorphies that are highly consistent, almost without exceptions. The wing venation provides at least two synapomorphies unknown in other tephritids: a (usually) long posterodistal lobe of cell bcu, sometimes extending nearly to wing margin (shorter in other tephritids); cell bm about twice as wide as cell bcu (about as wide as cell bcu in all other tephritids); and males and females also have unique terminalia. None of these apomorphies occur in *Ichneumonopsis*. However, several abdominal synapomorphies (female’s T6 greatly reduced and hidden below T5; male often with a pecten of setae posterolaterally on T3, probably used for audible stridulation, and usually with a pair of large depressed areas (ceromata) on T5, probably secreting pheromones) that occur in *Dacus* and *Bactrocera* are, as in *Ichneumonopsis*, absent in the primitive Dacini genus *Monacrostichus*. Kovac *et al.* (2013), however, have provided convincing biological evidence that at least one species of *Ichneumonopsis* develops in bamboo host plants, while collection data also suggests a bamboo relationship in the other two species.

It is worth noting that bamboo species are the hosts of most Gastrozonini but only of some Acanthonevrini (where decaying tissue is generally used). Although *Ichneumonopsis* is morphologically an atypical gastrozonine, it still shares the somewhat weak synapomorphies of that group (antenna with spine-like setulae on pedicel, and arista plumose, with long rays; aculeus broad and flat). Conversely, it does not share any of the distinctive synapomorphies of the Dacini, or the single consistent apomorphy of the Adraminae (setulose pleurotergum), and it also does not share the rather weak apomorphies of the Acanthonevrini, some of which breed in bamboo. In our opinion, these accumulated data together comprise convincing evidence that *Ichneumonopsis* is a gastrozonine and not, as suggested by Hancock (1986) and Drew & Hancock (1994), a primitive dacine. A phylogenetic molecular study of the Gastrozonini may help further to resolve this debate.

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