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Review of the genus *Indocryphalus* Eggers, 1939 (Coleoptera, Curculionidae, Scolytinae) in Taiwan with a new species

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ABSTRACT: A new species of ambrosia beetle *Indocryphalus chiyui* Lin & Beaver (tribe Xyloterini LeConte, 1876) from Taiwan is described. The species is monogamous and xylomycetophagous, breeding in *Castanopsis cuspidata* var. *carlesii* (Hemsl.) Yamazaki (Fagaceae). *Indocryphalus sordidus* (Blandford) is recorded for the first time from Taiwan. Diagnostic characters, biological data and a key to species of *Indocryphalus* in Taiwan are provided.

KEY WORDS: Ambrosia beetle, Xyloterini, *Castanopsis*, *Indocryphalus chiyui*, *Indocryphalus pasohensis*, *Indocryphalus sordidus*.

INTRODUCTION

The tribe Xyloterini LeConte, 1876, in the weevil subfamily Scolytinae currently includes only three genera, *Indocryphalus* Eggers, 1939 (=*Dendrotrypum* Schedl 1951), *Trypodendron* Stephens, 1830 (=*Xyloterus* Erichson, 1836), and *Xyloterinus* Swaine, 1918 (Wood, 1986; Alonso-Zarazaga and Lyal, 2009; Johnson *et al.,* 2020). *Indocryphalus* was established by Eggers (1939) as a monotypic genus for *Indocryphalus malaisei* Eggers from Myanmar. Schedl (1951), Browne (1970) and Beaver (2000) revised the genus, and a cladistic analysis was recently provided by Cognato *et al*. (2015). Ten *Indocryphalus* species have been described and are distributed in Asia from India (Punjab) in the West, to Japan, East Siberia and the Kurile Islands in the North, and to Indonesia (Java, Sulawesi) in the South (Wood and Bright, 1992; Beaver, 2000; Maiti and Saha, 2009; Cognato *et al*., 2015; Johnson *et al.,* 2020).

The species of *Indocryphalus* show slight to moderate sexual dimorphism. In the male, the anterior slope of pronotum is more flattened and the apex is prolonged anteriorly (Figs 1H, 2H); the proepimeron lacks a mycangial opening; the eyes may be enlarged and more narrowly separated on the frons (Figs 1I, 2I). In the female, the anterior slope of the pronotum is strongly convex (Figs 1B, 2B, 3B); the proepimeron has a mycangial opening which may be either vertical or horizontal (Figs 1F, 2F, 3F) (Beaver, 2000). Further differences between male and female may be present in the sculpture of the frons, in the elytral length relative to that of the pronotum, and in the vestiture of the elytra.

All species of *Indocryphalus* are monogamous and xylomycetophagous (Wood, 1986; Beaver, 2000; Cognato *et al.*, 2015; Johnson *et al.*, 2020). Most of the species are polyphagous. The female initiates the gallery system in the wood of newly cut, dead or dying angiosperm trees, and probably produces a pheromone to attract a male. After mating, the male guards the entrance, and removes frass, while the gallery is extended by the female. Females possess proepimeral mycangia and inoculate the gallery with ambrosia fungi which serve as food for both adults and larvae (Beaver, 2000; Cognato *et al*., 2015; Kirkendall *et al*., 2015). Eggs are laid singly in niches above and below the egg gallery. After hatching, the larvae expand the niche into a larval cradle perpendicular to the grain of the wood as they grow. Mature larvae pupate in the larval cradles with the head oriented towarded the main gallery and the teneral adults leave through the parental gallery. Both male and female remain in the gallery system during larval development (Beaver, 2000; Cognato *et al*., 2015; C. S. Lin *pers*. *obs*.).

Only one *Indocryphalus* species, *I. pubipennis* (Blandford, 1894), has been recorded in Taiwan (Beaver and Liu, 2010). In this paper, we describe a new species of *Indocryphalus* from Taiwan, and record *I. sordidus* (Blandford, 1894) for the first time in the island. Diagnostic characters, biological data and a key to the Taiwanese species of *Indocryphalus* are provided.

MARERIALS AND METHODS

Specimens were collected from February 2014 to March 2024 using twelve-unit Lindgren multi-funnel traps (Contech Enterprises, Inc., Delta, British Columbia, Canada), baited with 95% ethanol, and 95% α-pinene (Merck, Germany), or collected from unhealthy branches and fallen twigs to confirm the host trees, and to observe the gallery systems and breeding biology in Taiwan. Specimens were examined and identified using a Leica stereomicroscope (M 205-C) equipped with an eyepiece micrometer in a Pl 10x/22 eyepiece. Length was measured from the pronotal apex to the elytral apex in dorsal view.

TAXONOMIC TREATMENT

Tribe Xyloterini LeConte, 1876
Genus *Indocryphalus* Eggers, 1939
Indocryphalus chiyui Lin & Beaver, ***sp. nov.***
棘毛暗翅印木小蠹
urn:lsid:zoobank.org:pub:**1AF25046-3B3C-41F5-A820-B7CA84F112D**

Type: **Holotype**, female, Taiwan: Taichung city, Heping Dist., alt. 1984 m, 24°13'35.8699"N, 120° 58'29.7143"E, from *Castanopsis cuspidata* var. *carlesii* (Hemsl.) Yamazaki (Fagaceae), 13 January 2024, C. S. Lin, deposited in National Museum of Natural Science (NMNS), Taichung, Taiwan. **Paratype**, male, the same data as the holotype (NMNS). **Paratypes**: 27 males, 19 females; as the holotype. Paratypes are deposited in Michigan State University Arthropod Research Collection (MSUC), East Lansing, MI, USA; The Natural History Museum (NHML), London, UK; National Museum of Natural History (NMNH), Washington, DC, USA; Naturhistorisches Museum, Wien (NMW), Austria; Taiwan Agricultural Research Institute (TARI), Taichung, Taiwan; National Taiwan University Insect Museum (NTU), Taipei, Taiwan; R. A. Beaver's private collection (RAB), Chiangmai, Thailand; 27 paratypes in the first author's collection.

Diagnosis. *Indocryphalus chiyui* is similar to *I. pasohensis* Beaver and *I. tropicus* (Browne) in its very small body size (<1.5 mm long), and characters of the head and elytral declivity. The eyes are enlarged, especially in the male, and the male elytra may bear rows of strong, pointed, bristly setae. The female can be distinguished from *I. pasohensis* by its dark brown elytra, the width of frons (half width of head *vs* one third width of head), relatively longer elytra, and serrations rather than minute spines on the posterior margin of fourth abdominal sternite. The female can be distinguished from *I. tropicus* by its larger size (1.33–1.43 mm *vs* 0.8–1.05 mm), narrower frons, shorter elytra, and the presence of scattered longer setae on the elytral declivity. The male of *I. chiyui* can be distinguished from *I. pasohensis* by the width of frons (one third width of head *vs* one fifth width of head), much less dense elytral vestiture with the bristly setae clearly in rows, not confused on the inner interstriae, and a row of serrations not minute spines on the fourth abdominal sternite. The male can be distinguished from *I. tropicus* by the larger eyes, narrower frons, and the presence of rows of bristly setae on the declivital interstriae (absent in *I. tropicus*).

Description. **Female** (Fig. 1A–F): Length 1.38 ± 0.04 mm (mean ± sd, n = 5) (range 1.33–1.43 mm); 2.00–2.08 times as long as wide. Body stout, subshining, mature adults yellow-brown, upper part of frons slightly darker, elytra dark brown. Frons convex, wide, about half width of head, surface weakly shining, finely reticulate, sparsely punctate, punctures bearing fine, yellowish-white, hair-like setae, epistomal margin with fringe of distinctly longer hairs, vertex with longitudinal striations. Eyes extending well onto front of head, upper part smaller than lower part, and separated from it by a funicle width, the space between with short, closely placed setae. Mandibles with a tooth in middle of inner margin. Antennal scape long and slender, gradually thickening to apex, longer than the four-segmented funicle (including pedicel), antennal club fairly big, about 1.3 times as long as wide, rounded apically, pubescent to base (Fig. 1E). Pronotum 1.22 ± 0.05 (1.18–1.30) times wider than long, the base transverse, finely margined, sides convex, widest just behind middle, apex almost rounded, anterior margin with four teeth, the median pair larger than the distal pair, anterior slope strongly convex, asperate, asperities nearly in rows, acute, weaker towards the summit and sides, summit at basal third, basal part of disc weakly rugose, the sides smooth, finely punctate, vestiture of short, fine semi-erect, posteriorly-directed hairs. Proepimeron mycangial opening horizontally elongate, wider on posterior 2/3, with a weak elliptical carina dorsal to it on the side of the pronotum, ventral margin setose (Fig. 1F) Scutellum large, triangular, wider than long. Elytra 1.32 ± 0.03 (1.27–1.35) times longer than wide, 1.63 ± 0.05 (1.59–1.70) times longer than pronotum, bases transverse, humeral angles rounded, subparallel-sided in basal 2/3, then broadly rounded to apex, declivity occupying 1/3 of elytra, obliquely convex, slightly flattened on either side of suture. Disc subshining, finely, densely punctured, striae and interstriae strongly confused on disc, each puncture with a short, appressed hair-like setae, the declivity in addition with sparse fine granules bearing longer, recumbent, hair-like setae. Apical half of protibia with 5–7 fine socketed teeth on outer margin. Posterior margin of fourth abdominal sternite with a row of 3–4 serrations (Fig. 1K).

Male (Fig. 1G–J): similar to female except for head and armature of elytral declivity, length 1.28 ± 0.01 mm (mean ± sd, n = 5), (range 1.28–1.30 mm); 2.00–2.04 times as long as wide. Head narrower, eyes larger, frons occupying about one third the width of the head, surface shining, with three transverse rugae between eyes and a distinct median longitudinal impression above epistomal margin. Pronotum 0.45 ± 0.02 mm (mean ± sd, n = 5), (range 0.43–0.48 mm); 1.41 ± 0.09 (1.32–1.53) times wider than long. Pronotum comparatively weakly convex, obliquely sloping and more narrowly rounded anteriorly, slightly apically constricted, anterior margin with four teeth, median pair slightly larger than distal pair, asperities on the anterior slope weak and scattered, summit poorly defined. Mycangium absent. Elytra more slongate, 0.84 ± 0.03 mm (mean ± sd, n = 5), (range 0.80–0.88 mm); 1.33 ± 0.03 (1.28–1.36) times longer than wide, 1.88± 0.15 (1.68–2.06) times longer than pronotum, elytral declivity very densely setose, each interstria with a row of long and spinose bristle-like setae arising from granules, the setae longer on alternate interstriae, ground

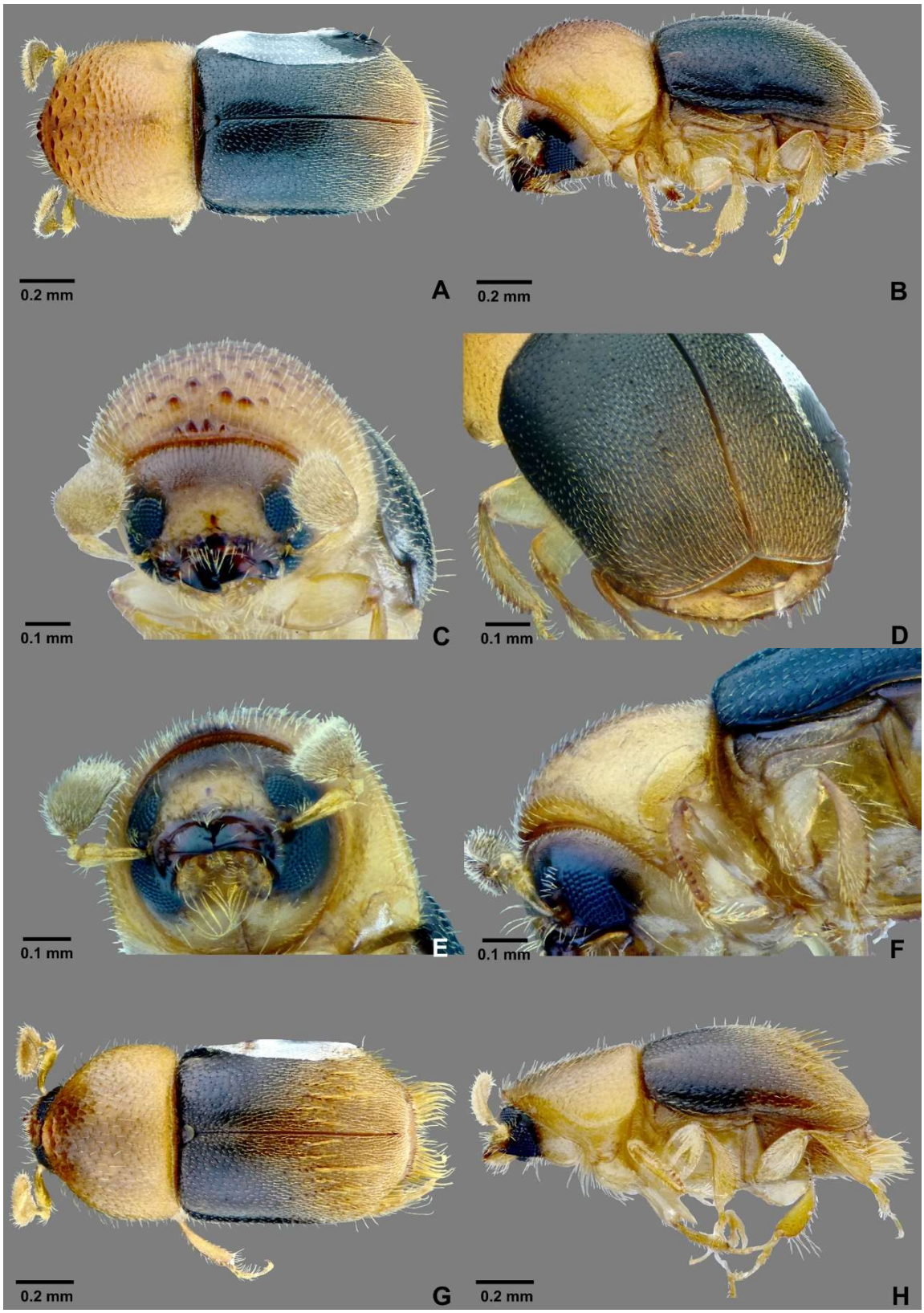

Fig. 1. ***Indocryphalus chiyui*** Lin & Beaver, *sp. nov*. Female (**A-F & K**): **A.** dorsal view, **B.** lateral view, **C.** front view, **D.** elytral declivity, **E.** antennae, **F.** mycangial opening, Male (**G-K & L**): **G.** dorsal view, **H.** lateral view, **I.** front view, **J.** elytral declivity, **K.** female abdomen, **L.** male abdomen. **M-P**. Biology: **M.** The male guards the entrance, **N.** separate cradles, **O.** gallery system, **P.** clerid larvae and female of ***I. chiuyui***.

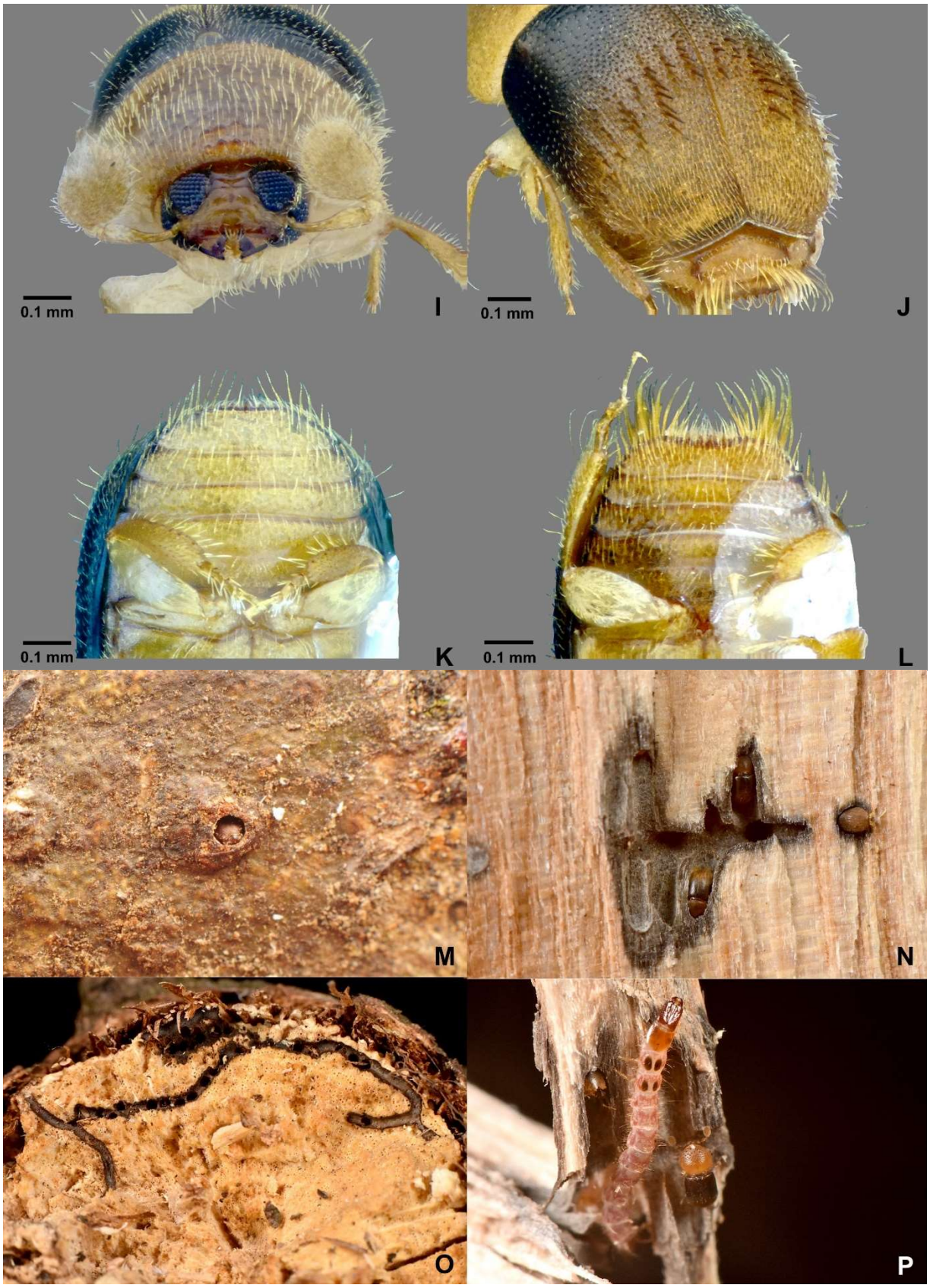

Fig. 1. Continued

vestiture longer than in female. Apical half of protibia with 3–4 small socketed teeth on outer margin. Posterior margin of fourth abdominal sternite with a row of 6–7 serrations (Fig. 1L). Posterolateral margin of fifth abdominal sternite with a brush of dense, long, hair-like setae on each side extending well beyond apical margin.

Etymology: The new species is named in honor of Dr. Chi-Yu Chen (Department of Plant Pathology, National Chung Hsing University), one of the specialists who help us to identify the host trees of scolytines in Taiwan.

Biology: Adults were found on twigs and branches of unhealthy *Castanopsis cuspidata* var. *carlesii* (Fagaceae) with a diameter between 1.7 and 4.7 cm. Branches were transported from the mountain to the laboratory on 13 January, 2024, and kept in boxes at room temperature. Mature adults in pupal cells, were collected from branches on February 04, 2024. The species is monogamous and xylomycetophagous. The female initiates and excavates the gallery system with a few branches (Fig. 1O). Eggs are laid singly in niches above and below the branched tunnels, and the larvae expand the niche into a larval cradle perpendicular to the grain of the wood and consume ambrosia fungi. Mature larvae pupate in separate cradles (Fig. 1N). The male guards the entrance (Fig. 1M), removes the frass from the galleries, and the female remains inside the tunnel to maintain the fungus garden, and removes the debris from the gallery. Both male and female remain in the gallery system until they die. The gallery system may extend into the wood or form surface galleries between the thick bark and the sapwood parallel to the grain (Fig. 1O). The larvae of an unidentified species of clerid (Coleoptera: Cleridae) move freely in the tunnels, and the debris of *Indocryphalus* adults and larvae found in the same gallery system (Fig. 1P) indicates that they prey on the scolytine adults and larvae.

Indocryphalus pubipennis (Blandford)

Trypodendron pubipenne Blandford, 1894:125.
Xyloterus pubipennis (Blandford): Hagedorn, 1910: 116.
Dendrotrypum pubipenne (Blandford): Schedl, 1951: 77.
Indocryphalus pubipennis (Blandford): Browne, 1970: 562.

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Identification note. Female (Fig. 2A–F): This species can be distinguished by the pronotum with coarse asperities extending from apex to basal quarter and shagreened to the base. Anterior margin with median pair of teeth clearly larger than outer pair. The proepimeron mycangial opening elongate antero-posteriorly (Fig. 2F).Elytral striae clearly marked and with punctures of similar size to those of interstriae, declivity with small granules, declivity vestiture densely comprised of long, semi-erect, hair-like setae.

Male (Fig. 2G–J): Male is very similar to female except for frons weakly concave. The inner corner of upper part of eye drawn to an acute point. Pronotum much less strongly convex, obliquely sloping and more narrowly rounded anteriorly, strongly apically constricted, asperities on the anterior slope weaker. Proepimeron without mycangial opening. Elytral declivity more densely setose with more erect and longer hair-like setae, declivital striae 1 and 2 not impressed.

Material examined. Taichung City, Heping Dist. (24° 14'48.06"N, 120° 54'41.82"E), 1181 m, 10 ♂ 11♀, 10. ii. 2020, C. S. Lin leg.; Nantou county, Ren'ai Township, (24° 1'8.1"N, 121° 0'43.38"E), 1423 m, 68 ♂ 53♀, 09. iv. 2022, C. S. Lin leg., from *Machilus zuihoensis* Hayata; Nantou county, Puli Township, (24° 0'5.94"N, 121° 0'22.56"E), 1026 m, 22 ♂ 27♀, 12. iii. 2022, C. S. Lin leg., from *Cinnamomum osmophloeum* Kanehira; Taichung City, Heping Dist. (24° 14'13.6959"N, 120° 58'36.6893"E), 1997 m, 17 ♂ 21 ♀, 25. ii. 2024, C. S. Lin leg., from *Machilus thunbergii* Sieb. & Zucc. (Lauraceae).

Distribution. Japan, Korea, Kurile Islands, Taiwan, Sakhalin Island, Russia (Far East) (Wood and Bright, 1992).

Biology. *I. pubipennis* was collected and bred twice from *Machilus zuihoensis* Hayata and once from *Cinnamomum osmophloeum* Kanehira and *Machilus thunbergii* Sieb. & Zucc.. The species shows a preference for Lauraceae hosts in Taiwan. It attacks newly cut, dying or dead twigs or branches on the forest floor. The species is also recorded from *Cinnamomum japonicum* Sieb., *Lindera erythrocarpa* Makino, *L. umbellata* Thunb. (as *Benzoin thunbergii* (Sieb. & Zucc.) Mak.), *Machilus thunbergii* Sieb. & Zucc. (Lauraceae), *Cleyera japonica* Thunb. (Pentaphylaceae), *Fagus crenata* Blume (Fagaceae), *Ficus carica* L. (Moraceae), *Hamamelis japonica* Siebold & Zucc. (Hamamelidaceae), *Phyllanthus flexuosus* (Sieb. & Zucc.) Müll. Arg. (Phyllanthaceae), *Toxicodendron trichocarpum* (Miq.) Kuntze (as *Rhus trichocarpa* Miq.) (Anacardiaceae), *Zelkova serrata* (Thunb.) Makino (Ulmaceae) (Murayama, 1957; Wood and Bright, 1992; Beaver, 2000).

Indocryphalus sordidus (Blandford, 1894)

Trypodendron sordidum, Blandford, 1894: 577.
Xyloterus sordidus (Blandford): Hagedorn, 1910: 116.
Indocryphalus sordidus (Blandford): Browne, 1970: 562.
Trypodendron sinense Eggers, 1941: 225. Synonymy: Beaver, 2000: 175.

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Identification note. Female (Fig. 3A–F): This species can be distinguished by the pronotum broadly paler on base and sides, its anterior margin with median pair of teeth clearly larger than outer pair. The proepimeral mycangial opening is elongate dorso-ventrally (Fig. 3F). The punctures are of equal size on elytral striae and interstriae, and discal striae are not distinct in dorsal view. Declivital striae 1 and 2 clearly distinguishable, striae 2 not extending to elytral apex.

Male: Not available for study.

Material examined. Taichung City, Heping Dist. (24°14'51.6688"N, 120°55'59.6443"E), 1561 m, 1 ♀, 02. iv. 2014, C. S. Lin leg., from Lindgren multi-funnel traps; as previous but (24°13'32.39"N, 120°58'18.49"E), 1920 m, 1 ♀, 05. vii. 2014.

Distribution. China, Japan, Vietnam (Beaver, 2000; Cognato *et al*., 2015). New to Taiwan.

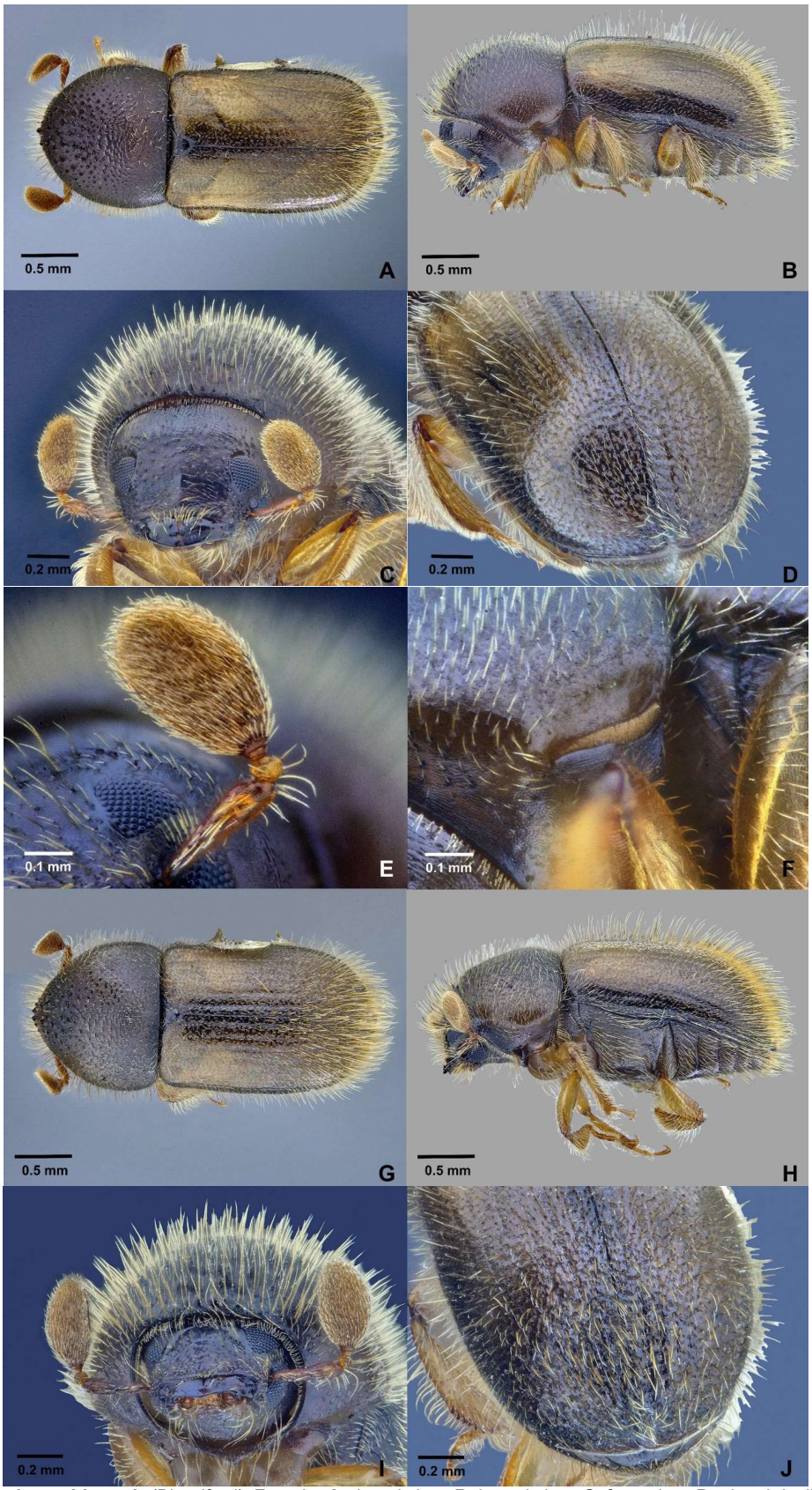

Fig. 2. ***Indocryphalus pubipennis*** (Blandford). Female: **A.** dorsal view, **B.** lateral view, **C.** front view, **D.** elytral declivity, **E.** antennae, **F.** mycangial opening. Male: **G.** dorsal view, **H.** lateral view, **I.** front view, **J.** elytral declivity.

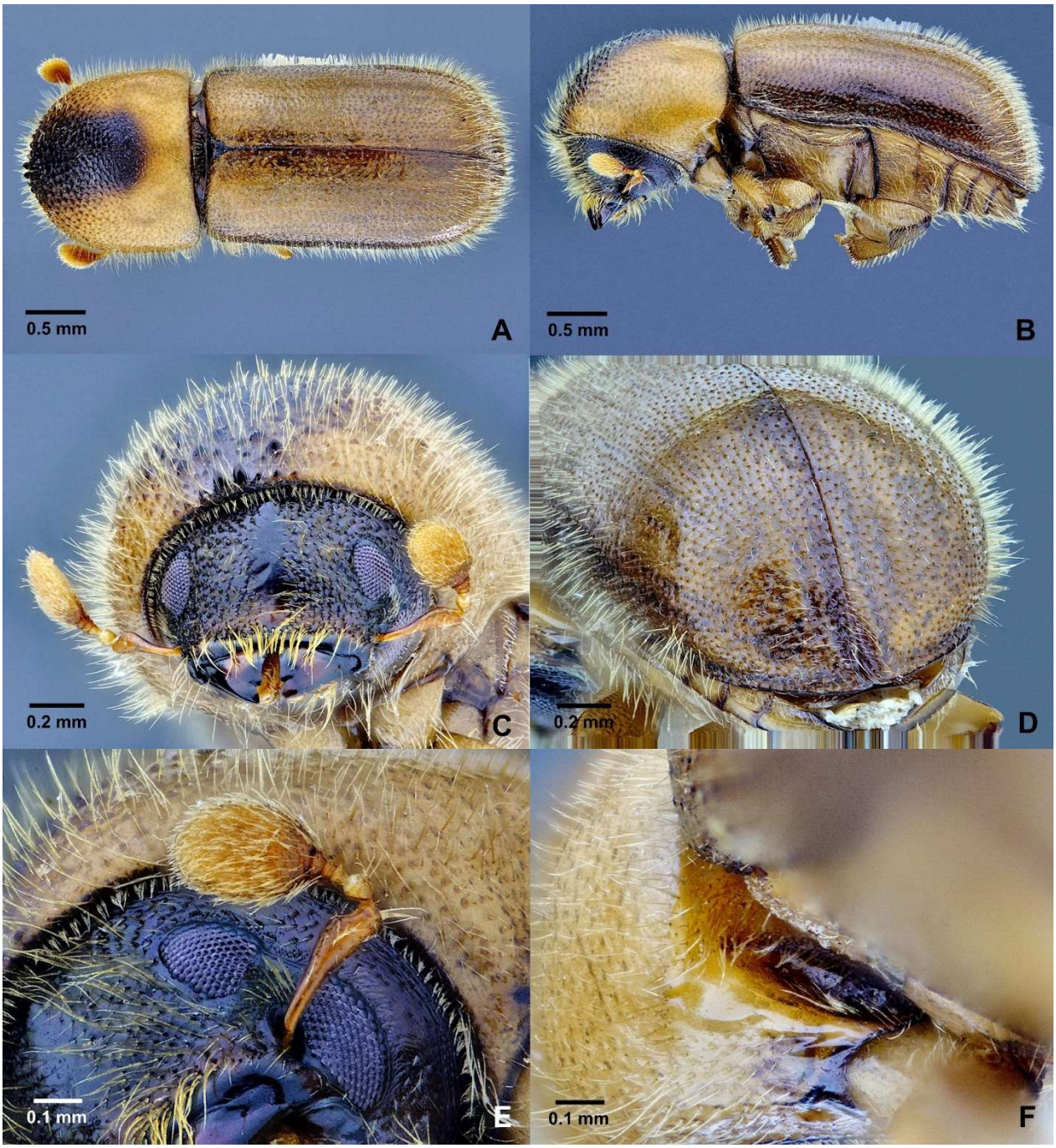

Fig. 3. ***Indocryphalus sordidus*** (Blandford). Female: **A.** dorsal view, **B.** lateral view, **C.** front view, **D.** elytral declivity, **E.** antennae, **F.** mycangial opening.

Biology. Recorded from *Prunus jamasakura* Siebold ex Koidz. (Rosaceae), *Illicium anisatum* L. (as *I. religiosum* Sieb. & Zucc.) (Schisandraceae), *Cleyera japonica* (as *C. ochnacea* DC.) (Pentaphylacaeae) (Murayama, 1957).

Key to *Indocryphalus* species of Taiwan
(modified from Beaver, 2000)

1a. Very small species, <1.5 mm. Male elytral declivity with a row of long, pointed bristle-like setae on interstriae; female declivity with sparse longer, hair-like setae……..……..... ***I. chiyui*** sp. n.

1b. Large species, >3 mm. Elytral declivity of male lacks bristle-like setae ……..…… 2

2a. Proepimeron with a mycangial opening (Fig. 1F, 2F, 3F). Anterior slope of pronotum strongly convex. Upper margins of eyes widely separated on frons, the inner corner of upper section of the eye never acute. Frons convex. Females…… 3

2b. Proepimeron without a mycangial opening. Anterior slope of pronotum more flattened. Upper margins of eyes closer together on frons, the inner corner of the upper section of the eye often acute. Frons weakly concave with an impression on either side of midline.

Fig. 4. Biology of ***Indocryphalus pubipennis*** (Blandford) : **A.** gallery system with a few brahches, **B.** egg protected by a covering of frass, **C.** egg niches above and below the egg gallery, **D.** larval cradle perpendicular to the grain of the wood, **E.** larvae pupate in the larval cradles with the head oriented towarded the main gallery, **F.** teneral adults.

Males……..…….. 4

3a. Mycangial opening vertical (Fig. 3F), elongate dorso-ventrally, triangular with base of triangle dorsal. Pronotum broadly paler basally and at sides. Strial and interstrial punctures of equal size, and striae not distinct when viewed from above. Elytral declivity with striae 1 and 2, but not interstriae 2 very weakly impressed. Length 3.4–3.8 mm…… ***I. sordidus*** (Blandford)

3b. Mycangial opening horizontal (Fig. 2F), elongate antero-posteriorly, triangular. Pronotum with coarse asperities extending to basal quarter and shagreened to the base. Elytral declivity with striae 1 clearly marked and slightly impressed, declivity with small granules, declivity vestiture comprised of long, fine semi-erect setae ……. ***I. pubipennis*** (Blandford)

4a. Elytral declivity with vestiture dense, long and rather woolly. Striae 1 and 2 not impressed on declivity ……..… ***I. pubipennis*** (Blandford)

4b. Elytral declivity with vestiture less dense, shorter and not woolly. Striae 1 and 2 impressed on declivity ……..... ***I. sordidus*** (Blandford)

DISCUSSION

The species of *Indocryphalus* can be divided into two groups based on size and geographical distribution. The first group includes six larger species (≥3 mm long) which are found in the northern temperate zone forests of China, Japan, Korea and Far Eastern Russia (*I. aceris* (Niijima), *I. major* (Eggers), *I. pubipennis* (Blandford), *I. sordidus* (Blandford)), or of northern India and the Himalayas (*I. intermedius* (Sampson), *I. machili* Wood). The second group includes five smaller species (≤2.0 mm long) recorded primarily in the tropical forests of South-

East Asia and western Indonesia (*I. pasohensis* Beaver*, I. sericeus* (Schedl), *I. suongmu* Cognato, Smith & Pham, *I. tropicus* (Browne)), but with one species (*I. chiyui*) in the temperate forest of Taiwan. As a result of its latitudinal range and mountainous physiography, both temperate and tropical forests occur in Taiwan, and species from both groups of *Indocryphalus* are now known to occur in the country. Two more undescribed species of small-sized *Indocryphalus,* known only from single male specimens, have been collected in Southeast Asia, at similar latitudes (19–24ºN) to *I. chiyui*. It is now clear that the small species are not confined to tropical regions, but extend into more temperate areas, although perhaps not further North than Taiwan. Cognato *et al.* (2015) provide a species distribution map which includes all described species except *I. chiyui* (Taiwan)*,* and *I. sericeus* (Java).

The first group of species are relatively well-known from numerous collections, and breed in large diameter branches rather than small diameter twigs. The species in the second group are each known only from one to three collections. Apparently they utilize dying or dead twigs or branches in the canopy to raise their broods, and are only collected when the twigs fall to the ground, or the dispersing adults are attracted to traps at canopy level. Based on a cladistic analysis of morphological characters, it is likely that this canopy-breeding habit has evolved more than once in *Indocryphalus* (Cognato *et al.*, 2015). It is associated with small size, and often with enlarged eyes, especially in the male (Beaver, 2000). The tropical forest canopy is still poorly known as a habitat for beetles (e.g. Basset *et al.,* 2003; Sprick and Floren, 2018; Floren *et al.,* 2020). It is not surprising that surveys using canopy fogging in the Bornean (Sprick and Floren, 2018) and Ecuadorean (Dole *et al.,* 2021) rain forests have revealed a high diversity of scolytine species. It is likely that more species of *Indocryphalus* will be found if further collections are made in the canopy.

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