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Four new species of *Cyclorhipidion* and five new records of other xyleborine genera (Coleoptera, Curculionidae, Scolytinae, Xyleborini) from Taiwan

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ABSTRACT: We describe four new ambrosia beetle species of the tribe Xyleborini, *Cyclorhipidion beaveri* Lin & Smith sp. nov., *Cyclorhipidion cognatoi* Lin & Smith sp. nov., *Cyclorhipidion hsuae* Lin & Smith sp. nov., and *Cyclorhipidion wui* Lin & Smith sp. nov., which complete their lifecycle on the host plant *Castanopsis cuspidata* var. *carlesii* (Hemsl.) Yamazaki (Fagaceae). Five newly recorded species, *Anisandrus ursulus* (Eggers, 1923), *Arixyleborus minor* (Eggers, 1940), *Coptodryas mus* (Eggers, 1930), *Cyclorhipidion japonicum* (Nobuchi, 1981), and *Xyleborinus octiesdentatus* (Murayama, 1931) are reported in Taiwan for the first time. We provide brief diagnoses, photographic images and biological information for each species in Taiwan.

KEY WORDS: Ambrosia beetles, *Anisandrus*, *Arixyleborus*, *Coptodryas*, new species, new records, Xyleborini, *Xyleborinus*.

INTRODUCTION

The diverse weevil subfamily scolytinae, colloquially known as the bark and ambrosia beetles, exhibit a multitude of feeding habits but most species can typically be classified as bark beetles (phloeophagous) or ambrosia beetles (xylomyceptophagous). Ambrosia beetles excavate galleries in the xylem of dead or moribund parts of trees and cultivate mutualistic fungi which they transport in specialized structures called mycangia. The larvae and maturing adults both feed on the ambrosia fungi and this fungal farming habit has evolved at least 12 independent times within the scolytinae (Farrell *et al*., 2001; Kirkendall *et al*., 2015; Johnson *et al*., 2020). The ambrosia beetle tribe Xyleborini is both the most speciose scolytine tribe and contains the largest number of ambrosia beetles, comprised of nearly 1300 species (Smith, unpublished). Most xyleborine species are benign decomposers that exhibit low host tree specificity though some genera and species are host specific at the family level (Smith *et al*., 2020). Typically, xyleborines have minimal effect on forestry, however, the group also includes some of the most invasive and destructive forest, agro-forest and timber pests (Hulcr *et al*., 2007; 2015; Novotny *et al*., 2010) in the world.

Another feature of the Xyleborini is their haplodiploid reproductive system in which diploid females produce haploid flightless males that mate with their sisters prior to their dispersal from their natal gallery. As a consequence of this inbreeding reproductive system, the Xyleborini have evolved strongly female-biased sex ratios, and marked sexual dimorphism in both body size and pronotal shape, which allowed the Xyleborini to be some of the most successful scolytine colonizers of new environments (Jordal *et al*., 2001; Kirkendall *et al*., 2015; Ospina-Garcés *et al*., 2021). Because of the combination of haplodiploid reproduction and fungal farming, many xyleborine species become the world's most pestiferous and invasive insect species (Smith and Hulcr, 2015).

Eighty-three species of Xyleborini have been recorded in Taiwan (Beaver and Liu, 2010; Lin *et al*., 2019; Smith *et al*., 2020). In this paper, four new *Cyclorhipidion* Hagedorn, 1912 species are described, and five additional Xyleborini species are recorded in Taiwan for the first time. For each species, diagnostic characters, collecting localities and information on host plants and hosts are provided where available from Taiwan. A key to the Taiwanese species of *Cyclorhipidion* is provided to facilitate identification.

MATERIALS AND METHODS

Specimens were collected from October 2012 to October 2021 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 reared from collected branches and logs. Beetles were identified to species level using the keys of Maiti and Saha (2004), and Smith *et al*. (2020). 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. The antennal pedicel of *Cyclorhipidion* is not included in the number of funicle segments. Beetle photographs were taken using a Canon 50D camera and macro lens MP-e65. Beetle montage images were assembled using Helicon Focus V. 6.8 (Helicon Soft.).

All specimens of the newly recorded species are deposited in the collection of first author.

The following abbreviations for collections are used in the text:

CSL: C.S.Lin's private collection, Taichung, Taiwan.
MSUC: Albert J. Cook Arthropod Research Collection, Michigan State University, East Lansing, MI, USA.
NCHU: National Chung Hsing University Museum of Entomology, Taichung, Taiwan.
NHML: Natural History Museum, London, UK.
NMNH: National Museum of Natural History, Washington, DC, USA.
NMNS: National Museum of Natural Science, Taichung, Taiwan.
NMW: Naturhistorisches Museum, Wien, Austria.
NTU: National Taiwan University Insect Museum, Taipei, Taiwan
TARI: Taiwan Agricultural Research Institute, Taichung, Taiwan.

TAXONOMIC TREATMENT

New species

Tribe **Xyleborini** LeConte, 1876

Cyclorhipidion beaveri Lin & Smith, ***sp. nov.***

瘤粒茸翅小蠹 Fig. 1

http://zoobank.org/1E4BC8A0-EC96-49A5-BA63-122C6F131681

Type: Holotype, female, Taiwan: Taichung city, Heping Dist., alt. 2050 m, 24°14.2990′N, 120°58.6790′E, from *Castanopsis cuspidata* var. *carlesii* (Hemsl.) Yamazaki (Fagaceae), 20 vii 2020, C. S. Lin, (NMNS). ***Paratypes***: 3 males, 7 females, as holotype except: 27 viii 2020, C. S. Lin (CSL, 2♂, 2♀; MSUC, 1♀; NHML, 1♀; NMNH, 1♀; NMNS, 1♂; NMW, 1♀; TARI, 1♀).

Diagnosis. This species is most similar to *C. bodoanum* (Reitter, 1913) based on the position of declivital granules but can be easily distinguished from *C. bodoanum* by the granules along declivital interstriae 2 (interstriae 2 always unarmed in *C. bodoanum*).

Description. **Female** (Fig. 1A–D): Length 1.75 ± 0.09 mm (mean ± sd, n = 5), and ranging from 1.68–1.85 mm; 2.91–3.05 times as long as wide. Body slender and cylindrical, head and pronotum reddish brown, elytra dark brown in mature specimens. Frons weakly convex, surface shining, finely reticulate, with scattered punctures; vestiture consisting of scattered, golden setae, a row of transverse setae in the upper part of epistoma. Eyes elongate-oval and moderately emarginate just above antennal insertion, upper part small than lower part. Antennal funicle 4–segmented, scape regularly thick, as long as club, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face and two procurved sutures near apex on posterior face. Pronotum 1.25 ± 0.06 (1.17–1.32) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides parallel in basal 2/3, base transverse, posterior angles broadly rounded; in lateral view elongate with disc much longer than anterior slope, disc flat, summit at apical 1/4; surface shiny, with feeble fine reticulation, and distinct, sparse punctures, from midpoint of pronotum to posterior margin, each with hair-like yellow setae, only anterior slope with small asperities, gradually decreasing in size posteriorly. Scutellum linguiform, flush with elytra, shiny. Elytra 1.74 ± 0.01 (1.72–1.75) times longer than wide, 1.39 ± 0.07 (1.31–1.48) times longer than pronotum; basal margin transverse, humeral angles rounded, parallel–sided in basal 3/4, then narrowly rounded to apex, disc flat, shiny, striae not impressed, punctures separated by 2–4 diameters of a puncture, each with a microhair; interstriae flat, interstriae 1 with two confused rows of long hair-like erect setae, the others with two or three confused rows of long hair-like erect setae, gradually becoming longer towards apex; declivity occupying 1/4 of elytra, obliquely truncate, declivital slope very steep, face subshiny, striae 1 and 2 feebly impressed, strial punctures rugose, shallow, much larger than those on disc, variably spaced by 1/2–1/3 diameters of a puncture, each with a microhair; interstriae on declivity inflated, with uniseriate, small and distinct granules which gradually increasing in size towards apex, each with long erect hair. Procoxae contiguous; prosternal coxal piece gradually tapering to pointed apex. Protibiae semi-circular with 6– 7 socketed denticles. Meso- and metatibiae with 7–8 socketed denticles.

Male (Fig. 1E–H): Length 1.76 ± 0.1mm (mean ± sd, n = 3), and ranging from 1.65–1.85 mm; 2.03–3.75 times as long as wide, head and pronotum reddish brown, elytra deep reddish brown in mature specimens. Head large, nearly as wide as pronotum, not vertical, obliquely sloped in frontal face. Frons convex, with a deep emargination between mandibles in anterior margin; surface shining, finely reticulate, sparsely punctured, each puncture bearing an erect hair-like seta, antero-lateral areas with scattered, golden setae, a row of transverse long setae on the upper part of epistoma. Mandibles distinctly large and stout, downwardly curved apically, pointed at apex, inner margin with large triangular teeth near middle and base. Eyes small, elongate, anterior margin without emargination. Antennal funicle 4–segmented, scape regularly thick, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face. Pronotum 0.83 ± 0.05 (0.78–0.88) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides subparallel in basal 1/3, gradually widened anteriorly, widest just before apex, base transverse, posterior angles broadly rounded; in lateral view disc prolonged anteriad, summit indistinct; surface shiny, sparse but distinct punctures, each with hair-like yellow setae, then gradually becoming longer toward lateral margin, anterior slope, lateral margin and base with feeble finely reticulated, anterior slope with small and sparse asperities. Scutellum linguiform, flush with elytra, shiny. Elytra 0.93 ± 0.05 (0.88–0.98) times

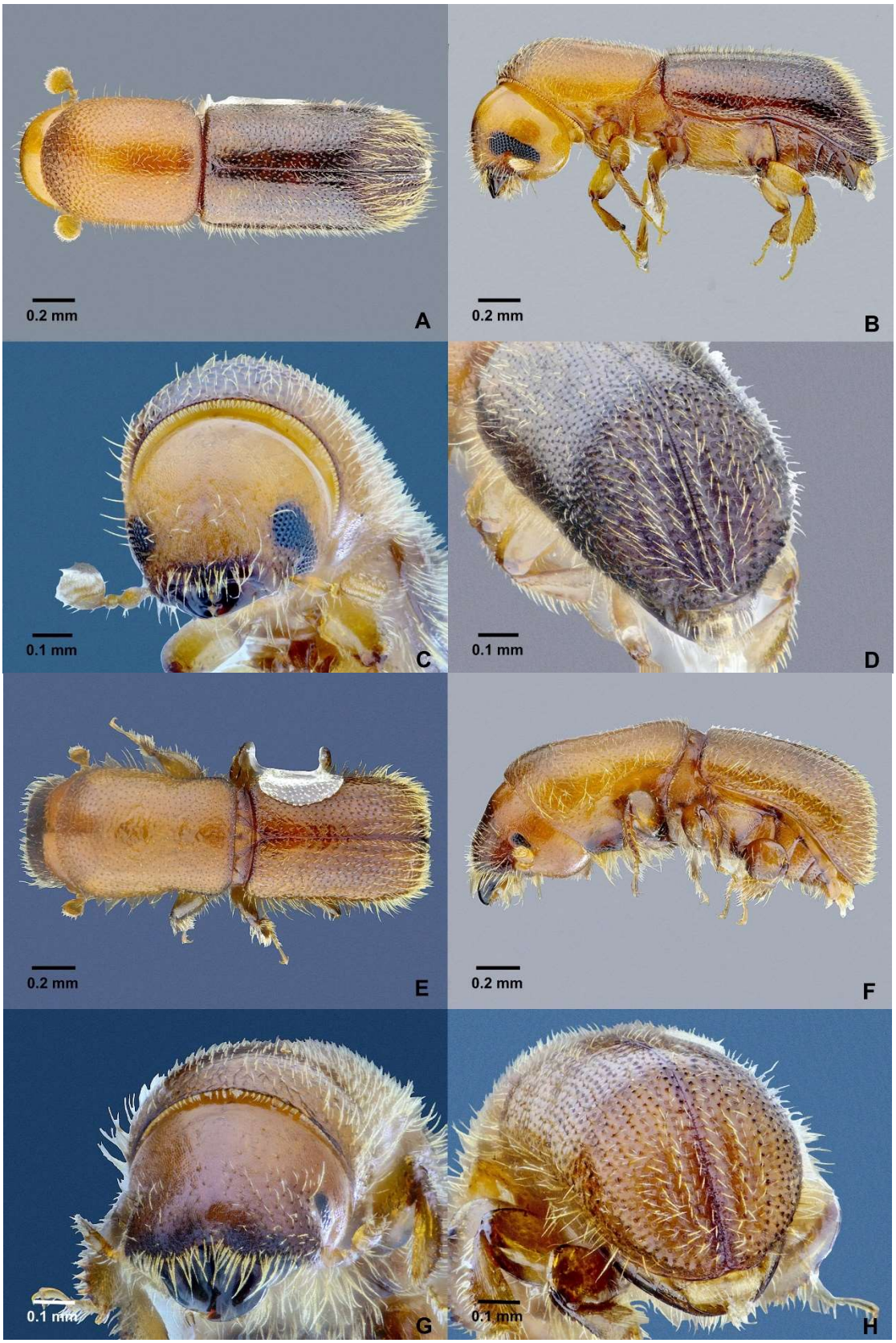

Fig. 1. ***Cyclorhipidion beaveri*** Lin & Smith, sp. nov., female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity, male: **E.** dorsal view, **F**. lateral view, **G**. front view, **H**. declivity view.

longer than wide, 1.13 ± 0.02 (1.11–1.15) times longer than pronotum; basal margin transverse, humeral angles rounded, parallel–sided in basal 3/4, then broadly rounded to apex, disc flat, shiny, striae not impressed, punctures separated by 1–2 diameters of a puncture, each with a microhair; interstriae flat, interstriae 1 and 2 with two confused rows of long hair-like erect setae, the others with one rows of long hair-like erect setae, gradually becoming longer towards apex; declivity occupying 1/4 of elytra, subvertical, declivital slope very steep, face subshiny, striae 1 impressed, striae 2 feebly impressed, strial punctures rugose, shallow, much larger than those on disc, variably spaced by 1/2–1/3 diameters of a puncture, each with a microhair; interstriae inflated, with uniseriate, small granules and gradually increasing in size towards apex, each with long erect hair. Procoxae contiguous; prosternal coxal piece tall and long, lobe-like, anterior margin broadly rounded (Fig. 6A). Protibiae semi-circular with 6–7 socketed denticles. Meso- and metatibiae with 7–8 socketed denticles. Large body size males with longer pronotum, lateral sides are more diverging anteriorly in dorsal view, prosternal coxal piece wider, anterior margin more broadly rounded; small body size males with shorter pronotum, lateral sides subparallel up to anterior margin in dorsal view (Fig. 5A–B), prosternal coxal piece slender, lateral sides subparallel then converging towards apex, terminating into a narrowly rounded apex (Fig. 6A–B).

Etymology: The new species is named in honor of Dr. Roger A. Beaver, the preeminent authority on the systematics and taxonomy of Scolytinae and Platypodinae.

Biological notes: *C. beaveri* were found on branches of *C. cuspidata* with a diameter between 4.2 and 7.5 cm. The fallen tree logs were transported from the forest to the laboratory on July 20, 2020, and kept in boxes at room temperature. The first generation was collected on August 27, 2020. The life cycle was completed in about one month in the laboratory when the temperature was about 30–31°C. The temperature range in the place of origin is about 18–22°C. The time to complete one generation will be longer than in the laboratory.

Cyclorhipidion cognatoi Lin & Smith, ***sp. nov.***

寡毛茸翅小蠹 **Fig. 2**

http://zoobank.org/0B29A44D-3D03-440D-ACCA-B5AF52B43E5D

Type: Holotype, female, Vietnam, Lao Cai Prov., Hoang Lien N.P., 22°21'N, 103°46.1999'E, 19 V 2019, VN180, S.M. Smith, A.I. Cognato, ex 5 cm branch (MSUC). ***Paratypes***: as holotype (MSUC, 1♀), Taiwan, Taichung City, Heping Dist. (24°13.54'N, 120°58.3083'E), alt.1920 m, 1♀, 8 xi 2014, C. S. Lin leg. in funnel trap (CSL); 22 xi 2014 (NMNS).

Diagnosis. *Cyclorhipidion cognatoi* is closely related to *C. armiger* (Schedl, 1953) and *C. distinguendum* (Eggers, 1930) based on elytral disc shape and the number of declivital interstrial setae. It can be distinguished from *C. armiger* by the flat elytral disc (disc medially impressed in *C. armiger*) and from *C. distinguendum* by declivital interstriae 1 with two rows of setae and interstriae 2 with one row of setae (interstriae 1 with three rows of setae and interstriae 2 with two rows of setae in *C. distinguendum*).

Description. **Female** (Fig. 2A–D): Length 3.13 ± 0.14 mm (mean ± sd, n = 4), and ranging from 2.95–3.28 mm; 2.82–2.93 times as long as wide. Body slender and cylindrical, head and pronotum dark reddish brown, elytra dark brown in mature specimens. Frons weakly convex, surface shining, finely reticulate, with scattered punctures; vestiture consisting of scattered, golden setae, a row of transverse setae in the upper part of epistoma. Eyes elongate-oval and moderately emarginate just above antennal insertion, upper part small than lower part. Antennal funicle 4–segmented, scape regularly thick, as long as club, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face and two procurved sutures near apex on posterior face. Pronotum 1.13 ± 0.03 (1.09–1.14) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides parallel in basal 2/3, base transverse, posterior angles broadly rounded; in lateral view elongate with disc longer than anterior slope, disc flat, summit at apical 2/5; surface subshiny, with feeble fine reticulation, and distinct, dense punctures, each with a yellow hair-like seta, only anterior slope with small asperities, gradually decreasing in size posteriorly. Scutellum linguiform, flush with elytra, shiny. Elytra 1.72 ± 0.05 (1.67–1.79) times longer than wide, 1.53 ± 0.06 (1.46–1.58) times longer than pronotum; basal margin transverse, humeral angles rounded, parallel–sided in basal 3/4, then narrowly rounded to apex, disc flat, shiny, striae not impressed, strial and interstrial punctures strongly confused, separated by 2–4 diameters of a puncture, each with a microhair; declivity occupying 1/4 of elytra, obliquely truncate, declivital slope very steep, face strongly shining; striae 1 and 2 feebly impressed, in irregular rows, strial punctures rugose, shallow, much larger than those on disc, variably spaced by 1/8–1.5 diameters of a puncture, each with a microhair; interstriae 1 and 3 with two confused rows of long hair-like erect setae, interstriae 2 with one irregular of long hair-like erect setae; interstriae 1 with 4–5 a row of small to moderate tubercles and those on the declivital face much larger than those on base, each with long erect hair, interstriae 3 with two tubercles on anterior half, interstriae 2 unarmed. Procoxae contiguous; prosternal coxal piece gradually tapering to pointed apex. Protibiae semi-circular with 8 socketed denticles. Meso-and metatibiae with 10–11 socketed denticles.

Etymology: This new species is named in honor of the scolytine systematist Dr. Anthony I. Cognato, one of the collectors of the type series, and husband of SMS who is her companion in life and scolytine research.

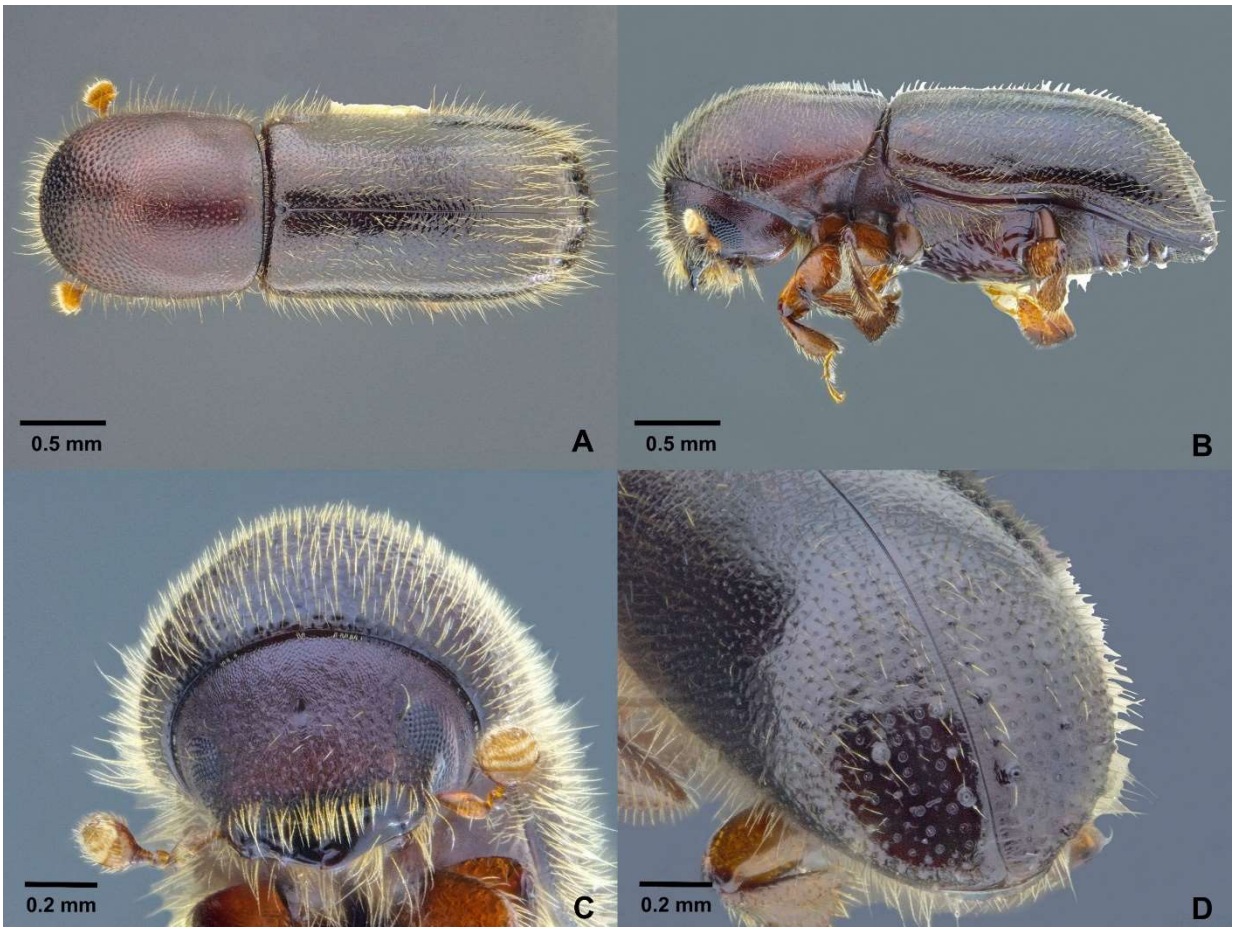

Fig. 2. ***Cyclorhipidion cognatoi*** Lin & Smith, sp. nov., female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity.

Cyclorhipidion hsuae Lin & Smith, ***sp. nov.***

擬雙齒茸翅小蠹 Fig. 3

http://zoobank.org/88F0A58D-78C8-47D6-B707-B239A13C14A5

Type: Holotype, female, Taiwan: Taichung city, Heping Dist., alt. 1970 m, 24°13.5860′N, 120°58.5060′E, from *Castanopsis cuspidata* var. *carlesii* (Hemsl.) Yamazaki (Fagaceae), 20 ii 2020, C. S. Lin, (NMNS). ***Paratypes***: 15 males, 30 females, as holotype except: 27 viii 2020, C. S. Lin (CSL, 7♂, 22♀); as holotype except: 5 iv 2020, MSUC, 1♂, 1♀; NCHU, 1♂, 1♀; NHML, 1♂, 1♀; NMNH, ♂, 1♀; NMNS, 1♂; NTU, 1♂, 1♀; NMW, ♂, 1♀; TARI,1♂, 1♀).

Diagnosis. This species is most similar to *C. bispinum* (Nobuchi, 1981) based on the number of spines on elytral apex and can be easily distinguished by the larger body (2.50–2.69 mm in *C. hsuae* and 1.9–2.1 mm in *C. bispinum*) and elytral apex with four triangular spines (one on each striae 1 and 2, of which the outer pair are larger) while *C. bispinum* have two spines, one on each interstriae 2.

Description. **Female** (Fig. 3A–D): Length 2.63 ± 0.07 mm (mean ± sd, n = 5), and ranging from 2.50–2.69 mm; 2.53–2.67 times as long as wide. Body stouter and cylindrical, head and pronotum reddish brown, elytra dark reddish brown in mature specimens. Frons weakly convex, surface shining, finely reticulate, with scattered shallow punctures; vestiture consisting of scattered, golden setae, a row of transverse setae in the upper part of epistoma. Eyes elongate-oval and moderately emarginate just above antennal insertion, upper part small than lower part. Antennal funicle 4–segmented, scape regularly thick, as long as club, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face and two procurved sutures near apex on posterior face. Pronotum 1.10 ± 0.05 (1.06–1.17) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides parallel in basal 1/3, base transverse, posterior angles broadly rounded; in lateral view elongate with disc slightly longer than anterior slope, disc flat, summit at apical 1/3; surface shiny, with feeble fine reticulation, and distinct, sparse punctures from midpoint of pronotum to posterior margin, each with hair-like yellow setae, only anterior slope with small asperities, gradually decreasing in size posteriorly. Scutellum linguiform, flush with elytra, shiny. Elytra 1.49 ± 0.02 (1.47–1.52) times longer than wide, 1.36 ± 0.05 (1.29–1.43) times longer than pronotum; basal margin slightly

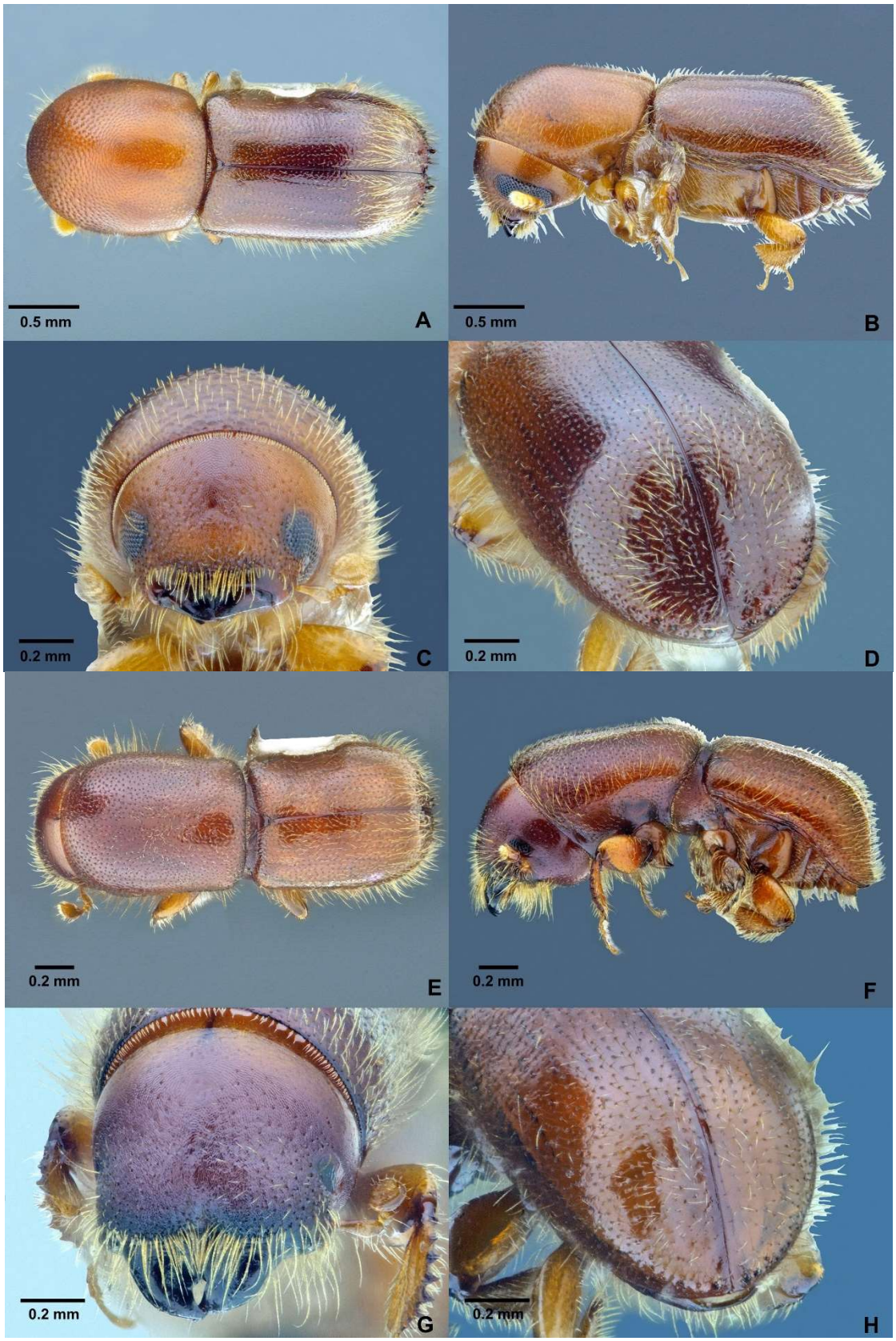

Fig. 3. ***Cyclorhipidion hsuae*** Lin & Smith, sp. nov., female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity, male: **E**, dorsal view, **F**. lateral view, **G**. front view, **H**. declivity view.

bisinuate, humeral angles rounded, sides parallel in basal 2/3, then gradually converging posteriorly to broadly rounded apex, disc flat, shiny, striae not impressed, punctures separated by 1–4 diameters of a puncture, each with a microhair; interstriae flat, weakly outwardly towards declivity, interstriae with two or three confused rows of long hair-like erect setae, gradually becoming longer towards apex; declivity occupying 1/3 of elytra, obliquely truncate, declivital slope very steep, face shiny, striae weakly curved outwardly from declivital summit to apical 1/3 then toward to apex, slightly impressed along striae 1, striae 2 weakly impressed from the middle of declivity to apex, strial punctures slightly deeper and as large as those of disc, variably spaced by 1–4 diameters of a puncture, each with a microhair; interstriae on declivity inflated, interstriae 2–4 with weakly recurved apical margin, interstriae with one row of minute punctures, punctures bearing a long, semi-recumbent hair-like seta; elytral apex bearing two pairs of triangular spines at striae 1 and 2, of which outer pair are larger. Procoxae contiguous; prosternal coxal piece gradually tapering to pointed apex. Protibiae semi-circular with 7–8 socketed denticles. Meso- and metatibiae with 8–10 socketed denticles.

Male (Fig. 3E–H): Length 2.53 ± 0.17mm (mean ± sd, n = 5), and ranging from 2.03–2.59 mm; 2.50–2.77 times as long as wide, head deep reddish brown, pronotum and elytra reddish brown in mature specimens. Head large, nearly as wide as pronotum, not vertical, obliquely sloped in frontal face. Frons convex, with a deep emargination between mandibles in anterior margin; surface subshining, finely reticulate, sparsely punctured, each puncture bearing an erect hair-like seta, antero-lateral areas with scattered, golden setae, a row of transverse long setae on the upper part of epistoma. Mandibles distinctly large and stout, downwardly curved apically, pointed at apex, inner margin with large triangular teeth near middle and base. Eyes small, elongate, anterior margin without emargination. Antennal funicle 4–segmented, scape regularly thick, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face. Pronotum 1.28± 0.07 (1.20–1.33) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides subparallel in basal 1/3, gradually widened anteriorly, widest just before apex, base slightly bisinuate, posterior angles broadly rounded; in lateral view disc prolonged anteriad, summit indistinct; surface shiny, sparse but distinct punctures, each with hair-like yellow setae, then gradually becoming longer toward lateral margin, lateral margin and base with feeble finely reticulated, anterior slope with small and sparse asperities. Scutellum linguiform, flush with elytra, shiny. Elytra 1.37 ± 0.07 (1.30–1.43) times longer than wide, 1.06 ± 0.03 (1.02–1.17) times longer than pronotum; basal margin transverse, humeral angles rounded, parallel–sided in basal 2/3, then broadly rounded to apex, disc flat, shiny, striae not impressed, punctures separated by 1–3 diameters of a puncture, each with a microhair; interstriae flat, interstriae 2 with irregularly uniseriate long hair-like erect setae, others with two or three confused rows of long hair-like erect setae, gradually becoming longer towards apex; declivity occupying 1/3 of elytra, subvertical, declivital slope very steep, face shiny, slightly impressed along striae 1, striae 2 weakly impressed at middle of declivity, striae 2 and 3 weakly curved outwardly from declivital summit to apical 1/3 then toward to apex, strial punctures slightly deeper and as large as those of disc, variably spaced by 1–3 diameters of a puncture, each with a microhair; interstriae with one rows of minute punctures, punctures bearing a long, semi-recumbent hair-like seta; elytral apex bearing one or two pairs of triangular spines at striae 1 and 2, of which outer pair are larger. Procoxae contiguous; prosternal coxal piece tall and long, lobe-like, anterior margin broadly rounded (Fig. 6C). Protibiae and metatibiae with 6–7 socketed denticles. Mesotibiae with 6–8 socketed denticles. Large body size males with longer pronotum, lateral sides are more diverging anteriorly in dorsal view, prosternal coxal piece wider, anterior margin more broadly rounded; small body size males with shorter pronotum, lateral sides subparallel up to anterior margin in dorsal view (Fig. 5C–D), prosternal coxal piece slender, lateral sides subparallel then converging towards apex, terminating into a narrowly rounded apex (Fig. 6C–D).

Etymology: The new species is named in honor of Dr. Ju-Chun Hsu (Department of Entomology, National Taiwan University), CSL's wife who has always supported his bark beetle research.

Biological notes: *C. hsuae* were found on branches of *C. cuspidata* with a diameter between 4.5 and 8.4 cm. The fallen logs were transported from the forest to the laboratory on February 10, 2020, and kept in boxes at room temperature. The first generation was collected on March 15, 2020. The life cycle was completed in about one month in the laboratory when the temperature was about 20–23°C. The temperature range in the place of origin is about 6–15°C, the time to complete one generation will be longer than in the laboratory.

Cyclorhipidion wui Lin & Smith, ***sp. nov.***

六齒茸翅小蠹 Fig. 4

http://zoobank.org/6936311F-DFBA-4DEA-9096-BC06F649C0F1

Type: Holotype, female, Taiwan: Taichung city, Heping Dist., alt. 2010 m, 24°14.1870′N, 120°58.6030′E, from *Castanopsis cuspidata* var. *carlesii* (Hemsl.) Yamazaki (Fagaceae), 18 viii 2021, C. S. Lin (NMNS). ***Paratypes***: 3 males, 16 females, 21 ix 2021, C. S. Lin (CSL, 2♂, 9♀; MSUC, 1♀; NCHU, 1♀; NHML, 1♀; NMNH, 1♀; NMNS, 1♂; NMW, 1♀; NTU, 1♀; TARI, 1♀).

Diagnosis. This species is most similar to *C. miyazakiense* (Murayama, 1936) and *C. armiger* (Schedl, 1953) based on the number of spines on elytral apex and

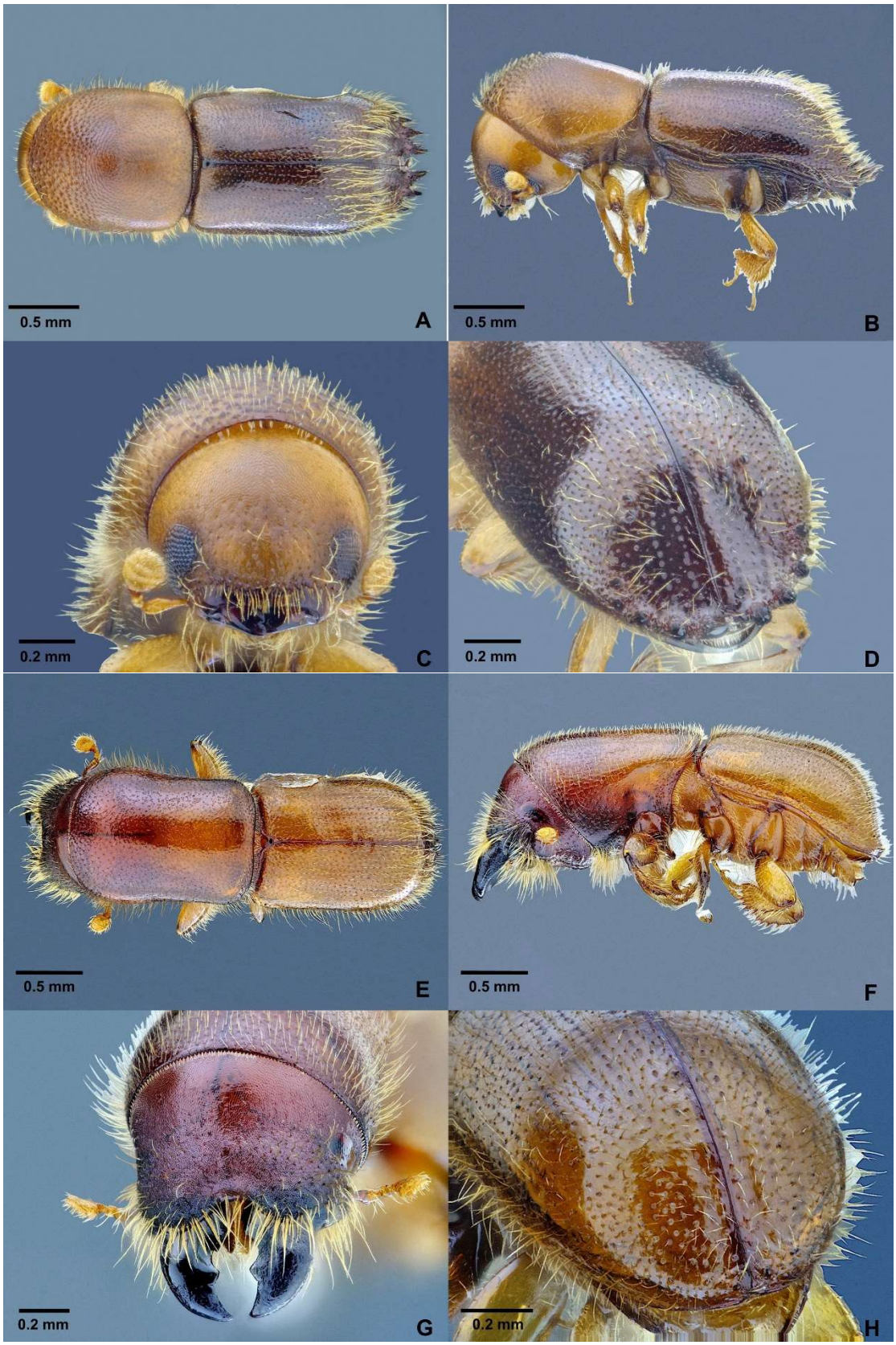

Fig.4. ***Cyclorhipidion wui*** Lin & Smith, sp. nov., female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity, male: **E** dorsal view, **F**. lateral view, **G**. front view, **H**. declivity view.

can be easily distinguished by the elytral apex with six large triangular spines (one on each interstriae 2–4) while *C. miyazakiense* and *C. armiger* each have four spines.

Description. **Female** (Fig. 4A–D): Length 2.57 ± 0.03 mm (mean ± sd, n = 5), and ranging from 2.53–2.63 mm; 2.56–2.63 times as long as wide. Body stout and cylindrical, head and pronotum reddish brown, elytra dark brown in mature specimens. Frons flat convex, surface shining, finely reticulate, with sparse punctures; vestiture consisting of scattered, golden setae, a row of transverse long setae in the upper part of epistoma. Eyes elongate-oval and moderately emarginate just below antennal insertion, upper part small than lower part. Antennal funicle 4–segmented, scape regularly thick, as long as club, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face and two procurved sutures near apex on posterior face. Pronotum 1.08 ± 0.02 (1.06–1.09) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides parallel in basal 1/2, base margin slightly bisinuate, posterior angles broadly rounded; in lateral view disc flat, summit at midpoint; surface shiny, with feeble fine reticulation, and distinct, sparse punctures from midpoint of pronotum to posterior margin, each with hair-like yellow setae, only anterior slope with small asperities, gradually decreasing in size posteriorly. Scutellum linguiform, flush with elytra, shiny. Elytra 1.49 ± 0.03 (1.47–1.53) times longer than wide, 1.39 ± 0.03 (1.34–1.41) times longer than pronotum; humeral angles rounded, parallel–sided in basal 2/3, then broadly rounded to apex, disc flat, shiny, striae not impressed, punctures separated by 1–4 diameters of a puncture, each with a microhair; interstriae flat, interstriae with two or three confused rows of setae, which gradually becoming longer towards apex; declivity occupying 1/3 of elytra, obliquely truncate, declivital slope very steep, face shiny, impressed along striae 1, striae 2 and 3 weakly impressed from the middle of declivity to apex, strial punctures shallow, usually slightly larger than those on disc, variably spaced by 1–2 diameters of a puncture, each with a microhair; interstriae 1 feebly elevated, interstriae 2 and 3 slightly depressed at the middle of declivity, interstriae with one row of minute punctures, punctures bearing a long, semi-recumbent hair-like seta, interstriae 1 with 0–1 small tubercle near declivital summit, interstriae 2 always unarmed, interstriae 3 with 1–3 small tubercles; elytral apex bearing 3 pairs of triangular spines at interstriae 2–4, of which median two pairs are very largest, interstriae 5 and 6 with a variably tubercle. Procoxae contiguous; prosternal coxal piece gradually tapering to pointed apex. Protibiae semi-circular with 7 socketed denticles, mesotibiae with 8–10 socketed denticles, and metatibiae with 7–9 socketed denticles.

Male (Fig. 4E–H): Length 2.44 ± 0.27 mm (mean ± sd, n = 3), and ranging from 2.24–2.75 mm; 2.50–2.84 times as long as wide, head and pronotum deep reddish brown, elytra reddish brown in mature specimens. Head large, nearly as wide as pronotum, not vertical, obliquely sloped in frontal face. Frons convex, with a deep emargination between mandibles in anterior margin; surface shining, finely reticulate, sparsely punctured, each puncture bearing a erect hair-like seta, antero-lateral areas with scattered, golden setae, a row of transverse long setae on the upper part of epistoma. Mandibles distinctly large and stout, downwardly curved apically, pointed at apex, inner margin with large triangular teeth near middle and base. Eyes small, elongate, anterior margin without emargination. Antennal funicle 4–segmented, scape regularly thick, club approximately circular and inflated with two straight, transverse, corneous segments on anterior face. Pronotum longer than wide, 1.21 ± 0.12 (1.11–1.34) times longer than wide, in dorsal view anterior margin broadly rounded without serrations, lateral sides subparallel in basal 1/2, gradually widened anteriorly, widest just before apex, base margin slightly bisinuate, posterior angles broadly rounded; in lateral view disc prolonged anteriad, summit not pronounced; surface shiny, sparse but distinct punctures, each with hair-like yellow setae, then gradually becoming longer toward lateral margin, anterior slope with small and sparse asperities. Scutellum linguiform, flush with elytra, shiny. Elytra 1.30 ± 0.09 (1.24–1.41) times longer than wide, 1.14 ± 0.1 (1.05–1.24) times longer than pronotum; humeral angles rounded, parallel–sided in basal 2/3, then broadly rounded to apex, disc flat, shiny, striae not impressed, punctures separated by 1–4 diameters of a puncture, each with a microhair; interstriae flat, interstriae with one or two confused rows of long hair-like setae; declivity occupying 1/3 of elytra, obliquely truncate, declivital slope very steep, face shiny, impressed along striae 1, striae 2 and 3 weakly impressed from the middle of declivity to apex, strial punctures shallow, usually slightly larger than those on disc, variably spaced by 1–3 diameters of a puncture, each with a microhair; interstriae 1 feebly elevated, interstriae 2 and 3 slightly depressed at the middle of declivity, interstriae with sparse minutely or small pointed tubercles, tubercles bearing a long, semi-recumbent hair-like seta; elytral apex bearing one pair of conical tubercles at interstriae 2, interstriae 2 and 3 with a variably tubercle. Procoxae contiguous; prosternal coxal piece tall and long, lobe-like, anterior margin broadly rounded (Fig. 6E). Protibiae semi-circular with 6–7 socketed denticles, mesotibiae with 7–8 socketed denticles, and metatibiae with 6–7 socketed denticles. Large body size males with longer pronotum, lateral sides are more diverging anteriorly in dorsal view, prosternal coxal piece wider, anterior margin more broadly rounded; small body size males with shorter pronotum, lateral sides subparallel up to anterior margin in dorsal view (Fig. 5E–F) prosternal coxal piece slender, lateral sides subparallel then converging towards apex,

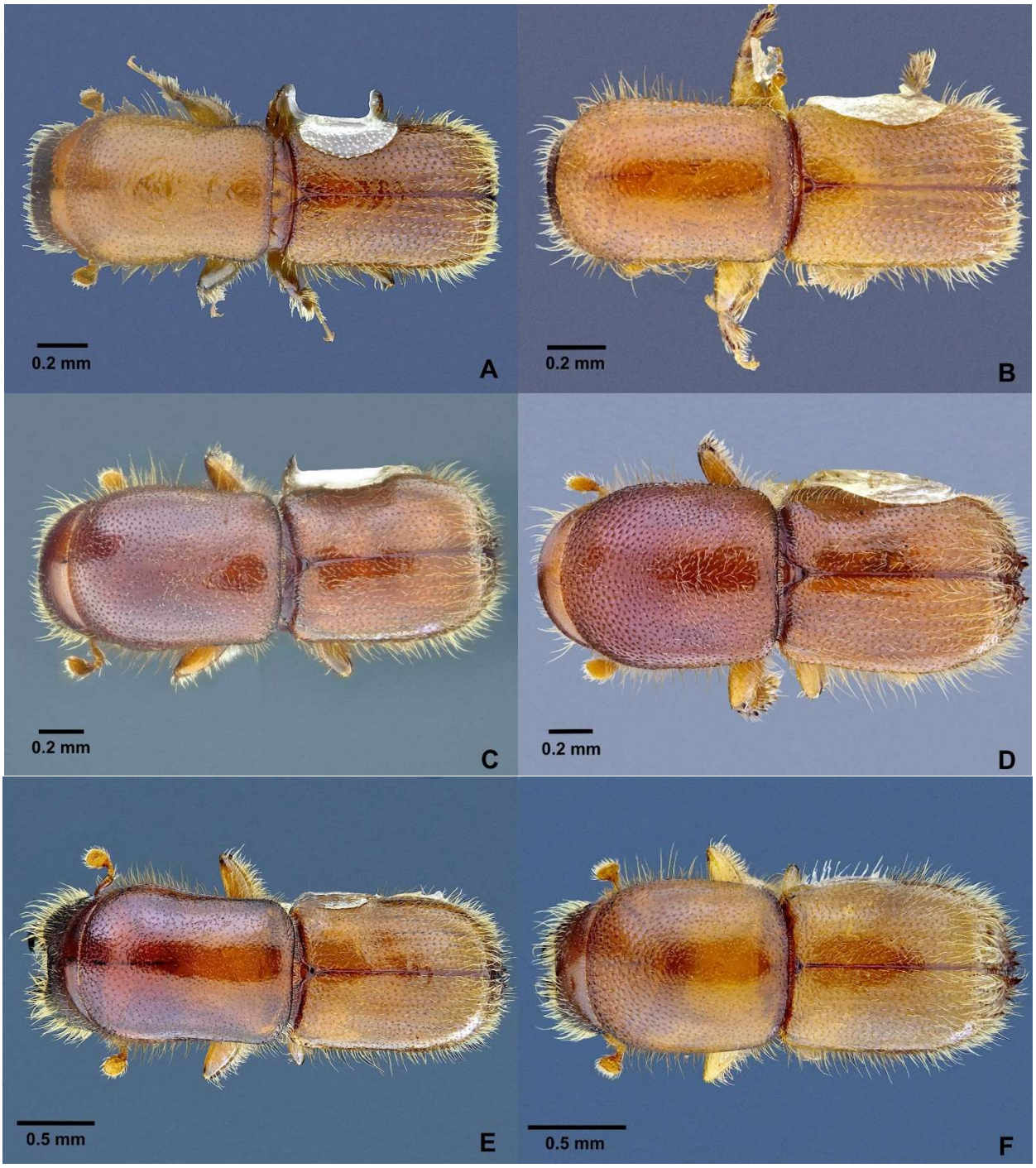

Fig. 5. Male dorsal view of ***Cyclorhipidion beaveri*** Lin & Smith, sp. nov. (**A-B**), ***Cyclorhipidion hsuae*** Lin & Smith, sp. nov. (**C-D**), and ***Cyclorhipidion wui*** Lin & Smith, sp. nov. (**E-F**). **A, C**, **E**. large body size, **B**, **D**, **F**. small body size.

terminating into a narrowly rounded apex (Fig. 6E–F).

Etymology: The new species is named in honor of Dr. Wen-Jer Wu, CSL's thesis advisor who introduced him to the bark beetle world.

Biological notes: *C. wui* were found on branches of *C. cuspidata* with a diameter between 5.8 and 9.2 cm. The fallen logs were transported from the forest to the laboratory on August 12, 2021, and kept in boxes at room temperature. The first generation was collected on September 21, 2021. The life cycle was completed in about one month in the laboratory with a temperature of 30–31°C. The temperature range in the place of origin is about 18–22°C. The time to complete one generation will be longer than in the laboratory.

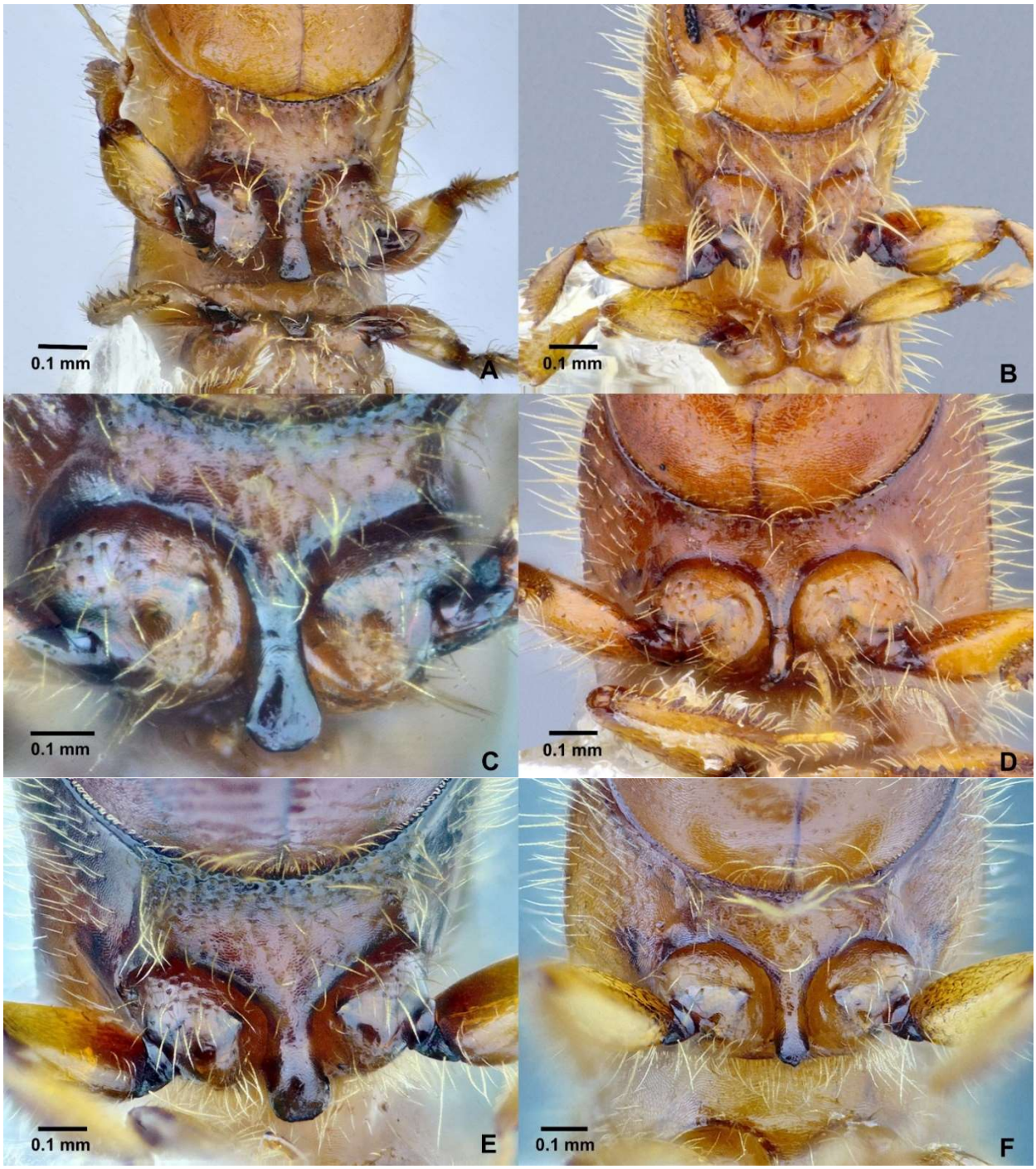

Fig. 6. Prosternal coxal piece of male ventral view, ***Cyclorhipidion beaveri*** Lin & Smith, sp. nov. (**A-B**), ***Cyclorhipidion hsuae*** Lin & Smith, sp. nov. (**C-D**) and ***Cyclorhipidion wui*** Lin & Smith, sp. nov. (**E-F**): **A, C, E**. large body size, **B, D, F**. small body size.

Key to females of *Cyclorhipidion* species found in Taiwan

1 Body length short, < 2.5 mm; elytral apex always unarmed 2
- Body length large, > 2.5 mm; elytral apex armed or unarmed 4
2 Declivity obliquely truncate; declivity laterally sulcate to interstriae 3; interstriae 3 bearing 3–5 tubercles along its length …….. ***C. japonicum***
- Declivity convex or truncate; declivity never laterally sulcate; occupying 1/4 of elytral length …….. 3
3 Declivity rather steep, moderately convex; interstriae 2 always unarmed, interstriae 1 and 3 with tubercles …..... ***C. bodoanum***
- Declivity obliquely truncate; declivital interstriae 1–3 with conspicuous granules ..... ***C. beaveri***
4 Elytral disc with a median shallow saddle-like impression; elytral apex with two pairs of moderate blunt teeth; declivity very steep, tuberculate and granulated ..... ***C. armiger***
- Elytral disc without a median shallow saddle-like impression 5
5 Elytral apex armed by sharp spines 6
- Elytral apex without sharp spines 7

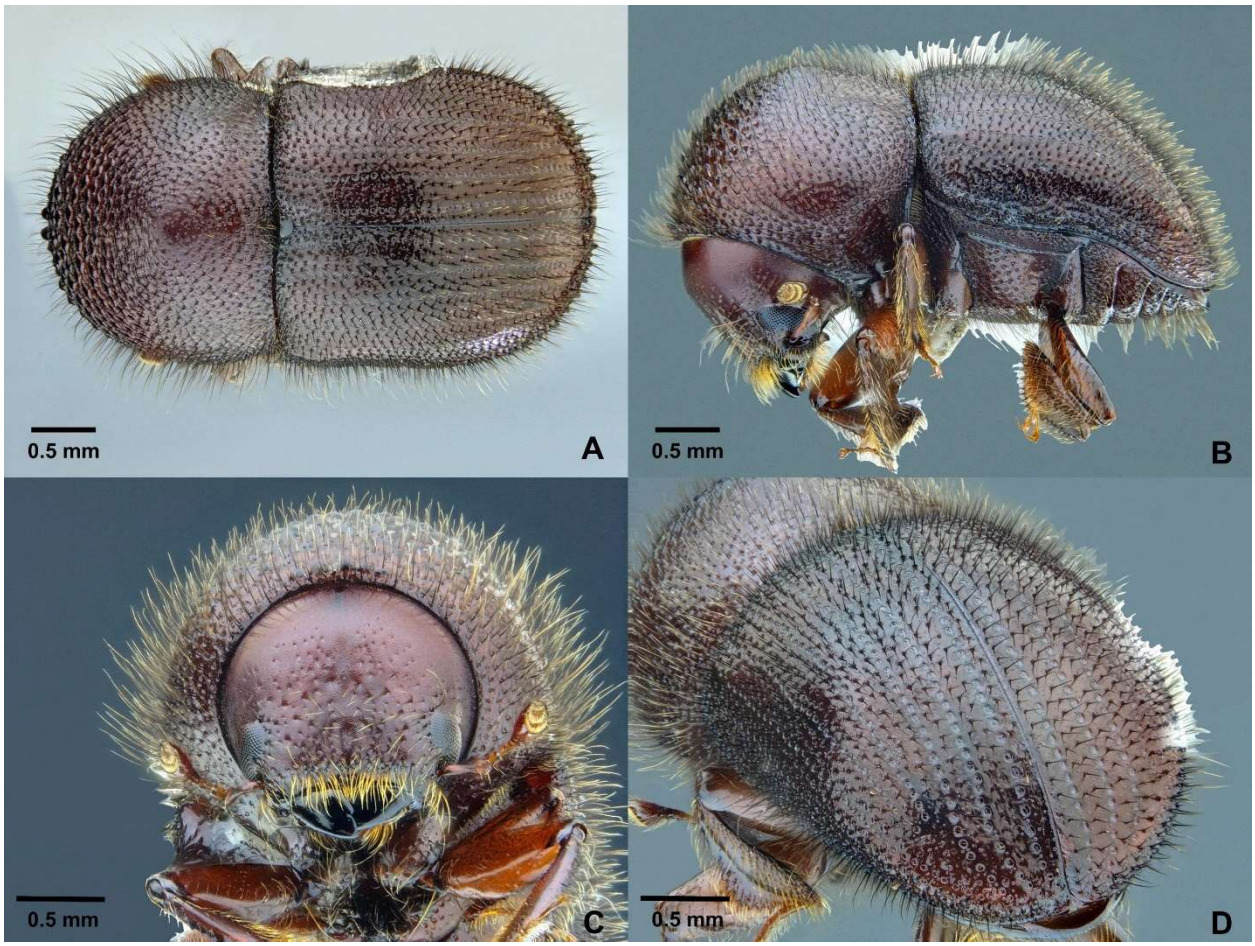

Fig. 7. ***Anisandrus ursulus*** (Eggers), female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity.

6 Elytral apex bearing two single triangular spines at striae 1 and 2, of which outer pair are larger ..... ***C. hsuae***
- Elytral apex bearing three single triangular spines at interstriae 2–4, of which median two pairs are larger ..... ***C. wui***
7 Declivital slope gentle, gradual, occupying 1/3 of elytral length; declivity impressed between suture and striae 1; tubercles on interstriae 2 larger than those of interstriae 1and 3; size > 4.0 mm ..... ***C. ohnoi***
- Declivital slope steep and short, occupying 1/4 of elytral length; tubercles on interstriae 2 absent or as large as those of interstriae 1 and 3; size ≤ 3.5mm 8
8 Declivital striae not impressed; granules present on interstriae 1–3; posterolateral margin with a row of granules ……..... ***C. xyloteroides***
- Declivital striae impressed 9
9 Declivital interstriae 1 with two rows of confused setae, interstriae 2 with one row of setae ..... ***C. cognatoi***
- Declivital interstriae 1 with three rows of confused setae 10
10 Declivital interstriae 2 with one rows of setae ..... ***C. pelliculosum***
- Declivital interstriae 2 with two rows of confused setae ..... ……..…….. ***C. distinguendum***

New records

Anisandrus ursulus (Eggers, 1923)

壯圓胸小蠹 Fig. 7

Xyleborus ursulus Eggers, 1923: 173.
Xylosandrus ursulus: Wood and Bright, 1992: 801.
Anisandrus ursulus: Dole and Cognato, 2010: 527.

***Identification note*. Female** (Fig. 7A–D): This species can be distinguished from all other *Anisandrus* recorded in Taiwan by more stout body, elytral disc convex, declivity unarmed and declivital striae not impressed.

Male: Not available in the material studied.

***Material examined*.** Nantou county, Yuchi Township, Sun Moon Lake (23°50.6083′N, 120°55.1983'E), 890 m, 2♀, 22. vi. 2016, C. S. Lin leg., from *Schefflera octophylla* (Araliaceae) (NMNH).

***Distribution*.** China, India, Indonesia, Laos, East and West Malaysia, New Guinea, Philippines, Solomon Islands, Thailand, Vietnam (Smith *et al*., 2020). New to Taiwan.

***Biology*.** Bred from *Schefflera octophylla* (Araliaceae) with a diameter about 8.7 cm in Taiwan. Also recorded from *Castanea argentea* (Fagaceae), *Celtis luzonica* (Cannabaceae), *Cinchona* sp. (Rubiaceae), *Eupatorium pallescens* (Asteraceae), *Ficus septica* (Moraceae), *Gluta* sp., *Semecarpus* sp., (Anacardiaceae), *Gonystylus* sp. (Thymelaeaceae), *Gossampinus heptaphylla* [=*Pseudobombax septenatum*] (Malvaceae), *Podocarpus imbricata* (Podocarpaceae), *Schefflera aromatica* (Araliaceae) (Kalshoven, 1959; Wood and Bright, 1992).

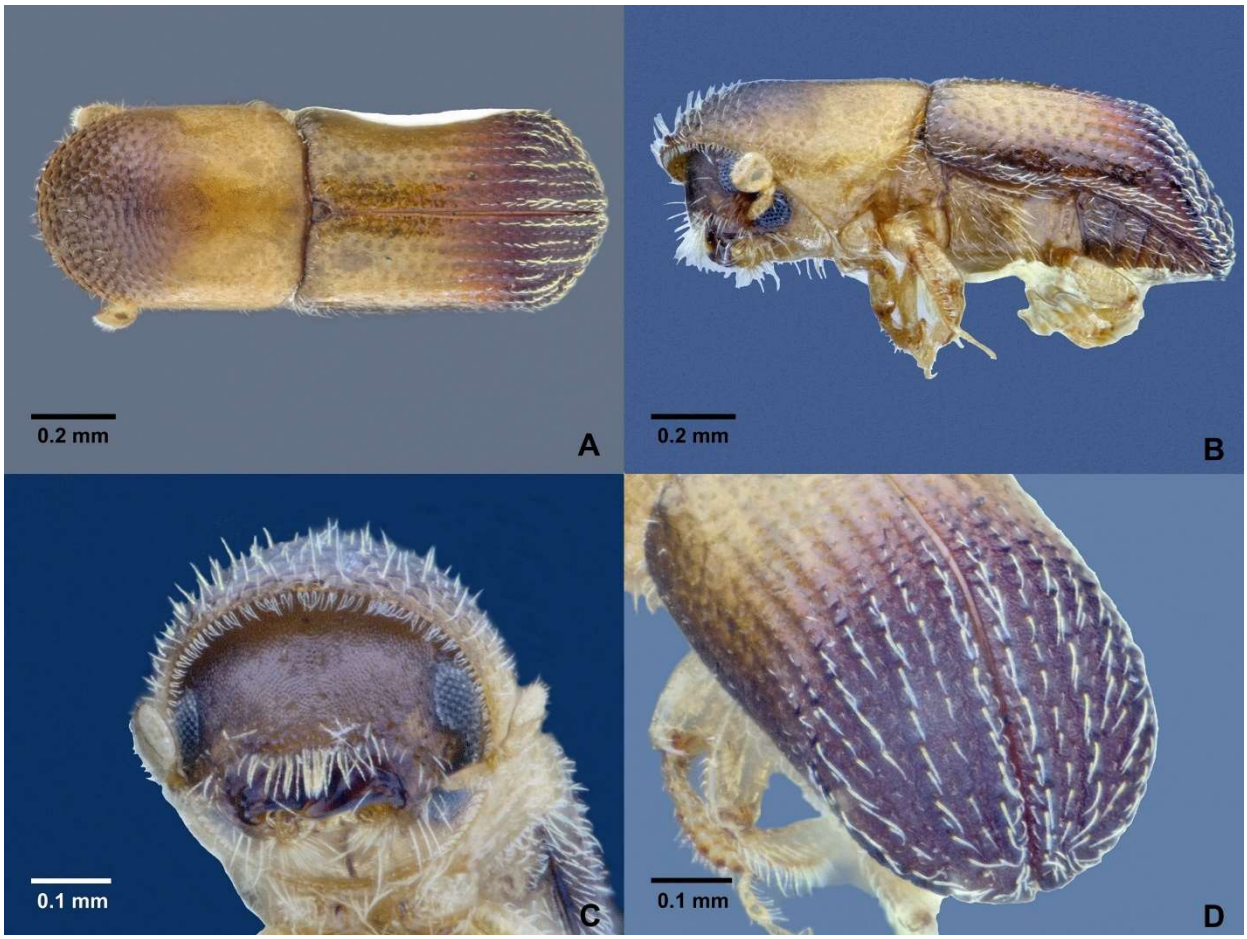

Fig. 8. ***Arixyleborus minor*** (Eggers), female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity.

Arixyleborus minor (Eggers, 1940)

微脊間小蠹 Fig. 8

Xyleboricus minor Eggers, 1940: 134.
Arixyleborus minor (Eggers): Schedl, 1958: 145.
Arixyleborus trux Schedl, 1975: 359. Hulcr and Cognato 2013: 47.

Identification note. **Female** (Fig. 8A–D): This species can be distinguished from all other *Arixyleborus* recorded in Taiwan by the smallest body size and the declivity with odd interstriae wider than even interstriae.

Male: Not available in the material studied.

Material examined. Chiayi county, Zhongpu Township (23°55.9686'N, 120°30.6405'E), 90 m, 2♀, 5. ii. 2019, P. H. Chen leg., in ethanol-baited trap (NMNH).

Distribution. Indonesia, East and West Malaysia, New Guinea, Thailand (Smith *et al*., 2020). New to Taiwan.

Biology. Recorded from *Castanopsis tunggurut, Dalbergia* sp., (Fagaceae) *Dryobalanops oblongifolia* (Dipterocarpaceae), *Palaquium maingayi* (Sapotaceae), *Shorea balanocarpoides*, *S. leprosula* (Dipterocarpaceae) (Browne, 1961; Kalshoven, 1959).

Coptodryas mus (Eggers, 1930)

尖尾壯茸翅小蠹 Fig. 9

Xyleborus mus Eggers, 1930: 203.
Microperus mus (Eggers): Saha and Maiti, 1984: 3.
Coptodryas mus (Eggers): Wood and Bright, 1992: 825.

Identification note. **Female** (Fig. 9A–D): This species is most similar to *Tricosa metacuneolus* (Eggers, 1940) and can be easily distinguished by the scutellum not visible and a dense tuft of setae present along elytral base associated with an elytral mycangium.

Male (Fig. 9E–H): This male is very similar to the female except the following characters: frons and epistomal area clearly depressed, either side of which on lateral margins bear two rounded swellings with long erect hairs. Mandibles relatively large, inner margin without any tooth. Pronotum much longer and without asperities, anterior margin unarmed.

Material examined. Taichung City, Heping Dist. (24°14.8000'N, 120°54.6960'E), 1188 m, 3♂4♀, 16. x. 2021, C. S. Lin leg., from *Machilus zuihoensis* (Lauraceae) (NMNH).

Distribution. Bangladesh, China, India, Vietnam (Smith *et al*., 2020). New to Taiwan.

Biology. Bred from *Machilus zuihoensis* (Lauraceae) with a diameter about 6 to 45 cm in Taiwan. Also recorded from *Gmelina arborea* (Lamiaceae) and *Michelia champaca* (Magnoliaceae) (Maiti and Saha, 2004).

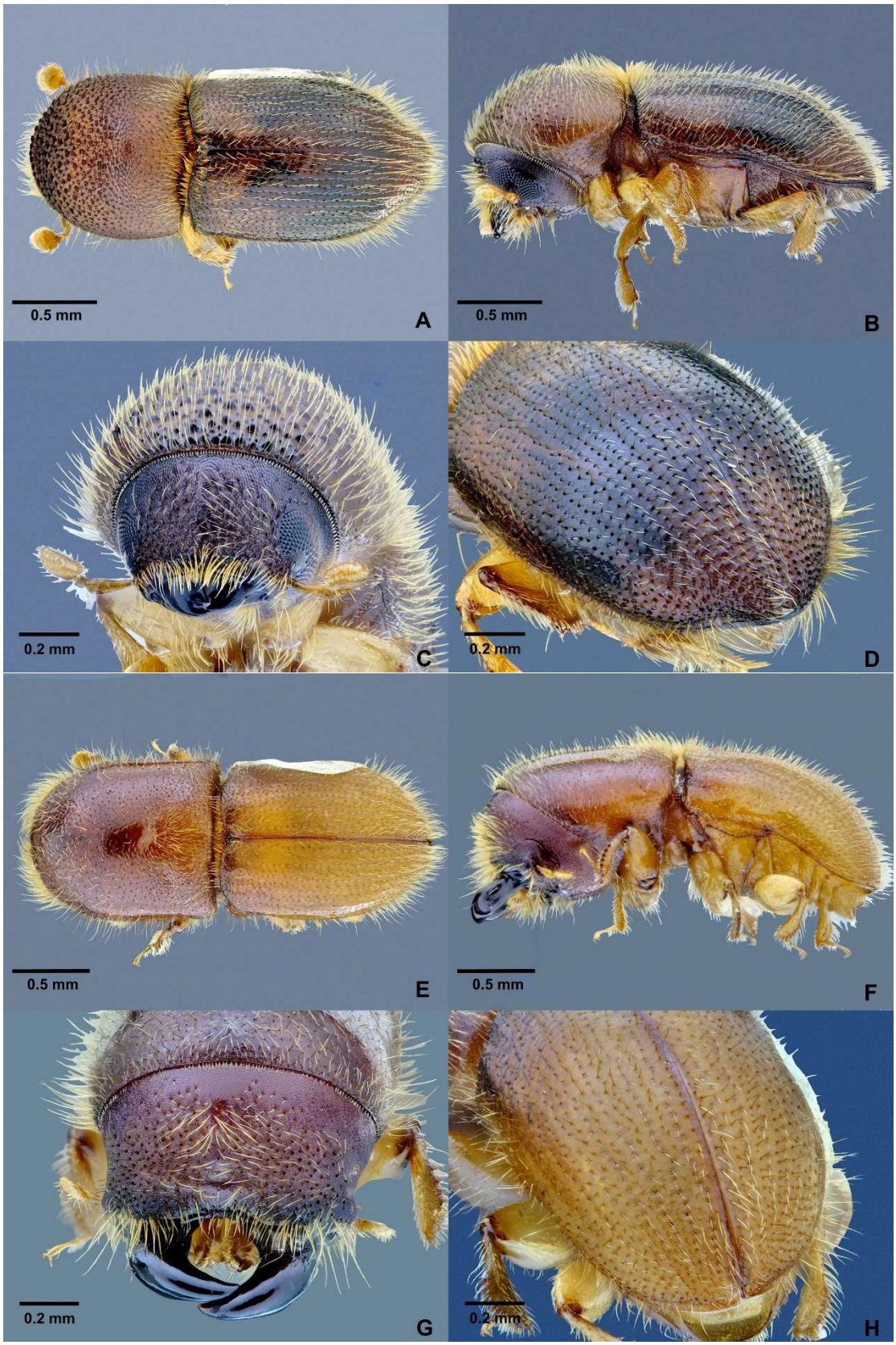

Fig. 9. ***Coptodryas mus*** (Eggers), female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity, male: **E**, dorsal view, **F**. lateral view, **G**. front view, **H**. declivity view.

Fig. 10. ***Cyclorhipidion japonicum*** (Nobuchi), female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity.

Cyclorhipidion japonicum (Nobuchi, 1981)

四尾茸翅小蠹 Fig. 10

Xyleborus japonicus Nobuchi, 1981: 153.
Cyclorhipidion japonicum (Nobuchi): Smith *et al.* 2018: 394.

***Identification note*. Female** (Fig. 10A–D): This species can be distinguished from all other *Cyclorhipidion* recorded in Taiwan by declivital face impressed from suture towards interstriae 3, interstriae 3 with 3–5 small conical tubercles.

Male: Not available in the material studied.

***Material examined*.** Nantou county, Yuchi Township, Sun Moon Lake (23°51.4733′N, 120°56.6733'E), 824 m, 1♀, 1.xi. 2012, C. S. Lin leg., in funnel trap (NMNH).

***Distribution*.** China, Japan, Russia (Far East), South Korea, Thailand (Smith *et al*., 2020). New to Taiwan.

***Biology*.** Recorded from *Castanopsis cuspidata*, *Quercus myrsinaefolia* (Fagaceae) (Nobuchi, 1981).

Xyleborinus octiesdentatus (Murayama, 1931)

溝齒錐盾小蠹 Fig. 11

Xyleborus octiesdentatus Murayama, 1931: 46.
Xyleborinus octiesdentatus (Murayama): Beaver *et al*., 2008: 234.

***Identification note*. Female** (Fig. 11A–D): This species can be distinguished from all other *Xyleborinus* recorded in Taiwan by the declivital face impressed and shiny, lateral edges formed by strongly elevated of interstriae 3, bearing four pairs of long, narrow sharply pointed spines which increase in sizes posteriorly.

Male: Not available in the material studied.

***Material examined*.** Nantou county, Yuchi Township, Sun Moon Lake (23°50.6016'N, 120°55.1833′E), 887 m, 1♀, 12.ii. 2015, (23°50.6083' N, 120°55.1983'E), 890 m, 1♀, 16.vii. 2015, C. S. Lin leg., in funnel trap (NMNH).

***Distribution*.** China, Japan, Korea, Vietnam and USA (Wood and Bright, 1992; Rabaglia *et al*., 2010). New to Taiwan.

***Biology*.** Recorded from *Carpinus laxiflora* (Betulaceae) *Clyera* spp., *Eurya japonica* (Pentaphylacaceae), *Illicium religiosum* (Schisandraceae), and *Ilex rotunda* (Aquifoliaceae) (Murayama, 1934; Wood and Bright, 1992).

Discussion

Prosternal processes have previously been a demonstrated to be a valuable character for species recognition in Asian *Scolytoplatypus* Schaufuss, 1891 by Browne (1955), Tsai and Huang (1965), Nobuchi (1980), Beaver and Gebhardt (2006) and Gebhardt *et al*. (2021). The male prosternal processes could possibly be used in courtship and pre-mating behaviour (Beaver and Gebhardt, 2006; Gebhardt *et al*., 2021). Here we note for the first time that males of three *Cyclorhipidon* species also have unique characteristics of the prosternal process. It seems likely that some form of sexual selection is occurring in *Cyclorhipidion* species, resulting in greater

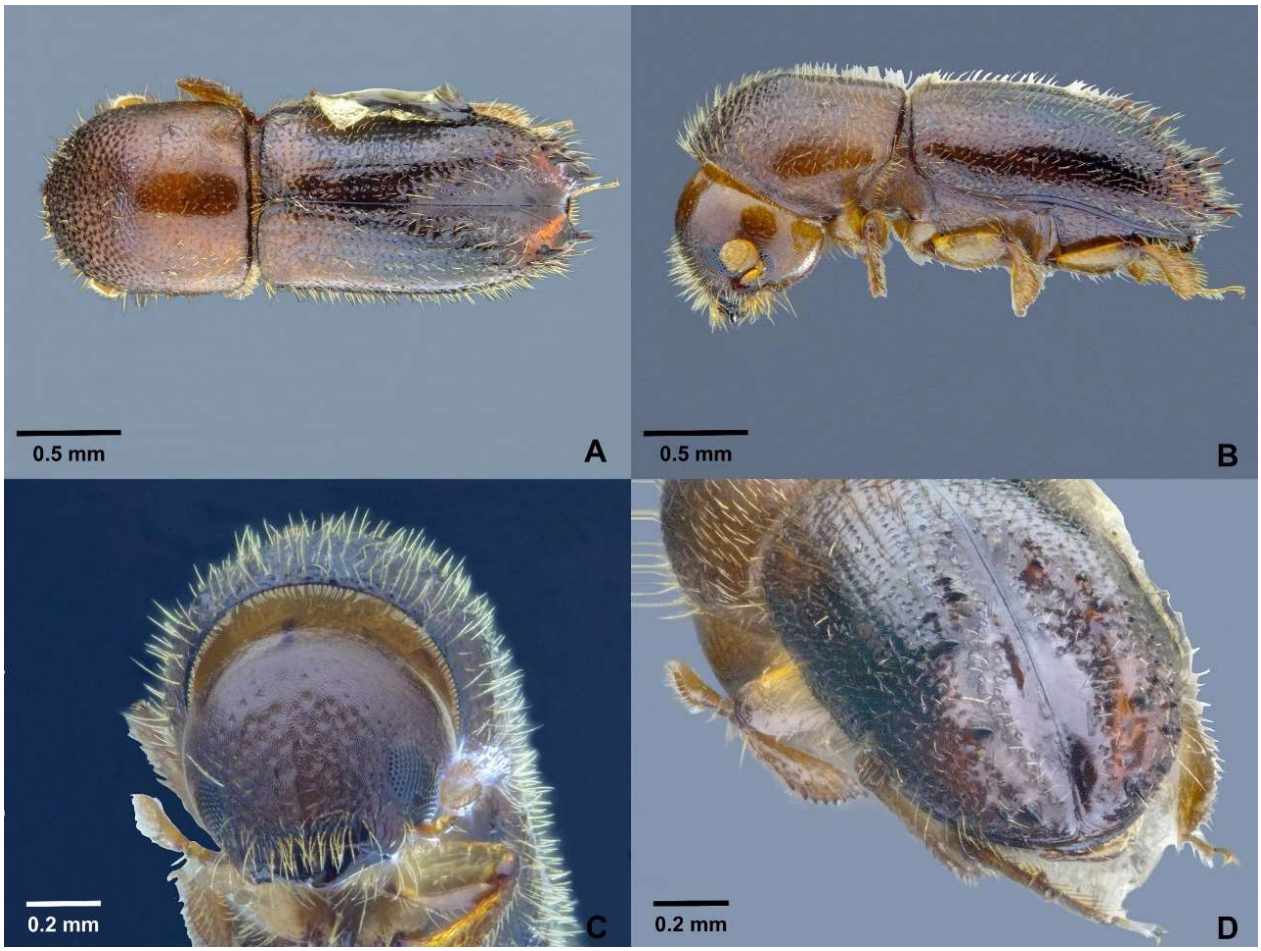

Fig. 11. ***Xyleborinus octiesdentatus*** (Murayama), female: **A**. dorsal view, **B**. lateral view, **C**. front view, **D**. elytral declivity.

morphological divergence of this structure in males than females. The prosternum is posteriorly raised and is flat, subrectangular and sparsely punctate, each puncture with erect long setae. In larger individuals the prosternal processes are slightly outcurved, expanded anteriorly with the outer anterior margin broadly rounded to form lobe-like plates, smaller individuals have the lateral sides subparallel and narrowly rounded at the apex, all of which are immoveable. The color of processes is the same as body, except black anteriorly. The variance of shape and color distribution of prosternal process are more obvious in larger individuals than smaller individuals. Morphological characters involved in mating behavior of bark beetles often develop more rapidly than other morphological features (Kirkendall *et al*., 2015). Whether the forms of the prosternum are species-specific remains unclear. Additional individuals of each species will need to be collected and studied to compare intraspecific and interspecific difference. At present the function of prosternal processes has never been examined in living specimens. Behavioural studies of mating pairs will be necessary to determine the exact function of prosternal processes.

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