

The Eneopterinae crickets from Leyte Island (Philippines) with description of two new species [Insecta: Orthoptera: Grylloidea: Gryllidae]

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Abstract. Leyte Island is the eighth largest island in the Philippines. The centre part of the island is considered as a high priority area in terms of biodiversity conservation; however, no detailed biological inventories or assessment of insects have ever been done in the island. In this paper, we present a first contribution toward a better knowledge of this island's fauna. We provide new information about the crickets Eneopterinae. We compile new information about five species: we describe two new species, *Lebinthus estrellae*, new species and *Paranisitra leytensis*, new species. We present new geographical data about *Lebinthus luae* Robillard & Tan, 2013, and redescribe two *Cardiodactylus* cricket species, *Cardiodactylus empagatao* Otte, 2007 and *Cardiodactylus riga* Otte, 2007, previously known respectively from Mindanao and Luzon.

Key words. Lebinthini, Nisitriini, new species, redescription, Philippines, Leyte

INTRODUCTION

Leyte Island is the eighth largest island in the Philippines with an area of 7,367.6 km² (UNEP, 2013). It is located southeast of Luzon, northeast of Mindanao, south of Samar, and northeast of Cebu and Bohol islands, between 100°50'0" North latitude and 124°50'0" East longitude (Fig. 1). The island is bounded by different bodies of water, San Juanico and Biliran Straits at the north, Philippine Sea and Pacific Ocean at the east, Camotes Sea at the west, and Surigao Strait at the south. Politically, the island is divided into two parts, Northern Leyte which comprised two-thirds of the island, and Southern Leyte.

During the recent Pleistocene period, Leyte belonged to the Greater Mindanao Island (Heaney, 1985; Peterson et al., 2000). The island constitutes a volcanic centre of Pliocene-Quaternary origin, part of the Philippine Trench running parallel to the eastern coast of Luzon, Samar, Leyte and Mindanao (Reyes, 1979; Vasquez & Javellana, 1997). It is one of the many belts that provide geothermal power sources in the island. The parent material of the soil is composed of basaltic-andesitic breccias that gave rise to haplic Andosol with rudic phase, which is a good soil for plant growth (Langenberger, 2000).

There are conservation sites that have been identified on the island. In the north is a mountain range with three peaks: Mt. Lobi, the highest and standing at 1,346 m asl, Mt. Burauen Graben and Mt. Camaiyak while in the south standing at 1,007 m asl is Mt. Nacolod (Mallari et al., 2001). The island has a two weather types: Type IV, rainfall is more or less evenly distributed through the year, which is mostly experienced by the whole island, and Type II, no dry season with a very pronounced rainfall from November to April and wet during the rest of the year, which is experienced at the southern part of the island. These types lead to a large diversity of flora and fauna.

The mountains and forested areas are important biodiversity conservation sites in the island. Leyte Island has been included in the list of high-priority area for research and conservation (Ong et al., 2002). In terms of plant and animal diversity, the central part of the island was considered as the high priority area. However, no detailed biological inventories or assessment of insects have been done in the island. Overall, the floristic, faunistic and geological composition of Leyte Island is very unique that it belongs to the fourth largest biogeographic zone in the Philippines.

In this paper, we present a first contribution toward a better knowledge of this island's fauna. Based on recent field sampling in several localities, we provide new information about the eneopterine crickets from Leyte Island. Eneopterinae sensu Robillard & Desutter-Grandcolas (2008) constitute a cricket subfamily particularly diversified in the Pacific and in the Philippines, where two distinct tribes are present, the Nisitriini Robillard, 2004 and the Lebinthini Robillard, 2004. These crickets not only show high diversification rates and endemism in island systems (Nattier et al., 2011, 2012), but they also possess distinct acoustic traits for communication

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(e.g., Robillard & Desutter-Grandcolas, 2004a, b; Robillard & Desutter-Grandcolas, 2011; Robillard et al., 2007, 2013a). Here we present the first data about these crickets in Leyte Island. We compile new information about five species: we describe two new species, *Lebinthus estrellae*, new species and *Paranisitra leytensis*, new species, we provide new geographical data about *Lebinthus luae* Robillard & Tan, 2013, and redescribe two *Cardiodactylus* cricket species, *Cardiodactylus empagatao* Otte, 2007a and *Cardiodactylus riga* Otte, 2007a, previously known respectively from Mindanao and Luzon and for which new collections yielded more specimens for a more accurate description.

MATERIAL AND METHODS

Material. Field collections and observations were made in several localities in Leyte Island (Philippines) in 2012 and 2013 (TR). Specimens were collected by sight only, by night and day, in order to observe their habitat and estimate their period of activity. Newly collected specimens are deposited in the collections of the Muséum national d'Histoire naturelle, Paris (MNHN) and in the Museum of Natural History of Los Baños (University of the Philippines, Los Baños; UPLB-MNH). Species identifications and decisions for describing new species were based on the observation of the collection of eneopterine specimens gathered from many institutions. Square brackets are used for additional information not mentioned on specimen labels or translated from French labels.

Observations and morphological analysis. Direct observations and dissections have been made using a binocular microscope Leica MZ16 at magnifications up to 115×, equipped with a camera lucida for the line drawings. Male tegminal veins and cells follow terminology by Ragge (1955) and Robillard & Desutter-Grandcolas (2004a).

Male and female genitalia have been dissected in softened or fresh specimens by cutting the membranes between the paraprocts and the subgenital plate, or between the ovipositor and the subgenital plate respectively; they have been cleaned with cold KOH and then kept in glycerine in vials pinned under specimens. Male genitalia are named according to Desutter (1987), modified in Desutter-Grandcolas (2003) and Robillard & Desutter-Grandcolas (2004a). Photographs of male genitalia were obtained using an AmScope MU1000 digital camera (www.amscope.com). Abbreviations: see below.

Acoustic data. The basic cricket song terminology follows Ragge & Reynolds (1998): One song unit is called a syllable and corresponds to one opening-closure cycle of the male forewings; a group of syllables forming a cricket calling song unit is called an echeme.

The new species *Lebinthus estrellae* and one of the redescribed species (*Cardiodactylus riga*) have been recorded in the field and/or in the laboratory. The recordings were made with a modified Condenser Microphone Capsule CM16 (Avisoft Bioacoustics, Berlin), with a relatively flat

frequency response from 3 to 150 kHz (R. Specht pers. comm.), connected to a Fostex FR-2LE digital field recorder (96 kHz sampling frequency, 16 bit) in the field, or using Avisoft Triggering Harddisk Recorder version 2.97 and a 8-Pre MOTU sound card at a sampling frequency of 96 k-samples s⁻¹ (16 bit). Song features were measured using the automatic commands under Avisoft-SASLab Pro version 4.40 (Specht, 2008). All recording files are deposited in the Sound Library of the MNHN.

ABBREVIATIONS

Institutions:

BPBM: Bernice P. Bishop Museum, Department of Zoology, Honolulu, Hawaii, USA.

MNHN: Muséum national d'Histoire naturelle, Paris, France.
UPLB-MNH: Museum of Natural History, University of the Philippines Los Baños.

ZRC: Zoological Reference Collection, Lee Kong Chian Natural History Museum (formerly Raffles Museum of Biodiversity Research), National University of Singapore.

General morphology:

I, II, III: front, median, hind respectively (legs, femora, tibiae).

F: femora.

FW: forewing.

Tarsomere III-1: basal segment of hind leg tarsomere.

T: tibiae.

Tegminal venation:

1A-4A: first to fourth anal veins.

CuA: anterior cubitus; CuA1, CuA2, ... : first, second, ... bifurcations of CuA.

CuP: posterior cubitus.

M: median vein.

Sc: subcostal vein.

R: radial vein.

c1-3: first to third cells of C alignment.

d1 cell (mirror): first cell(s) of D alignment.

d2: second cell of D alignment.

e1: first cell of E alignment.

Measurements (length and width in mm):

FIIL: length of hind femora.

FIIIW: width of hind femora.

FWL: forewing length.

FWW: forewing width (at the level of maximal width).

HWT: Hind wing tail length (part of the hind wings longer than the FWs).

Ias: inner spines on TIII dorsal side, above the spurs.

Ibs: inner spines on TIII dorsal side, between the spurs.

Oas: outer spines on TIII dorsal side, above the spurs.

Obs: outer spines on TIII dorsal side, between the spurs.

OL: ovipositor length.

PronL: pronotum length.

PronW: pronotum width.

ST: number of stridulatory teeth.

TIIL: length of hind tibiae.

TaIIIs: spines on outer edge of third hind tarsomere, not including the apical spine, when there are spines on a second

raw on external side of tarsomere, the number of spines is notified “number of dorsal spines [number of lateral spines].”

TAXONOMY

Subfamily Eneopterinae Saussure, 1874

Tribe Lebinthini Robillard, 2004

Genus *Lebinthus* Stål, 1877

Type species. *Lebinthus bitaeniatus* Stål, 1877

Diagnosis. Among Lebinthini genera, *Lebinthus* is closely related to *Agnotecous* Saussure, 1878, to which it resembles by microptery and FW venation. It is characterised by its rather smaller size and male FW venation with mirror almost not differentiated from apical field, dorsal field as long or longer than lateral field (it is shorter in *Agnotecous*), median fold short, triangular and located on dorsum.

Lebinthus luae Robillard & Tan, 2013

(Figs 1, 2A)

Lebinthus luae Robillard & Tan, 2013: 718 – Eades et al., 2014 (Orthoptera Species File Online).

Lebinthus bitaeniatus Stål, 1877 – Robillard & Desutter-Grandcolas, 2004a: 275; 2006: 644; Robillard, 2011: 25 (Specimens misidentified).

Lebinthus sp. – Tan, 2010: 246; Tan et al., 2012: 66; Tan, 2012: 4; Tan & Wang, 2012: 315.

Lebinthus n. sp. affinis *bitaeniatus* – Robillard et al., 2013a: 2003 > mechanism of stridulation.

Type material. Holotype (male): **Singapore:** male (TR6), day, leaf litter (ZRC), Labrador park, forêt secondaire littorale [coastal secondary forest], 01°15'59"N, 103°48'8.1"E, 57 m (GPS Lab1), coll. T. Robillard, 12 June 2011.

Allotype (female): **Singapore:** female (TR42bis), day, leaf litter (ZRC), Pulau Ubin Island, Jalan Endut Senin, 01°24'19.3"N, 103°57'58.7"E, 0 m, coll. T. Robillard, 30 June 2009.

Paratypes (14 males, 7 females): **Singapore:** 1 male (TR4), call recording (MNHN-EO-ENSIF 3207), same information as HT. 1 male (TR17) (ZRC); 1 male (TR41) (UPLB MNH); 1 male (TR16), 1 female (TR53) (MNHN-EO-ENSIF3206), same information as AT. 2 males (TR10, 11), leaf litter, call recording (MNHN-EO-ENSIF3107-3209); 1 male (TR9) copulation recording in the field (MNHN-EO-ENSIF3210), Labrador park, coastal secondary forest, 01°15'58.7"N, 103°48'10.3"E, 46 m (GPS Lab3), day, coll. T. Robillard, 14 June 2011. 2 males (TR38, 54), day, leaf litter, call recording (MNHN-EO-ENSIF2740-3208), Labrador park, 01°16'02.2"N, 103°48'05.6"E, 46 m, coll. T. Robillard, 7 July 2009. 2 females, day, leaf litter (dead in captivity) (ZRC), 1 female, day, leaf litter (dead in captivity) (UPLB MNH), Sentosa Island, 01°14'49.4"N, 103°50'01.1"E, 17 m, coll. T. Robillard, 6 July 2009. 1 female (MNHN-EO-ENSIF3205),

Semakan landfill, coll. RMBR Nature Guide, 5 December 2009. 1 male (ZRC), Pulau Tekong, 7 April 1984, coll. D. H. Murphy; 1 male (ZRC), Sentosa, 20 January 1985, coll. D. H. Murphy; 1 male, 1 female (ZRC), Pulau Ubin, along Sensory Trail, 4 December 2009, coll. M. K. Tan; 1 male, 1 female (ZRC), Hindhede Nature Park, secondary forest, 2 June 2011, coll. M. K. Tan; 1 male (TR23), night (MNHN-ENSIF3090), Bukit Timah Nature Reserve, Hindhede trail, 01°15'57"N, 103°46'33.6"E, 68 m, 20 June 2011, coll. T. Robillard [examined]

Studied material from Leyte and Biliran islands.

Philippines: 2 females (MNHN), 2 males (MNHN), 1 male (MNHN), call recording, 1 juvenile (MNHN), day, South Leyte, prox. Kuting Reef, 10°2'22.7"N 124°58'58.11"E, 10 m, zone herbacée en bord de route [herbaceous area near road], coll. T. Robillard, August 2013. 1 male, call recording (MNHN), day, Biliran islands, North Maripipi Island, zone secondaire en bord de route [secondary area near road], 11°48'48.7"N 124°18'57.3"E, 52 m, coll. T. Robillard, March 2013. 1 male (TR61), call recording (MNHN), day, Biliran islands, South Maripipi Island, zone secondaire en bord de route [secondary area near road], 11°48'48.7"N 124°18'57.3"E, 52m, coll. T. Robillard, March 2013. 7 males (TR4, 8, 9, 10, 13, 15, 16), 2 females (TR11-12) (MNHN), day, Leyte [Island], Leyte-Leyte, zone ouverte en bord de route, 11°23'33.5"N 124°29'14.4"E (118 m), coll. T. Robillard, 22 June 2012. 1 juvenile (MNHN), day, Leyte Island, Dulag, zone ouverte en bord de route [open area near road], 10°57'22"N 125°01'47.7"E (1 m), coll. T. Robillard, 26 June 2012.

Distribution. Singapore, Indonesia (Western Java, Sumatra, Riau islands, Durian Island), Philippines (Leyte, Biliran Islands) (Fig. 1).

Diagnosis. Species close to *L. bitaeniatus*, from which it differs by general shape more stocky and colouration, darker with wider yellowish or whitish longitudinal band along body, without a black line ventrally. Male genitalia wider and shorter than in *L. bitaeniatus*, differing by shape of pseudepiphallic parameres, ectophallic fold membranous (without strong M-shape sclerotisation) (Robillard & Tan, 2013).

Taxonomic discussion. Despite the geographical vicinity between Leyte and Luzon, it is interesting to notice that the species *Lebinthus bitaeniatus*, known from Luzon, is not found in Leyte, but that *L. luae* is found in this part of the Philippines, while it was previously known from Singapore, Java and Sumatra. The similarity of specimens of *L. luae* with the newly observed specimens from Leyte is clearly established based on morphology, acoustic features (calling song) and molecular data (TR unpublished results). This distribution is probably due to the geographical history of the region relating the south of the Philippines to Sundaland more than to the northern part of the archipelago in the recent past (Hall, 2002). Such lack of relationship between Luzon and Samar and Leyte islands was also demonstrated

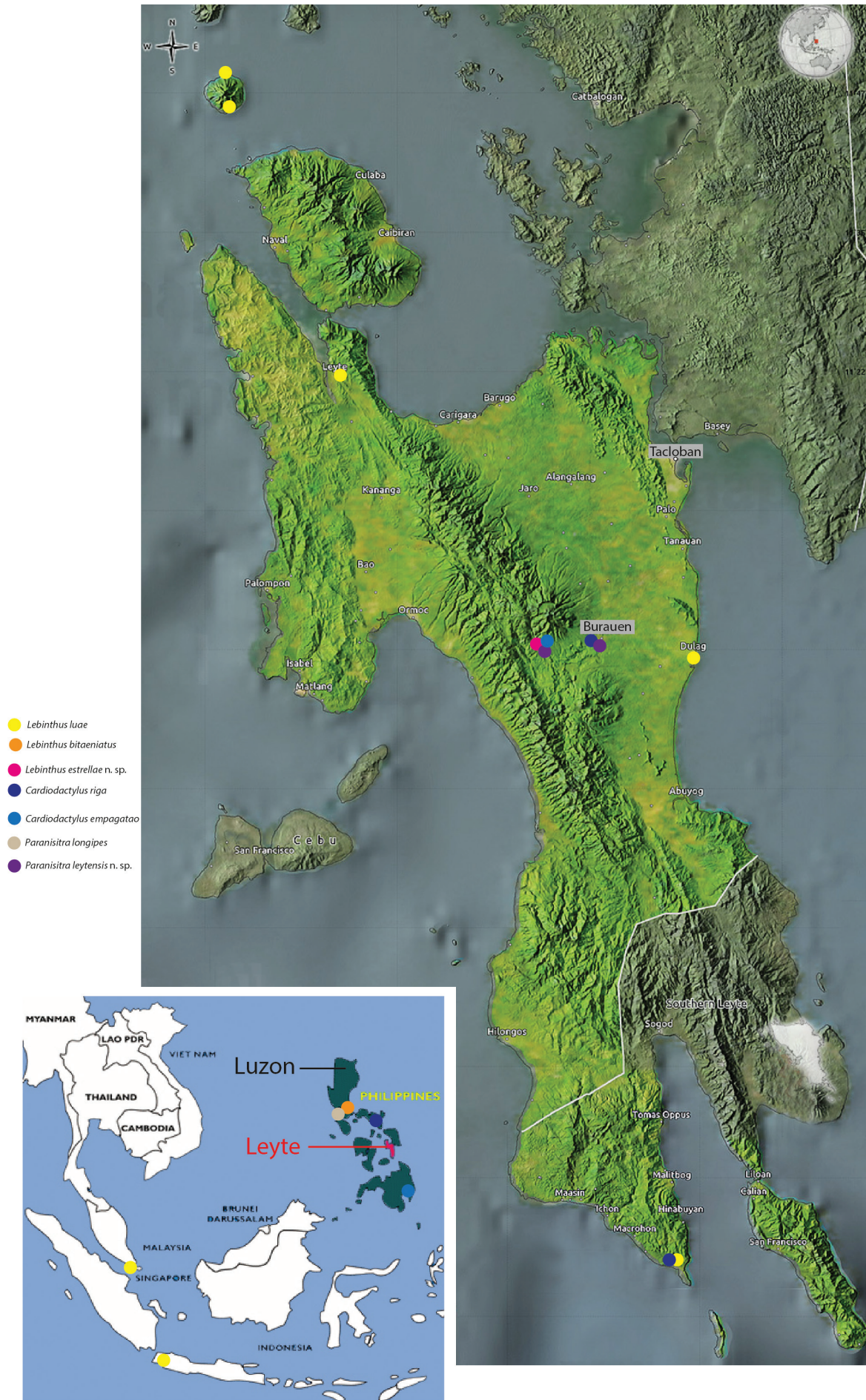


Fig.1. Map of Leyte and distribution of the species mentioned in the study. Map modified after snapshots from www.maphill.com.

for bird faunas (Townsend et al., 2000). Additional sampling in other parts of the Philippines will permit to understand the origin on both species in the archipelago.

Life history traits. The populations of *L. luae* found in Leyte and Maripipi islands conform to that found in Singapore (Robillard & Tan, 2013): they are diurnal and live in forested secondary habitats (Fig. 2A), near rivers and along the road on coastal areas. Males sing from low plants above the leaf litter from early morning to dusk. Interestingly, the species was not found in the inland parts of Leyte, where *L. estrellae*, new species, occurs (see below).

***Lebinthus estrellae* Robillard, new species**

(Figs. 1, 2B, 3, 4, 5, 6, 7A–C, 8, 9)

Type material. Holotype (male). **Philippines:** male (TR29), day, leaf litter (UPLB-MNH), Leyte, Burauen, Barangay Villa Corazon, forêt secondaire sur pente [secondary forest on slope] (GPS Bar2), 10°57'52.1"N 124°46'39.8"E, 345 m, T. Robillard, March 2013.

Allotype (female): same information as HT (TR47) (UPLB-MNH).

Paratypes (2 males, 15 females): same information as HT: 1 male (TR48) (UPLB-MNH); 1 male, adulte en élevage [adult in captivity], call recording (MNHN-EO-ENSIF3342); 7 females (2 mortes en élevage [dead in captivity], TR40, 41, 43, 53, 56) (UPLB-MNH); 8 females (2 mortes en élevage, TR30, 42, 51, 52, 57, 59) (MNHN-EO-ENSIF3343-3350).

Other material examined. Philippines: 1 male, reared specimen F1, call recording (MNHN-EO-ENSIF3351), same information as HT. 4 juveniles (TR27, 28, 54, 60) (MNHN), same information as HT.

Type locality. Philippines, Leyte Island, Burauen, Barangay Villa Corazon, secondary forest on slope, 10°57'52,1"N 124°46'39,8"E, 345 m.

Distribution. Only known from type locality: Philippines, inland part of Leyte Island (Fig. 1).

Etymology. This species is dedicated to R. "Estrella" Portillo for her help accessing the type locality and collecting specimens.

Diagnosis. *L. estrellae* is close to *L. sanchezi* Bolivar, 1889 found in Luzon Island and belonging to the same species group as *L. puyos* Robillard, 2013 (in Robillard et al., 2013b), *L. truncatipennis* Chopard, 1929, *L. villemantae* Robillard, 2010 and characterised by rounded false mirror on the harp, dark brown colouration, male genitalia with well-developed lophi. *L. estrellae* differs from the other species by head colouration (vertical whitish bands below eyes, clypeus black with yellow edge), male genitalia with short rounded lophi, female FWs very short (reaching posterior margin of first tergite).



Fig. 2. A, Secondary habitat of *Lebinthus luae* in Maripipi Island (Biliran Islands, Philippines); B, Secondary forested habitat of *Lebinthus estrellae*, new species (in the leaf litter), *Cardiodactylus empagatao* Otte (in low trees and banana trees) and *Paranisitra leytenis*, new species (intermediate vegetation) in Villa Corazon Barangay, Burauen, Leyte.

Description. Size small for the genus. Colouration contrasted, mostly dark brown with white and yellow details (Figs. 3, 4). Head dorsum (Fig. 4) with 4 wide but faint brown longitudinal bands, each band containing a thin black line; area posterior to eyes yellow. Eyes dark brown, with a pale dorsal longitudinal band, orange brown to pink brown. Fastigium wider than long, setose, dark brown, with a contrasted vivid orange band apically; upper facial part with four black patches forming a square. Scapes light yellow; antennae orange brown. Face and lateral part of head mostly dark brown to black, with a vertical whitish band below eyes; epistomal suture yellowish. Mouthparts black, variably mottled with yellow, clypeus black, its margins yellow; maxillary palpi mostly dark brown. Pronotum: Dorsal disk slightly trapezoidal, straight posteriorly; yellow brown mottled with dark brown, lateral edges always whitish, posterior area with dark brown patterns. Lateral lobes dark brown dorsally, ventral margin yellow with a median brown pattern (Fig. 4C). Legs: Fore and median legs whitish, femora with dark brown spots, tibiae with dark rings. Hind femora brown, with strong striated dark brown patterns on outer faces, knees dark brown with a pale inner preapical area; hind tibiae with dark rings. Tarsomeres I/III-1 yellow brown, apices dark brown. Tarsomeres III-1 with 2 spines on dorsal outer edges ($n = 5$) and 0–1 ($m = 1$, $n=5$) on outer faces. Abdomen dark brown with black spots dorsally, yellowish brown ventrally. Cerci yellowish brown, with dark rings near apex.

Male: FWs not reaching abdomen midlength. FW colouration (Fig. 5A): Cells dark brown, not translucent; veins mostly



Fig. 3. *Lebinthus estrellae*, new species: A, male in dorsal; B, lateral views; C, female in dorsal; D, lateral views. Scale bar: 5 mm.

dark brown and faint; chords orange brown; apex of longitudinal veins orange brown. M and R orange brown, area in between whitish to yellowish, without transverse veins; Sc dark brown, area between R and Sc dark brown, rest of lateral field progressively lighter toward ventral margin, with dark brown longitudinal veins. FW venation (Fig. 5A): 1A widely curved (angle > 120°); stridulatory file with 200 teeth (n = 1), located on the straight transverse part of 1A only. CuP missing. Diagonal vein weak near CuA, then stronger, underlined by a convex fold underlying harp posterior margin. Harp wide, occupying most of dorsal field surface, with a strong transverse harp vein, polyfurcated anteriorly and delimiting a rounded false mirror, i.e., a distinctive area located on harp posterior corner (not homologous to the mirror of other cricket species: cell d1, Robillard & Desutter-Grandcolas, 2004a). CuA curved innerly near apex, its distal part weak, surrounding the median fold, small and located dorsally. Longitudinal veins of dorsal field stronger apically, transverse veins very weak. Mirror (d1) not differentiated. Apical field absent, with no bifurcation of CuA posterior to diagonal vein. Lateral field with 5 strong longitudinal veins including R, Sc and 3 more ventral veins; latero-dorsal angle made by M; Sc without bifurcating veins. Subgenital plate elongate, clog-shaped.

Male genitalia (Fig. 6): Intermediate between male genitalia of *L. puyos* and *L. sanchezi*, with short and rounded lophi. Pseudepiphallallic sclerite triangular, convex dorsally; posterior apex with short individualised lophi, rounded, slightly setose and separated by a weak indentation; anterior margin almost straight, its lateral margins not raised dorsally. Rami short, prolonging the triangular shape of pseudepiphallus. Pseudepiphallallic parameres rounded. Ectophallic arc complete and thick, deeply curved posteriorly. Ectophallic fold with a wide bilobate preapical sclerite. Ectophallic apodemes parallel and very long, exceeding anterior margin of pseudepiphallus. Endophallic sclerite very long, curved



Fig. 4. *Lebinthus estrellae*, new species. head in: A, dorsal; B, facial; C, lateral views. Scale bars: 1 mm.

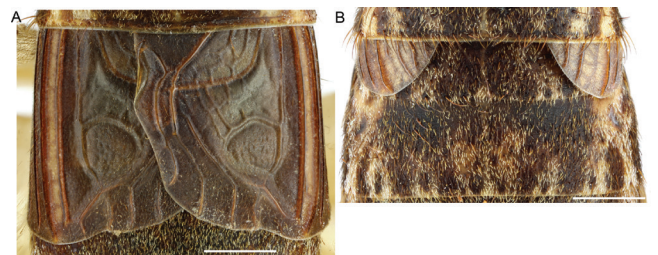


Fig. 5. *Lebinthus estrellae*, new species: A, dorsal FW venation of male; and B, female. Scale bars: 1 mm.



Fig. 6. *Lebinthus estrellae*, new species: A, male genitalia in dorsal; B ventral; C, lateral views. Scale bar: 1 mm.

Table 1. Measurements of *Lebinthus estrellae*, new species

	PronL	PronW	FWL	FWW	HWT	FIHL	FIHW	THIL
Male holotype	2.4	3.5	3	–	–	10.9	3.5	8.7
Males (n=5)	2.3–2.4	3.5–3.6	3–3.6	–	–	10.4–11.5	3.5–3.8	8.4–9.6
(mean)	(2.4)	(3.5)	(3.4)	–	–	(11.1)	(3.7)	(9.0)
Female allotype	2.3	3.5	1.2	–	–	11.1	3.8	8.2
Females (n=4)	2.1–2.4	3.4–3.8	0.6–1.2	–	–	10.1–11.1	3.1–3.8	8.2–8.7
(mean)	(2.3)	(3.6)	(0.9)	–	–	(10.7)	(3.4)	(8.4)

	TIIIs				TaIIIs	ST (n=2)	OL
	Ias	Ibs	Oas	Obs			
Male holotype	4	3	8	5	3[1]	?	–
Males (n=5)	4–5	2–5	7–11	4–5	3[0–1]	200–210	–
(mean)	(5)	(3)	(9)	(5)	(3[1])	(205)	–
Female allotype	5	3	8	4	3[1]	–	7.5
Females (n=4)	5–6	3–5	8–10	4–5	3[1]	–	7.4–7.5
(mean)	(5)	(4)	(9)	(5)	(3[1])	–	(7.5)

dorsally, exceeding anterior margin of pseudepiphallus, its posterior apex with a small median expansion and with short lateral arms; endophallic apodeme made of lateral lamellas but without a median crest.

Female: FWs shorter than in *L. sanchezi* and *L. puyos*, reaching posterior margin of first tergite (Fig. 5B), far from overlapping; dorsal field light brown with 3–5 strong brown longitudinal veins and a weaker lateral whitish one. Lateral field brown, with 4 strong brown longitudinal veins. Ovipositor slightly shorter than hind femora; apex lanceolate, slightly denticulate on dorsal edge (Fig. 14A).

Female genitalia (Fig. 7A–C): small, conical, and narrow dorso-ventrally; apex wide, slightly sclerotised and concave dorsally, with a narrow basal C-shaped sclerotisation.

Juvenile: Colouration almost homogeneously brown, with pink brown eyes (Fig. 8B). First instar black with whitish head.

Measurements. see Table 1.

Habitat and life history traits. *L. estrellae* is found in secondary forested areas (Fig. 8). It is found on top of leaves in small bushes and sometimes in the leaf litter.

Behaviour. Calling song (Fig. 9): The calling song of *L. estrellae* was recorded in the laboratory (23.7°C, MNHN-EO-ENSIF3351). It consists of short trills comprising 87 ± 4 syllables beginning with a few syllables with a longer period than in the rest of the song. Each echeme lasts for 1.6 ± 0.1 s with a period of 20.236 ± 4.62 s. Syllables are short (duration = 7.7 ± 0.8 ms; period = 18.3 ± 13.5 ms) and show a homogeneous amplitude profile suggesting a regular wing closing movement during wing stridulation. The spectrum shows a clear dominant peak at 22.04 ± 0.92 kHz with one peak harmonically related at about 44 kHz.

Mating behaviour: Observations in the laboratory showed multiple matings, as described in another *Lebinthus* species (Narvaez & Robillard, 2012), but no tremulation were observed in this species.

Genus *Cardiodactylus* Saussure, 1878

Type species. *Cardiodactylus novaeguineae* (Haan, 1842)

Diagnosis. Among Lebinthini genera, *Cardiodactylus* is characterised by its large size, long wings most often with whitish spots in both sexes, male FW venation (W-shaped harp veins, mirror incomplete generally elongated longitudinally), and male genitalia (pseudepiphallic dorso-lateral ridges, posterior apex of pseudepiphallus more or less spoon-like).

Cardiodactylus empagatao Otte, 2007a

(Figs. 1, 2B, 7D–F, 10A–D, 11A, B, 12A, B, 13A–C, 14A, 15)

Cardiodactylus empagatao Otte, 2007a: 351 – 2007b: 31 (confirmation of depository). Eades et al., 2014 (Orthoptera Species File Online); Robillard et al., 2014: 33 (new signalisations).

Type material. Holotype (male): **Philippines:** male (BPBM), Mindanao, Misamis Oriental, Mt. Empagatao, 28 km SW of Gingoog, coll. H.M. Torre Villas, 12 April 1961 [not examined].

Material examined. **Philippines:** 1 male (#6316) (MNHN-EO-ENSIF1194), Mindanao [Island], Davao, coll. Baker. 1 male (TR50), 2 juveniles (TR45, 55) (MNHN), 1 male (TR49) (UPLB MNH), day, sur bananier [on banana tree], Leyte [Island], Burauen, Barangay Villa Corazon, forêt secondaire sur pente [secondary forest on slope] (GPS Bar2), $10^{\circ}57'52.1''N$ $124^{\circ}46'39.8''E$, 345 m, coll. T. Robillard, March 2013. 1 juvenile (TR31), day, Leyte [Island], Burauen, Barangay Villa Corazon, zone herbacée [herbaceous area]

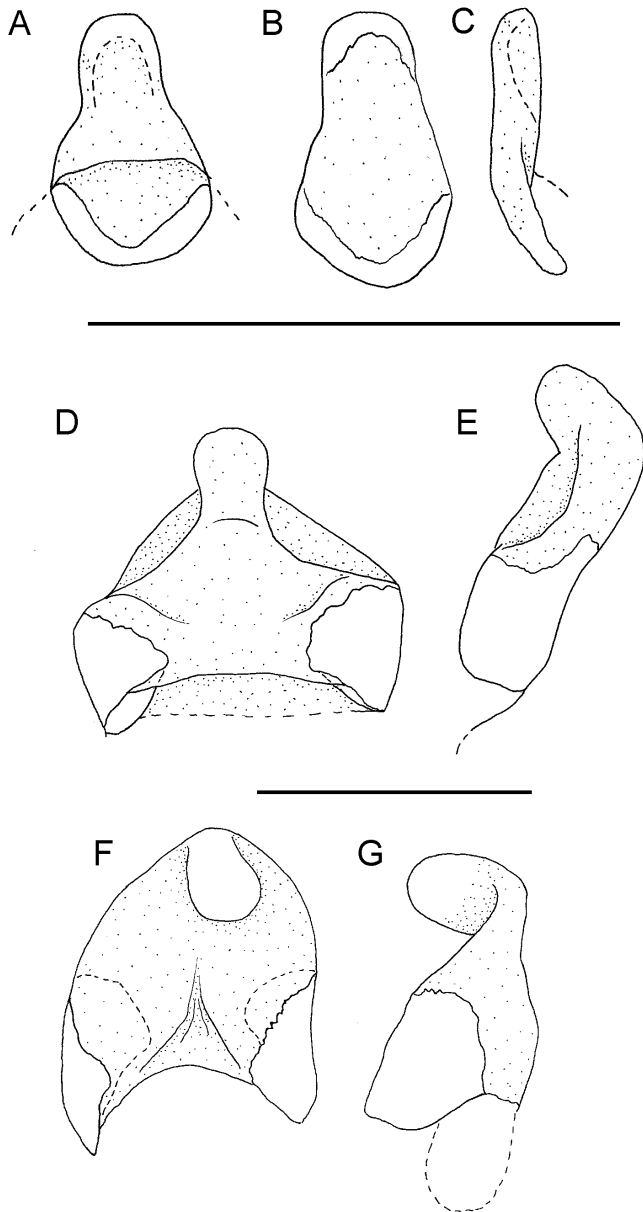


Fig. 7. Female genitalia: *Lebinthus estrellae*, new species: A, in dorsal; B, ventral; C, lateral views. *Cardiodactylus empagatao*: D, in ventral; E, lateral views. *Cardiodactylus riga*: F, in ventral; G, lateral views. Scale bars: 1 mm.

(GPS Bar1), 10°57'50.5"N 124°46' 35.3"E, 282 m, March 2013, coll. T. Robillard (molecular sample C79) (MNHN-EO-ENSIF3353).

Distribution. Southern Philippines, Mindanao and Leyte Islands (Fig. 1).

Emended diagnosis. Species of average size for the species group, contrasted colouration, face yellow with 3 dark spots, dorsal disk of pronotum pale yellow anteriorly; very similar in colouration and external morphology to *C. riga* Otte, 2007a, to which it differs by yellow Sc vein (brown in *C. riga*), female FW colouration with dark brown veins and cells and characteristic whitish and yellow patterns, and male genitalia with only one wide curve in profile (Fig. 13C).



Fig. 8. *Lebinthus estrellae*, new species: A, female; B, juvenile specimens in leaf litter secondary forest, Barangay Villa Corazon (type locality).

Taxonomic discussion. Otte (2007a) mentioned that the species he described from the Philippines (*C. kondoi*, *C. riga* and *C. empagatao*) were collected far from Mindanao on separate islands. However, Misamis Oriental (the type locality of *C. empagatao*) is a province of the Philippines located in the Northern part of Mindanao (http://en.wikipedia.org/wiki/Misamis_Oriental), thus on the same island as the type of *Cardiodactylus haani philippinensis* Bolivar, 1913. *C. empagatao* could consequently correspond to this species. However the type of *C. haani philippinensis* being lost (Robillard, 2014) and the original description being inconsistent with observed specimens, *C. empagatao* should be considered as a valid species. The redescription presented here is based on newly collected specimens only, but both external morphology, colouration and male genitalia are consistent with photographs of the original description.

Redescription. In addition to the characters given by Otte (2007a: figs 34, 37): size average for the species group, colouration contrasted including yellow brown, dark brown, black and orange brown patterns (Fig. 10A–D). Head dorsum (Fig. 11A) yellow brown with 3 dark brown bands including 2 wide lateral ones with an anterior notch not related to black colouration of fastigium, and a median punctuated band made of the fusion of two thin parallel bands; short triangular bands posterior to eyes not connected to lateral bands. Face (Fig. 11B) yellow with 3 black spots, one in the middle of epistomal suture, and 2 between antennae; front part of fastigium usually with 2 small dark brown lines dorsally. Scapes yellow with basal dark brown patterns. Pronotum: Dorsal disk anterior part pale yellow, median area with 2 transverse symmetrical black patches, posterior area black. Lateral lobes pale, homogeneously yellow brown or cream,

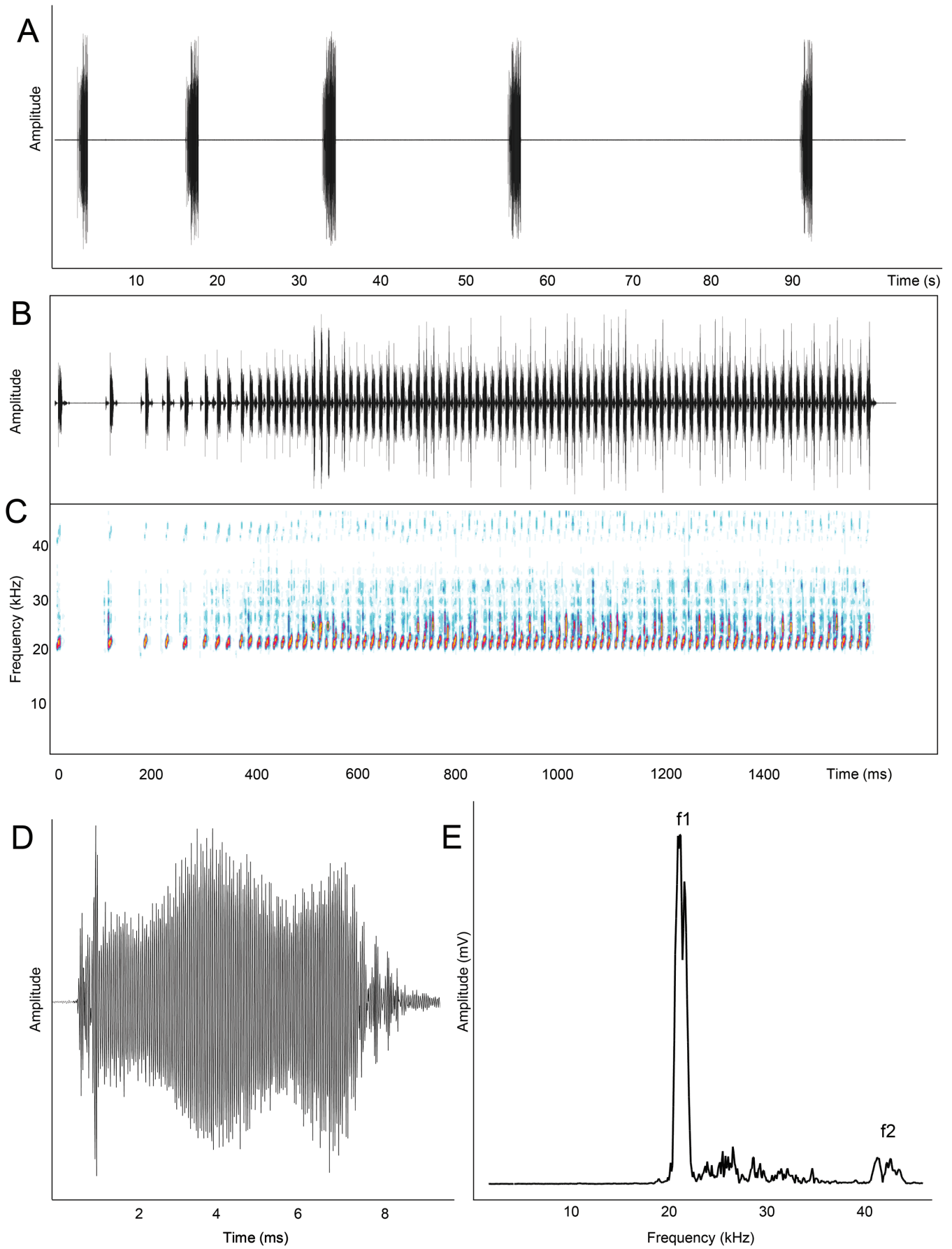


Fig. 9. Calling song of *Lebinthus estrellae*, new species: A, oscillogram of 5 echemes; B, detail oscillogram; C, sonogram of 1 echeme. D, detail oscillogram of 1 syllable. E, frequency spectrum of 1 syllable.

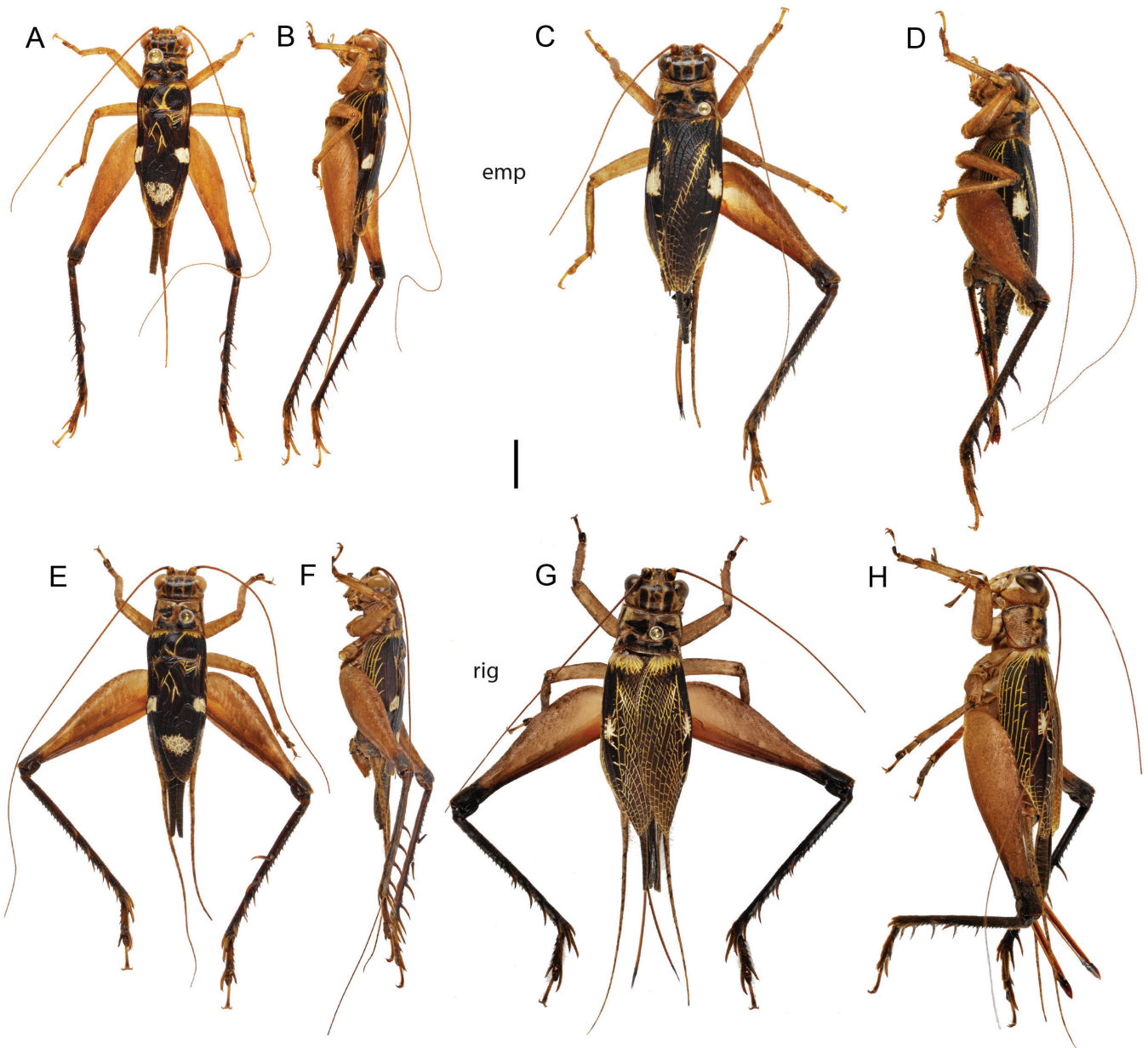


Fig. 10. *Cardiodyctylus empagatao* (A–D): A, male in dorsal; B, lateral views. C, female in dorsal; D, lateral views. *Cardiodyctylus riga* (E–H): E, male in dorsal; F, lateral views. G, female in dorsal; H, lateral views. Scale bars: 5 mm.

with a thin discontinuous dark line separating dorsal disks and lateral lobes. Legs I and II almost homogeneously orange brown. FIII homogeneously orange brown, tibiae and knees dark brown. Tarsomeres III-1 orange brown to dark brown. Cerci yellow brown, base faintly mottled with dark brown, apex with dark brown rings. Abdomen brown.

Male: FW (Fig. 12A) colouration mostly dark brown to black (cells and veins), with a wide semicircular whitish region posterior to mirror and areas with vivid yellow veins including bases of anal veins, anterior part of 3A, harp veins and part of 1A and CuA close to harp veins, and part of chord veins (2 inverted y-shape). M/R area and veins dark brown. Sc yellow, with a small dark brown preapical area; projections of Sc and more ventral veins of lateral field yellow. FW venation (Fig. 12A): 1A almost not bisinuated. CuP absent. Harp with 2 w-shaped veins. Mirror area: mirror (d1) oval, separated in two parts near midlength; d2 area as wide as

mirror but d2 not differentiated. Apical field with 4 cell alignments posterior to mirror (n = 2). Lateral field with 7–8 projections of Sc (n = 2) and 3 more ventral veins (n = 2).

Male genitalia (Fig. 13A–C): Pseudepiphallus shaped as a wide gutter. Apex of dorsal ridges with short setae, folded laterally and carinated innerly, the lateral triangular expansions clearly asymmetrical. Ventral side of pseudepiphallus with a wide little sclerotised median area. Dorsal ridges almost convex in lateral view (forming only one wide curve) (Fig. 13C). Pseudepiphallic sclerite with wide triangular anterior expansions, the membrane between them setose. Posterior pseudepiphallic apex rounded, with a rounded translucent area slightly sclerotised medially. Ectophallic arc complete, with a posterior triangular expansion. Ectophallic fold with thin lateral sclerites; apex trilobate, membranous, median lobe oval. Base of ectophallic apodemes with a short ventro-anterior sclerotisation. Endophallic sclerite small, with a

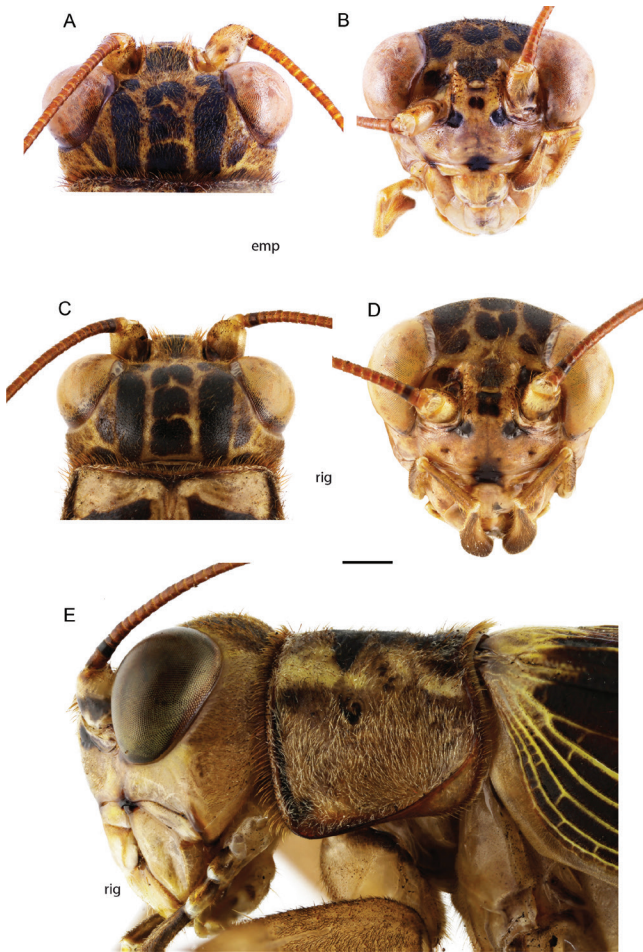


Fig. 11. *Cardiodactylus empagatao* (A, B): A, head in dorsal; B, facial views. *Cardiodactylus riga*: C, head in dorsal; D, facial; E, lateral views. Scale bars: 1 mm.



Fig. 12. *Cardiodactylus empagatao*: A, dorsal FW venation of male; B, female. *Cardiodactylus riga*: C, dorsal FW venation of male; D, female. Scale bar: 1 mm.

triangular posterior expansion. Endophallic apodeme with a dorsal crest and lateral lamellas. Membrane of endophallic cavity smooth.

Female: FW colouration (Fig. 12B, 15B): mostly dark brown with no contrast between cells and veins; base of FW whitish; a large whitish area on external lateral margin at FW midlength; light yellow narrow diagonal stripe from antero-external corner, including one of the longitudinal veins. CuA/M/R area and veins dark brown; Sc and its projections and more ventral veins yellow. FW venation (Fig. 12B): dorsal field with 12 ($n = 1$) strong longitudinal veins; lateral field with 9 ($n = 1$) longitudinal veins including 5 projections of Sc and 4 more ventral veins. Ovipositor of similar size as FIII; apex not denticulate on dorsal and ventral edges (Fig. 14B).

Female genitalia (Fig. 7D–F): Copulatory papilla triangular, with 2 baso-lateral sclerites; apex rounded, sclerotised and folded ventrally.

Juvenile: Colouration pattern of head and legs close to that of adults; body light brown mottled with dark brown.

Variation. The males from Leyte differ slightly from HT in male genitalia: the rami are well sclerotised while they are

mostly membranous in HT, and the observed males show a wide membranous line along pseudepiphallus in ventral view which is absent in HT. These characters may however result from conservation artefacts in the HT or from individual or slight geographical variations, as it is commonly observed in *Cardiodactylus*. Observation of more material from Mindanao should allow determining if the specimens from Leyte could constitute a different species or, as we suggest here, geographic variation.

Habitat and life history traits. *Cardiodactylus empagatao* is a nocturnal species living in secondary forest habitats. In Leyte, males and females have been observed singing and mating in banana trees (Fig. 15).

Behaviour. Calling song: Heard in Leyte, but not recorded. The song of *Cardiodactylus empagatao* consists of a single syllable close to that of *C. riga*.

***Cardiodactylus riga* Otte, 2007a**

(Figs. 1, 7G–I, 10E–H, 11C–E, 12C, D, 13D–F, 14B)

Cardiodactylus riga Otte, 2007a: 348 – 2007b: 30 (confirmation of depository). Eades et al., 2014 (Orthoptera Species File Online); Robillard et al., 2014: 86 (new signalisations).

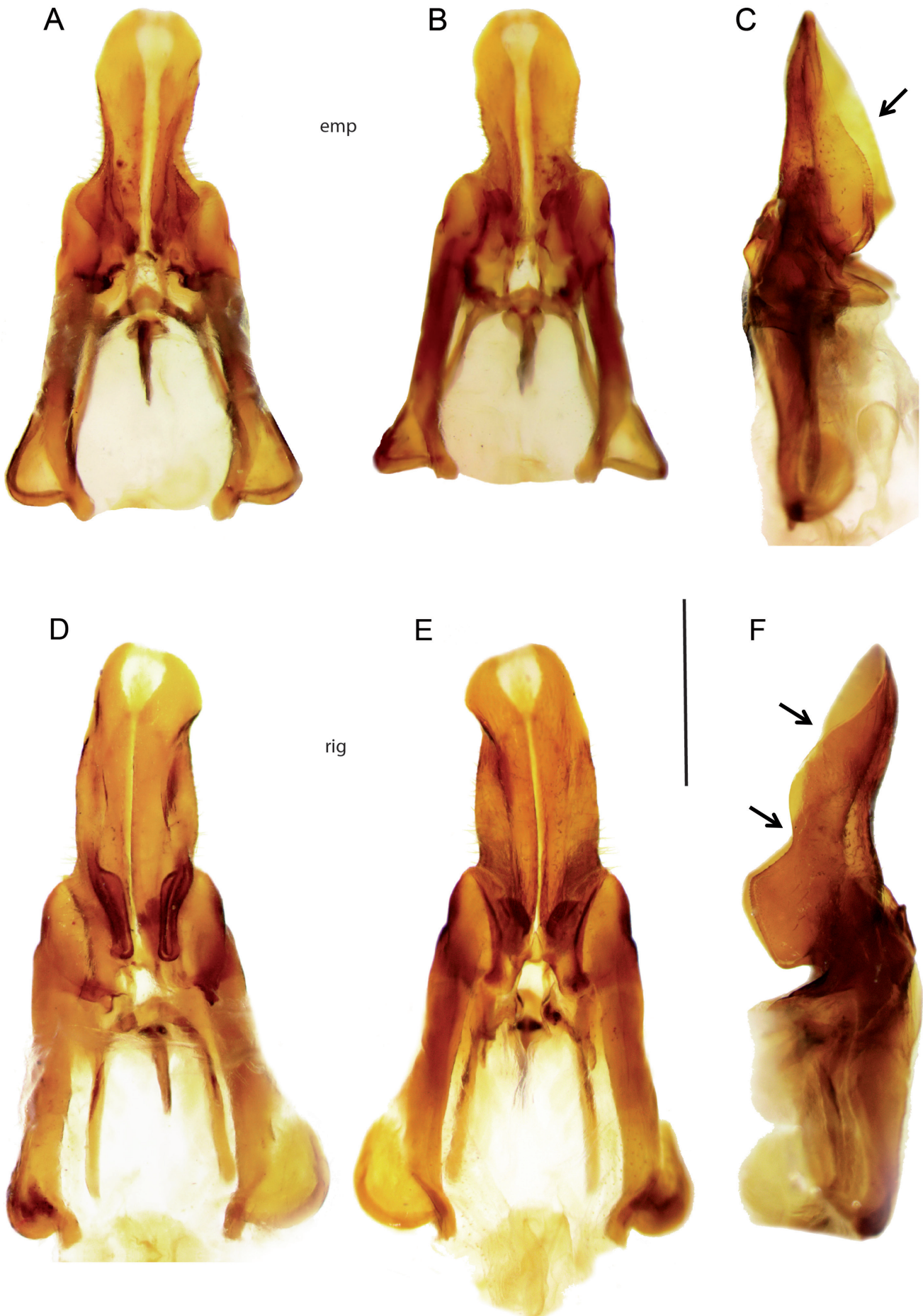


Fig. 13. *Cardiodyctylus empagatao*: A, male genitalia in dorsal; B, ventral; C, lateral views. *Cardiodyctylus riga*: D, male genitalia in dorsal; E, ventral; F, lateral views. Black arrows on lateral views indicate the curves discussed in descriptions. Scale bar: 1 mm.

Type material. Holotype (male): **Philippines:** male (BPBM), Luzon, Camarines Sur, Mt. Iriga, 500–600 m, coll. H.M.Torrevillas, 3 April 1962 [not examined].

Material examined. **Philippines:** 1 male (TR1), day, call recording, sur bananier [on banana tree] (molecular sample C83) (MNHN-EO-ENSIF3352), 1 male (TR35), day, sur bananier [on banana tree] (UPLB-MNH), Leyte, Burauen, Buo, zone secondaire en bord de route [secondary area near road], 10°57'59.8"N 124°52'35.5"E, 108 m, coll. T. Robillard, March 2013. 1 male, 1 female (MNHN), day, South Leyte, prox. Kuting Reef, forêt secondaire sur sol karstique [secondary forest on karstic soil], 11°48'48.7"N 124°18'57.3"E (10 m), coll. T. Robillard, August 2013.

Distribution. Central and southern Philippines, Luzon and Leyte islands (Fig. 1).

Emended diagnosis. Species of average size, colouration contrasted, face yellow with 3 black spots, very similar in colouration and external morphology to *C. empagatao*, to which it differs by brown Sc vein (yellow in *C. empagatao*), female venation yellow with dark brown cells and male genitalia bisinuated in profile view (Fig. 13F).

Redescription. In addition to the characters given by Otte (2007a: figs 17, 19): size average for the species group, colouration contrasted including yellow brown, dark brown, black and orange brown patterns. Head dorsum yellow brown with 3 dark brown bands including 2 wide lateral ones with an anterior notch not related to black colouration of fastigium, and a median punctuated band made of the fusion of two thin parallel bands; short triangular bands posterior to eyes slightly connected to lateral bands. Face yellow or light brown with 3 black spots, one in the middle of epistomal suture, and 2 between antennae; front part of fastigium usually with 2 small dark brown lines dorsally. Scapes yellow with basal dark brown patterns. Pronotum: Dorsal disk anterior part pale yellow, median area with 2 transverse symmetrical black patches, posterior area black. Lateral lobes pale, homogeneously yellow brown or cream, with a thin discontinuous dark line separating dorsal disks and lateral lobes. Legs I and II almost homogeneously orange brown. FIII homogeneously orange brown, tibiae and knees dark brown. Tarsomeres III-1 orange brown to dark brown. Cerci yellow brown, base faintly mottled with dark brown, apex with dark brown rings. Abdomen brown.

Male: FW colouration mostly dark brown to black (cells and veins), with a wide semicircular whitish region posterior to mirror and areas with vivid yellow veins including bases of anal veins, anterior part of 3A, harp veins and part of 1A and CuA close to harp veins, part of chord veins (2 inverted y-shape), and anterior part of diagonal vein. M/R area and cells dark brown. Sc dark brown, its apex yellow; projections of Sc and more ventral veins of lateral field yellow. FW venation (Fig. 12C): 1A almost not bisinuated. CuP absent. Harp with 2 w-shaped veins. Mirror area: mirror (d1) oval, separated in two parts near midlength; d2 area as wide as mirror but d2 not differentiated. Apical field with 4 cell

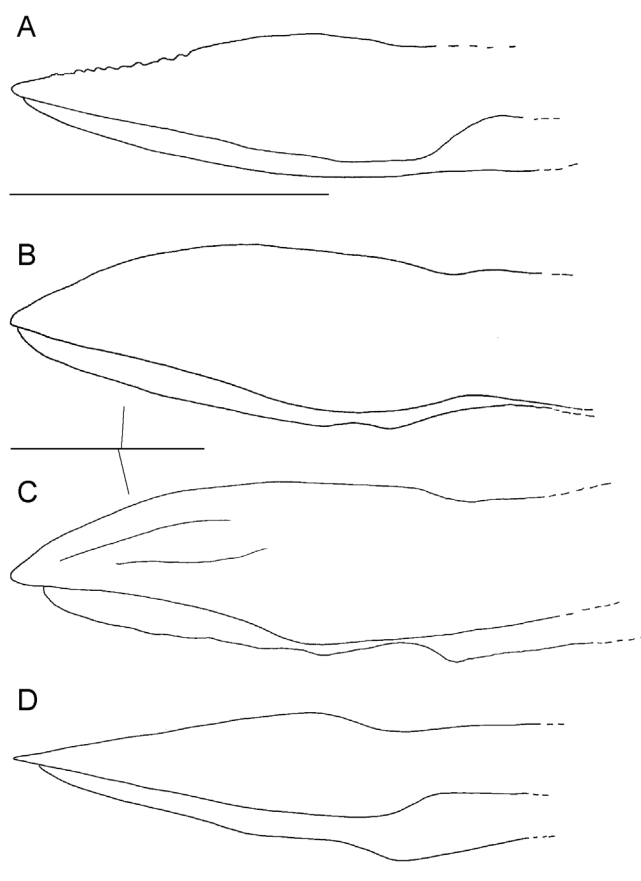


Fig. 14. Apex of Ovipositor of: A, *Lebinthus estrellae*; B, *Cardiodyctylus empagatao*; C, *Cardiodyctylus riga*; D, *Paramisitra leytensis*. Scale bars: 1 mm.

alignments posterior to mirror (n = 2). Lateral field with 7-8 projections of Sc (n = 2) and 3 more ventral veins (n = 2).

Male genitalia (Fig. 13D–F): Pseudepiphallus elongate, shaped as a wide gutter, narrowed anteriorly and preapically, slightly asymmetrical; bisinuated in profile (Fig. 13F). Dorsal ridges showing 2 upper levels in lateral view, the most anterior level the most dorsal, carinated and bean-shaped, the preapical one forming convergent sclerotised blades. Pseudepiphallic sclerite with wide anterior expansions narrowed at midlength and parallel, membrane between them setose. Posterior pseudepiphallic apex rounded, with a rounded translucent area. Ectophallic arc complete, v-shaped. Ectophallic fold with thin lateral sclerites; apex trilobate, membranous, median lobe oval. Base of ectophallic apodemes with a short ventro-anterior sclerotisation. Endophallic sclerite small. Endophallic apodeme with a dorsal crest and lateral lamellas. Membrane of endophallic cavity smooth.

Female: FW (Fig. 12D) dark brown with contrasted yellow veins; base whitish with a whitish area at FW midlength external margin. Lateral field: M/R/Sc areas dark brown to black; Sc dark brown, its projections and more ventral veins yellow. FW venation: dorsal field with 15 strong longitudinal veins; Sc with 8 projections and 3 more ventral veins. Ovipositor of similar size as FIII; apex not denticulate on dorsal and ventral edges (Fig. 14C).



Fig. 15. *Cardiodactylus empagatao*: A, secondary forest habitat; B, female on low vegetation in Villa Corazon Barangay, Burauen, Leyte.

Female genitalia (Fig. 7G–I): Copulatory papilla triangular, longer than wide, with 2 baso-lateral sclerites; apex rounded and little sclerotised, folded ventrally.

Juvenile: Colouration of head and legs close to that of adults; body light brown mottled with dark brown.

Variation. The observed males from Leyte differ slightly from the photographs of HT in terms of male genitalia. In particular, the pseudepiphallus seems longer in the observed specimens; this could be due to the photographs of HT in Otte (2007a) or to geographic or individual variation.

Habitat and life history traits. *Cardiodactylus riga* was encountered in Leyte in secondary areas in banana trees along the roads and in secondary habitats in coastal areas, mostly on large rocks. They are not strictly nocturnal since the calling song occurs from late afternoon and continues at night. Couples were heard and observed mating during afternoon, between leaves of banana trees or on large stones.

Behaviour. Calling song (Fig. 16): *Cardiodactylus riga* has a long mono-syllabic calling song. At 27.5°C, the calling songs show a very indented amplitude profile. Syllables have the following characteristics: syllable duration = $262.1 \pm$

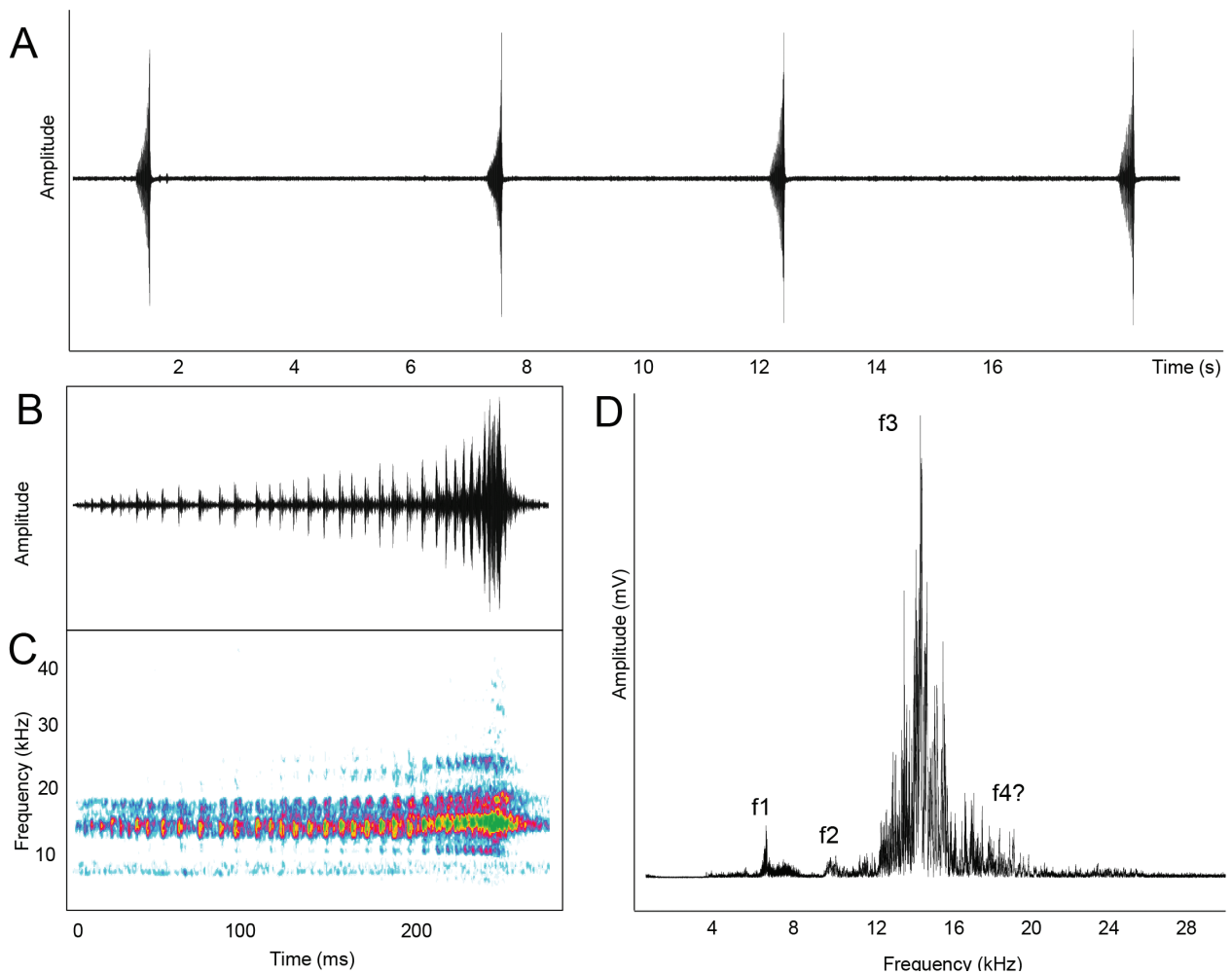


Fig. 16. Calling song of *Cardiodactylus riga*: A, oscillogram of 4 syllables; B, detailed oscillogram; C, sonogram of 1 syllable; D, frequency spectrum of 1 syllable.

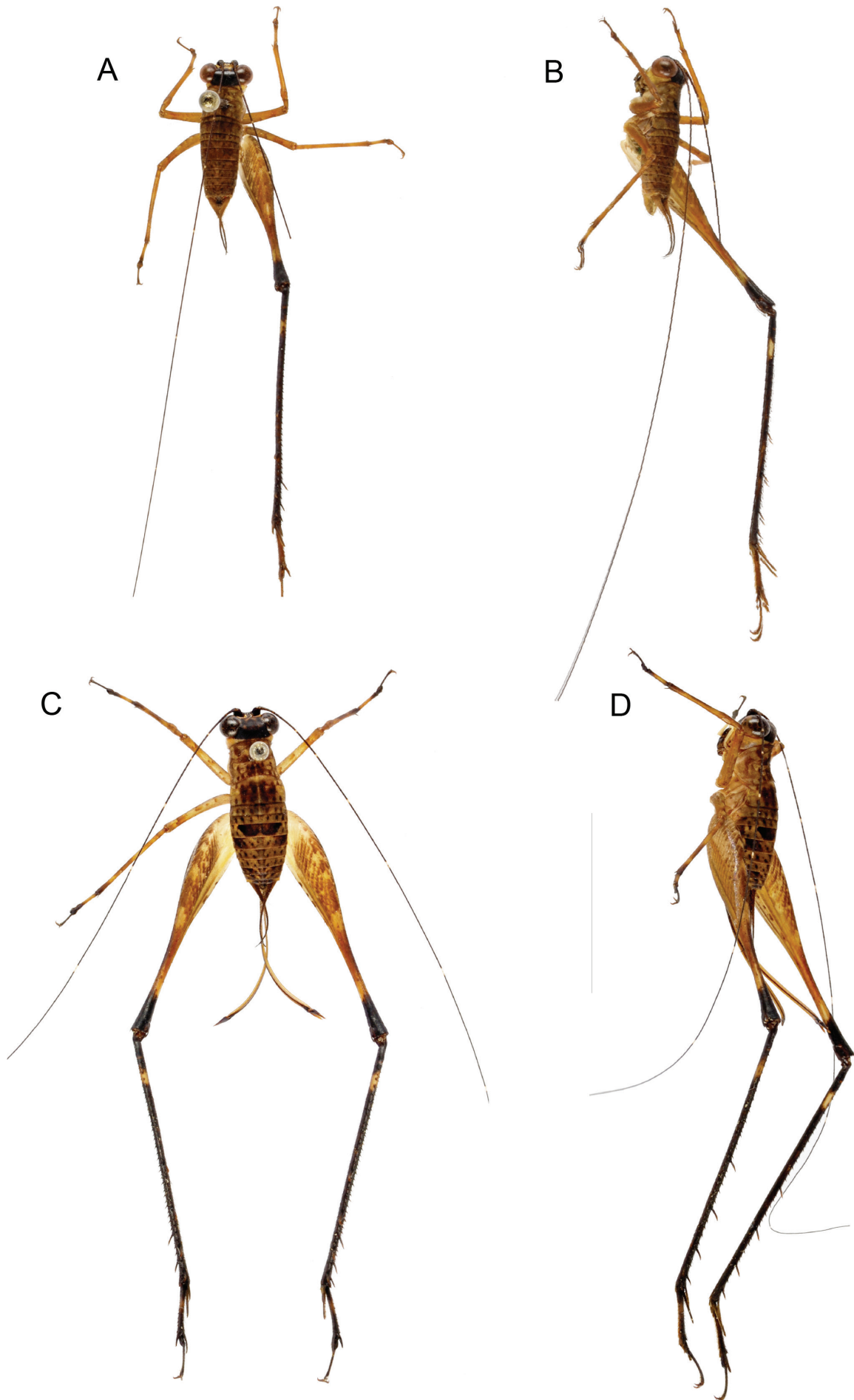


Fig. 17. *Paranisitra leytensis*, new species: A, male in dorsal; B, lateral views; C, female in dorsal; D, lateral views. Scale bar: 5 mm.

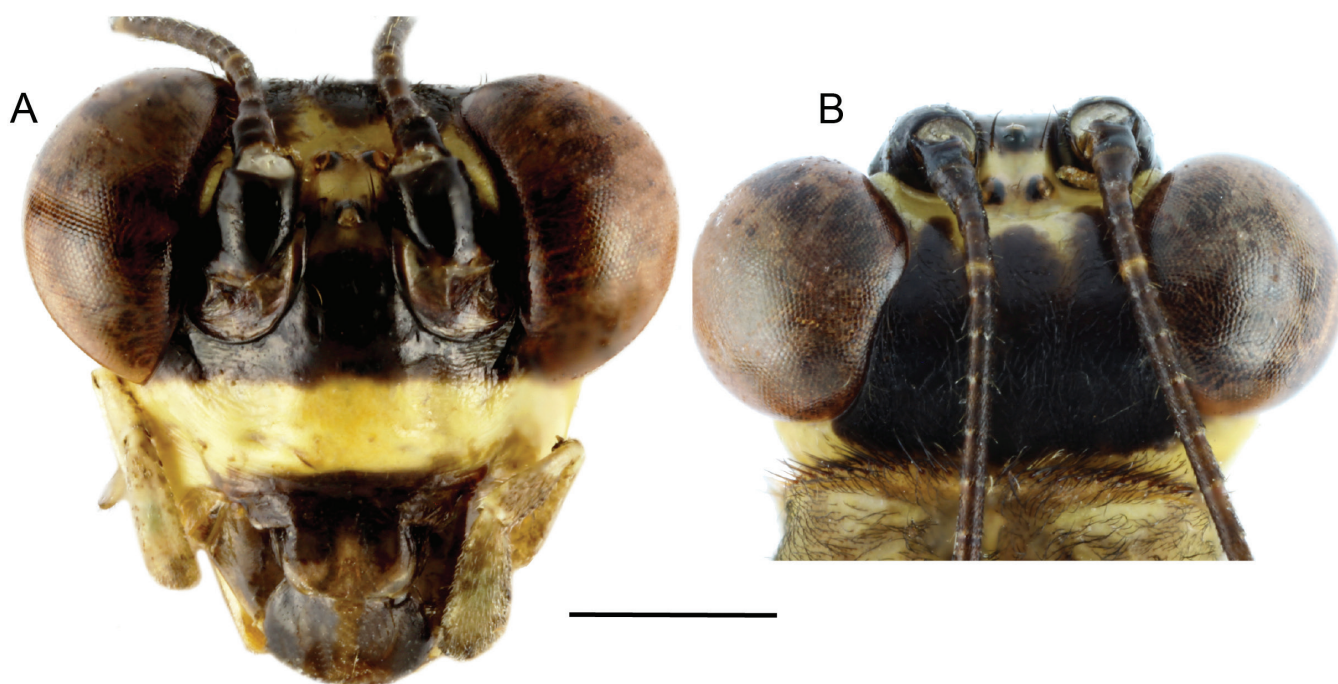


Fig. 18. *Paranisitra leytensis*, new species: A, head in facial; B, dorsal views. Scale bar: 1 mm.

6.0 ms; syllable period = 6.3 ± 1.4 s; syllable duty cycle = 4.2%. The power spectrum shows no clear harmonic pattern and dominant frequency of 14.29 ± 0.19 kHz.

Tribe Nisitrini Robillard, 2004

Genus *Paranisitra* Chopard, 1925

Type species. *Paranisitra longipes* Chopard, 1925

Emended diagnosis. Among Eneopterinae genera, *Paranisitra* is characterised by complete lack of wings in both sexes and its elegant slender shape with long and thin legs, small abdomen and cerci, and a characteristic head shape with narrow fastigium, large prominent eyes and protruding rounded ocelli. Size average for the subfamily. Colouration of adults dominantly yellow brown with specific black and yellow patterns variable between species. Pronotum not carinated; its lateral angles rounded, posterior edge slightly concave, lateral lobes almost triangular. Other general traits: TI with 2 tympana, inner one slit-like, covered by a swollen cuticular expansion; outer tympanum oval, its membrane transversally plicate in dorsal half. TI and TII with 3 apical spurs, 2 inner and 1 outer. TII with 4 apical spurs, inner longest. TIII with 3 inner and 3 outer apical spurs, median longest on each side; 4 inner subapical spurs and only 3 outer subapical spurs (4 in other eneopterine genera), inner and outer spurs almost straight, their apex hook-like; TIII serrulate over whole length and slightly furrowed dorsally. Tarsomeres III-1 with 2 rows of spines on external edge (1 dorsal and 1 more lateral) in addition to apical spines. Apical claws of legs slightly indented. Both males and females show characteristic genitalia: male genitalia with membranous and setose lophi, short but well individualised. Female ovipositor

apex thin and not denticulate; copulatory papilla conical to diamond-shaped, with a basal sclerotised ring.

Phylogenetic relationships. *Paranisitra*, reviewed in Gorochoy (2009), is very close to the winged genus *Nisitrus* Sausure, 1878 (see Robillard & Tan (2013) for diagnosis). Together they constitute the Nisitrini tribe (Robillard & Desutter-Grandcolas, 2008). Contrary to *Paranisitra*, *Nisitrus* species possess both pairs of wings and their shape is less slender than *Paranisitra* and their legs less elongate; aside from these characters, the two genera share a similar general body shape, long thin legs with indented claws, colouration with yellow and black, head shape and the general structure of male and female genitalia.

***Paranisitra leytensis* Robillard, new species**
(Figs 1, 2B, 14C, 17, 18, 19, 20, 21, 22)

Type material. Holotype (male): **Philippines:** male (TR14), day, Leyte [Island], Burauen, Barangay Villa Corazon, zone herbacée [herbaceous area] (GPS Bar1), $10^{\circ}57'50.5''N$ $124^{\circ}46'35.3''E$, 282 m, March 2013, coll. T. Robillard (UPLB-MNH).

Allotype (female): **Philippines:** female (TR34), day, Leyte [Island], Burauen, Buo, zone secondaire en bord de route [secondary area near road], $10^{\circ}57'59.8''N$ $124^{\circ}52'35.5''E$, 108 m, March 2013, coll. T. Robillard (UPLB-MNH).

Paratypes (1 male, 5 females): **Philippines:** 1 female, day, on plant (UPLB-MNH); 1 female, day, on plant (MNHN-EO-ENSIF3166), Leyte [Island], Burauen, Barangay Villa Corazon, forêt secondaire sur pente [secondary forest on slope] (GPS Bar2), $10^{\circ}57'52.1''N$ $124^{\circ}46'39.8''E$, 345 m, coll. T. Robillard, March 2013. 1 female (TR58), day (molecular sample PaBa) (MNHN-EO-ENSIF3165), same

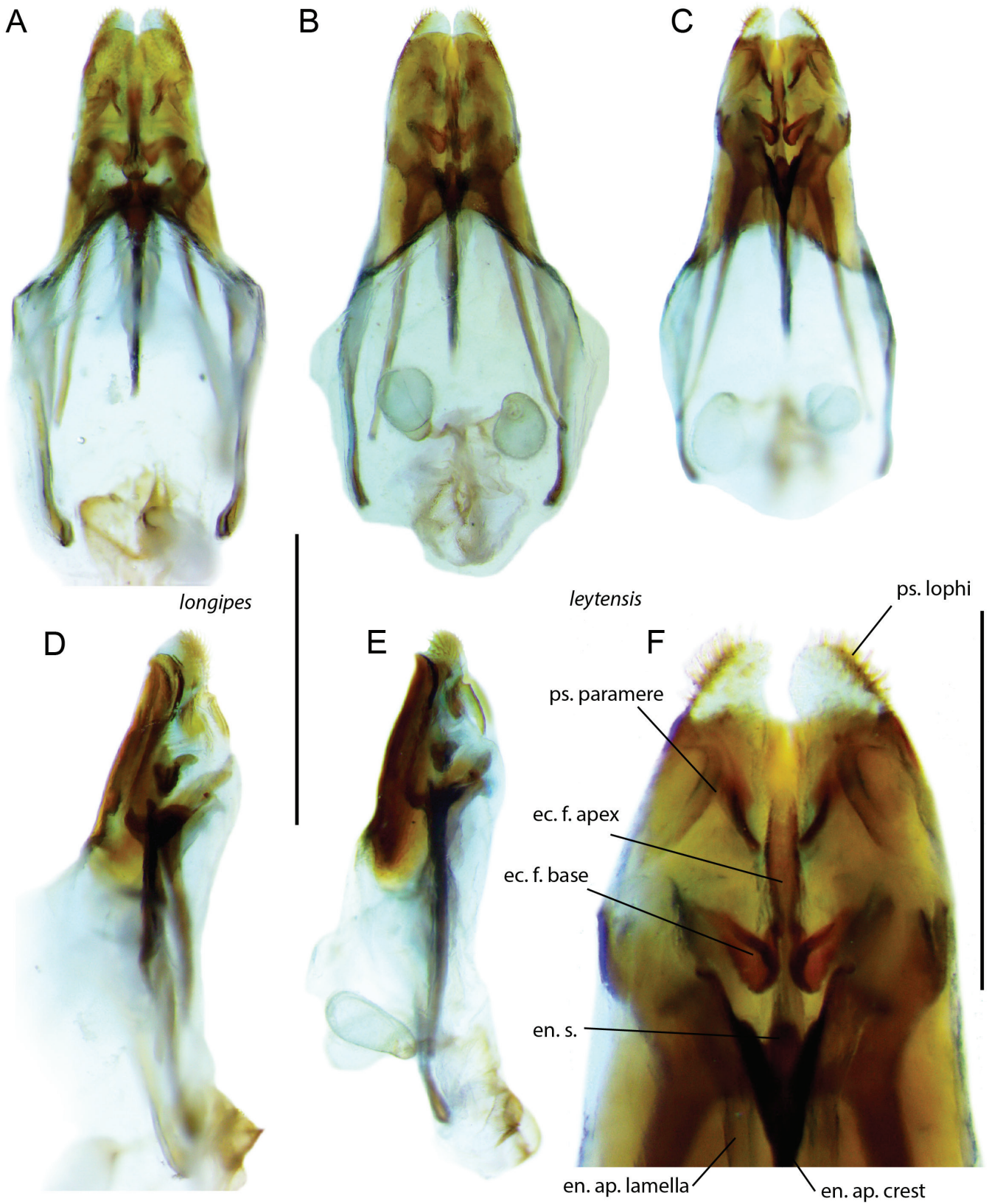


Fig. 19. Male genitalia of *Paranisitra longipes* for comparison: A, dorsal; D, lateral views; *Paranisitra leytensis*, new species: B, dorsal; C, ventral; E, lateral view; F, later view with details of the ventral side. Scale bars: A–E, 1 mm; F, 0.5 mm.

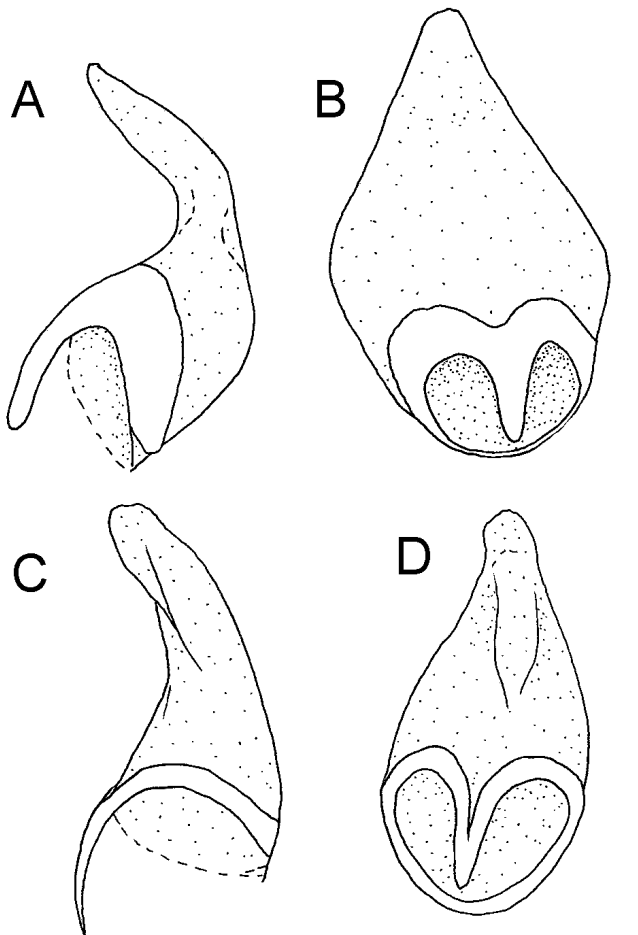


Fig. 20. Female copulatory papilla of *Paranisitra longipes* (for comparison): A, lateral; B, ventral views; *Paranisitra leytensis*, new species: C, lateral; D, ventral views. Scale bar: 1 mm.

information as HT. 1 male (TR7), day, on vegetation (h=50 cm) (molecular sample PaBu) (MNHN-EO-ENSIF3162); 1 female (TR7b), day, on vegetation; 1 female (TR33), day, on vegetation (MNHN-EO-ENSIF3162, 3163, 3164), same information as AT.

Other material examined. Philippines: 2 juveniles (TR37 & no #), day, on plant (UPLB-MNH); 1 juvenile (TR36), day, Leyte [Island], Burauen, Barangay Villa Corazon, forêt secondaire sur pente [secondary forest on slope] (GPS Bar2), 10°57'52.1"N 124°46'39.8"E, 345 m, coll. T. Robillard, March 2013. 2 juveniles (TR2–3), day, on plant (MNHN), Leyte [Island], Burauen, Buo, zone secondaire en bord de route [secondary area near road], 10°57'59.8"N 124°52'35.5"E, 108 m, March 2013, coll. T. Robillard.

Type locality. Philippines, Leyte Island, Burauen, Barangay Villa Corazon, 10°57'50.5"N 124°46' 35.3"E, 282 m

Distribution. Philippines, inland part of Leyte Island (Fig. 1).

Etymology. Named after the type locality.

Taxonomic discussion. Newly collected specimens were compared with paratypes of *P. diluta* Gorochov, 2009 and *P. maculata* Gorochov, 2009 deposited in MNHN.

Comparisons with *P. longipes* Chopard, 1925 were made based on observations of the two types from Chopard (1925) (MNHN-EO-ENSIF446-644), and with comparison of many newly collected specimens from the type locality (Mount Makiling, Philippines).

The new species is very close to the species *P. longipes* from Luzon. The two species are morphologically similar except for smaller size of *P. leytensis*, details of male and female genitalia, and colouration. From *P. maculata*, *P. leytensis* differs strikingly by its less spotted colouration and smaller size; from *P. diluta*, from islands near north of New Guinea, all the species from the Philippines, including *P. leytensis*, differ by the yellow transverse band on face. Also, preliminary molecular data (nuclear and mitochondrial markers) show that the sampled populations of *Paranisitra* from Leyte clearly correspond to a separate species, closer to *P. maculata* than from *P. longipes*.

Diagnosis. Species of small size, very close to *P. longipes* from Luzon, from which it differs by general colouration lighter, by smaller size and by male and female genitalia. In male genitalia, compared to *P. longipes* (Fig. 19), *P. leytensis* has smaller and more triangular pseudepiphallal lophi, narrower pseudepiphallus at base of rami, shorter endophallic sclerite and narrower lateral endophallic lamellas.

Description. Species typical of the genus (Figs 17–18), size small, near half of the other species of the genus. General colouration yellow brown to grey brown, with different patterns in males and females. Vertex homogeneously dark brown or black, colouration usually fainter near fastigium (Fig. 18). Region of head posterior to eyes and vertex yellow. Fastigium yellow, narrow with a slight median furrow and with a few long apical setae, the ocelli protruding, each one underlined by black. Scapes black. Antennae black with white rings widely spaced out. Face and mouth parts entirely black including facial part of fastigium, with a wide transverse yellow band from below antennae to epistomal suture. Maxillary palpi white, very conspicuous and always moving up and down together in living specimens. Head lateral side yellow, sometimes with a faint brown pattern dorsally. Pronotum yellow brown covered with thin dark setae, in females sometimes mottled with brown and with dark spots; lateral lobes light yellow covered with white setae, sometimes with a faint dark brown line separating the lateral lobe from the dorsal disk, in absence of lateral angle. Legs orange brown to yellowish brown or golden. Hind femora yellow brown with brown stripes, knees black, with a narrowed yellow region before knees; hind tibiae dark brown with a yellow region near knees; tarsomeres dark brown to black. Tarsomeres III with 0–1 spines on dorso-external edges (n = 3). Abdomen colour differing between male and female (see below). Cerci light brown, short and conical.

Male: Significantly smaller than female, general body colouration yellow brown to light brown, almost homogeneous (Fig. 17A, B). Subgenital place yellow brown, clog-shaped.

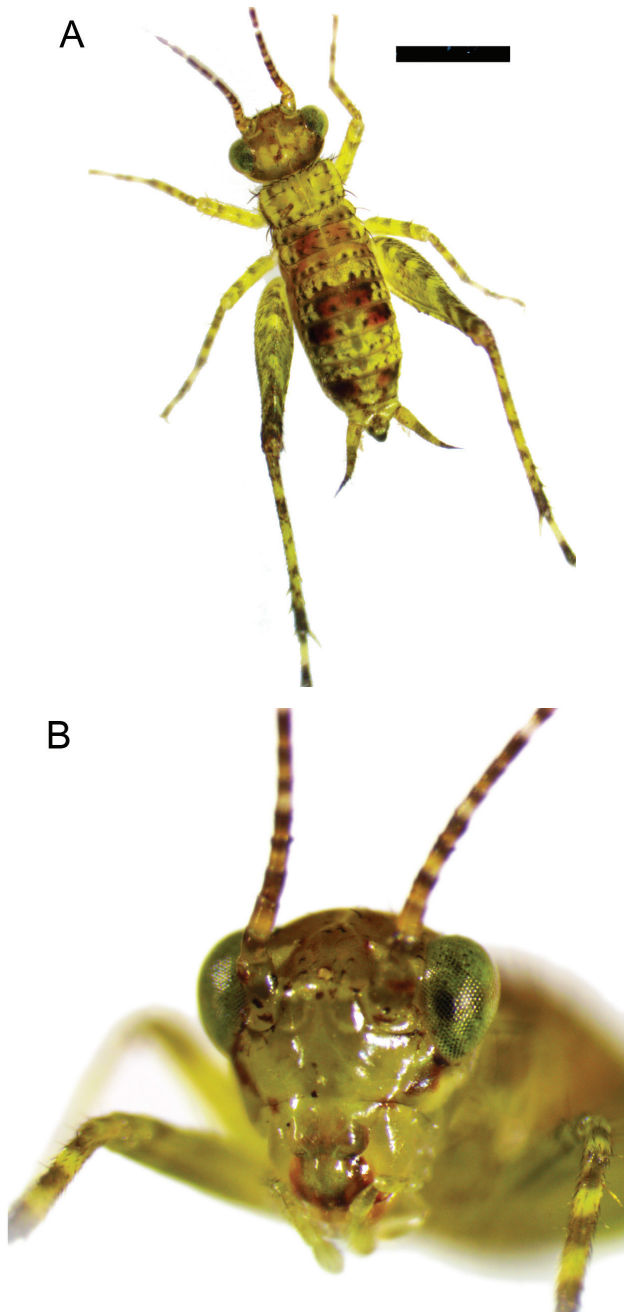


Fig. 21. *Paranisitra leytensis*, new species: A, juvenile specimen in dorsal view; B, with detail of face. Scale bar: 1 mm.

Male genitalia (Fig. 19): Pseudepiphallus conical, posterior sclerotised margin flat slightly indented (more in *P. longipes*), lophi membranous, small and with strong apical setae; anterior margin very indented. Rami thin and long, slightly convergent apically. Pseudepiphallic parameres narrow, fused to pseudepiphallus dorsally, their basis membranous, with a narrow anterior lobe converging anteriorly. Ectophallic arc complete and wide, straight. Ectophallic fold narrowed preapically, with strong rounded lateral sclerites; apex narrow and sclerotised dorsally, between the anterior apex of pseudepiphallic parameres. Ectophallic apodemes long and slightly divergent. Endophallic sclerite very sclerotised and large, its posterior apex with divergent lateral arms and with a short median expansion. Endophallic apodeme with both wide lateral lamellas (narrower than in *P. longipes*) and longer than wide dorsal crest. Membrane of endophallic cavity smooth.

Female: General colouration less homogeneous than in males (Figs. 17C, D, 21), in particular on pronotum and abdomen, most often yellow, variably mottled with brown and with many black spots. Abdomen velvet-like, with a colouration pattern on 5th tergite with a median semicircular dark area including vivid orange or red parts. Ovipositor shorter than hind femora; apex thin with both dorsal and ventral edges smooth (Fig. 14D).

Female genitalia: Copulatory papilla more diamond shaped than in *P. longipes*, with a narrower basal sclerotised ring (Fig. 20).

Juvenile (Fig. 21): Very colourful, with elaborate patterns including green, dark red and yellow shades. Later instars more similar to the adults.

Measurements. See Table 2.

Habitat and life history traits. *Paranisitra leytensis* is a diurnal species found on plant leaves in secondary habitats (Fig. 22), both in open prairies near forest and in secondary forest, along trails and slopes.

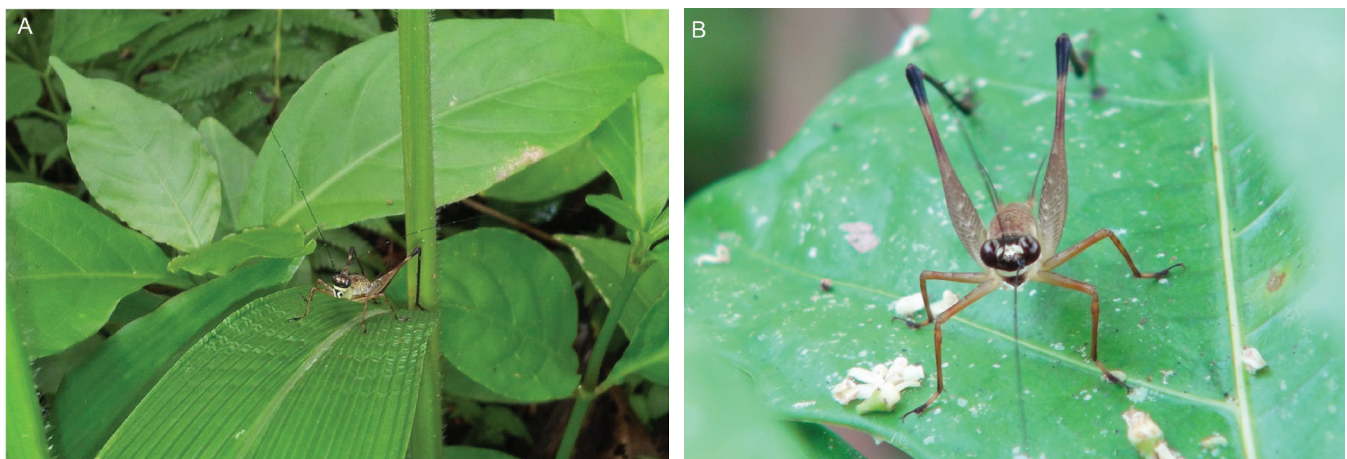


Fig. 22. *Paranisitra leytensis*, new species: A, female; B, male specimens in natural habitat near Buraun, Leyte (Photographs by R. Portillo).

Table 2. Measurements of *Paranisitra leytensis*, new species

	PronL	PronW	FWL	FWW	HWT	FIHL	FIHW	TIHL
Male holotype	1.9	2.5	–	–	–	13.5	2.5	15.2
Males (n=2)	1.8–1.9	2.5	–	–	–	13.3–13.5	2.4–2.5	14–15.2
(mean)	(1.9)	(2.5)	–	–	–	(13.4)	(2.5)	(14.6)
Female allotype	2	2.8	–	–	–	15	2.7	16.4
Females (n=4)	1.9–2.2	2.5–2.8	–	–	–	13.3–16.1	2.4–2.9	13.8–16.8
(mean)	(2.3)	(2.7)	–	–	–	(14.7)	(2.6)	(14.9)

	TIHs				TaIHs	ST (n=2)	OL
	Ias	Ibs	Oas	Obs			
Male holotype	19	12	38	3	6[5]	–	–
Males (n=5)	16–19	10–12	38	3	3–6[4–5]	–	–
(mean)	(18)	(11)	35	(3)	(5[5])	–	–
Female allotype	14	10	8	3	3[2]	–	10.2
Females (n=4)	14–19	10–15	33–39	2–4	3–7[2–4]	–	9.6–10.5
(mean)	(17)	(12)	(36)	(3)	(4[4])	–	(10.1)

Behaviour. Notable behaviours include possible visual communication using the maxillary palpi which seem always in movement up and down together. This behaviour is shared with *P. longipes* observed in Luzon (TR pers. obs.) and probably with other species of the genus.

Key of the Eneopterine species reported from Leyte Island

1. Habitus slender, legs long and thin. Male and female apterous..... *Paranisitra leytensis*, new species
- Habitus less slender, legs shorter and stronger. Male and female winged.2
2. Microptery in both sexes (FW truncated, hind wings absent).Genus *Lebinthus* (3)
- Macroptery in both sexes (FW long, hind wings longer and surpassing FW). Genus *Cardiodactylus* (4)
3. Colouration more or less homogenous brown, with lateral yellow bands along the whole body, male FW without false mirror in harp*Lebinthus luae*
- Colouration more or less homogenous brown, without lateral yellow bands along the body, male FW with a rounded false mirror in harp*L. estrellae*, new species
4. Vein Sc brown in both sexes; male genitalia with three levels in lateral view..... *Cardiodactylus riga*
- Vein Sc yellow in both sexes; male genitalia with only one level in lateral view..... *C. empagatao*

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