Redefinition of the cricket genus *Protathra* Desutter-Grandcolas, 1997 (Orthoptera, Grylloidea, Phalangopsidae), with description of the calling song of *Protathra centralis* Desutter-Grandcolas, n. sp.

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ABSTRACT

The cricket genus *Protathra* Desutter-Grandcolas, 1997a is redefined, adding male characters (stridulatory apparatus, genitalia) to the original diagnosis. The study of newly collected specimens allows precising the definition of the type species *Protathra gigantea* Desutter-Grandcolas, 1997a, and to describe an additional, new species for the genus, *Protathra centralis* Desutter-Grandcolas, n. sp. from Aoupinié and Amoa mountains. A key to identify Phalangopsidae crickets from New Caledonia is given. The calling song of *Protathra gigantea* is described, documenting the acoustic behavior of New Caledonian Phalangopsidae for the first time.

RÉSUMÉ

Redéfinition du genre de grillons *Protathra* Desutter-Grandcolas, 1997 (Orthoptera, Grylloidea, Phalangopsidae), avec la description du chant d'appel de *Protathra centralis* Desutter-Grandcolas, n. sp.

Le genre de grillons *Protathra* Desutter-Grandcolas, 1997a est redéfini, avec l'ajout des caractères des mâles (appareil stridulatoire, genitalia) à la diagnose originale. L'étude de spécimens nouvellement collectés permet de préciser la définition de l'espèce type *Protathra gigantea* Desutter-Grandcolas, 1997a, et de décrire une espèce nouvelle supplémentaire pour le genre, *Protathra centralis* Desutter-Grandcolas, n. sp. originaire du massif de l'Aoupinié et du Pic Amoa. Une clé d'identification des Phalangopsidae de Nouvelle-Calédonie est proposée. Le chant d'appel de *Protathra gigantea* est décrit, ce qui constitue la première contribution sur le comportement acoustique des Phalangopsidae néocalédoniens.

DESUTTER-GRANDCOLAS L., ROBILLARD T. & ANSO J. 2014 — Redefinition of the cricket genus *Protathra* Desutter-Grandcolas, 1997 (Orthoptera, Grylloidea, Phalangopsidae), with description of the calling song of *Protathra centralis* Desutter-Grandcolas, n. sp., *in* GUILBERT É., ROBILLARD T., JOURDAN H. & GRANDCOLAS P. (eds), *Zoologia Neocaledonica 8. Biodiversity studies in New Caledonia*. Muséum national d'Histoire naturelle, Paris : 277-288 (Mémoires du Muséum national d'Histoire naturelle ; 206). ISBN : 978-2-85653-707-7.

INTRODUCTION

The Phalangopsidae crickets from New Caledonia include four genera, two probably endemic to the Grande Terre, *Caltathra* Otte, 1987 and *Protathra* Desutter-Grandcolas, 1997, and two largely distributed in Oceania, *Parendacustes* Chopard, 1924 (see Desutter-Grandcolas 2002) and *Pseudotrigonidium* Chopard, 1915.

Protathra was originally described on females only (Desutter-Grandcolas 1997). Since then, additional material has been collected or found in Museum collections. These specimens proved to belong to the type species of the genus, *P. gigantea* Desutter-Grandcolas, 1997, but also to a species new to science, *P. centralis* Desutter-Grandcolas, n. sp., which is described here.

These new data allow to complete the diagnosis and description of *Protathra*, taking into account the characters of the males. Male genitalia clearly confirm that *Protathra* is close to *Caltathra*, as hypothesized earlier (Desutter-Grandcolas 2002). Both genera can however easily be separated by their morphology and male genitalia (see the key below).

Among New Caledonian phalangopsids, *Caltahra* is apterous and mute. *Parendacustes* has usually well-developed tegmina and stridulatory apparatus, and must be able to emit acoustic signals, but *P. lifouensis* Desutter-Grandcolas, 2002, which lives in cavities of calcareous shore (Desutter-Grandcolas 2002), is apterous. *Pseudotrigonidium* forages on understorey plants, low trees and ferns and most species are able to call (Desutter-Grandcolas 1997b). Males *Protathra* are also able to call (Figure 3) and occupies the same habitat as *Caltathra* in new Caledonian rainforests (Desutter-Grandcolas 1997c, Fig. 4).

MATERIAL AND METHODS

Material

Extensive field work in New Caledonia for more than 30 years by MNHN field trips (Desutter-Grandcolas 1997a, b, c, 2002; Robillard *et al.* 2010) allowed a comprehensive cricket sampling in many localities of Grande Terre and the prospection of the Loyalty Islands (Lifou). Specimens were collected by sight only, by night and day, in order to observe their precise habitat and type of activity. Additional material from the Brisbane Museum, collected for biodiversity surveys of Southern New Caledonia, were also examined.

Taxonomic analysis

Male tegminal veins and cells were named according to homology statements proposed by Desutter-Grandcolas (2003). The apical field is very reduced in *Protathra*, and only C, D, E and perhaps F cell alignments (sensu Robillard & Desutter-Grandcolas 2004) can be identified (Figures 6, 13).

Male and female genitalia have been dissected in softened specimens by cutting the membranes between the paraprocts and the subgenital plate or between the ovipositor and the subgenital plate respectively; they have been observed after cleaning with cold KOH using a binocular Leica MZ12, at magnification up to 160, and then kept in glycerine in vials pinned under studied specimens. Male genitalia are named according to Desutter (1987), modified in Desutter-Grandcolas (2003).

Acoustic recording and analysis

Males of *Protathra centralis* Desutter-Grandcolas, n. sp. have been recorded by T. Robillard (MNHN) with a Sony Handycam HDR-HC3 video recorder at dusk at Col d'Amieu. Calling songs were extracted from the video using the software Ulead Video Studio ver 11 and analyzed using the software Avisoft-SAS-Lab Pro version 4.40 (Specht 2008). Song description follows Ragge and Reynolds (1998).

ABBREVIATIONS

Morphology. FW, forewing; FI, II, III, fore, median, hindfemora; TI, II, III, fore, median, hindtibiae. Male genitalia: arc, ectophallic arc; ec. ap., ectophallic apodeme; ec. f., ectophallic fold; en. ap., endophallic apodeme; en. s., endophallic

sclerite; d.v., ectophallic dorsal valves; ps., pseudepiphallus; ps. m., median process of pseudepiphallus; ps. p., pseudepiphallic paramere; pr., paired processes of pseudepiphallus; r., rami. Male tegmina: 1A, first anal vein; CuA, anterior cubitus; di, diagonal vein (CuA1); MA, MP, anterior, posterior media veins; c1, c2, first, second cells of C alignment; mi, mirror (d1 cell); ch, chords; E, E cell alignment.

Institutions. MNHN, Muséum national d'Histoire naturelle, Paris; QMF, Queensland Museum, Brisbane, Australia.

Measurements (in mm, mean value in parentheses). LFIII, hindfemur length; LFW, forewing length; Lpron, pronotum length; LTIII, hindtibia length; Lovip, ovipositor length; wFW, forewing width at the level of mirror anterior angle; wpron, pronotum width (posterior margin).

SYSTEMATICS PART

KEY TO PHALANGOPSIDAE CRICKETS FROM NEW CALEDONIA

1. TIII with 3 inner and 4 outer subapical spurs **2**

– TIII with 2 inner and 3 outer subapical spurs ..... *Parendacustes lifouensis* Desutter-Grandcolas, 2002

2. Species from small or medium size. Male and female apterous. Fastigium at the same level as the vertex. TI without a tympanum ..... *Caltathra* Otte, 1987

– Species of very large size. Female apterous. Male with short forewings covering less than half abdomen; stridulatory apparatus complete (harp and mirror crossed by several parallel veins; stridulatory file functional). Fastigium below the vertex, from which it is separated by a transverse furrow. TI with a small, outer tympanum ..... *Protathra* Desutter-Grandcolas, 1997

Family PHALANGOPSIDAE Blanchard, 1845

Genus ***PROTATHRA*** Desutter-Grandcolas, 1997

Protathra Desutter-Grandcolas, 1997a: 150.

Type species. *Protathra gigantea* Desutter-Grandcolas, 1997a.

OTHER SPECIES INCLUDED — *Protathra centralis* Desutter-Grandcolas, n. sp. (Aoupinié).

DISTRIBUTION — *Protathra* is known from New Caledonia only, where it has been found in the Central mountains chain.

EMENDED DIAGNOSIS — Size very large; coloration variegated yellow and brown, legs annulated (Figure 1). Face yellow and brown; a wide longitudinal yellow band between median ocellus and clypeus distal margin (Figure 2). Eyes very protruding. Fastigium very narrow and separated from the vertex by a thin transverse furrow; median ocellus vertical, subapical on fastigium; lateral ocelli very close to each other, the distance between one lateral and the median ocelli much greater than the distance between the lateral ocelli. Scapes very large. Maxillary palpi moderately elongate; joint 3 smaller than joint 4; joint 5 the longest, truncate apically, regularly widened toward apex. Pronotum DD with a clear longitudinal median furrow; distal margin widely bordered with white setae (Figure 3); LL anterior angles raised dorsally, posterior angles truncate. TI with a small inner tympanum only; 2 apical spurs, the inner the longest. TII with 3 apical spurs, the ventral inner spur the longest, the dorsal outer spur missing. FIII with a thin apical part. TIII higher than wide; 3 inner and 4 outer subapical spurs; 3 inner and 3 outer apical spurs, the median spur the longest on both sides, median

FIGURES 1-5

Protathra gigantea Desutter-Grandcolas, 1997: **1**, male MNHN-EO-ENSIF3131, habitus; **2**, face coloration; **3**, right FW; **4**, supra anal plate; **5**, subgenital plate. Scale 1mm for 1.

inner spur as long as one third to one half of basitarsomere III. TIII serrulated over their whole length with numerous, widely separate, very small spines. Basitarsomeres III very long; with two rows of few, small dorsal spines.

Male. Metanotum without setae and glandular pits. Tergites (Figure 1) and supra anal plate (Figure 4) without glandular areas. Forewings short, covering less than half of abdomen (Figure 1); dorsal and lateral fields separated by high MA; median area dorsal and flat, MP and CuA faint, CuP missing; lateral field narrow, narrowed in distal half, with faint and irregular veins, R close to MA and faint. Stridulatory apparatus complete and functional (Figures 6, 13): harp crossed by several oblique parallel veins; mirror crossed by several oblique or transverse veins. Male subgenital plate low, with a distinct bump at about mid length of lateral margin (Figures 7, 14); with a short distal, longitudinal, median furrow (Figure 5).

Male genitalia. Compact. Pseudepiphallic sclerite transverse (Figures 8, 15); median process broadly conical and completely sclerotized; on each side of the median process, a long and thin tube-shaped process with a bunch of long setae on its tip. Pseudepiphallic parameres large, thick and greatly sclerotized, bifid on distal margin (Figures 10, 16). Rami wide, separated from pseudepiphallic sclerite but almost in contact with it; with abruptly narrowed anterior part. Ectophallic dorsal valves short and sclerotized (Figure 9); ectophallic fold short, truncate apically; ectophallic apodemes wide and flat; ectophallic arc incomplete. No dorsal cavity. Endophallic sclerite U-shaped, with a faint median sclerotization (Figure 10).

Female. Apterous; ovipositor longer than FIII.

Female genitalia. Copulatory papilla triangular, heavily sclerotized (Figure 19).

CALLING SONG — According to observations of *P. gigantea*, the call of *Protathra* is a short echeme made of a few syllables emitted from dusk to night (Figure 11).

HABITAT — *Protathra* is a forest dwelling cricket, which forage on standing trees at night (Figure 12B); a small population of *P. gigantea* has been observed during the day hiding under a dead fallen tree (Figure 12A), males calling to attract nearby females (T. Robillard & F. Müller, pers. obs.).

RELATIONSHIPS — *Protathra* is most closely related to *Caltathra* Otte, 1987, as shown by the common features of their male genitalia (endophallic sclerite and apodeme, ectophallic valves) and morphology (TIII subapical and apical spurs). Both genera clearly constitute monophyletic entities, and their straightforward recognition using morphological characters justify their generic status (see below). Their sistership relation is supported by molecular data, as documented by a forth coming paper on cricket molecular phylogeny (Chintauan-Marquier, Legendre *et al*., submit.).

Protathra gigantea Desutter-Grandcolas, 1997a

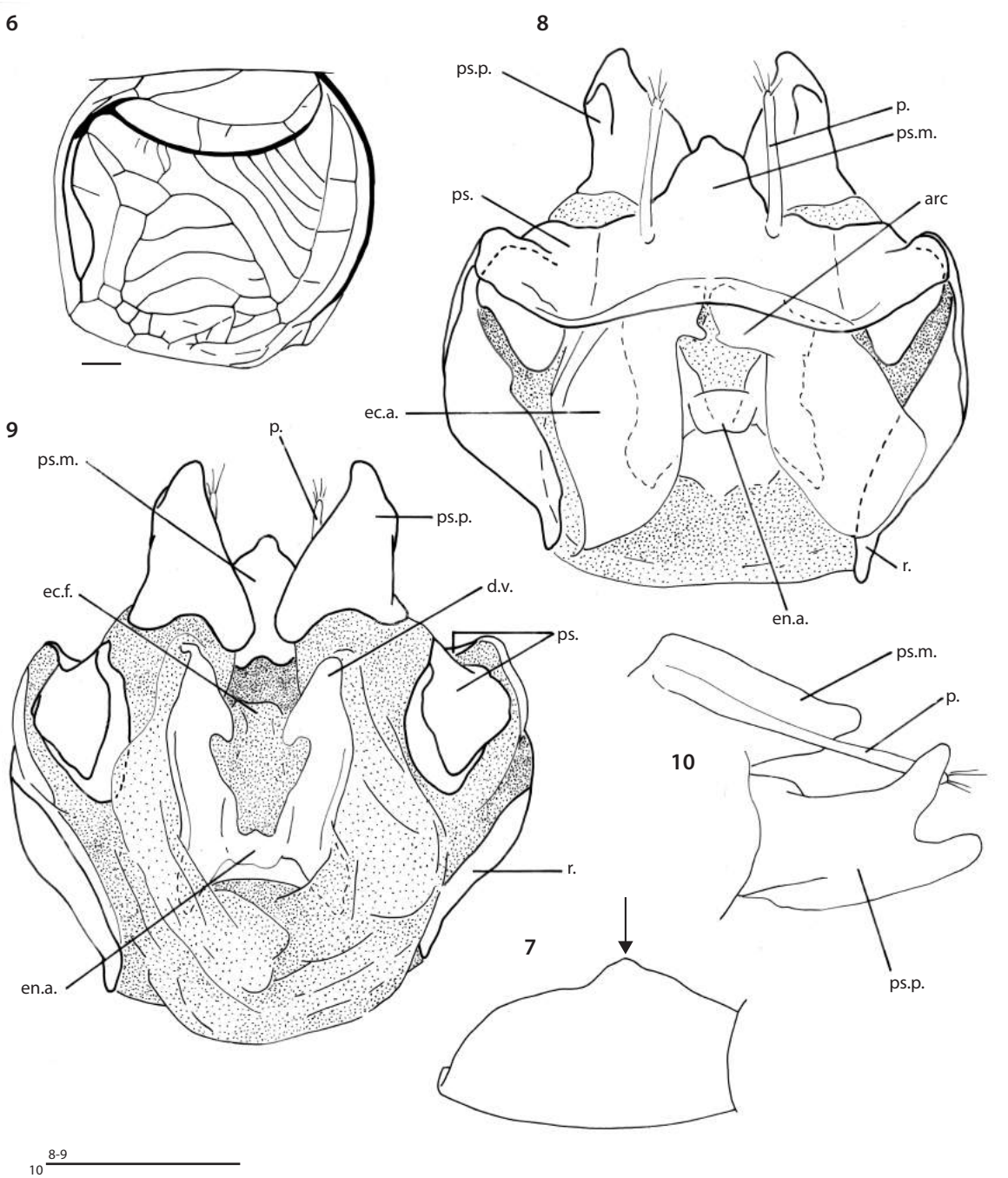
Figures 1-11, 12A

Desutter-Grandcolas, 1997a: 150.

TYPE MATERIAL — Holotype: New Caledonia, 3 km WNW Col d'Amieu, N. La Foa, 450-550 m, 1 female, forêt sempervirente, 18.ii.1994, nuit, sur tronc, L. Desutter-Grandcolas (MNHN-EO-ENSIF2846). Paratype, 1 female: Same locality and collector as the holotype, 1 female, 16.ii.1994, nuit, sur tronc (MNHN-EO-ENSIF2847).

ADDITIONAL MATERIAL EXAMINED — New Caledonia, 8 km NW Col d'Amieu, N. La Foa, Pied Table Unio (PK 8), 21°34'42˝S 165°47'38˝E, 450 m, 8.v.2008, 1 male, 3 females, fnFM29-32, jour, sous tronc mort, T. Robillard & F. Müller (MNHN-EO-ENSIF3127-3130). Same locality and collectors, 21°34'50˝S 165°47'47˝E, 450 m, 12.v.2008, 1 male, fnFM113 (MNHN-EO-ENSIF3131), 1 juvenile, fnTR220, nuit, sur tronc (MNHN).

TYPE LOCALITY — New Caledonia, 3 km WNW Col d'Amieu, N. La Foa, 450-550 m, rain forest.



FIGURES 6-10

Protathra gigantea Desutter-Grandcolas, 1997: **6**, male FW venation; **7**, male subgenital plate, lateral (right) (arrow, lateral bump); **8**-**10**, male genitalia, dorsal (**8**), ventral (**9**), lateral (left, **10**). Abbreviations: see material and methods. Scales 1mm.

EMENDED DIAGNOSIS — In addition to the characters indicated by Desutter-Grandcolas (1997):

Male. FWs short but with a complete stridulatory apparatus (Figures 1, 6): harp with 6 oblique parallel veins, mirror crossed by 2-3 transverse, parallel veins, file with 130-169 teeth. Lateral field with only one strong, longitudinal vein.

Male genitalia. Median and lateral processes of pseudepiphallus long, compared to those of *P. centralis* Desutter-Grandcolas, n. sp. (compare Figures 8, 10 and 15, 16); dorsal and ventral branches of paramere forceps equal in length (Figure 10).

EMENDED DESCRIPTION — In addition to the characters of the genus, and the specific characters given by Desutter-Grandcolas (1997a): TIII inner serrulation: no spine before subapical spur 1, and between subapical spurs 1 and 2, one to four spines in females (mean 2.5) and one to two spines in males (mean 1.3) between spurs 2 and 3, 23 to 29 spines in females (mean 25.8) and 22 to 24 in males (mean 23.3) above spur 3. TIII outer serrulation: no spine before spur 1, one to three spines in females (mean 1.2) and no spine in males between spurs 1 and 2, three to five spines in females (mean 3.7) and two to five spines in males (mean 3.5) between spurs 2 and 3, three to five spines in females (mean 4.3) and five to seven spines in males (mean 6) between spurs 3 and 4, 15 to 20 spines in females (mean 18.2) and 17 in males above spur 4. Basitarsomeres III with five to seven inner spines in females (mean 5.7) and three to six in males (mean 4.7), and 5 to 10 outer spines in females (mean 6.8) and 8 in males.

Male. FWs not covering half abdomen. Stridulatory apparatus (Figure 6): harp with 6 oblique, parallel veins; mirror triangular, anterior angle rounded, crossed by 2-3 veins; stridulatory file with 130-169 teeth (mean 149.5, n=2). Lateral field narrowed in distal half; only one, longitudinal, vein, parallel and close to MP; some very faint traces of additional, not parallel veins. Supra anal plate distal margin rounded, without elongate distal angles (Figure 4). Subgenital plate low and short, furrowed distally over 1/8 of its length (Figure 5); lateral bump as on Figure 7.

Male genitalia. Median process of pseudepiphallus reaching pseudepiphallic parameres mid length; lateral processes as long as three / fourth paramere length (Figures 8, 10). Branches of paramere forceps equal in length (Figure 10). See measurements table 1.

CALLING SONG — *Protathra gigantea* has a short calling song consisting of a short echeme (Figure 11A) comprising three to four syllables (m=3.9±0.2). Each echeme lasts for 129 ± 6 ms with a period of 1.34 ± 0.82 s. Syllables within echemes are of two types (Figure 11C): the first one is long (duration = 52 ± 8 ms, period = 74.4 ± 8.9 ms) and shows an indented amplitude profile, while the next syllables are shorter with a homogeneous amplitude profile (duration = 21.6 ± 5.6 ms, period = 35.9 ± 7.8 ms). The frequency spectrum shows a clear dominant peak at 3.23 ± 0.16 kHz, corresponding to the first harmonic (Figure 11B, D).

TABLE 1

Measurements (in mm) for *Protathra gigantea* Desutter-Grandcolas, 1997

	Lpron	wpron	LFW	wFW	LFIII	LTIII	File
Males	3.7-4.4	4.3-4.8	5.3-5.8	5.4-6.3	18.8-22.5	18.3-21.6	130-169
mean (n=2)	4.1	4.6	5.6	5.9	20.7	20	149.5

Protathra centralis Desutter-Grandcolas, n. sp.

Figures 12B, 13-21

TYPE MATERIAL — Holotype: New Caledonia, Massif de l'Aoupinié, avant barrière vers sommet, forêt sur pente, 21°10'52"S 165°18'06"E, 801m, 1 male, 17.v.2008, nuit, fn FM125, sur tronc, 1,5 m H, T. Robillard & F. Müller (MNHN-EO-ENSIF3126). Allotype: New Caledonia, Aoupinié, top camp, 21°11'S 165°19', 850m, 1 female, 2-3.xi.2001, G. Burwell &

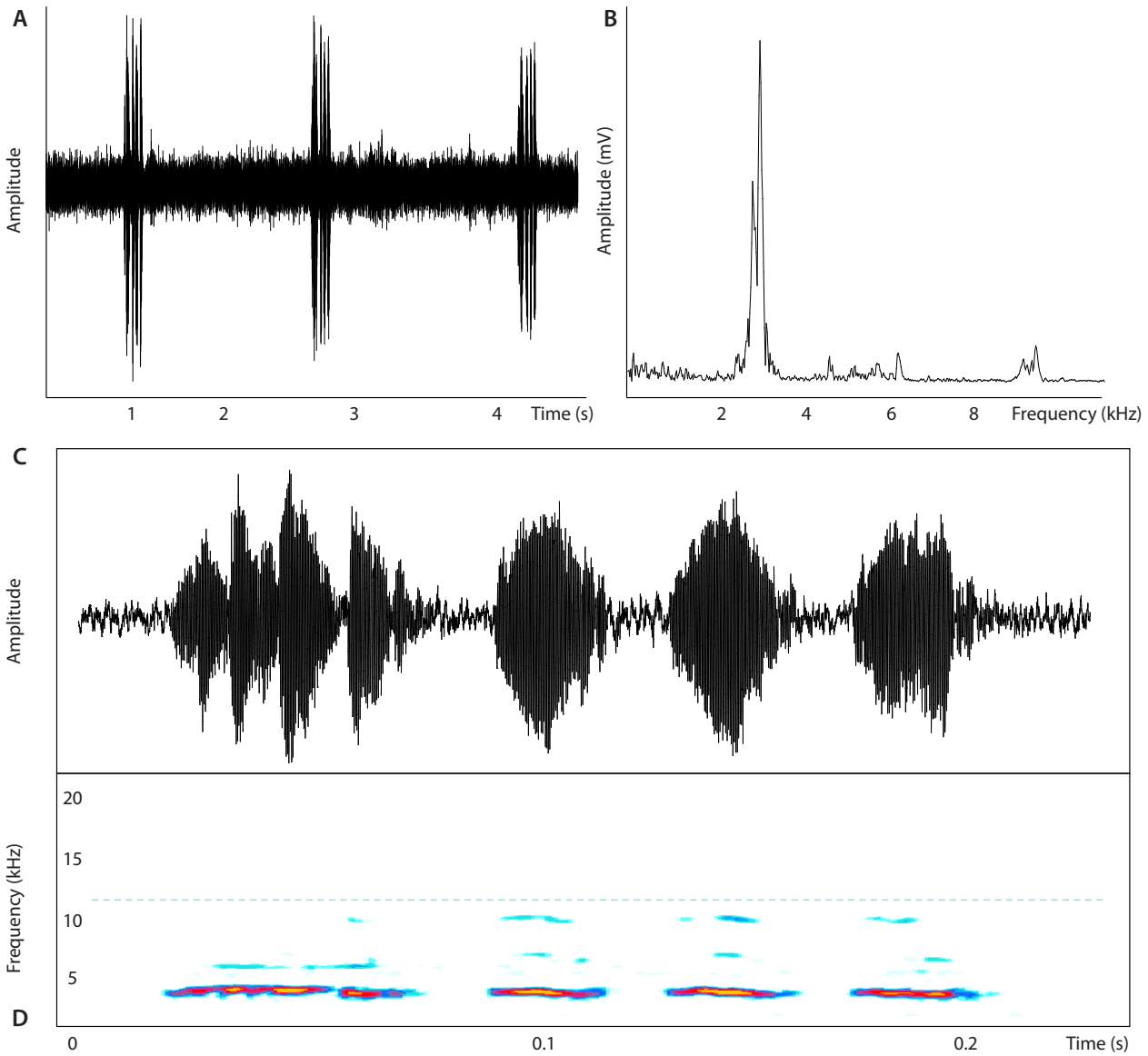


FIGURE 11

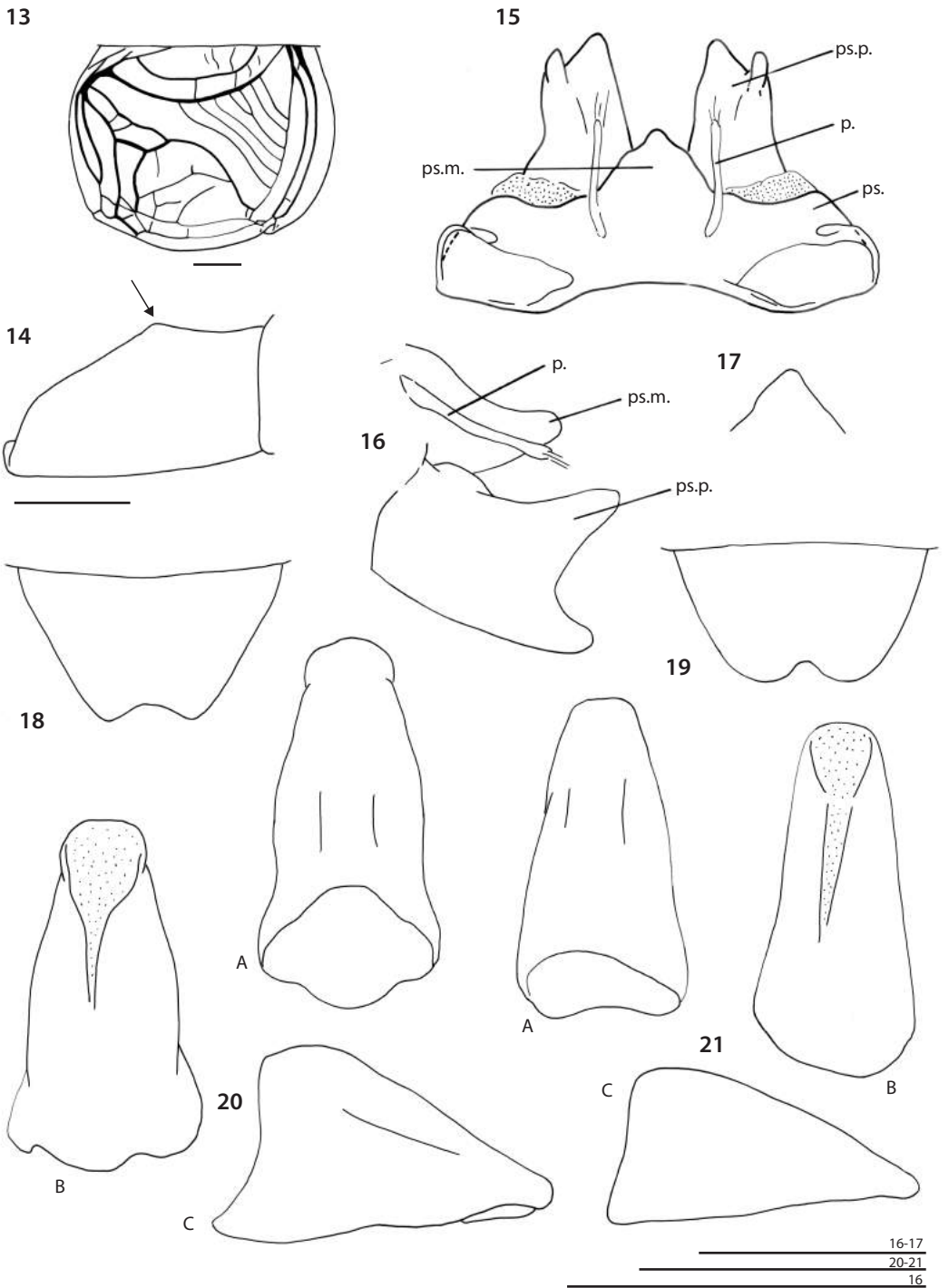
Protathra gigantea Desutter-Grandcolas, 1997, calling song: Oscillogram of three echemes (**A**); linear power spectrum of one syllable (**B**); oscillogram (**C**) and spectrogram (**D**) of one echeme.

G. Monteith, hand collect (MNHN-EO-ENSIF3123). Paratypes, 2 males: Same data as the holotype, 1 male, fnTR267, tronc, 1,4m H, T. Robillard & F. Müller (MNHN-EO-ENSIF3125). Aoupinié top camp, 21°11'S 165°19'E, 850 m, 1 male, 2-3.xi.2001, C. Burwell & G. Monteith, molecular sampling LDG005 (MNHN-EO-ENSIF3124).

ADDITIONAL MATERIAL EXAMINED — New Caledonia, Pic d'Amoa, N slopes, 20°50'S 165°17'2, 500m, 1 male, 27.xi.2003-30.i.2004, G. Monteith, flight int. trap. New Caledonia, Aoupinié, top camp, 21°11'S 165°19', 850m, 1 female, 2-3.xi.2001, G. Burwell & G. Monteith, hand collect (QMF).

FIGURE 12

Protathra species in their natural environment: **A**, *P. gigantea* Desutter-Grandcolas, 1997, male calling in a fallen hollow tree; **B**, *Protathra centralis* Desutter-Grandcolas, n. sp. on tree trunk at night.



FIGURES 13-21

Protathra centralis Desutter-Grandcolas, n. sp.: **13**, male FW venation; **14**, male subgenital plate, lateral (right) (arrow, lateral bump); **15**-**17**, male genitalia, dorsal (**15**), lateral (left, **16**), male paratype, pseudepiphallic median process, dorsal (**17**); **18**-**19**, female subgenital plate, ventral, allotype (**18**), additional female (**19**); **20**-**21**, female copulatory papilla, dorsal (**A**), ventral (**B**), lateral (**C**), in female allotype (**20**) and additional female (**21**). Scales 1mm.

TYPE LOCALITY — New Caledonia, Aoupinié mountains.

ETYMOLOGY — Species named after the central location of Aoupinié mountains in New Caledonia.

DIAGNOSIS — Species very close to *P. gigantea*, from which it can be separated by its male genitalia (lateral processes of pseudepiphallus shorter, not reaching pseudepiphallic forceps, pseudepiphallic parameres wider, dorsal part of their forceps longer than ventral part).

DESCRIPTION — TIII inner serrulation: no spine before subapical spur 1; zero spine in females, zero to one spine in males (mean 0.2) between spurs 1 and 2; two to four spines in females (mean 2,5), two to six spines in males (mean 3.5) between spurs 2 and 3; 23-27 spines in females (mean 24.5), 22-27 spines in males (mean 23.8) above spur 3. TIII outer serrulation: no spine before spur 1; zero to three spines in males (mean 1.2) and females (mean 1.3) between spurs 1 and 2; two to four spines in females (mean 3), three to six spines in males (mean 4.2) between spurs 2 and 3; three to six spines in females (mean 4.5), four to six spines in males (mean 5) between spurs 3 and 4; 16 – 17 spines in females (mean 16.8), 17-22 spines in males (mean 18.7) above spur 4. Basitarsomeres III with five to six in females (mean 5.5), two to six in males (mean 5.3) inner spines, and five to eight in females (mean 6,8), seven to nine in males (mean 7.8) outer spines.

Coloration. Face light yellowish brown with a light yellow band between median ocellus and clypeus tip, bordered with black brown between the scapes; a wide brown band below each antennal pit, prolonged down to mandibula margin, connected or not to brown lateral margins of cheeks; head dorsum yellow between the eyes, with a thin transverse brown line posterior to fastigium and two irregular brown lines toward vertex; posterior margin of vertex brown; fastigium brown with a transverse V-shaped yellow line anterior to lateral ocelli. Pronotum black brown, with yellowish pyriform inscriptions, lighter margins, a pair of wide yellow spots close to anterior margin, a curved yellowish line lateral to inscriptions and a wide band of whitish setae along posterior margin; LL dark brown. Legs yellow and brown; FI with four dorsal flecks, ventral margin yellow, FII with three dorsal flecks, the basal one long, FIII with two apical rings, and three dorsal irregular flecks otherwise, Tibiae with four dark rings. Basitarsomeres I, II light brown, yellow at base; basitarsomeres III light brown. Abdomen yellow and brown, with transverse lines of black dots. Cerci light brown, inner side darker at base.

Male. FWs as on Figure 13; mirror crossed by 1-2 veins. Stridulatory file with 157-167 teeth (n=2, mean 162). FWs light brown, veins lighter; MA yellowish. Subgenital plate as on Figure 14.

Male genitalia. Median process of pseudepiphallus shorter than in *P. gigantea*, not reaching pseudepiphallic paramere mid length (Figure 16); paired processes shorter than in *P. gigantea*, going slightly beyond paramere mid length (Figure 15, 16); in lateral view, pseudepiphallic parameres wider and paramere forceps more asymmetrical, the dorsal branch longer than ventral one (Figure 16).

Female. Subgenital plate transverse, distal margin largely sinuate (Figure 18). Ovipositor longer than FIII.

Female genitalia. Copulatory papilla very similar to that of *P. gigantea* (Figure 20), with the same membranous part ventrally, and slight dorsal constriction; *P. centralis* papilla however somewhat shorter and wider than that of *P. gigantea* (see Desutter-Grandcolas 1997a, Figure 27). See measurements table 2.

REMARK — The male originating from Amoa is similar to males from Aoupinié, except for its much smaller size (compare measurements); as neither FW venation, nor male genitalia are significantly different (but see pseudepiphallic median process, Figure 17), it is identified here *P. centralis* Desutter-Grandcolas, n. sp. Stridulatory file teeth could not be observed (specimen pinned in the file).

In the same way, one female from the type locality is much smaller than the allotype (compare measurements); it has somewhat different subgenital plate (Figure 19) and copulatory papilla (Figure 21), but this could result from allometric size difference.

Protathra centralis Desutter-Grandcolas, n. sp. could anyway reveal highly variable in size, as observed previously for phalangopsid crickets with the same general appearance (see Desutter-Grandcolas, 1992 for *Phalangopsis longipes* Serville, 1831).

All these specimens have been kept in alcohol, and their coloration is much less contrasted than other specimens.

TABLE 2

Measurements (in mm, mean in parentheses) for *Protathra centralis* Desutter-Grandcolas, n.sp.

	Lpron	wpron	LFW	wFW	LFIII	LTIII
Holotype	3.9	4.5	4.5	5.2	19.7	18.6
Paratypes (n=2)	4.1-4.6	5.3	4.9-5.7	5.6-6.2	20.7-23.4	20.9-22.2
Mean (n=3)	4.2	5	5	5.7	21.3	20.6
Amoa male	3.5	4.1	3.9	4.7	18.2	17.2

	Lpron	wpron	LFIII	LTIII	Lovip
Allotype	4.5	5.2	20.4	20.2	21.5
Additional female	3,9	4,8	17,3	17	18,5

ACKNOWLEDGEMENTS

We thank G. Monteith, Brisbane Museum, for the loan of New Caledonian crickets, F. Müller (MNHN) for his help during field work, H. Jourdan (IRD Nouméa) for his long lasting collaboration, S. Hugel and D. Rentz for their comments on the manuscript. Field work has been supported by ANR BIONEOCAL (P. Grandcolas) and IRD, Nouméa. Photos of studied specimens were made by G. Lecorvec (MNHN).

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(Mémoires du Muséum National d'Histoire Naturelle ; 206). ISSN 1243-4442