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TAXONOMIC REVIEW OF *PROCERATOPHRYS MELANOPOGON* (MIRANDA-RIBEIRO, 1926) WITH DESCRIPTION OF FOUR NEW SPECIES (AMPHIBIA, ANURA, ODONTOPHRYNIDAE)[1]

(With 24 figures)

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ABSTRACT: We performed a taxonomic review of *Proceratophrys melanopogon* based on morphological, morphometric, and bioacoustic parameters from the whole species distribution. The results revealed considerable variation among populations, and we conclude that four populations have sufficient differences in call and morphology to be considered as new species allied to *Proceratophrys melanopogon*: *Proceratophrys mantiqueira* sp. nov. [type locality, Parque Estadual da Serra do Brigadeiro (20°53'S, 42°52'W, SAD69 *datum*, ca. 1300m a.s.l.), District of Careço, Municipality of Ervália, State of Minas Gerais, Brazil], *Proceratophrys gladius* sp. nov. [type locality, Parque Nacional da Serra da Bocaina (22°34'S; 44°45'W, SAD69 *datum*, 1600m a.s.l.), Campo de Fruticultura, Municipality of São José do Barreiro, State of São Paulo, Brazil], *Proceratophrys pombali* sp. nov. [type locality, Municipality of Itanhaém (24°11'S; 46°47'W, SAD69 *datum*, 70m a.s.l.), State of São Paulo, Brazil], and *Proceratophrys itamari* sp. nov. [type locality, Parque Estadual de Campos do Jordão (22°41'S, 45°27'W, SAD69 *datum*, 1470m a.s.l.), Municipality of Campos do Jordão, State of São Paulo, Brazil].

Key words: *Proceratophrys mantiqueira* sp. nov. *Proceratophrys gladius* sp. nov. *Proceratophrys pombali* sp. nov. *Proceratophrys itamari* sp. nov. Atlantic Rain Forest Domain. Taxonomy. Geographic distribution.

RESUMO: Revisão taxonômica de *Proceratophrys melanopogon* (Miranda-Ribeiro, 1926) com descrição de quatro espécies novas (Amphibia, Anura, Odontophrynidae).
Realizamos uma revisão taxonômica de *Proceratophrys melanopogon* com base em parâmetros

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morfológicos, morfométricos e acústicos, abrangendo toda distribuição da espécie. Os resultados revelaram considerável variação entre as populações e concluimos que quatro populações possuem diferenças suficientes em canto e morfologia para serem consideradas como espécies novas aliadas a *Proceratophrys melanopogon*: *Proceratophrys mantiqueira* sp. nov. [localidade-tipo, Parque Estadual da Serra do Brigadeiro (20°53'S, 42°52'W, SAD69 *datum*, ca. 1300m a.n.m.), Distrito de Careço, Município de Ervália, Estado de Minas Gerais, Brasil], *Proceratophrys gladius* sp. nov. [localidade-tipo, Parque Nacional da Serra da Bocaina (22°34'S; 44°45'W, SAD69 *datum*, 1600m a.n.m.), Campo de Fruticultura, Município de São José do Barreiro, Estado de São Paulo, Brasil], *Proceratophrys pombali* sp. nov. [localidade-tipo, Município de Itanhaém (24°11'S; 46°47'W, SAD69 *datum*, 70m a.n.m.), Estado de São Paulo, Brasil] e *Proceratophrys itamari* sp. nov. [localidade-tipo, Parque Estadual de Campos do Jordão (22°41'S, 45°27'W, SAD69 *datum*, 1470m a.n.m.), Município de Campos do Jordão, Estado de São Paulo, Brasil].

Palavras-chave: *Proceratophrys mantiqueira* sp. nov. *Proceratophrys gladius* sp. nov. *Proceratophrys pombali* sp. nov. *Proceratophrys itamari* sp. nov. Mata Atlântica. Taxonomia. Distribuição geográfica.

INTRODUCTION

The genus *Proceratophrys* Miranda-Ribeiro currently consists of 31 species distributed in Brazil, northeastern Argentina, and Paraguay (Frost, 2013; Teixeira-Jr. *et al.*, 2012; Ávila *et al.*, 2012; Dias *et al.*, 2013). Except for *Proceratophrys rondonae* Prado & Pombal, 2008 and the allied species *P. schirchi* (Miranda-Ribeiro, 1937), *P. minuta* Napoli, Cruz, Abreu & Del Grande, 2011, and *P. redacta* Teixeira, Amaro, Recoder, Vechio & Rodrigues, 2012 (Cruz & Napoli, 2008; Napoli *et al.*, 2011; Teixeira-Jr. *et al.*, 2012), the other species are arranged into three morphological groups (Prado & Pombal, 2008; Cruz & Napoli, 2010) without phylogenetic support (Amaro *et al.*, 2009; Pyron & Wiens, 2011).

Proceratophrys species with a single, long, and uni-cuspidate palpebral appendage are arranged in two species complexes: *P. boiei* and *P. appendiculata* (Izecksohn *et al.*, 1998; Prado & Pombal, 2008). The *P. boiei* complex (Prado & Pombal, 2008) lacks a triangular fleshy rostral appendage and includes: *P. boiei* (Wied-Neuwied, 1824), *P. paviotii* Cruz, Prado & Izecksohn, 2005, and *P. renalis* (Miranda-Ribeiro, 1920). The *P. appendiculata* complex (Izecksohn *et al.*, 1998; Cruz & Napoli, 2010) has a triangular fleshy rostral appendage and includes: *P. appendiculata* (Günther, 1873), *P. laticeps* Izecksohn & Peixoto, 1981, *P. melanopogon* (Miranda-Ribeiro, 1926), *P. moehringi* Weygoldt & Peixoto, 1985, *P. phyllostomus* Izecksohn, Cruz & Peixoto, 1999, *P. subguttata* Izecksohn, Cruz & Peixoto, 1999, *P. tupinamba* Prado & Pombal, 2008, and *P. sanctaritae* Cruz & Napoli, 2010. *Proceratophrys rondonae* has a single, short, and multi-cuspidate palpebral appendage.

Miranda-Ribeiro (1926) described *Proceratophrys melanopogon* as *Stombus melanopogon* based on one adult female from Alto da Serra, Municipality of Paranapiacaba, State of São Paulo, Brazil; subsequent authors did not recognize the validity of this species (Cochran, 1955; Bokermann, 1966; Lynch, 1971; Izecksohn & Peixoto, 1981). Izecksohn & Peixoto (1981) described *P. laticeps* and associated this species to the *P. appendiculata* complex considering *P. melanopogon* as a junior synonym of *P. appendiculata*. Heyer *et al.* (1990) revalidated *P. melanopogon* and provided some data on morphology, coloration, and seasonal and spacial distribution. *Proceratophrys melanopogon* occurs in the Atlantic rainforest of southeastern Brazil and is restricted to high altitudinal areas on the south, central, and northern portions of the State of Rio de Janeiro, east of

State of São Paulo, and south and southeast State of Minas Gerais (Feio *et al.*, 2003; Prado & Pombal, 2008; Mângia *et al.*, 2010).

Phylogenetically closely related species with restricted distributions and occupying the same environmental physiognomy in different mountain ranges (*e.g.*, Serra do Mar and Serra da Mantiqueira), suggest the influence of the geomorphologic and climatic evolution, meanning a common history, and speciation influenced by the same past events (Nascimento *et al.*, 2005; Cruz & Feio, 2007). Cruz & Feio (2007) cited species in both Serra do Mar and Serra da Mantiqueira that represent species complexes (*e.g.*, *Ischnocnema lactea* and *I. parva*).

Herein we perform an analysis and taxonomic revision of *Proceratophrys melanopogon*, based on external morphology, morphometry, and bioacoustic characteristics, to clarify the taxonomic status of the populations under this name.

MATERIAL AND METHODS

Specimens examined (122 ♂ and 65 ♀) are deposited at: CCLZU (Coleção Científica do Laboratório de Zoologia da Universidade de Taubaté, State of São Paulo, Brazil), CHUFMG (Coleção Herpetológica da Universidade Federal de Minas Gerais, Belo Horizonte, State of Minas Gerais, Brazil), CFBH (Coleção Célio F.B. Haddad, Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, State of São Paulo, Brazil), DZSJRP (Coleção do Departamento de Zoologia, Universidade Estadual Paulista, São José do Rio Preto, State of São Paulo, Brazil), MNRJ (Museu Nacional, Rio de Janeiro, State of Rio de Janeiro, Brazil), MZUFV (Museu de Zoologia João Moojen, Universidade Federal de Viçosa, State of Minas Gerais, Brazil), MZUSP (Museu de Zoologia, Universidade de São Paulo, State of São Paulo, Brazil), UFBA (Universidade Federal da Bahia, Salvador, State of Bahia, Brazil), UFJF (Universidade Federal de Juiz de Fora, State of Minas Gerais, Brazil), and ZUEC (Museu de História Natural Prof. Adão José Cardoso, Universidade Estadual de Campinas, State of São Paulo, Brazil). Specimens examined are referred in Appendix 1.

The recent tree topologies for *Proceratophrys* (Amaro *et al.*, 2008; Teixeira-Jr. *et al.*, 2012; Dias *et al.*, 2013), did not recovered the traditional groups as monophyletic, except for the *P. bigibbosa* group. Despite this fact, we still use these groups names, just aiming the comparisons of morphology, because several discrete morphological characters define these groups and this greatly simplifies species comparisons along our text. We follow Giaretta *et al.* (2000), Kwet & Faivovich (2001), and Prado & Pombal (2008) groupings in these comparisons.

Terminology for external morphology followed Prado & Pombal (2008), Napoli *et al.* (2009), Cassini *et al.* (2010), and Napoli *et al.* (2011). Herein we defined the use the following states for several characteristics: the shape of rostral fleshy appendage (triangular, triangular fringed, or triangular fringed with a constriction on distal half; Fig.1), the presence or absence of a constriction on symmetrical dorsal crest of tubercles (Fig.2), the presence of short or long tubercles on symmetrical dorsal crest (Fig.3), palpebral appendage long or short (Fig.4) with presence of a distinct row of tubercles, or absence to poorly developed tubercles (Fig.5), palpebral appendage triangular or triangular bluntly pointed (Fig.6), and interocular crest markedly curved, or slightly curved (Fig.7).

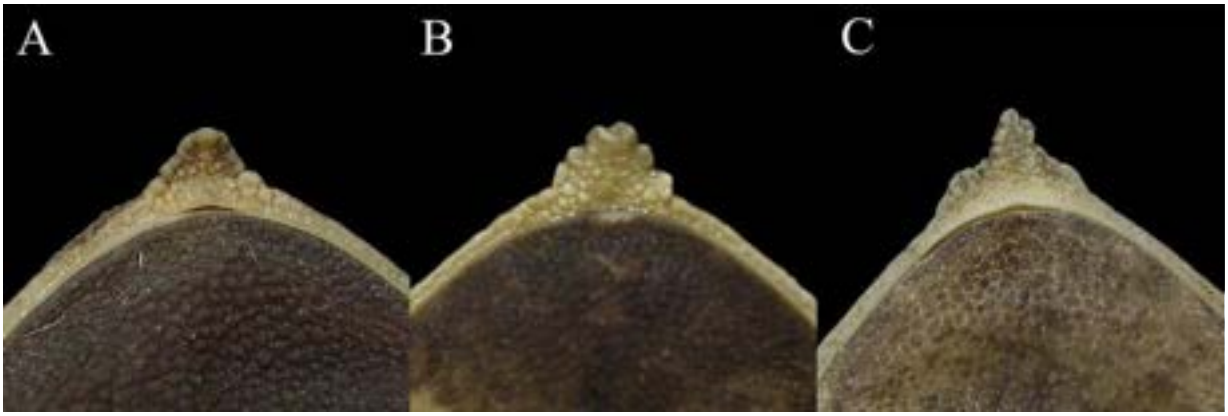

Fig.1– Ventral views of triangular rostral fleshy appendage: (A) triangular (adult ♂ , CHUFMG 536, SVL 32.4mm), (B) triangular fringed (adult ♂, CFBH 15983, SVL 31.9mm), and (C) triangular fringed with a constriction on distal half (adult ♂, CCLZU 2270, SVL 34.7mm). Photos: S. Mângia.

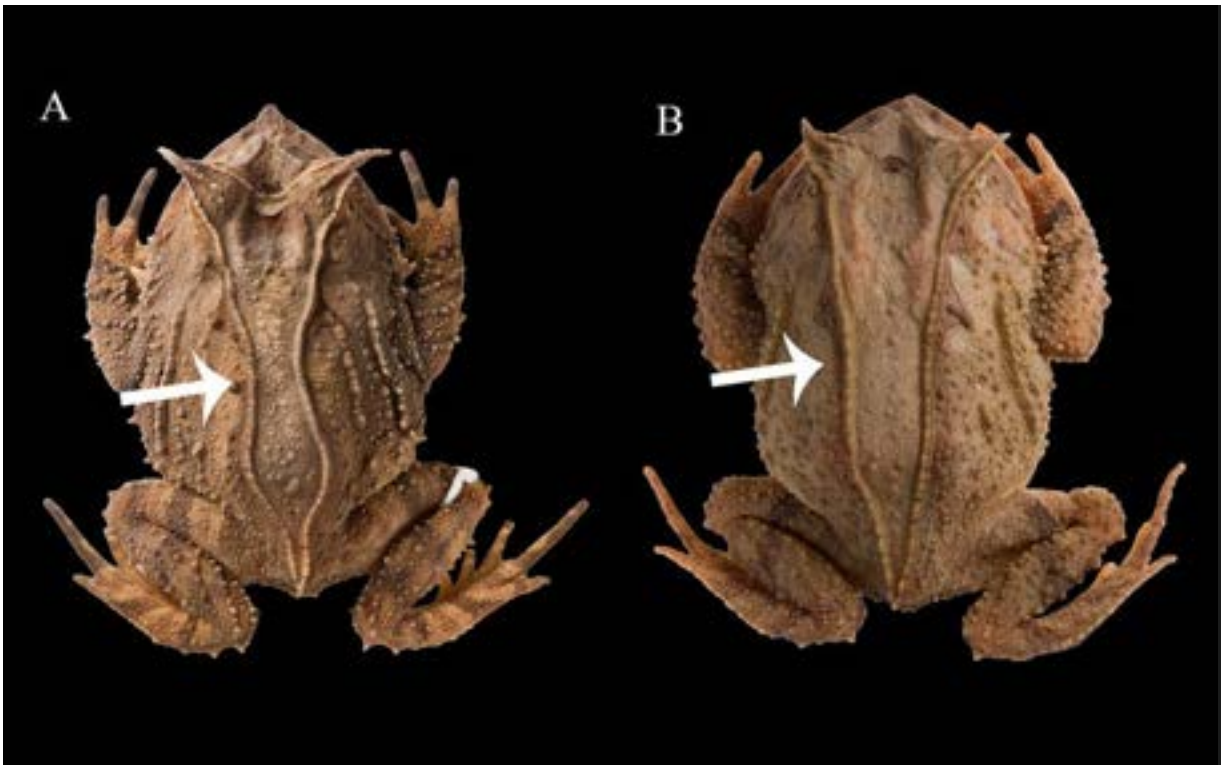

Fig.2– Dorsal views of head, with (A) presence (adult ♂, ZUEC 6895, SVL 44.5mm or (B) absence) of a constriction in symmetrical dorsal crests of tubercles (adult ♂, MZUSP 96345, SVL 37.5mm). Photos: José Lino-Neto.

Fig.3– Dorsal views of body, with (A) presence of short (adult ♂, MNRJ 82580, SVL 36.7mm), or (B) long tubercles in symmetrical dorsal crests (adult ♂, CFBH 15982, 35.1mm). Photos: José Lino-Neto.

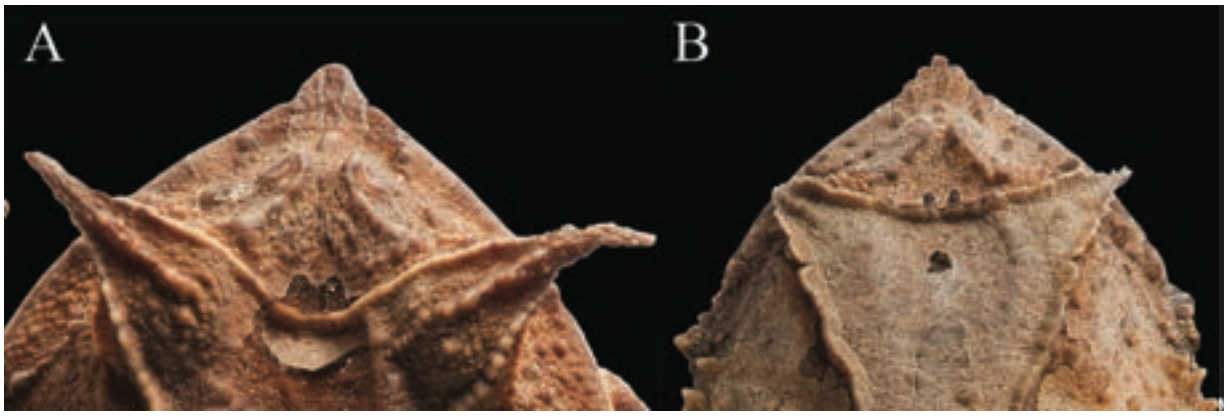

Fig.4– Dorsal views of head, with palpebral appendage (A) long (adult ♂, ZUEC 6895, SVL 44.5mm) and (B) short (adult ♂, CFBH 15982, 35.1mm).Photos: José Lino-Neto.

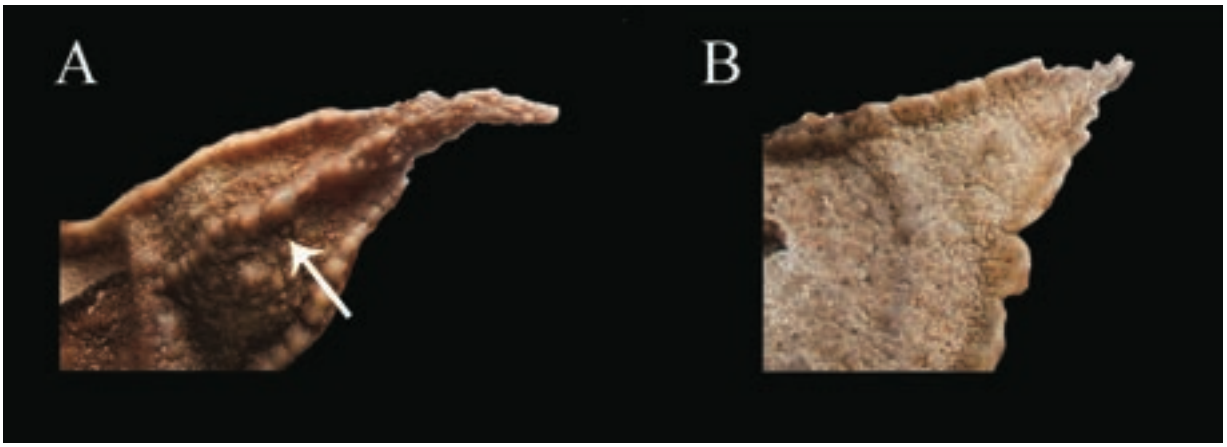

Fig.5– Dorsal views of head, with (A) presence (adult ♂, ZUEC 6895, SVL 44.5mm) and (B) absence to poorly developed row of tubercles (adult ♂, CFBH 15982, 35.1mm). Photos: José Lino-Neto.

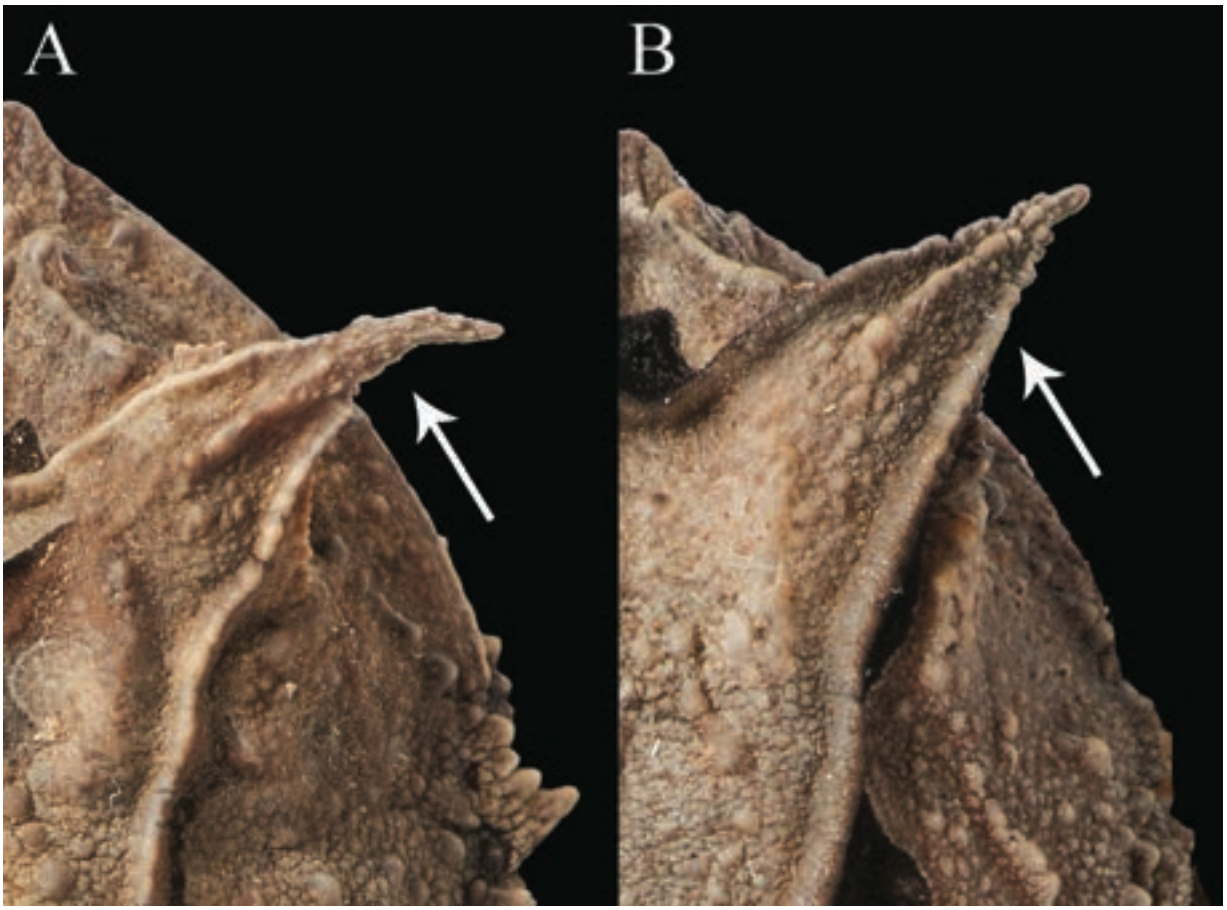

Fig.6– Dorsal views of head, with (A) palpebral appendage triangular, bluntly pointed (adult ♂, ZUEC 6895, SVL 44.5mm) and (B) triangular, not bluntly pointed (adult ♂, MNRJ 82573, SVL 34.4mm). Photos: José Lino-Neto.

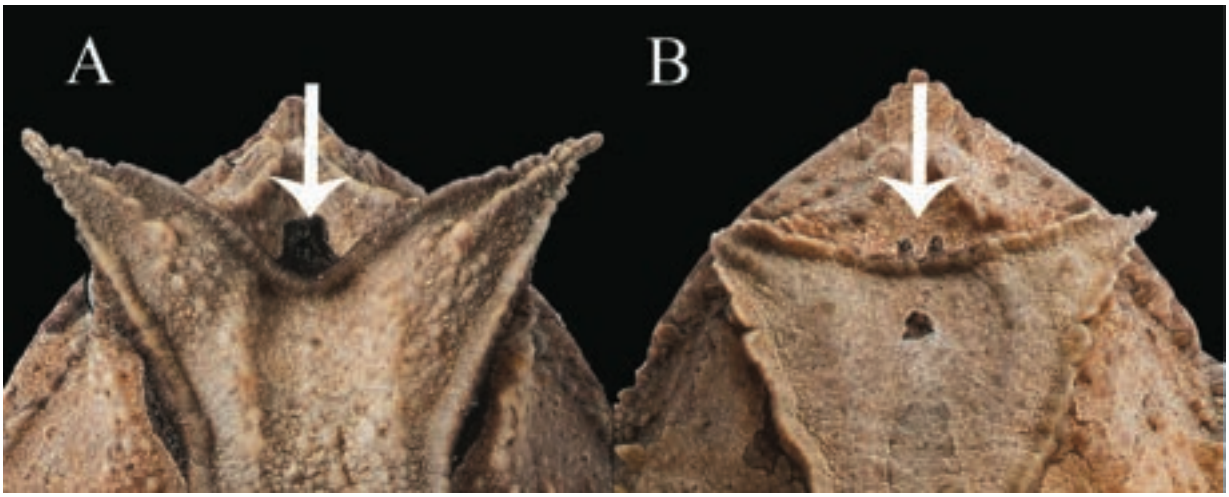

Fig.7– Dorsal views of head, with interocular crest (A) markedly curved (adult ♂, MNRJ 82573, SVL 34.4mm) and (B) slightly curved (adult ♂, CFBH 15982, 35.1mm). Photos: José Lino-Neto.

Measurements of adult specimens followed Prado & Pombal (2008) and are in millimeters: SVL (snout-vent length), HL (head length), HW (head width), DICS (distance from the interocular crest to the tip of snout), IND (internarial distance), END (eye-nostril distance), ED (eye diameter), UEW (upper eyelid width), IOD (interorbital distance), THL (thigh length), TL (tibia length), FL (foot + tarsus length), and forearm and hand length (FHL). In addition, we analyzed variation of the length of the rostral appendage (RAL).

For acoustic comparisons, we used published records of the advertisement call of *P. melanopogon* (Mângia *et al.*, 2010) from the State of Minas Gerais (ASUFRN 219-222). In addition, we analyzed recordings of three new samples from Parque Nacional da Serra da Bocaina, Municipality of São José do Barreiro (M.V. Garey) (ASUFRN 215-218), Municipality of Campos de Jordão (I. Martins) (ASUFRN 211-213), and Municipality of Bertioga (P.C.A. Garcia) (ASUFRN 214), all in State of São Paulo. The acoustic analysis and sonograms were made using Raven 1.3 for Windows (Cornell Lab of Ornithology). We analyzed usual acoustic parameters for anuran taxonomy (*e.g.*, Kwet & Faivovich, 2001; Brasileiro *et al.*, 2008): call duration, pulse number per call, pulse number per second, and dominant frequency. Call terminologies followed Duellman & Trueb (1986). Recordings are deposited in the Arquivo Sonoro da Universidade Federal do Rio Grande do Norte (ASUFRN).

RESULTS

Proceratophrys melanopogon (Miranda-Ribeiro, 1926)
Figs 8-10

Stombus melanopogon Miranda-Ribeiro, 1926.
Ceratophys appendiculata – Cochran, 1955.
Ceratophrys boiei – Bokermann, 1966.
Proceratophrys melanopogon – Heyer, Rand, Cruz, Peixoto & Nelson, 1990.

Holotype – MNRJ 0294, adult ♀, collected at Alto da Serra (= Paranapiacaba), 23°47'S, 46°18'W, State of São Paulo, Brazil, by F.C. Hoehne and D. Lemos.

Diagnosis – The zygomatic ramus of the squamosal in sutural contact with the maxilla diagnoses the species of the genus *Proceratophrys*. The presence of a single and long uni-cuspidate palpebral appendage and a triangular rostral fleshy appendage places the species in the *P. appendiculata* species complex. *Proceratophrys melanopogon* is diagnosed by the following combination of traits: (1) medium size (SVL 28.9-45.6mm in adult males; 39.2-65.9mm in adult females); (2) triangular rostral fleshy appendage longer than upper lip width; (3) snout rounded in dorsal view, obtuse spatulate in profile; (4) palpebral appendage long, triangular bluntly pointed, with a row of tubercles; (5) interocular crest well curved; (6) frontoparietal crests well developed; (7) region between frontoparietal crests deep; (8) symmetrical dorsal crest with short aggregate tubercles, forming a continuous line, with a mid dorsal constriction; (9) gular region blackish brown or black and belly with irregular dark brown spots; (10) outer metacarpal tubercle divided in two parts, the internal oval and the external elliptical, outer metatarsal tubercle small, rounded; (11) advertisement call consisting of a multipulsed note with duration of 0.4-0.8 seconds, 20-38 pulses, 47-55 pulses/second, and dominant frequency 831.3-1033.6 Hz.

Additional holotype characteristics – Prado & Pombal (2008) provided description and illustration of the holotype; in addition we found it to have a triangular rostral fleshy appendage, symmetrical dorsal crest of short tubercles with a constriction on mid dorsum, palpebral appendage long, triangular bluntly pointed with a row of tubercles, and interocular crest well curved.

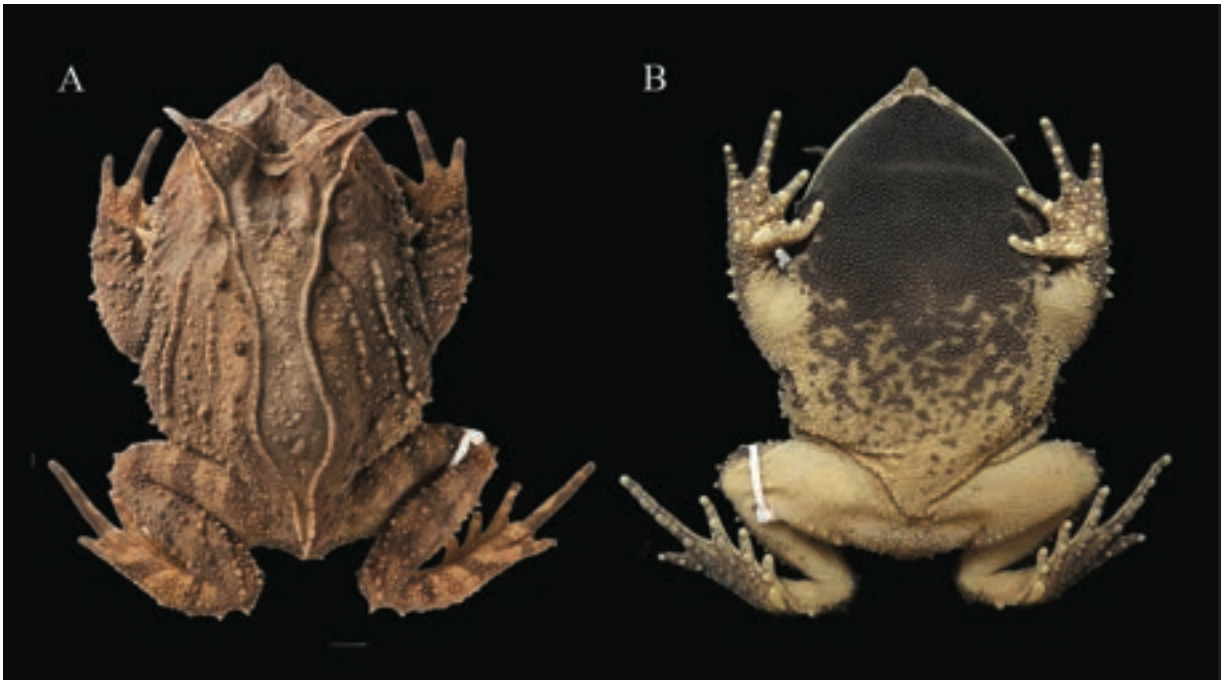

Fig.8– *Proceratophrys melanopogon*. Dorsal (left) and ventral (right) views of topotype, adult ♂, ZUEC 6895, SVL 44.5mm. Photos: José Lino-Neto.

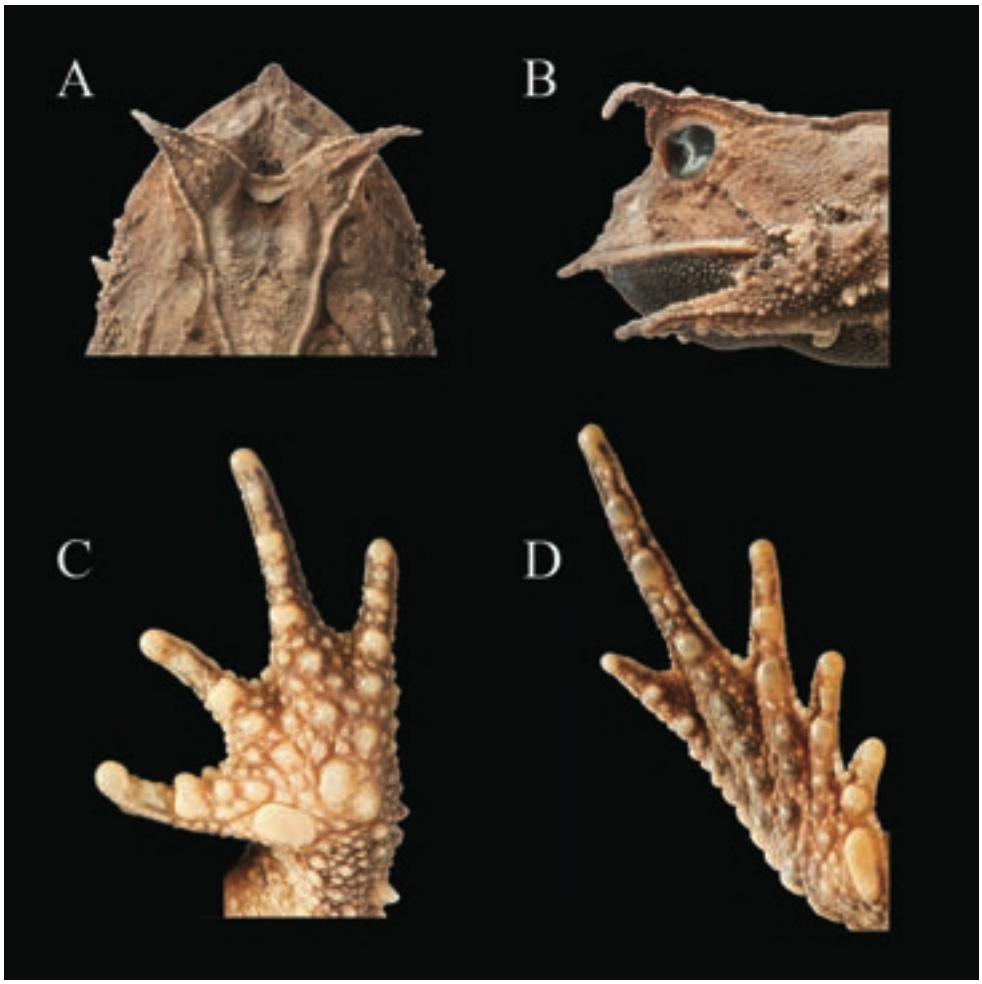

Fig.9– Topotype of *Proceratophrys melanopogon*, adult ♂, ZUEC 6895, SVL 44.5mm. (A) dorsal and (B) lateral views of head; ventral views of (C) hand and (D) foot. Photos: José Lino-Neto.

Comparisons with other species – The absence of a preocular crest separates *Proceratophrys melanopogon* from *P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. moehringi*, *P. sanctaritae*, and *P. tupinamba* (presence of preocular crest). Additionally, adult males of *P. melanopogon* (mean SVL = 38.7mm ± 4.5; 28.9-45.6mm) are shorter than *P. appendiculata* (mean SVL = 51.6mm ± 5.1; 40.4-59.9mm). *Proceratophrys melanopogon* can be distinguished from *P. laticeps*, *P. moehringi*, and *P. tupinamba* by the presence of fleshy rostral appendage longer than upper lip width and the region between the frontoparietal crests deep (rostral fleshy appendage vestigial, shorter than upper lip width, and shallow region between frontoparietal crests in *P. laticeps*, *P. moehringi*, and *P. tupinamba*). Belly pattern of *P. melanopogon* presents irregular dark brown spots, while *P. phyllostomus* presents few tan blotches on belly and legs and *P. subguttata* has large rounded dark brown markings. *Proceratophrys melanopogon* differs from *P. phyllostomus* by the snout rounded in dorsal view, obtuse spatulate in profile (obtuse to sloping in *P. phyllostomus*), and from *P. subguttata* by the palpebral appendage long

(short in *P. subguttata*). *Proceratophrys melanopogon* is distinguished from *P. sanctaritae* by the advertisement call, presenting 47-55 pulses/second (102-142 pulses/s in *P. sanctaritae*) and 20-38 pulses/note (31-94 pulses/note in *P. sanctaritae*).

Variation – *Proceratophrys melanopogon* presents variation in dorsal pattern from cream to brown, and in ventral pattern, with the blotches varying in size and shape. Descriptive statistics of measurement variables from adults are presented in Table 1.

Advertisement call (Fig.11) – We analyzed recordings of the advertisement calls from populations of municipalities of Bertioga and São José do Barreiro (Bocaina), State of São Paulo (air temperature not available).

The advertisement call from Municipality of Bertioga consists of a multipulsed note (n = 31 calls, 1 individual), with a duration of 0.4-0.7 seconds ($\bar{x}$ = 0.5s ± 0.04), 21-30 pulses/note ($\bar{x}$ = 23.6 pulses/note ± 2.0), and 40-54 pulses/second ($\bar{x}$ = 51.9 pulses/s ± 0.1). The dominant frequency is 947.5-1033.6 Hz ($\bar{x}$ = 958.6 Hz ± 29.3). The advertisement call from Parque Nacional da Serra da Bocaina consists of a multipulsed note (n = 80 calls, 3 individuals) with a duration of 0.4-0.8 seconds ($\bar{x}$ = 0.5s ± 0.1), 20-38 pulses/note ($\bar{x}$ = 25.3 pulses/note ± 3.7), and 47-55 pulses/second ($\bar{x}$ = 50.3 pulses/s ± 2.0). The dominant frequency is 831.3-1033.6 Hz ($\bar{x}$ = 994.2 Hz ± 58.3).

These parameters differ from the published description of the advertisement call of *P. melanopogon* by Mângia *et al.* (2010) because it corresponds to a new species described below.

Tadpole – The tadpole was described by Provete *et al.* (2013).

Geographic distribution – *Proceratophrys melanopogon* occurs in the Atlantic Rainforest of southeastern Brazil. The species is restricted to the Serra do Mar range in south, central, and northern portions of the State of Rio de Janeiro and east of the State of São Paulo (Fig.12).

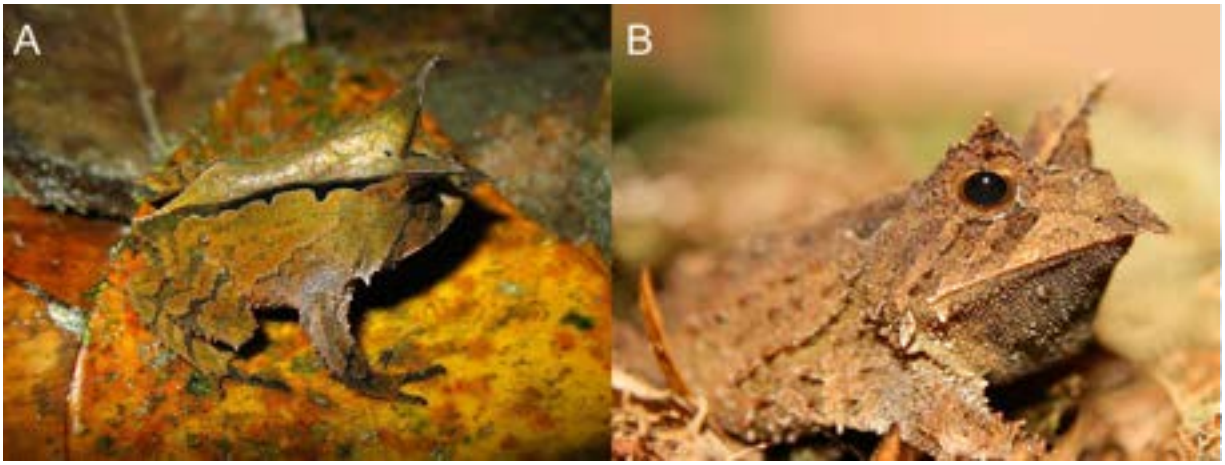

Fig.10– Live specimens of *Proceratophrys melanopogon* from (A) Estação Ecológica de Boracéia, Municipality of Salesópolis, and (B) Parque Nacional da Serra da Bocaina. Photos: (A) Mauro Teixeira Jr.; (B) Diogo B. Provete.

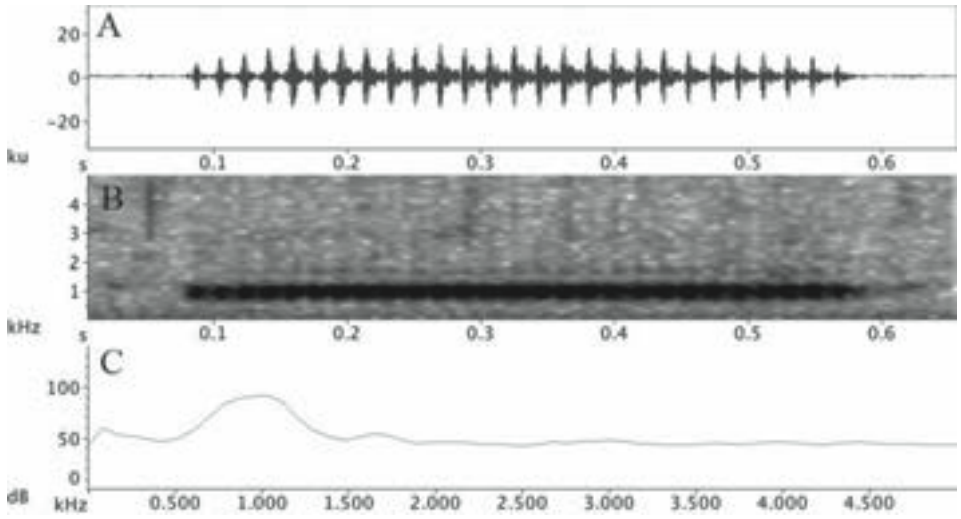

Fig.11– Advertisement call of *Proceratophrys melanopogon*: (A) oscillogram, (B) audiospectrogram, and (C) power spectrum of a single call.

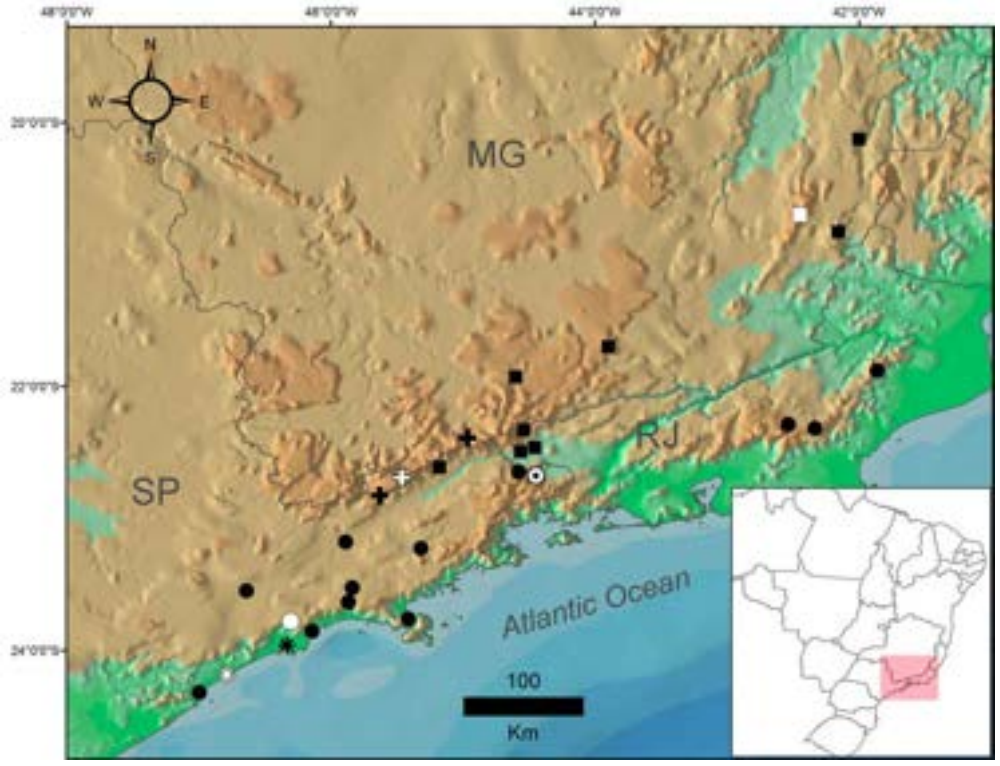

Fig.12– Geographic distribution of *Proceratophrys melanopogon* (dot); *Proceratophrys mantiqueira* sp. nov. (square); *Proceratophrys itamari* sp. nov. (cross); *Proceratophrys pombali* sp. nov. (asterisk); and *Proceratophrys gladius* sp. nov. (white circle dotted). White symbols represent type localities.

Proceratophrys mantiqueira sp. nov.
Figs 13-15

Proceratophrys melanopogon (*non* Miranda-Ribeiro, 1926) – Prado & Pombal, 2008 (part); Mângia *et al.* (2010) (part).

Holotype – MNRJ 82573, adult ♂, collected at Parque Estadual da Serra do Brigadeiro (20°53'S, 42°52'W, SAD69 *datum*, ca. 1300m a.s.l.), District of Careço, Municipality of Ervália, State of Minas Gerais, Brazil, in October 2009, by D.J. Santana and R.N. Feio.

Paratypes – Collected at the type locality: MNRJ 82574-82576, adult ♂, collected in November 1994, by R.N. Feio; MZUFV 10044, adult ♂, collected with the holotype; MZUFV 4302, adult ♂, collected in October 2001, by R.N. Feio and J. Cassimiro; MZUFV 8931-8932, adult ♂, collected in September 2008, by R.N. Feio and D.J. Santana; MZUFV 10244, adult ♀, collected in January 2010, by R.N. Feio; MZUFV 10405, adult ♂, collected in February 2010, by R.N. Feio and D.J. Santana; MNRJ 44607, adult ♀, collected at Municipality of Pedra Dourada, State of Minas Gerais, in December 2006, by C.A.G. Cruz, C.S. Cassini, R.N. Feio, and J.S. Dayrell.

Diagnosis – The zygomatic ramus of the squamosal in sutural contact with maxilla assigns the new species to the genus *Proceratophrys*. Species associated to the *P. appendiculata* complex by the presence of a single and long uni-cuspidate palpebral appendage and a triangular rostral fleshy appendage. *Proceratophrys mantiqueira* sp. nov. is diagnosed by the following combination of traits: (1) small size (SVL 28.4-42.5 mm in adult males; 36.3-54.3 mm in adult females); (2) triangular rostral fleshy appendage longer than upper lip width; (3) snout sub-elliptical in dorsal view, obtuse spatulate in profile; (4) palpebral appendage long, triangular, with a row of tubercles; (5) interocular crest well curved; (6) frontoparietal crests well developed; (7) region between frontoparietal crests deep; (8) symmetrical dorsal crest with short aggregate tubercles, forming a continuous line, mid dorsal constriction; (9) gular region blackish and belly with scattered small dark brown dots; (10) outer metacarpal tubercle divided in two parts, the internal oval and the external elliptical, outer metatarsal tubercle small, rounded; (11) advertisement call consisting of a multipulsed note with duration of 0.2-0.5 s ($\bar{x}$ = 0.4 s ± 0.6),12-41 pulses, 69-96 pulses/second, and dominant frequency 999.12-1274.1 Hz (Mângia *et al.*, 2010).

Comparisons with other species – The absence of a preocular crest separates *Proceratophrys mantiqueira* sp. nov. from *P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. moehringi*, *P. sanctaritae*, and *P. tupinamba* (presence of preocular crest). *Proceratophrys mantiqueira* sp. nov. can be distinguished from *P. laticeps*, *P. moehringi*, and *P. tupinamba* by the presence of fleshy rostral appendage longer than upper lip width (fleshy rostral appendage shorter than upper lip width in those species). The snout shape sub-elliptical from above distinguishes *P. mantiqueira* sp. nov. from *P. appendiculata*, *P. phyllostomus*, *P. subguttata*, and *P. melanopogon* (snout rounded from above). Belly pattern of *P. mantiqueira* sp. nov. presents scattered small dark brown dots, while *P. melanopogon* presents irregular dark brown spots, *P. phyllostomus* presents few tan blotches on belly and legs, and *P. subguttata* presents large rounded dark brown markings. *Proceratophrys mantiqueira* sp. nov. also differs from *P. melanopogon* by the palpebral appendage triangular, not bluntly

pointed (triangular bluntly pointed in *P. melanopogon*), and by the advertisement call with 69-96 pulses/second (47-55 pulses/second in *P. melanopogon*).

Description of holotype – Head wider than long, head length 37% of SVL; snout sub-elliptical in dorsal view, obtuse spatulate in profile; nares elliptical, slightly prominent, internarial distance 63% of eye diameter; eye directed anterolateraly, eye diameter 25% of head length; eye-nostril distance 24% of head length; eyelied width two times the eye diameter; palpebral appendage long, triangular, with a row of tubercles; interocular crest markedly curved; *canthus rostralis* well marked, with accentuated and thin canthal crest; no preocular crests; loreal region concave; indistinct tympanum; vocal sac not expanded externally; vomerine teeth in two groups lying between choanae; frontoparietal crests well developed; region between frontoparietal crests deep. Triangular fleshy rostral appendage longer than upper lip width. External portion of the forearms with a row of triangular tubercles reaching the hand; outer metacarpal tubercle divided in two parts, the internal oval and the external elliptical; inner metacarpal tubercle elliptical, larger than the external part of outer metacarpal tubercle; finger IV with diminute tubercles forming a fringe on external side; fingers length V < III < II < IV; webbing absent; numerous supernumerary tubercles; subarticular tubercles prominent, rounded. Legs moderately robust, thigh length slightly longer than tibia length; sum of thigh and tibia lengths 82% of SVL; foot length 1.4 times the thigh length; outer metatarsal tubercle rounded, small; inner metatarsal tubercle elliptical, elongated, prominent; toe V with diminute tubercles forming a fringe on external side; toes length I < II < V < III < IV; webbing poorly developed, webbing formula I 1 – 2 II 1^{-} – 3 III 2^{-} – 4 IV 4 – 2 V; subarticular tubercles prominent, rounded; plantar surface rough, supranumerary tubercles with uniform size; external foot margin with a row of spatulate conical tubercles. Dorsal surface rough, with conical tubercles of different sizes, more concentrated on the dorsolateral region, above the limbs; more developed triangular tubercles arranged in rows on dorsal surface of the limb; a row of tubercles extending from the posterior region of the eye to the insertion of the arm, and another row extending from the temporal region to the mid flank region; symmetrical dorsal crest of small tubercles well marked, joining the edge of palpebral appendage, extending to join above sacrum, and presenting a constriction on mid dorsum; ventral surfaces, except hands and feet, covered by numerous small, circular, uniform warts; skin and warts of dorsal and ventral surfaces covered by minuscule horny asperities.

Color of holotype in preservative – Dorsal background color brown, maculated with variegate brown looking like dead leaves. Area delimited by the symmetrical dorsal crests light brown, bordered along external sides by a wave-shaped dark brown band. Three transverse dark brown bars on forearm, thigh, tibia, and tarsus. Loreal region brown with a dark brown band from eye to upper lip. Ventral surface background color cream, gular region blackish, and belly with scattered small dark brown dots.

Measurements of holotype (mm) – SLV 34.4; HL 12.7; HW 17.6; DICS 8.2; IND 2.0; END 3.1; ED 3.2; UEW 8.6; RAL 1.5; IOD 3.9; THL 15.1; TL 13.2; FL 20.6; FHL 17.4.

Variation – Specimens are congruent with respect to morphological characters. The dorsal background color varies in adult specimens from dark brown to cream. Descriptive basic statistics of measurement variables from adults is presented in Table 1.

TABLE 1

Measurements of specimens of *Proceratophrys melanopogon*, *P. mantiqueira* sp. nov., *P. gladius* sp. nov., *P. pombali* sp. nov., *P. itamari* sp. nov.

	P. melanopogon		*P. mantiqueira* sp. nov.		*P. gladius* sp. nov.		*P. pombali* sp. nov.		*P. itamari* sp. nov.	
	♂ (n = 26)	♀ (n = 15)	♂ (n = 68)	♀ (n = 35)	♂ (n = 12)	♀ (n = 7)	♂ (n = 6)	♀ (n = 1)	♂ (n = 9)	♀ (n = 6)
SVL	38.7 ± 4.5 28.9-45.6	53.1 ± 6.4 39.7-65.8	34.9 ± 2.9 28.4-42.5	47.1 ± 5.0 36.3-54.3	36.4 ± 5.1 28.8-45.9	44.6 ± 3.9 36.7-48.5	37.8 ± 1.7 44.0-31.9	33.8	36.7 ± 3.5 31.1-42.5	47.0 ± 4.5 39.5-52.3
HW	21.0 ± 2.6 15.0-24.7	27.9 ± 3.4 20.7-34.0	17.2 ± 1.4 15.0-21.1	24.2 ± 3.0 17.5-28.4	19.5 ± 3.2 14.7-24.7	23.6 ± 2.0 19.4-25.1	19.7 ± 0.9 17.3-22.6	16.9	18.3 ± 1.8 15.7-21.1	24.6 ± 2.3 20.0-26.4
HL	14.6 ± 1.6 10.1-17.0	19.5 ± 2.2 15.6-24.2	11.9 ± 1.3 6.7-17.5	17.2 ± 1.8 12.3-21.0	13.7 ± 2.1 10.0-17.3	16.4 ± 1.6 12.8-17.7	12.8 ±0.7 11.0-14.8	11.6	9.6 ± 5.1 12.0-14.8	17.4 ± 1.5 14.6-18.6
DICS	8.8 ± 1.1 6.2-12.5	11.5 ± 1.7 8.0-14.9	7.2 ± 1.0 6.4-9.9	10.0 ± 0.9 7.6-12.4	8.3 ± 1.2 6.4-10.3	9.7 ± 0.9 8.0-10.7	7.8 ± 0.3 7.0-8.6	6.6	7.6 ± 0.8 6.7-8.9	10.3 ± 0.8 9.1-11.2
IND	2.0 ± 0.3 1.6-2.5	2.6 ± 0.3 2.2-3.4	1.4 ± 0.5 1.5-3.6	2.5 ± 0.4 1.7-5.8	2.2 ± 0.3 1.6-2.8	2.6 ± 0.2 2.3-2.9	1.9 ± 0.1 1.6-2.2	1.3	1.9 ± 0.3 1.5-2.4	2.7 ± 0.3 2.3-3.1
END	4.0 ± 0.4 3.3-4.8	5.1 ± 0.5 4.3-6.0	3.0 ± 0.4 2.7-4.7	4.7 ± 0.5 3.2-4.8	3.8 ± 0.5 3.1-4.7	4.6 ± 0.5 3.9-5.4	3.6 ± 0.3 2.8-4.6	3.3	3.6 ± 0.4 2.8-4.1	4.7 ± 0.6 3.7-5.6
ED	3.7 ± 0.6 2.4-4.4	4.7 ± 0.6 3.2-5.7	2.8 ± 0.4 2.3-4.4	4.1 ± 0.4 3.4-4.8	3.6 ± 0.4 2.8-4.3	3.8 ± 0.3 3.4-4.2	2.9 ± 0.2 2.4-3.5	2.4	3.1 ± 0.3 2.6-3.5	3.9 ± 0.3 3.3-4.2
UEW	9.0 ± 1.4 5.3-10.8	11.3 ± 1.3 8.3-13.7	7.8 ± 1.1 5.7-10.7	10.2 ± 1.2 7.2-12.3	7.6 ± 0.9 6.3-9.3	8.7 ± 0.6 8.0-9.8	7.2 ± 0.2 6.7-8.2	6.0	8.5 ± 0.8 7.3-9.9	10.8 ± 0.9 9.6-11.5
RAL	2.4 ± 0.4 1.6-3.0	2.8 ± 0.6 2.1-4.3	1.9 ± 0.6 1.5-3.5	2.6 ± 0.5 1.9-3.9	1.5 ± 0.3 1.0-2.0	1.9 ± 0.3 1.6-2.3	2.1 ± 0.2 1.7-2.7	2.0	3.0 ± 0.3 2.7-3.5	3.3 ± 0.2 3.2-3.6
IOD	3.7 ± 0.4 2.7-4.5	4.9 ± 0.8 3.7-6.7	3.0 ± 0.5 2.8-4.8	4.6 ± 0.6 3.4-6.7	3.6 ± 0.7 2.6-4.9	4.7 ± 0.5 4.0-5.6	4.3 ± 0.4 3.2-5.4	3.5	3.7 ± 0.3 3.2-3.9	4.7 ± 0.3 4.3-5.0
THL	16.7 ± 2.2 11.9-20.3	21.0 ± 2.9 15.2-26.3	14.5 ± 1.4 12.6-19.1	19.5 ± 2.1 13.6-22.2	14.5 ± 2.0 10.4-17.0	17.9 ± 1.6 15.3-19.4	14.5 ± 0.5 12.3-16.0	11.8	15.6 ± 1.5 13.7-18.7	20.0 ± 1.9 16.3-21.3
TL	15.8 ± 2.0 11.3-18.6	20.0 ± 2.5 15.3-23.9	13.5 ± 1.2 11.9-18.4	18.6 ± 2.2 13.8-26.4	14.1 ± 1.9 10.5-17.3	17.0 ± 1.3 14.6-18.1	13.7 ± 0.4 12.4-15.2	12.4	14.2 ± 1.5 12.3-16.5	18.7 ± 1.7 15.3-19.9
FL	23.8 ± 3.0 17.0-27.5	30.5 ± 3.5 23.6-37.2	20.8 ± 1.9 18.2-27.6	27.9 ± 3.0 20.8-31.7	22.3 ± 3.0 16.9-26.6	26.8 ± 2.3 22.2-29.5	21.3 ± 0.6 19.0-23.3	19.1	21.0 ± 2.3 18.2-24.9	28.3 ± 2.5 23.4-29.4
FHL	19.3 ± 4.6 15.9-23.8	26.5 ± 3.6 20.1-32.3	17.5 ± 1.7 14.8-23.3	24.0 ± 2.4 17.0-27.0	18.8 ± 3.1 13.1-22.4	22.5 ± 1.3 19.8-23.7	17.9 ± 0.6 16.5-19.8	14.7	18.5 ± 1.8 15.5-21.2	24.3 ± 2.5 20.2-27.0

The abbreviationsare listed in Material and Methods. Mean ± Standard Deviation; Range. Values in millimeters. n = number of specimens.

Advertisement call – Mângia *et al.* (2010) described the advertisement call of *Proceratophrys mantiqueira* sp. nov., referred as *P. melanopogon*. The calls were recorded in Parque Estadual da Serra do Brigadeiro, District of Careço, Municipality of Ervália, State of Minas Gerais, southeastern Brazil. The advertisement call consists of a multipulsed (n = 46 calls, 2 individuals) note with duration 0.2-0.5s ($\bar{x}$ = 0.4s ± 0.6), emitted sporadically with 12-41 pulses/note ($\bar{x}$ = 28.9 pulses/note ± 4.6), 69-96 pulses/second ($\bar{x}$ = 73.4 pulses/s ± 4.1), dominant frequency 999.12-1274.1 Hz ($\bar{x}$ = 1179 Hz ± 64).

Etymology – "*Mantiqueira*" is a Tupi (an indigenous South American language) word, here used as a noun in apposition. Its meaning is "home of the rain" ("amanty" = rain; "querd" = home or a place for stopping overnight). Serra da Mantiqueira is the name of the Brazilian mountain range where the new species was collected.

Geographic distribution – *Proceratophrys mantiqueira* sp. nov. occurs in the Atlantic Rain Forest and is distributed along the Serra da Mantiqueira mountain range, on the south and southeast State of Minas Gerais, and south of the State of Rio de Janeiro (Fig.12).

Remarks – The Parque Estadual da Serra do Brigadeiro, in the Atlantic Rain Forest biome, is a protected area managed by the Instituto Estadual de Florestas of the State of Minas Gerais. The 13,000ha of the park encompasses the highest portions of a set of mountains integrating the Mantiqueira Mountain Range Complex, with maximum of 1,985m a.s.l. The holotype of *Proceratophrys mantiqueira* sp. nov. was collected in a temporary rivulet, located in the District of Careço, Municipality of Ervália, State of Minas Gerais, southeastern Brazil. The rivulet presents sandy and stony bed, inside the forest.

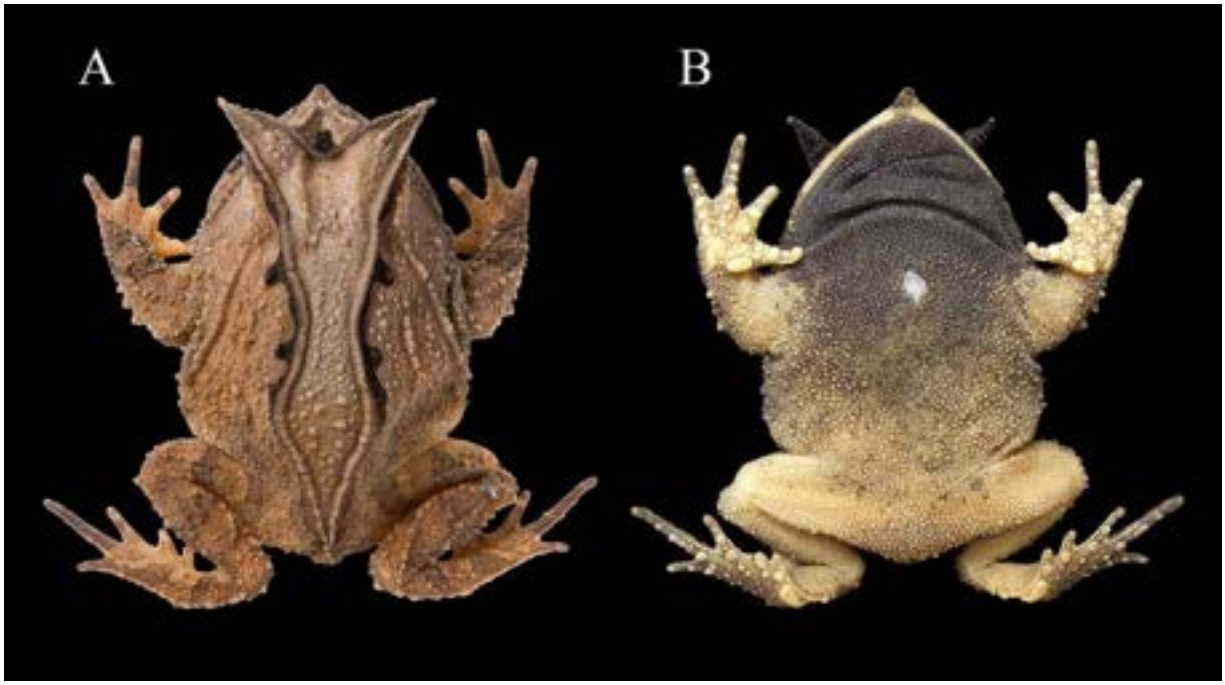

Fig.13– *Proceratophrys mantiqueira* sp. nov. (holotype, adult ♂, MNRJ 82573, SVL 34.4mm): (A) dorsal and (B) ventral views. Photos: José Lino-Neto.

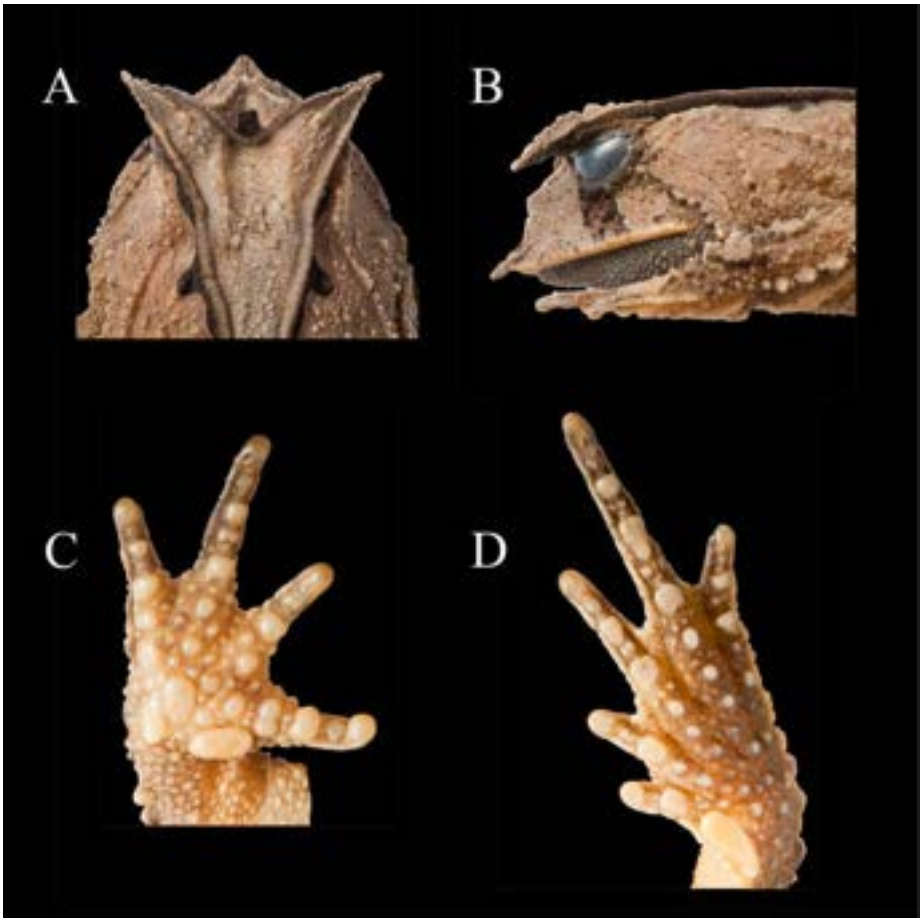

Fig.14– *Proceratophrys mantiqueira* sp. nov. (holotype, adult ♂, MNRJ 82573, SVL 34.4mm): (A) dorsal and (B) lateral views of head; ventral views of (C) hand and (D) foot. Photos: José Lino-Neto.

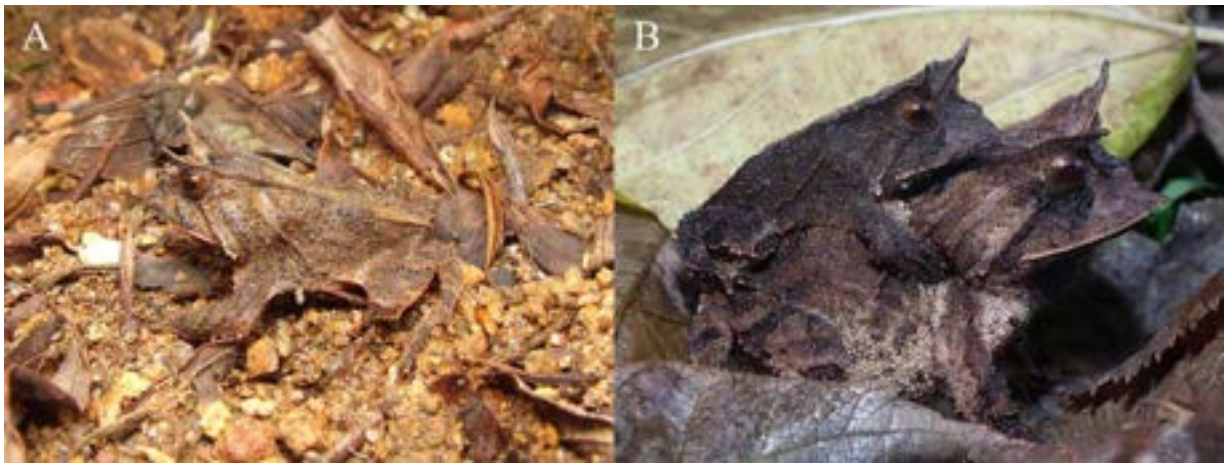

Fig.15– Live specimens of *Proceratophrys mantiqueira* sp. nov.: (A) adult ♂ from Parque Estadual da Serra do Brigadeiro, Municipality of Araponga, State of Minas Gerais, and (B) couple in amplexus from RPPN Mata do Sossego, Municipality of Simonésia, State of Minas Gerais. Photos: S. Mângia.

Proceratophrys gladius sp. nov.
Figs 16-17

Proceratophrys melanopogon (*non* MIRANDA-RIBEIRO, 1926) – PRADO & POMBAL, 2008 (part).

Holotype – MZUSP 96345, adult ♂, collected at Parque Nacional da Serra da Bocaina (22°34'S; 44°45'W, SAD69 *datum*, 1600m a.s.l.), Campo de Fruticultura, Municipality of São José do Barreiro, State of São Paulo, Brazil, in November 1968, by F.M. Oliveira, O. Oliveira, and W.C.A. Bokermann.

Paratypes – MNRJ 82577, adult ♀, MNRJ 82578-82579, adult ♂, MZUSP 96336-96337, adult ♀, MZUSP 96338, adult ♂, MZUSP 96339, adult ♀, MZUSP 96340, adult ♂ (cleared and stained), MZUSP 96341, adult ♂, MZUSP 96342, adult ♀, MZUSP 96343, adult ♂ (cleared and stained), MZUSP 96347, adult ♂, MZUSP 96348, adult ♂ (cleared and stained), collected with the holotype. MZUSP 76711-76712, adult ♂, collected at the type locality in October 1968, by F.M. Oliveira, O. Oliveira, and W.C.A. Bokermann. MZUSP 53047, adult ♂, collected at Fazenda do Veado, Municipality of São José do Barreiro, State of São Paulo, no collector, no date.

Diagnosis – The zygomatic ramus of the squamosal in sutural contact with maxilla assigns the new species to the genus *Proceratophrys*. Species associated to the *P. appendiculata* complex by the presence of a single and long uni-cuspidate palpebral appendage and a triangular fleshy rostral appendage. *Proceratophrys gladius* sp. nov. is diagnosed by the following combination of traits: (1) medium size (SVL 31.6-45.9mm in adult males; 36.9-48.5mm in adult females); (2) triangular fleshy rostral appendage shorter than upper lip width; (3) snout rounded in dorsal view, obtuse spatulate in

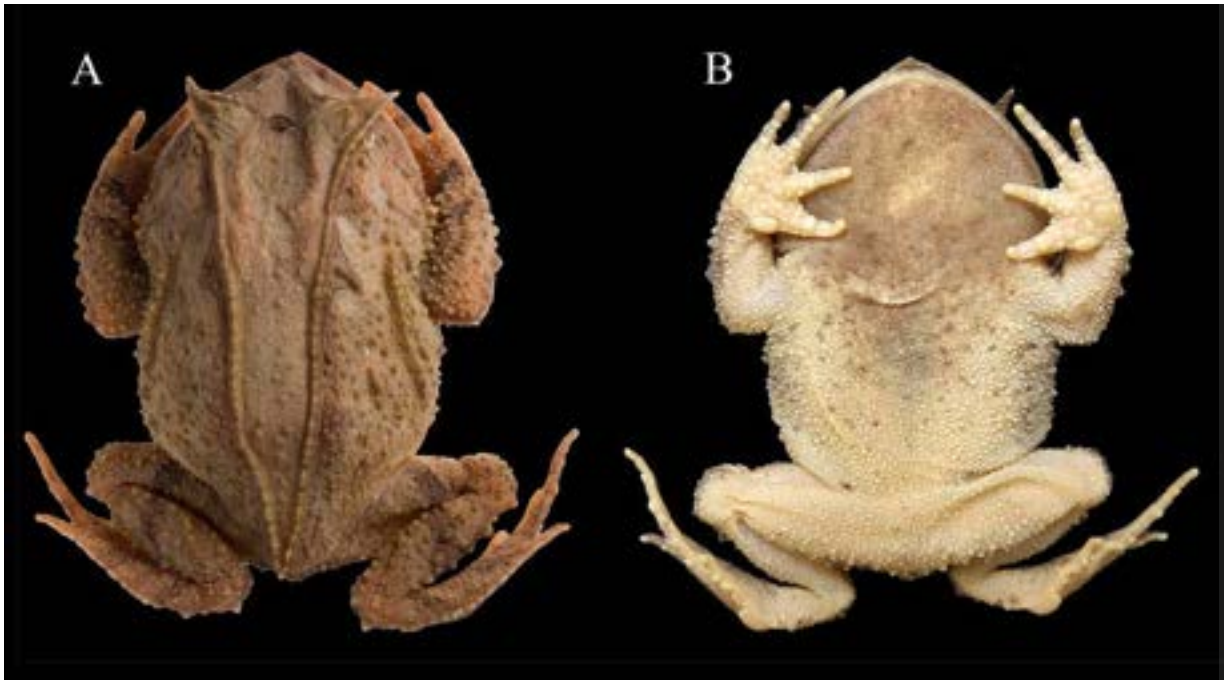

Fig.16– *Proceratophrys gladius* sp. nov. (holotype, adult ♂, MZUSP 96345, SVL 37.5mm): (A) dorsal and (B) ventral views. Photos: José Lino-Neto.

profile; (4) palpebral appendage short, with a row of tubercles; (5) interocular crest well curved; (6) frontoparietal crests well developed; (7) region between frontoparietal crests deep; (8) symmetrical dorsal crest with short aggregate tubercles, forming a continuous line, without constriction on mid dorsum; (9) gular region light brown and belly cream with scattered light brown dots; (10) outer metacarpal tubercle divided in two parts, the internal oval and the external elliptical, outer metatarsal tubercle absent.

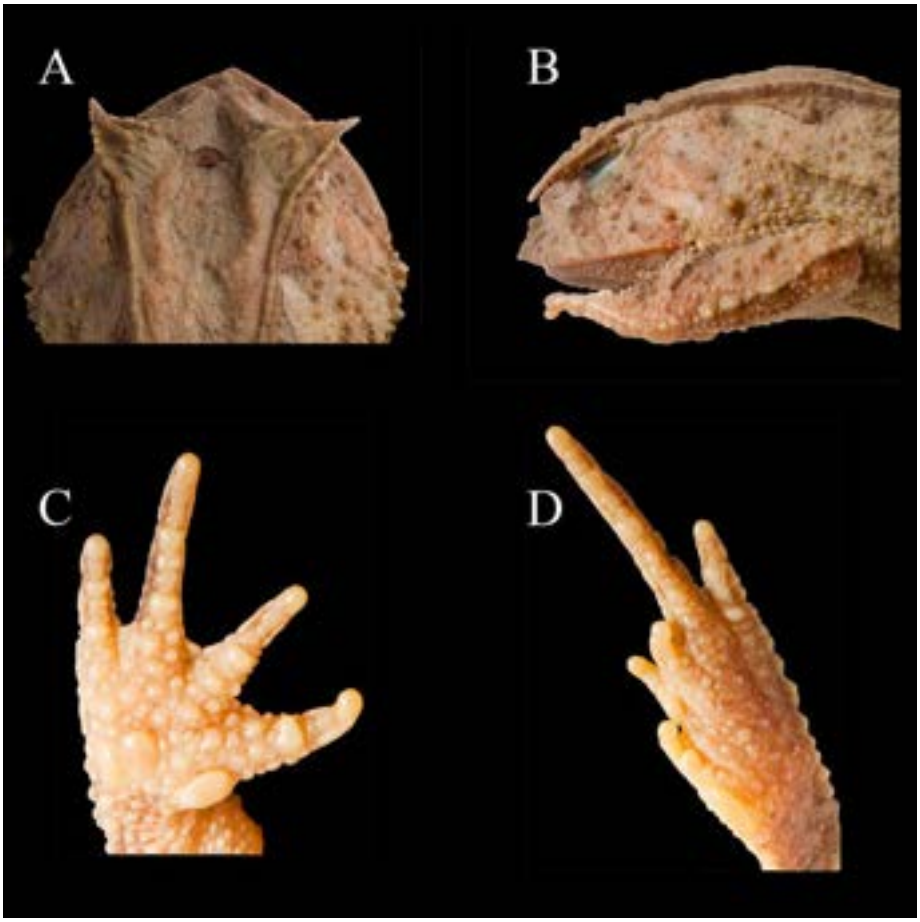

Fig.17– *Proceratophrys gladius* sp. nov. (holotype, adult ♂, MZUSP 96345, SVL 37.5mm): (A) dorsal and (B) lateral views of head; ventral views of (C) hand (D) foot. Photos: José Lino-Neto.

Comparisons with other species – *Proceratophrys gladius* sp. nov. is promptly diagnosed from all species of the *P. appendiculata* complex (*P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. laticeps*, *P. melanopogon*, *P. moehringi*, *P. subguttata*, *P. phyllostomus*, *P. sanctaritae*, and *P. mantiqueira*) by the absence of constriction in the symmetrical dorsal crests (present in those species). *Proceratophrys gladius* sp. nov. is distinguished from *P. appendiculata*, *P. phyllostomus*, *P. sanctaritae*, *P. subguttata*, and *P.mantiqueira* by the presence of a triangular fleshy rostral appendage shorter than upper lip width (fleshy rostral appendage longer than upper lip width in those species). *Proceratophrys gladius* sp. nov. is distinguished

from *P. laticeps* by male head width ($\bar{x}$ = 19.5mm in *P.gladius* sp. nov.; $\bar{x}$ = 43.6mm in *P. laticeps*). The absence of a preocular crest differs *P. gladius* sp. nov. from *P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. moehringi*, *P. sanctaritae*, and *P. tupinamba* (presence of preocular crest). Belly pattern of *P. gladius* sp. nov. is cream with scattered light brown dots, while *P. melanopogon* presents irregular dark brown spots, *P. phyllostomus* presents few tan blotches on belly and legs, *P. sanctaritae* presents dark brown dots, and *P. subguttata* presents large rounded dark brown markings. *Proceratophrys gladius* sp. nov. also differs from *P. melanopogon* by the absence of outer metatarsal tubercle (present in *P. melanopogon*) and palpebral appendage short, triangular, not bluntly pointed (long, triangular, bluntly pointed in *P. melanopogon*).

Description of holotype – Head wider than long, head length 38% of SVL; snout rounded in dorsal view, obtuse spatulate in profile; nares elliptical, slightly prominent, internarial distance 64% of eye diameter; eye directed anterolateraly, eye diameter 27% of head length; eye-nostril distance 30% of head length; eyelid width two times the eye diameter; palpebral appendage short, triangular not bluntly pointed, with a row of tubercles; interocular crest well curved; *canthus rostralis* well marked; presence of accentuated, thick canthal crest; no preocular crest; loreal region concave; indistinct tympanum; vocal sac not expanded externally; vomerine teeth in two groups lying between choanae; frontoparietal crests well developed; region between frontoparietal crests deep. Triangular fleshy rostral appendage shorter than upper lip width. External side of the forearms with a row of triangular tubercles until the hand; outer metacarpal tubercle divided in two parts, the internal oval and the external elliptical; inner metacarpal tubercle elliptical, slightly larger than the external part of outer metacarpal tubercle; finger IV with diminute tubercles forming a fringe; fingers length V < III < II < IV; webbing absent; numerous supernumerary tubercles; subarticular tubercles prominent, rounded. Legs moderately robust; thigh length slightly longer than tibia length; sum of thigh and tibia lengths 84% of SVL; foot length 1.4 times the thigh length; outer metatarsal tubercle absent; inner metatarsal tubercle elliptical, elongate, prominent; toe V with diminute tubercles forming a fringe on external side; toes length I < II < V < III < IV; webbing poorly developed, webbing formula I 1 – 2 II 1 – 3^{+} III 2 – 4^{+} IV 4^{+} – 2 V; subarticular tubercles prominent, rounded; plantar surface rough, supranumerary tubercles with uniform size; external foot margin with a row of spatulate conical tubercles on external margin. Dorsal surface rough with conical tubercles of different sizes, more concentraded on the dorsolateral region and above the limbs; triangular tubercles more developed, organized in rows above the members, a row of tubercles from posterior margin of eye to bucal corner, row of tubercles extending from the posterior region of the eye to the insertion of the arm, and another row extending from the squamosal region to the mid flank region; symmetrical dorsal crest of small tubercles well marked, joining the edge of palpebral appendage, extending to join above sacrum, with no constriction on mid dorsum; ventral surfaces, except hands and feet, covered by numerous small, circular, uniform warts; skin and warts of dorsal and ventral surfaces covered by minuscule horny asperities.

Color of holotype in preservative – Dorsal background color light brown, maculated with variegate browns looking like dead leaves. The symmetrical dorsal crest is bordered along external sides by a wave-shaped brown band. Two transverse brown bars on forearm, thigh, tibia, and tarsus. Lateral of head light brown with three

inclined brown bands, two from eye to upper lip, and one from posterior corner of eye to arm insertion. Ventral surface ground color cream, gular region light brown and belly cream with scattered light brown dots.

Measurements of holotype (mm) – SVL 37.5; HL 14.2; HW 20.6; DICS 8.6; IND 2.5; END 4.2; ED 3.9; UEW 7.9; RAL 1.1; IOD 3.4; THL 16.1; TL 15.4; FL 23.4; FHL 21.0.

Variation – Specimens are congruent with respect to morphological characters. The dorsal background color varies in adult specimens from dark brown to cream. Descriptive basic statistics of measurement variables from adults is presented in Table 1.

Advertisement call – Unknown.

Etymology – The specific epithet, "*gladius*", is a Latin masculine substantive, meaning "sword", and is used to represent the primary swords of Ancient Roman foot soldiers named "gladiators". The symmetrical dorsal crest of the new species ressembles these swords shape.

Geographical distribution – This species is known only from the type locality in the Serra do Mar, Parque Nacional da Serra da Bocaina, Campo de Fruticultura, Municipality of São José do Barreiro, State of São Paulo, Brazil (Fig.12).

Proceratophrys pombali sp. nov.
Figs 18-20

Proceratophrys melanopogon (*non* MIRANDA-RIBEIRO, 1926) – PRADO & POMBAL, 2008 (part).

Holotype – CFBH 15982, adult ♂, collected at the Municipality of Itanhaém (24°11'S; 46°47'W, SAD69 *datum*, 70m a.s.l.), State of São Paulo, Brazil, in May 2007, by L.R. Malagoli and F. Schunck.

Paratypes – CFBH 15983, adult ♂, collected with the holotype; MZUSP 69286, adult ♂, collected at the type locality, in November 1991, by M.T. Rodrigues; MZUSP 148085, adult ♂, collected at the Estação Ambiental da Universidade São Camilo, Suarão, Municipality of Itanhaém, State of São Paulo, in January 2012, by D.G. Cavalheri and R.M.S. Siqueira; MZUSP 148114, adult ♀, same locality, collected in March 2012, by D.G. Cavalheri.

Non-Type material – MZUSP 133962, adult ♀, MZUSP 133963, juvenile, MZUSP 133964, adult ♀, MZUSP 133966-133967, adult ♀, MZUSP 133965, adult ♂, collected at Municipality of Santos, State of São Paulo, in November 2003, by J. Wellington.

Diagnosis – The zygomatic ramus of the squamosal in sutural contact with maxilla assigns the new species to the genus *Proceratophrys*. Species associated to the *P. appendiculata* complex by the presence of a single and long uni-cuspidate palpebral appendage and a triangular fleshy rostral appendage. *Proceratophrys pombali* sp. nov. is diagnosed by the following combination of traits: (1) small size (SVL 31.9-41.9mm in adult males; 52.5mm in adult female); (2) triangular fleshy rostral appendage fringed, longer than upper lip width; (3) snout sub-elliptical in dorsal view, obtuse spatulate in profile; (4) palpebral appendage short, triangular, bluntly pointed, absence to poorly developed tubercles; (5) interocular crest slightly curved; (6) frontoparietal crests poorly developed; (7) region between frontoparietal crests shallow; (8) symmetrical

dorsal crests with long aggregate tubercles, forming a continuous line, with a constriction on mid dorsum; (9) gular region blackish and belly cream with few to numerous dark brown vermiculated blotches, extending on the ventral surface of arms and legs; (10) outer metacarpal tubercle divided in two oval parts, approximately of the same size, outer metatarsal tubercle small, elliptical.

Comparisons with other species – *Proceratophrys pombali* sp. nov. is promptly diagnosed from all species of the *P. appendiculata* complex (*P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. laticeps*, *P. melanopogon*, *P. moehringi*, *P. subguttata*, *P. phyllostomus*, *P. sanctaritae*, *P. mantiqueira*, and *P. gladius*) by the presence of rostral fleshy appendage fringed (rostral fleshy appendage slightly fringed in those species). The absence of a preocular crest differs *P. pombali* sp. nov. from *P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. moehringi*, *P. sanctaritae*, and *P. tupinamba* (presence of preocular crest). *Proceratophrys pombali* sp. nov. is distinguished from *P. appendiculata*, *P. phyllostomus*, *P. subguttata*, and *P. melanopogon* by the presence of snout sub-elliptical from above (snout rounded in those species). From *P. appendiculata*, *P. melanopogon*, *P. phyllostomus*, *P. sanctaritae*, *P. subguttata*, *P. mantiqueira*, and *P. gladius*, the new species is distinguished by the frontoparietal crests poorly developed (well developed in those species). From *P. melanopogon*, *P. mantiqueira*, and *P. gladius*, the new species is distinguished by the interocular crest slightly curved (interocular crest well curved in those species). The new species is distinguished by the belly pattern predominantly cream with few to numerous dark brown vermiculated blotches, extending on the ventral surface of arms and legs (belly pattern of *P. appendiculata* and *P. laticeps* cream with vermiculated or rounded disperse tan blotches, *P. moehringi* is predominantly brown with disperse light brown dots or vermiculated blotches, *P. tupinamba* presents numerous vermiculated or rounded disperse light brown blotches, *P. melanopogon* and *P. sanctaritae* present irregular dark brown dots, *P. phyllostomus* presents few tan blotches on belly and legs, *P. subguttata* has large rounded dark brown markings, and *P. mantiqueira* presents scattered small dark brown dots). *Proceratophrys pombali* sp. nov. also differs from *P. melanopogon* by the region between frontoparietal crests shallow (deep in *P. melanopogon*), palpebral appendage short (long in *P. melanopogon*), and outer metatarsal tubercle elliptical (rounded in *P. melanopogon*).

Description of holotype – Head wider than long, head length 37% of SVL; snout sub-elliptical in dorsal view, obtuse spatulate in profile; nares elliptical, slightly prominent, internarial distance 62% of eye diameter; eye directed anterolateraly, eye diameter 25% of head length, eye-nostril distance 29% of head length; eyelied width two times of the eye diameter; palpebral appendage short, triangular, bluntly pointed, absence to poorly developed tubercles; interocular crest slightly curved, almost straight; *canthus rostralis* poorly marked, presence of canthal crest slightly marked; no preocular crests; loreal region concave; indistinct tympanum; vocal sac not expanded externally; vomerine teeth in two groups lying between choanae; frontoparietal crests poorly developed; region between frontoparietal crests shallow. Triangular fleshy rostral appendage fringed, longer than upper lip width. External side of the forearms with a row of triangular tubercles until the hand; outer metacarpal tubercle divided in two oval parts, approximately the same size; inner metacarpal tubercle elliptical, slightly larger than outer metacarpal tubercle; finger IV with diminute tubercles forming a fringe on external side; fingers length V < III < II < IV; webbing absent; numerous

supernumerary tubercles; subarticular tubercles prominent, rounded. Legs moderately robust; thigh length slightly longer than tibia length; sum of thigh and tibia lengths 78% of SVL; foot length 1.5 times the thigh length; outer metatarsal tubercle small, elliptical; inner metatarsal tubercle elliptical, large, prominent; toe V with diminute tubercles forming a fringe on external margin; toes length I < II < V < III < IV; webbing poorly developed, webbing formula I 1 – 2 II 1 – 3 III 2^{-} – 4 IV 4^{-} – 2^{-} V; subarticular tubercles prominent, rounded; plantar surface rough, supranumerary tubercles with uniform size; external foot margin with a row of spatulate conical tubercles. Dorsal surface rough, with conical tubercles of different sizes, more concentraded on the dorsolateral region and above the members; triangular tubercles more developed and organized in rows above the members; a row of tubercles from posterior margin of eye to bucal corner; symmetrical dorsal crests with big and long tubercles, joining the edge of palpebral appendage, extending to join above sacrum, and presenting a constriction on mid dorsum; ventral surfaces, except hands and feet, covered by numerous small, circular, uniform warts; skin and warts of dorsal and ventral surfaces covered by minuscule horny asperities.

Color of holotype in preservative – Dorsal ground color light brown, maculated with variegate browns looking like dead leaves. Area delimited by the symmetrical dorsal crests bordered along external sides by a wave-shaped brown band. Lateral of head light brown with three inclined brown bands, two from eye to upper lip, and one from posterior corner of eye to arm insertion. Two transverse brown bars on forearm and three on thigh, tibia, and tarsus. Gular region dark brown and belly cream with few dark brown vermiculate blotches.

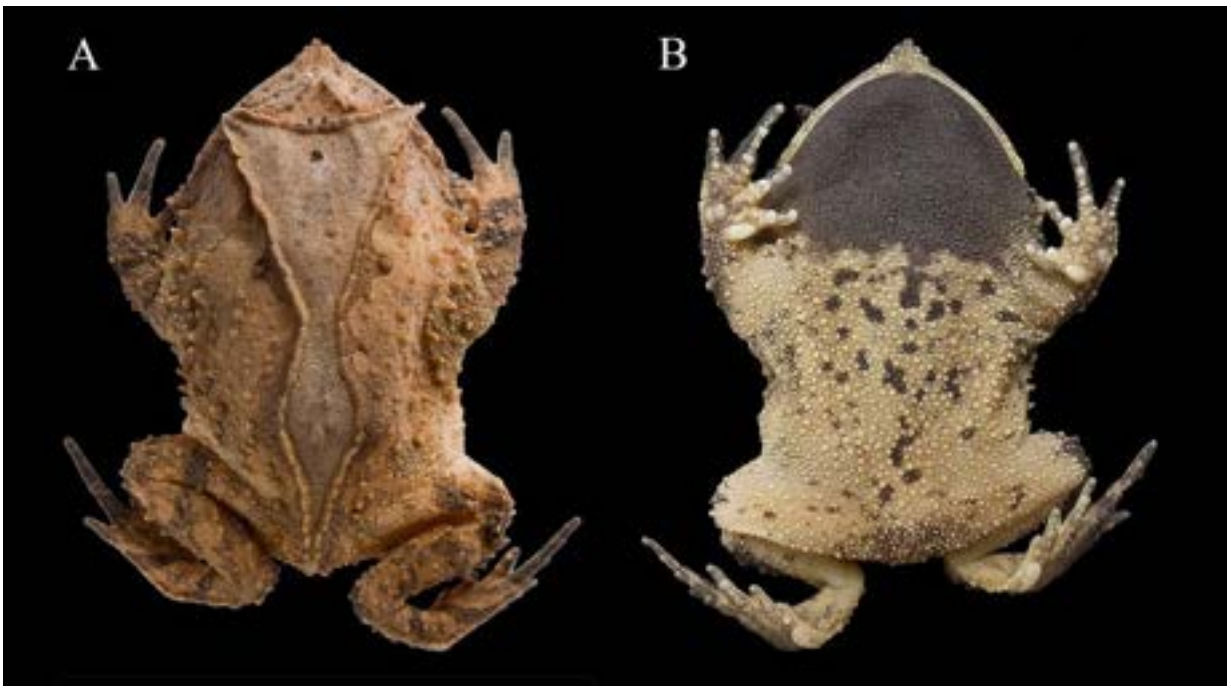

Fig.18– *Proceratophrys pombali* sp. nov. (holotype, adult ♂, CFBH 15982, SVL 35.1mm): (A) dorsal and (B) ventral views. Photos: José Lino-Neto.

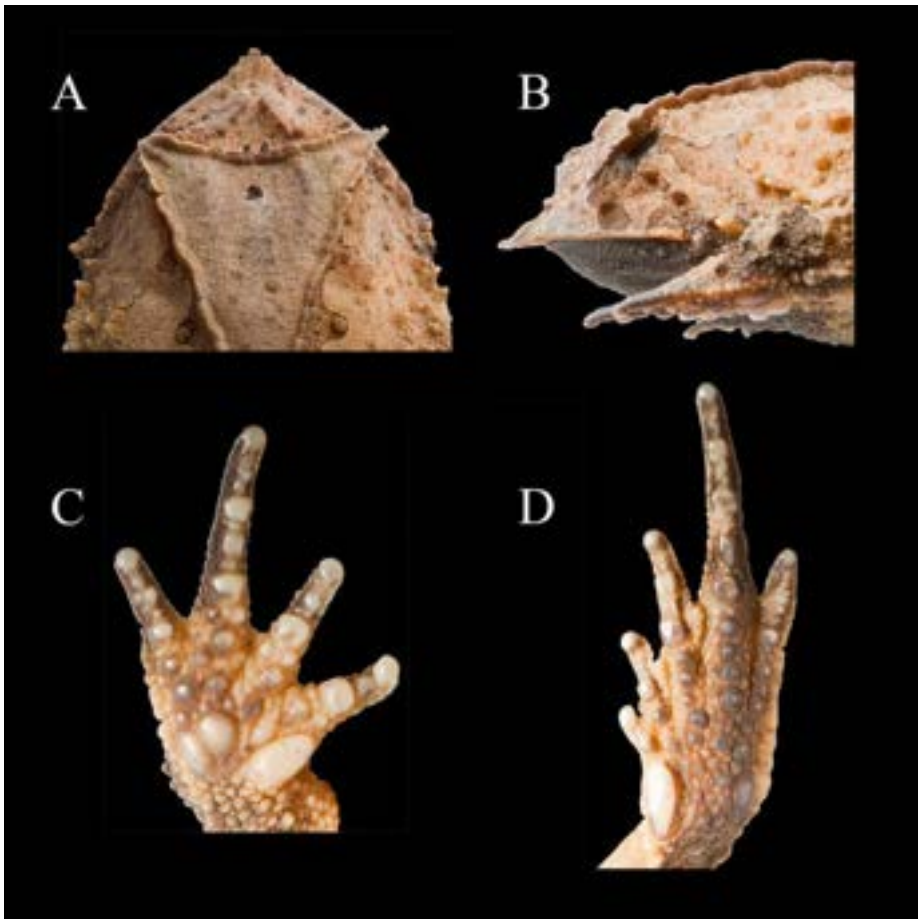

Fig.19– *Proceratophrys pombali* sp. nov. (holotype, adult ♂, CFBH 15982, SVL 35.1mm): (A) dorsal and (B) lateral views of head; ventral views of (C) hand and (D) foot. Photos: José Lino-Neto.

Measurements of holotype (mm) – SVL 35.1; HL 17.4; HW 11.6; DICS 7.2; IND 1.8; END 3.4; ED 2.9; UEW 6.8; RAL 1.8; IOD 4.0; THL 13.9; TL 13.4; FL 20.6; FHL 16.7.

Variation – Specimens are congruent with respect to morphological characters. The dorsal color pattern varies from beige to dark brown. The dark brown vermiculate blotches on the belly can be more numerous and extend to the ventral surfaces of arms and legs. Descriptive basic statistics of measurements variables from adults is presented in Table 1.

Advertisement call – Unknown.

Etymology – The specific name is a patronym honoring Prof. José Perez Pombal Jr. (MNRJ), for his extensive contribution to the knowledge of the Neotropical anurans.

Geographical distribution – This species is known from the type locality in the Municipality of Itanhaém and from the Municipality of Santos, both in State of São Paulo, Brazil (Fig.12).

Fig.20– Live specimen of *Proceratophrys pombali* sp. nov. from Municipality of Itanhaém, State of São Paulo. Photo: D. Cavalheri.

Proceratophrys itamari sp. nov.
Figs 21-23

Proceratophrys melanopogon (*non* Miranda-Ribeiro, 1926) – Prado & Pombal, 2008.

Holotype – MNRJ 82580, adult ♂, collected at Parque Estadual de Campos do Jordão (22°41'S, 45°27'W, SAD69 *datum*, 1470m a.s.l.), Municipality of Campos do Jordão, State of São Paulo, Brazil, in March 2007, by I.A. Martins, F.B.R. Gomes, and A.F.B. Junqueira.

Paratypes – Collected at the type locality: MNRJ 82581-82583, adult ♂, MNRJ 82584, adult ♀, CCLZU 835-838, juveniles, CCLZU 2270-2272, adult ♂, MZUSP 150575-150576, adult ♂, MZUFV 12568, 12570, adult ♀, MZUFV 12569, adult ♂, MZUSP 150577, adult ♂, CCLZU 2883, juvenile, CCLZU 2886, juvenile, CFBH 9897, adult ♀, CFBH 9939, adult ♀, all collected in October 2005, by I.A. Martins and P.H. Bernardo; CFBH 24049, adult ♂, collected at the type locality in December 2007, by I.A. Martins and F.B.R. Gomes.

Diagnosis – The zygomatic ramus of the squamosal in sutural contact with maxilla

assigns the new species to the genus *Proceratophrys*. Species associated to the *P. appendiculata* complex by the presence of a single and long uni-cuspidate palpebral appendage with a triangular fleshy rostral appendage. *Proceratophrys itamari* sp. nov. is diagnosed by the following combination of traits: (1) medium size (SVL 31.1-42.5mm in adult males; 39.5-52.3mm in adult females); (2) triangular fleshy rostral appendage fringed with a constriction on distal half, much longer than upper lip width; (3) snout sub-elliptical in dorsal view, obtuse spatulate in profile; (4) palpebral appendage long, triangular bluntly pointed, with a row of tubercles; (5) interocular crest well curved; (6) frontoparietal crests well developed; (7) region between frontoparietal crests deep; (8) symmetrical dorsal crests with aggregate short tubercles, forming a continuous line, with a constriction on mid dorsum; (9) ventral surface of body with large dark brown markings, slightly smoked on gular region; (10) outer metacarpal tubercle divided in two small parts, the internal oval and the external elliptical, outer metatarsal tubercle rounded, small; (11) advertisement call consisting of a multipulsed note with duration 0.4-0.8 seconds, 20-42 pulses per call, 49-55 pulses/second, and dominant frequency 1033.6-1205.9 Hz.

Comparisons with other species – *Proceratophrys itamari* sp. nov. is promptly diagnosed from all species of the *P. appendiculata* complex by the presence of fleshy rostral appendage fringed with a constriction on distal half, and much longer than upper lip width (*P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. laticeps*, *P. melanopogon*, *P. moehringi*, *P. subguttata*, *P. phyllostomus*, *P. sanctaritae, P. mantiqueira*, and *P. gladius* present fleshy rostral appendage triangular, without constriction, and not too long, and *P. pombali* presents fleshy rostral appendage fringed, without constriction, and not too long). The absence of a preocular crest differs *P. itamari* sp. nov. from *P. appendiculata*, *P. belzebul*, *P. izecksohni*, *P. moehringi*, *P. sanctaritae*, and *P. tupinamba* (preocular crest present). From *P. appendiculata*, *P. phyllostomus*, *P. subguttata*, *P. melanopogon*, and *P. gladius*, the new species is distinguished by the presence of snout sub-elliptical from above (snout rounded from above in those species). From *P. laticeps*, *P. moehringi*, *P. tupinamba*, and *P. pombali*, *P. itamari* sp. nov. is distinguished by the region between frontoparietal crest deep (region between frontoparietal crest shallow in those species). Ventral surface of body of *P. itamari* sp. nov. is cream with large dark brown markings, while *P. phyllostomus* presents few tan blotches on belly and legs, *P. mantiqueira* presents scattered, small dark brown dots, *P. gladius* presents belly cream with scattered light brown dots, and *P. pombali* presents belly cream with few to numerous dark brown vermiculate blotches. *Proceratophrys itamari* sp. nov. is distinguished from *P. mantiqueira* by the advertisement call presenting 49-55 pulses/second (69-96 pulses/second in *P. mantiqueira*) and of *P. melanopogon* by the frequency 1033.6-1205.9 Hz (831.3-1033.6 Hz in *P. melanopogon*).

Description of holotype – Head wider than long, head length 40% of SVL; snout sub-elliptical in dorsal view, obtuse spatulate in profile; nares elliptical, slightly prominent, internarial distance 32% of eye diameter; eye directed anterolateraly, eye diameter 25% of head length, eye-nostril distance 28% of head length; eyelied width three times of the eye diameter; palpebral appendage long, triangular, bluntly pointed, with a row of tubercles; interocular crest well curved; *canthus rostralis* well marked, with an accentuated, thick canthal crest; no preocular crests; loreal region concave; indistinct tympanum; vocal sac not expanded externally; vomerine teeth in two groups

lying between choanae; frontoparietal crests well developed; region between frontoparietal crests deep. Triangular fleshy rostral appendage fringed with a constriction on distal half, much longer than upper lip width. External side of the forearms with a row of triangular tubercles until the hand; outer metacarpal tubercle divided in two small parts, the internal oval and the external elliptical; inner metacarpal tubercle elliptical, prominent, larger than outer metacarpal tubercle; finger IV with diminute tubercles forming a fringe on external side; fingers length V < III < II < IV; webbing absent; numerous supernumerary tubercles; subarticular tubercles prominent, rounded. Legs moderately robust; thigh length slightly bigger than tibia length; sum of thigh and tibia lengths 82% of SVL; foot length 1.4 times the thigh length; outer metatarsal tubercle rounded, small; inner metatarsal tubercle elliptical, elongated, prominent; toe V with diminute tubercles forming a fringe on external margin; toes lengths I < II < V < III < IV; webbing poorly developed, webbing formula I 1 – 2 II 1 – 3 III 2 – 4 IV 4 – 2 V; subarticular tubercles prominent, rounded; plantar surface rough, supranumerary tubercles with uniform size; external margin of foot with a row of spatulate conical tubercles. Dorsal surface rough, with conical tubercles of different size, more concentrated on the dorso-lateral region and above the members; more developed, triangular tubercles, arranged in rows on the dorsum of the members; two oblique rows of tubercles from the posterior region of the eye to posterior third of mandible, an oblique row of tubercles from temporal region to mid flank; symmetrical dorsal crests of small tubercles well marked, joining the edge of palpebral appendage, extending to join above sacrum, presenting a constriction on mid dorsum; ventral surfaces, except hands and feet, covered by numerous small, circular, uniform warts; skin and warts of dorsal and ventral surfaces covered by minuscule horny asperities.

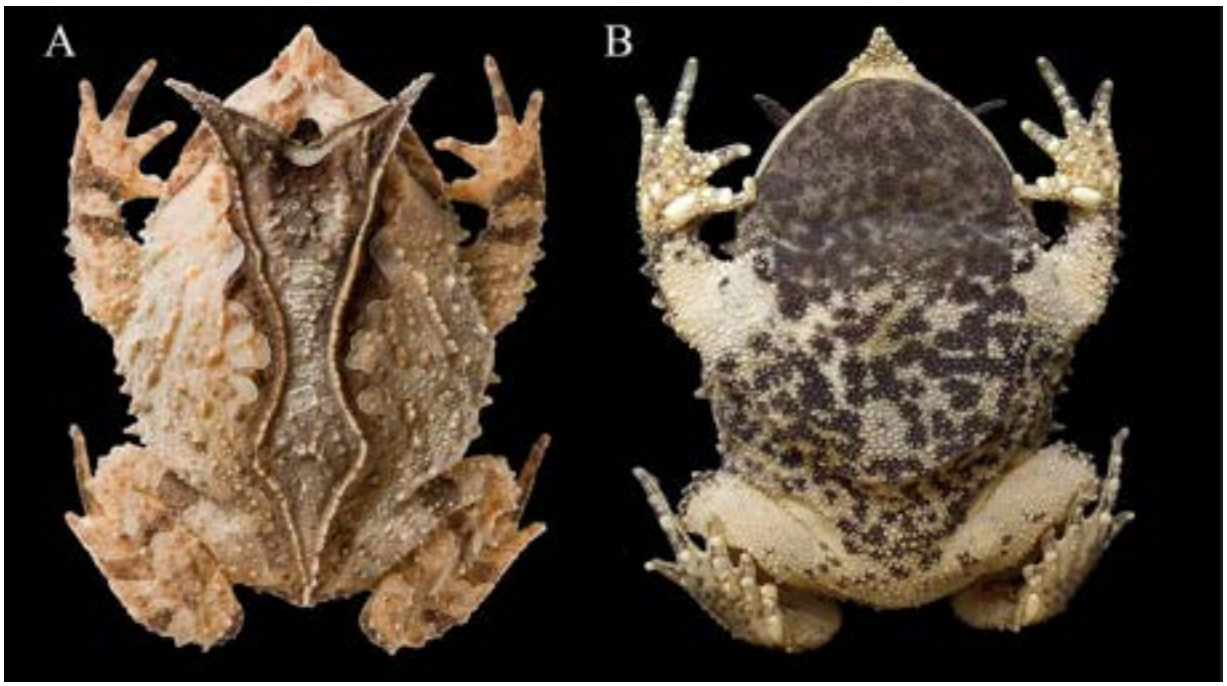

Fig.21– *Proceratophrys itamari* sp. nov. (holotype, adult ♂, MNRJ 82580, SVL 36.7mm): (A) dorsal and (B) ventral views. Photos: José Lino-Neto.

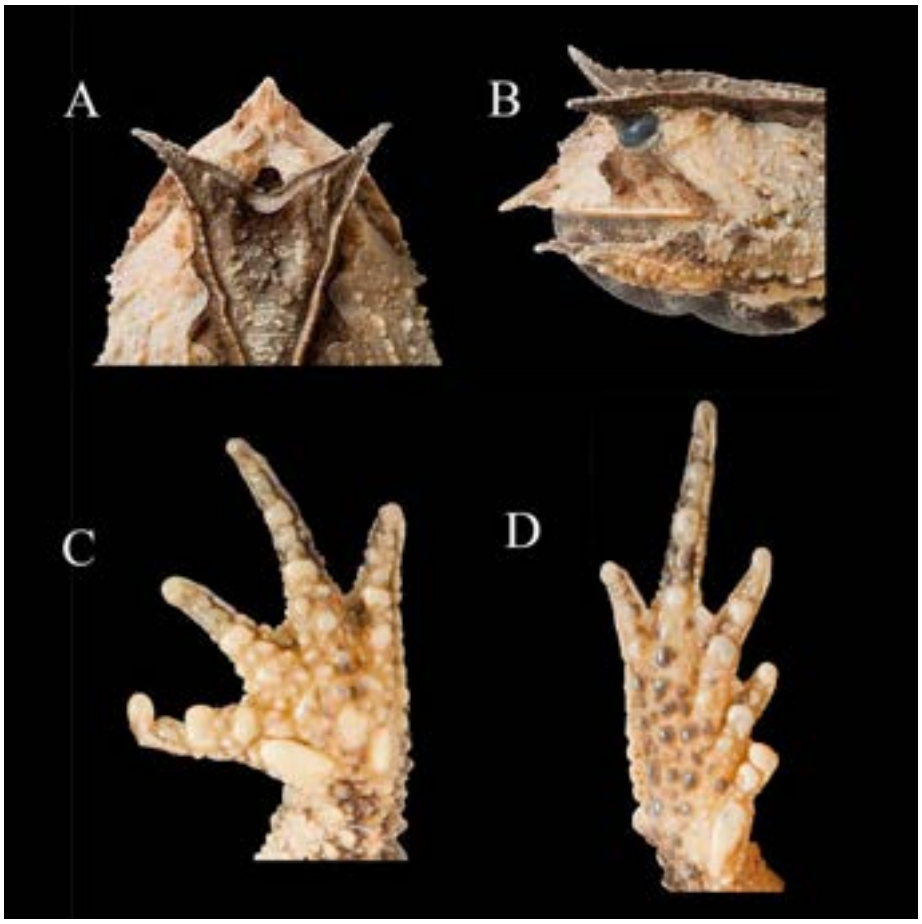

Fig.22– *Proceratophrys itamari* sp. nov. (holotype, adult ♂, MNRJ 82580, SVL 36.7mm): (A) dorsal and (B) lateral views of head; ventral views of (C) hand and (D) foot. Photos: José Lino-Neto.

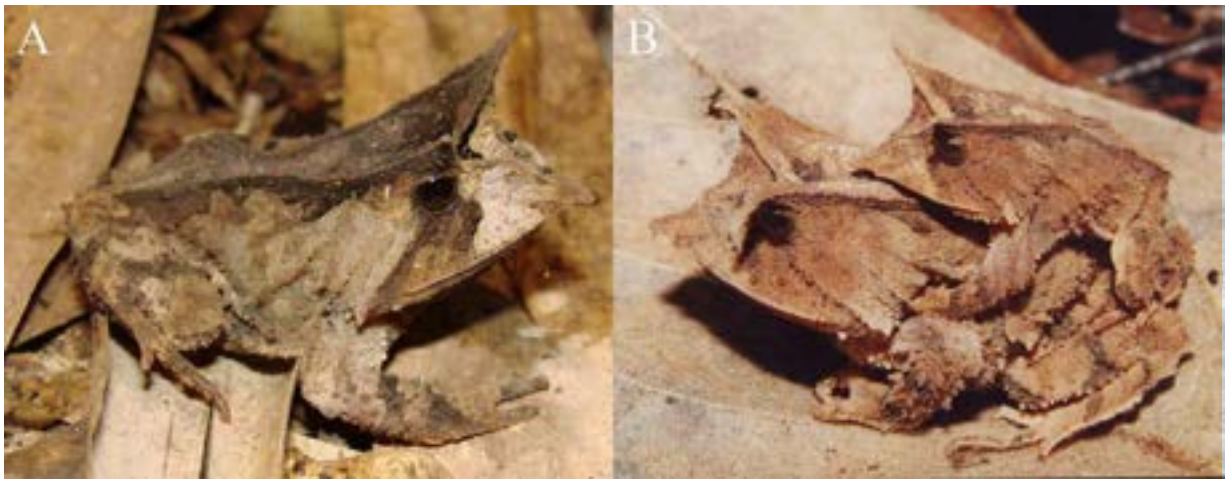

Fig.23– Live specimens of *Proceratophrys itamari* sp. nov. from Parque Estadual de Campos do Jordão, Municipality of Campos do Jordão, State of São Paulo. (A) a single ♂ from type locality, and (B) a couple in amplexus from type locality. Photos: I. Martins.

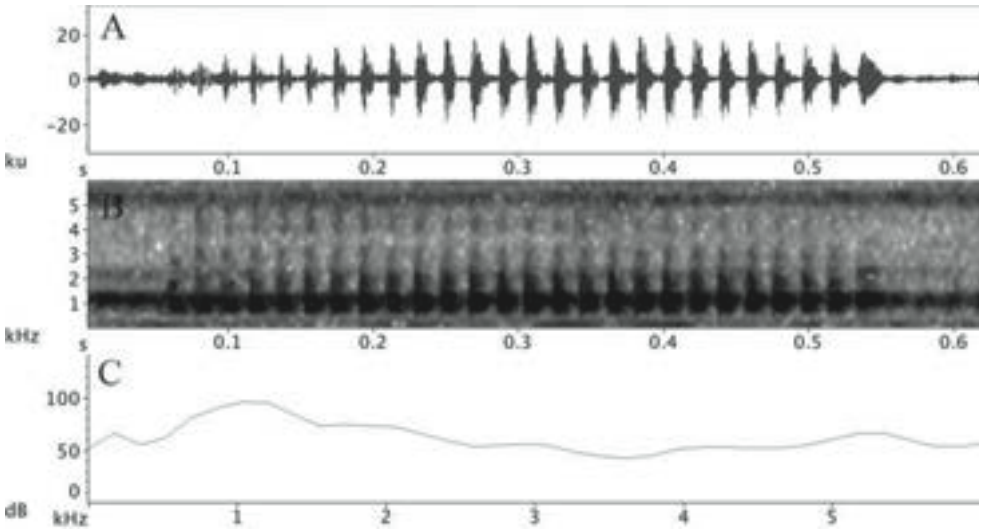

Fig.24– Advertisement call of *Proceratophrys itamari* sp. nov.: (A) oscillogram, (B) audiospectrogram, and (C) power spectrum of a single call.

Color of holotype in preservative – Dorsal ground color light brown, maculated with variegate browns looking like dead leaves. Area delimited by the symmetrical dorsal crests brown and bordered along external sides by a wave-shaped brown band; dark brown blotch on head in front the interocular crest.Two transverse brown bars on forearm, thigh, tibia, and tarsus. Lateral of head light brown with three inclined dark brown bands, two from eye to posterior third of mandible, and one from posterior corner of eye to arm insertion. Ventral surface of body with large dark brown markings, slightly smoked on gular region.

Measurements of holotype (mm) – SVL 36.7; HL 19.2; HW 13.6; DICS 8.0; IND 1.9; END 3.8; ED 3.4; UEW 9.2; RAL 3.3; IOD 3.9; THL 15.4; TL 14.8; FL 21.0; FHL 19.4.

Variation – Specimens are congruent with respect to morphologic characters. The dorsal color pattern varies from beige to dark brown. Descriptive basic statistics of measurement variables from adults is presented in Table 1.

Advertisement call – The advertisement call (Fig. 24) of *Proceratophrys itamari* sp. nov. consists of a multipulsed note (n = 40 calls, 1 individual) with duration 0.4-0.8 seconds ($\bar{x}$ = 0.5s ± 0.1), emitted sporadically with 20-42 pulses ($\bar{x}$ = 26.7 pulses/ note ± 5), and the pulse rate ranges from 49-55 pulses/second ($\bar{x}$ = 51 pulses/s ± 1.2). The dominant frequency 1033.6-1205.9 Hz ($\bar{x}$ = 1126.4 Hz ± 87).

Etymology – The specific name is a patronym honoring Prof. Itamar Martins (Universidade de Taubaté, State of São Paulo, Brazil), with gratitude for his contributions to the knowledge of the new species, having collected the type series and recorded the vocalizations.

Geographical distribution – *Proceratophrys itamari* sp. nov. is known from the type locality in the Serra da Mantiqueira mountain range, at Parque Estadual de Campos

de Jordão, Municipality of Campos do Jordão, from Municipality of Eugênio Lefevre, in the State of São Paulo, and at Municipality of Passa Quatro, State of Minas Gerais, Brazil (Fig.12).

Natural history notes – The reproduction season of the new species is from October to February. *Proceratophrys itamari* sp. nov. breeds in forested areas, in permanent or temporary streams. The calling activities begin at twilight (ca. 5:00 pm), during heavy rains. The individuals call at margin, varying about 20 to 120cm from water. Several males were observed in chorus, calling at distances 20 to 60cm close each other (data from 12 individuals). All individuals of *P. itamari* sp. nov. collected at Parque Estadual de Campos do Jordão were between 1,450 to 2,000m a.s.l.

DISCUSSION

The occurrence of sympatric species of *Proceratophrys* has been reported for several amphibian communities (*e.g.*, Rödder *et al.*, 2007; Moura *et al.*, 2012; Heyer *et al.*, 1990; Cruz *et al.*, 2009; Vrcibradic *et al.*, 2011) and these different species can be found calling side by side along the same stream (*e.g.*, Moura *et al.*, 2012; C.A.G. Cruz, pers. obs.). Accordingly, we found *P. gladius* and *P. melanopogon* living in sympatry in Serra da Bocaina.

Although *Proceratophrys melanopogon* and *P. mantiqueira* share morphological characterisitics, they present differences in external morphology and advertisement call that promptly distinguish them as two distinct species. The advertisement call differs in pulse rate (47-55 pulses/second in *P. melanopogon*, and 69-96 pulses/second in *P. mantiqueira*). Littlejohn (1969) mentioned that the main difference between calls of related species resides in the pulse rate, thus the specificity of the call might resides in this characteristic.

The geographic distributions of *P. melanopogon* and *P. mantiqueira* are allied to the mountain ranges of the Atlantic Forest from southeastern Brazil. Similar results were found by Pombal & Haddad (1999) to species of the genus *Paratelmatobius*. They cited that the slope of the Paraíba do Sul River valley formation, and consequently the separation of the Serra do Mar and Serra da Mantiqueira, caused the isolation of species of *Paratelmatobius* (Leptodactylidae), as *P. cardosoi*, *P. gaigeae*, and *P. poecilogaster* at Serra do Mar, and *P. mantiqueira* and *P. lutzii* at Serra da Mantiqueira. Cassini *et al.* (2010) performed a taxonomic review of *Physalaemus olfersii* (Leiuperidae) and also observed, on mountain ranges of southeastern Brazil, another example with *Physalaemus olfersii* occurring along the Serra do Mar and *P. feioi* along the Serra da Mantiqueira. Also, Verdade *et al.* (2009) observed that *Zachaenus carvalhoi* and *Z. parvulus* seem to be separated by the Paraíba do Sul River. These concordant distributional patterns might be related to geographic distinction (historical barriers), as rivers and mountains, associated with cyclical climatic alterations of the Tertiary and Quaternary (Marcelino *et al.*, 2009).

In the tree topology presented by Dias *et al.* (2013), is clear the separation between the Serra do Mar and Serra da Mantiqueira mountain ranges species, as well as the lowland species deeply separated from highland ones. This separation between highland and lowland species may represent physiological features, driving the species to have different niches.

DIAS *et al.* (2013) present a *Proceratophrys* phylogeny with some *Proceratophrys melanopogon* populations included. The tree topology is highly structured among these populations, and they may represent cryptic species (DIAS *et al.*, 2013). As proposed by us, the four new species, plus *P. melanopogon*, are well morphological and acoustical defined, and DIAS *et al.* (2013) topology give more credibility to describe them. Besides, this fact led us to believe that, even with all these morphological diagnoses, among other populations probably there are other new cryptic species (*i.e.*, without morphological diagnoses).

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APPENDIX

Additional specimens examined

Proceratophrys appendiculata. BRAZIL: SÃO PAULO: Cunha: CFBH 10751-10752; Mococa: CFBH 12150, 12709; São Luis do Paraitinga: CFBH 5820, 6489, 8062, 9887; Santa Virgínia: CFBH 16614; Ubatuba: CFBH 4324, 5414, 5660, 8410-8411, MNRJ 38190. RIO DE JANEIRO: Angra dos Reis: MNRJ 13479-13480; Parati: CFBH 1321, MNRJ 11299-11302, 64584-64586; Teresópolis: CFBH 22018; Visconde de Mauá: MNRJ 80728-80734.

Proceratophrys itamari. BRAZIL: SÃO PAULO: Campos do Jordão, Cidade Azul: MZUSP 14931-14932, 14934; Eugênio Lefevre: MZUSP 11330, 14905. MINAS GERAIS: Passa Quatro: MNRJ 41872.

Proceratophys laticeps. BRAZIL: ESPÍRITO SANTO: Aracruz: CFBH 4185; Cariacica: CFBH 23609, 23611, 23613-23615; Santa Teresa: MNRJ 30905, 30885-30887, 56018-56020; Sooretama, Paraju: CFBH 14925, 14936, 14944.

Proceratophrys mantiqueira. BRAZIL: MINAS GERAIS: Aiuruoca: MZUSP 142433; Conceição de Ibitipoca: CHUFMG 534-536, MZUFV 6859, 9044; Ervália, Parque Estadual Serra do Brigadeiro: MZUFV 4303 (cleared and stained), 6795 (cleared and stained), 6813 (cleared and stained), 6389, 6390, 6391 (cleared and stained), 6711 (cleared and stained), 6712, 6858, 7333-7334). RIO DE JANEIRO: Itatiaia: CCLZU 2883, 2885-2886, CFBH 5774, MZUSP 4137, 76407-76408, 7754, 4119-4120, ZUEC 13353-13354; Piquete, região do Pico dos Marins: CCLZU 2869-2870, 2873, 2887, 2895-2906, 2967-2968, 2970-2975.

Proceratophys melanopogon. BRAZIL: RIO DE JANEIRO: Macaé de Cima: MNRJ 34020, 40714, 64229; Nova Friburgo: MNRJ 51363; Santa Maria Madalena, Parque Estadual do Desengano: MNRJ 41874, 41937, 54017; Visconde de Mauá: MZUSP 68953. SÃO PAULO: Alto da Serra, Paranapiacaba: MNRJ 293, 5283-5284; Barra do Una: MZUSP 139116; Bertioga, Parque das Neblinas: CHUFMG 529-533, MZUSP 135740-135742; Campo de Fruticultura da Bocaina: DZSJRP 12085-12086, MZUSP 31357, 53036-53043, 53045-53046, 53048-53051; Estação Biológica de Boracéia: MZUSP 950, 3508, 4000, 23385, 31352, 31358, 68994, 68997, 69216, 137463-137465; Franca: MZUSP 612; Mongaguá: ZUEC 3897 (photo); Paranapiacaba: CFBH 867, ZUEC 6895; Peruíbe: CFBH 24010; Salesópolis: MZUSP 70431; São Paulo: MZUSP 931, 1035; Santa Virgínia: ZUEC 12082; São Luiz do Paraitinga: CFBH 12295, 16288, 16289 (cleared and stained); São José do Barreiro: ZUEC 6807-6808; São José dos Campos: CCLZU 658, 835-838; São Sebastião, Parque Estadual da Serra do Mar: MZUSP 135333-135334.

Proceratophrys moehringi. BRAZIL: ESPÍRITO SANTO: Castelo: CFBH 9671; Santa Teresa: MNRJ 46804.

Proceratophrys sanctaritae. BRAZIL: BAHIA: Amargosa: UFBA 8487 (holotype), MNRJ 62354-62357 (paratypes).

Proceratophrys subguttata. BRAZIL: SANTA CATARINA: Anitápolis: CFBH 20268; Humboldt: MNRJ 290 (paratype); Joinville: MNRJ 2293 (paratype); São Bento do Sul: CFBH 4435.

Proceratophrys tupinamba. BRAZIL: RIO DE JANEIRO: Angra dos Reis, Ilha Grande: MNRJ 38938, 57245, 54542, 40715-40716.