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The identity of *Zachaenus roseus* Cope, 1890 (Anura: *species inquirenda*)

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Abstract

Zachaenus roseus Cope, 1890, has puzzled systematists working in southern South America. A single individual, the holotype, has ever been collected and this specimen is in extremely poor preservation condition. Herein, the precise location of the type locality of *Z. roseus* is determined based on a historical review of the literature. Furthermore, following a careful comparison with all species that inhabit the southern austral forest, and that could potentially correspond to *Zachaenus roseus*, we conclude that this taxon is placed in the synonymy of *Eupsophus calcaratus* (Günther, 1881).

Key words: *Eupsophus calcaratus*, *Zachaenus roseus*, synonymy, type locality

Introduction

On February 9th, 1888, Leslie Alexander Lee, biologist on board of the U. S. Fish Commission Steamer Albatross, collected a small frog, 23 mm SVL, in a locality then known as "Port Otway", somewhere in Southern South America. The specimen was deposited at the United States National Museum with catalogue number 15126, and subsequently was described by E. D. Cope (1890) as a new species, *Zachaenus roseus*.

In the original description Cope (1890) indicated that the type locality was in the "Argentine Confederation", "Patagonia"; however, no locality named "Port Otway" exists or existed in Argentina, and no anuran with the characteristics of *Zachaenus roseus* has been ever reported for the Atlantic Coast of Patagonia. Unfortunately, as reported by Cochran, (1955; 1961), Lynch (1971), and Heyer (*in* Frost 1985) the name-bearing type is a macerated mass (Figure 1). Our examination of the holotype (February, 2010) showed that its remnants are a partially skinned soft mass, where the only identifiable elements are the eyes, few cranial bones (i.e., only a few disarticulated bony elements remain), some elements of the pectoral girdle, the vertebral column (i.e., the best preserved remain), and the urostyle. Absolutely no external morphological character is left to examine; furthermore several osteological characters that would set it apart from other species in the genus *Zachaenus* cannot be determined.

The extremely poor state of this holotype led Lynch (1971) to consider the taxon as a *species inquirenda*, i.e., a species of doubtful identity needing further assessment. *Zachaenus roseus* is a loose end in the systematics of the amphibian fauna of southern South America, with no additional specimens ever collected or deposited in any collection under this name beyond the name-bearing type. Coincidentally, it is one of the seldom-cited species in the literature, Lynch's (1971) monograph being the only reference that contributed new information since the original description (the re-description in Nieden 1923, being a partial translation of Cope 1890). Lynch (1971) and Heyer (*in* Frost 1985) stated that the holotype is clearly not associated with the genus *Zachaenus*; subsequently, in Duellman's (1999) description of the fauna of Patagonia the species is referred as the "…enigmatic *Zachaenus roseus*".

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The main goals of this contribution are: (1) to resolve the confusion on the geographical position of the type locality, (2) to provide a regional check-list of amphibians and, based on that list, (3) to assess the possibility of associating the name *Zachaenus roseus* to any amphibian species known from the area.

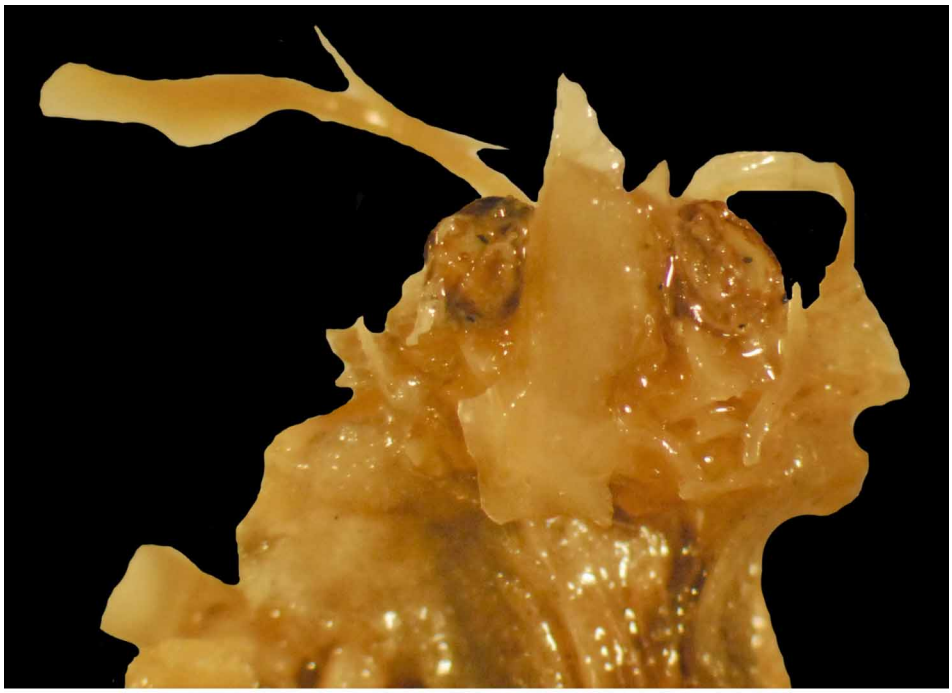

FIGURE 1. Dorsal view of the head of the holotype of *Zachaenus roseus*, USNM 15126. Eyes and left frontoparietal are the most clearly identifiable elements.

Material and methods

The identification of the type locality was done through the analysis of available publications, two charts from the H.M.S. Challenger Library (Bossard 2009), and maps retrieved through Google Earth and Google Maps.

Once the geographical location of the type locality was determined, we compiled a check list of the amphibians for that area based on the available literature, the collection database of the Instituto de Zoología, Universidad Austral, Valdivia, Chile (IZUA), and on the maps produced by the Global Amphibian Assessment international effort, housed at the IUCN website (IUCN 2010). Subsequently, each of the potential species was compared with the original description of *Zachaenus roseus* and with the few available skeletal elements of the name-bearing type, both through examination of the type specimen (USNM 15126) and with the description of Lynch (1971). A specimen of *Eupsophus calcaratus*, IZUA 3570, was cleared and doubled-stained for bone and cartilage to examine osteological characters. The list of examined specimens includes *Eupsophus emiliopugini*: Cordillera Pelada: IZUA 3605; *Eupsophus calcaratus*: Puerto Aguirre: IZUA 3570 (skeleton), 3571; Isla Guafo: IZUA3572–3590; Palena: IZUA 3591–3592; Yaldad: IZUA 3593–3597 and Cordillera Pelada: IZUA 2598–3604.

Results

1. The type locality

Under the subtitle “III. Argentine Confederation”, Cope (1890) cited four species of amphibians and one turtle (i.e., *Nannophryne variegata*, USNM 15123–24, from Mayne Harbor, Patagonia; *Batrachyla leptopus*,

USNM 15125, with no locality data in Cope (1890), but recorded as the same as the previous one according to the USNM Herpetological collection; *Zachaenus roseus*, USNM 15126, from Port Otway, *Leptodactylus latrans*, USNM 14889–94, and *Hydromedusa tectifera*, USNM 15189, from Buenos Aires). However, Berg (1897), in his classical contribution on the amphibians of Argentina, explicitly excluded the first three taxa, noting that they had been collected on the west coast of Patagonia.

In the report on the U.S. Steamer Albatross expedition of 1887–1888, Lieutenant Commander Zera Luther Tanner clearly identified the location of Port Otway when he wrote: "...We were under way at 4.20 the following morning [*February 9th, 1888*], and steaming through Messier Channel crossed Tarn Bay and the Gulf of Peñas (*sic*) to Tres Montes Gulf, made two hauls of the trawl in Holloway Sound in 57 and 61 fathoms, then steamed to Port Otway and anchored in 7 fathoms, sand and mud..." (Tanner 1891).

The location of Port Otway in the Golfo de Penas, Aysén, Chile, was confirmed from several sources, including the charts of the H.M.S. Challenger Library identified as "Chart 40: Valparaiso to Port Otway" and "Chart 41: Port Otway through Magellan Strait, touching at Hale Cove, Gray Harbour, Port Grappler, Tom Bay, Puerto Bueno, Isthmus Bay, Port Churruca, Port Famine, Sandy Point, and Elizabeth Island", and in the following sources: Findlay (1851), Godley (1970), Medina (1889), Miller (1884), Paynter (1988), Ridgway (1889), Riso Patrón (1924), and Spry (1876). Finally, according to Riso Patrón (1924) and Paynter (1988) nowadays Port Otway is known as Puerto Almirante Barroso, a marine harbor on the eastern side of Península Tres Montes [a.k.a. Península de Taitao], Aysén, at 46º49' S – 75º21' W (Figure 2).

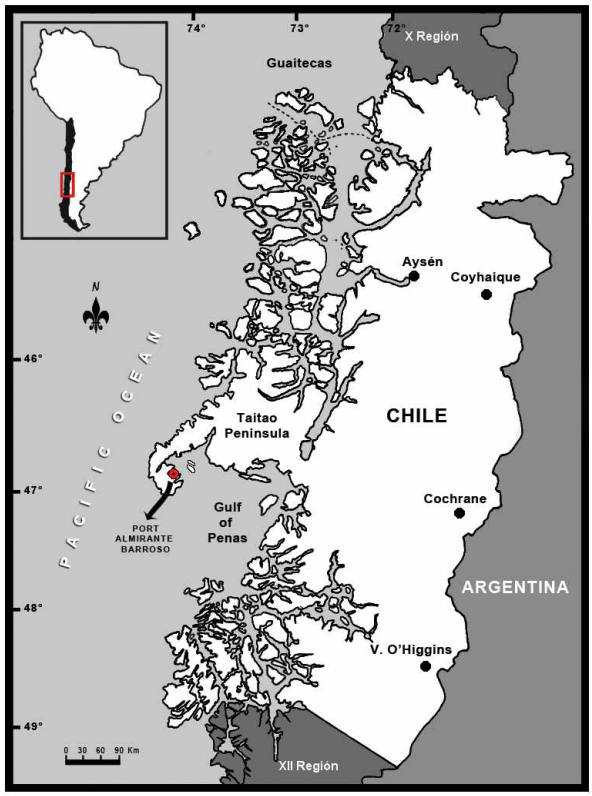

FIGURE 2. Red dot indicates the location of Puerto Almirante Barroso (= Port Otway), type-locality of *Zachaenus roseus*.

2. A check list of the amphibians of the XI Region (Aysén) and Península de Taitao

To include all species that could potentially correspond to *Zachaenus roseus*, the following checklist was expanded to contain the recorded amphibians from Chile's XI Region (Aysén) based on the above mentioned collection databases, and on Mella Avila (1999), Rabanal (2005), Ortiz and Díaz Páez (2006), Garcia *et al.* (2007), and Rabanal and Nuñez (2009).

The resulting list of species consists of (the asterisk indicates amphibians recorded at Península de Taitao): *Rhinella papillosa*, *Nannophryne variegata**, (Bufonidae); *Atelognathus ceii*, *Atelognathus jeinimenensis*, *Batrachyla antartandica**, *Batrachyla leptopus**, *Batrachyla nibaldoi*, *Batrachyla taeniata* (Ceratophryidae: Batrachylinae); *Alsodes australis*, *Alsodes monticola*, *Eupsophus calcaratus**, *Eupsophus emiliopugini*, *Hylorina sylvatica* (Cycloramphidae: Alsodinae); *Rhinoderma darwinii* (Cycloramphidae: Cycloramphinae); *Pleurodema bufoninum*, and *Pleurodema thaul* (Leiuperidae). Among these species, Cope (1890) studied *Nannophryne variegata*, *Batrachyla leptopus*, and *Pleurodema thaul* (as *Paludicola frenata*); consequently, these species were not included in the current analysis. Other species excluded, given that they are easily identifiable from *Zachaenus roseus* (*Z. roseus* characters in parenthesis), are: *Rhinella papillosa* (parotoid glands absent), *Pleurodema bufoninum* (lumbar glands absent), *Rhinoderma darwinii* (prognathus snout absent), *Hylorina sylvatica* (noticeably different dorsal pattern absent), *Batrachyla antartandica* and *B. leptopus* (toe tips not expanded), *B. nibaldoi*, *Atelognathus ceii*, *Atelognathus jeinimenensis*, *Alsodes australis*, and *A. monticola* (lack of webbing or toe fringes).

Of the remaining two species, the colour pattern of *Eupsophus emiliopugini* separates it from *Z. roseus*, leaving then *Eupsophus calcaratus* (Günther, 1881) as the only candidate among the currently known species to be considered as a senior synonym of *Zachaenus roseus* Cope, 1890.

3. Morphological comparison of *Zachaenus roseus* and *Eupsophus calcaratus*

The external morphology of *Eupsophus calcaratus* (Fig. 3).

Eupsophus calcaratus is a medium sized species (37.7 mm SVL in adults; summary measurements in Table I). The head is narrower than the body; head length 37% of SVL; head broader than long. Snout rounded in dorsal view, anteriorly short; loreal region flat, nostrils slightly prominent, oriented laterally, internarial region slightly convex; nostril slightly closer to the anterior border of the eye than to the terminus of snout; in dorsal view the canthus dorsalis is distinct. Prominent eyes, 33% of head length, oriented laterally; tympanus round; supratympanic fold well developed, extending from the posterior corner of eyelid, terminating dorsal to forelimb; maxillary and premaxillary teeth present, prevomerine teeth obliquely located between the choanae; choanae minutes, subcircular; tongue rounded, posterior border slightly notched. Skin smooth dorsally and ventrally.

TABLE I. Measurements of *Eupsophus calcaratus* (N=35) in mm.

Character	Mean (range)
Snout-vent length	37.7 (30.2–40.4)
Head width	13.8 (10.5–14.2)
Head length	13.1 (11.5–14.0)
Eye diameter	4.4 (4.3–4.4)
Internarial distance	3.6 (3.1–4.0)
Eye-narial distance	3.6 (2.2–4.0)
Tympanic diameter	3.0 (2.0–3.6)
Hand length	17.1 (15.4–18.9)
Tibial length	18.9 (17.3–21.3)
Foot length	25.6 (22.0–29.3)

Forelimbs slender; dorsal and ventral surfaces smooth. Relative length of the fingers: III>IV>II>I; tips of fingers rounded; inner palmar tubercle median-sized, ovoid; outer and inner palmar tubercles of equal size; one subarticular tubercle on fingers I–IV; supernumerary palmar tubercles absent. Hind limbs elongated (approximately 167% of SVL), toes long and thin; relative length of toes:IV>V=III>II>I; webbing absent, tips

of toes slightly rounded; inner metatarsal tubercle ovoid and well-developed; external tubercle conical, small, about one-fourth the length of the inner metatarsal tubercle; subarticular tubercles rounded; supernumerary subarticular tubercles and tarsal fold absent.

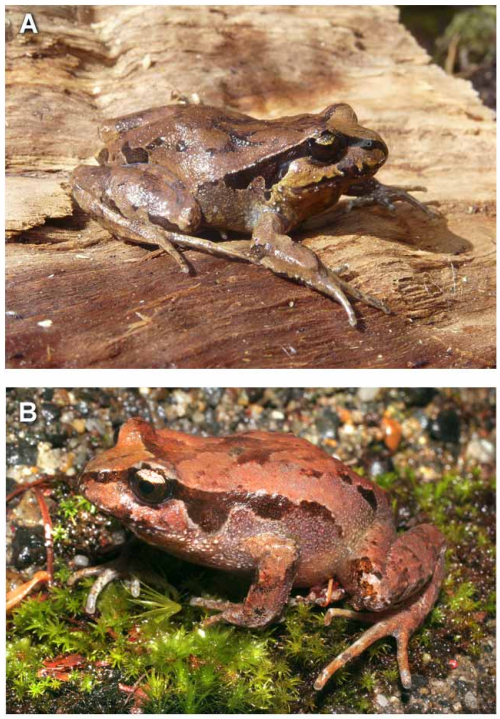

FIGURE 3. Coloration of *Eupsophus calcaratus*: A) greyish pattern, Puerto Aguirre, XI Región, Chile, and B) reddish pattern, Parque Nacional Alerce Andino (X Región, Chile).

Colour widely variable among specimens in the same population; background coloration varies from different tones of grey, brown, or reddish with darker irregular spots, which can form "sand-glass" pattern extending between the eyes to mid-dorsum. Another frequent marking is a dark band extending from the tip of the snout along the *canthus rostralis*, over the eye, and ending either at the tympanic ring or variably extending posteriorly to mid body or almost reaching the inguinal area. Upper lip usually with a dark spot found at the level of the anterior edge of the eye, other minor upper lip markings are variable. Also lumbar spots, on each side of the midline, are common as well as a pattern of bars over the posterior limbs. The ventral surface of the body ranges from yellowish to greyish, with or without spots. The eyes are black with a golden upper iris.

The colour pattern in the original description of *Z. roseus* stated "...Color, pale rose gray above, dirty white below. A black band extends from the end of the muzzle along the canthus rostralis, and follows the glandular fold to its end above the axilla. A branch descends and, crossing the tympanic drum, stops a short distance in front of the shoulder. Limbs with very indistinct dusky cross-bars. Tarsus dusky below. Two large brown spots on the front side of the forearm. Two similar spots on the proximal half of the front of the tibia." This description overall agrees with the pale reddish pattern of *E. calcaratus* and the common dark spots occurring in this species (Fig. 3B).

4. Osteology (Fig. 4, IZUA 3570).

The following is a partial description that mostly focuses on the vertebral column and pelvic girdle given that these structures are the best remants of the holotype of *Zachaenus roseus*. Although most of the skull of the holotype is destroyed, the skull was examined in detail considering its traditional role as a source of taxonomic characters.

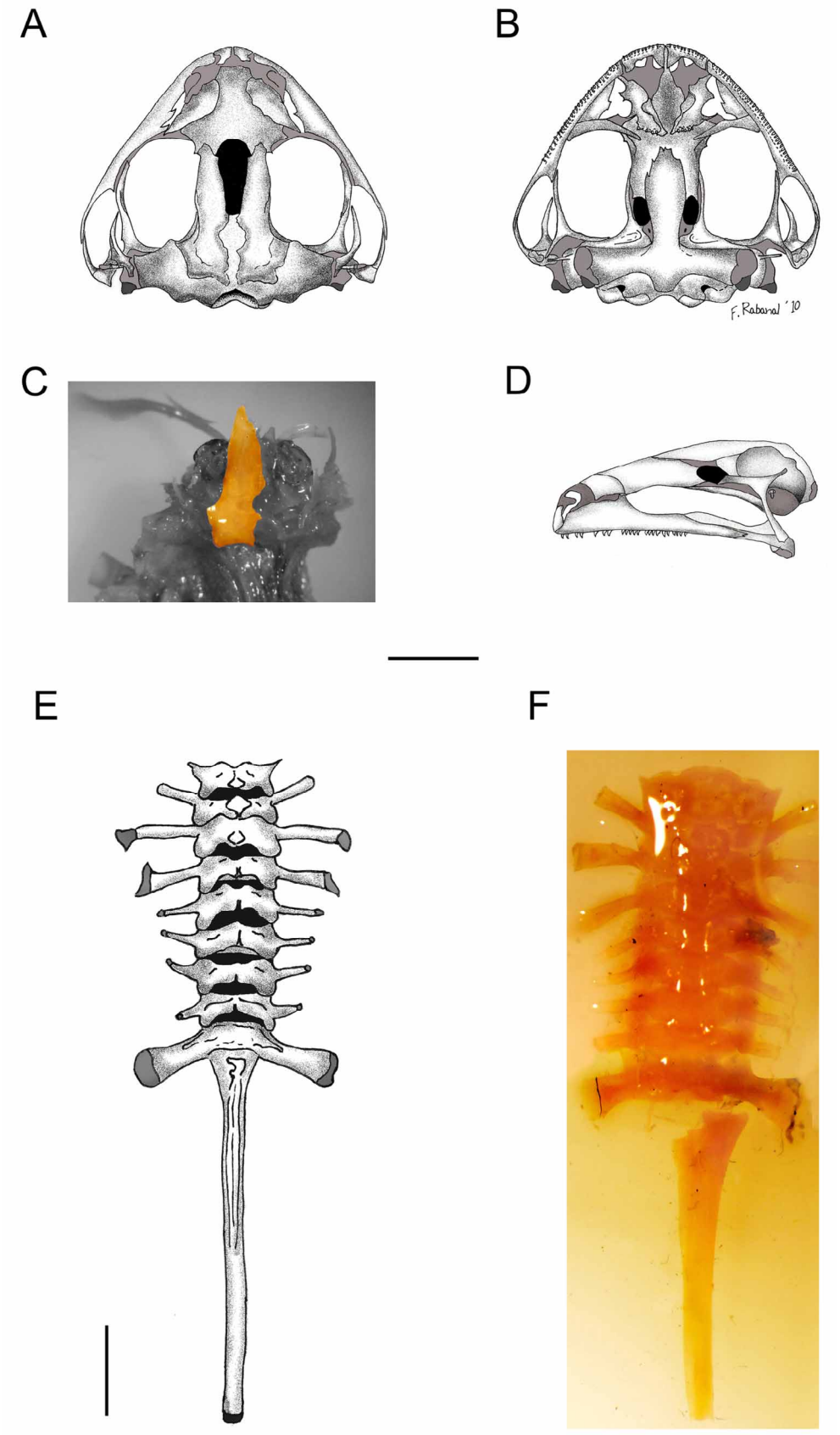

FIGURE 4. The skeleton of *Eupsophus calcaratus*, IZUA 3570, and *Zachaenus roseus*, USNM 15126. *Euspsophus calcaratus*: A) dorsal, B) ventral, and D) lateral views of the skull; E) dorsal view of vertebral column andurostyle. Holotype of *Zachaenus roseus*: C) left frontoparietal bone and F) vertebral column and urostyle. Bar = 5 mm.

The skull of *Eupsophus calcaratus* is rounded anteriorly. Slightly wider than longer, maximum width found at the level of the quadratojugals-maxillae articulations. Frontoparietals do not contact throughout their lengths, wide posteriorly, and slightly converging medially, but not contacting, in their posterior halves; each frontoparietal bears a lamina perpendicularis extending laterally to form the dorsolateral wall of the braincase; posterolaterally, the frontoparietals are not synchondrostically fused with the otoccipitals, distinct sutures are observed among these bones. Frontoparietal fenestra present, anteriorly wide, closed by membranous roof. Anterior tips of the frontoparietals overlap the posterior margins of the sphenetmoid. Nasals large, elongated, and acute posterolaterally, and dorsally overlaping the lateral margins of the sphenetmoids; nasals do not contact the pars facialis of the maxilla. Otoccipitals fused medially. Parasphenoid well-developed, maximum length about 78% of its width; alae form 90º angles with the cultriform process. Cultriform process medially widest, its anterior margin is sinuous and do not reach the level of the neopalatines. The neopalatines are slightly arcuate, widely separated medially, and extending from the pars palatine of the maxillae to the sphenethmoid. Prevomers robust, bearing 7–8 well-developed teeth, separated medially, and positioned oblique to the main axis of the skull. Premaxillae robust with well-developed alary processes, alary processes wide at the base and projecting dorsally and posteriorly. Each premaxilla bears nine pedicelate teeth. Maxillae slender, bearing 33–36 maxillary teeth; pars faciales of the maxillae broad with a low preorbital process that do not contact with the maxillary process of the nasals; quadratojugals articulating with the maxillae. Pterygoids slender, anterior ramus contacting the maxilla, a well-developed posterior ramus reaches the quadratojugal, and the medial ramus contacts the anteroventral margin of otic capsule. Squamosal T-shaped in lateral view, relative length of squamosal rami is: ventral ramus > zygomatic ramus > otic ramus; ventral ramus straight, articulating and forming a 45º angle with the quadratojugal; otic ramus articulates with the otoccipitals. Quadratojugals complete the posterior portion of the maxillary arcade. Each quadratojugal extends anteriorly and overlaps the posterior and inner surface of the maxilla, at about midlength of the pterygoid fossa. Columella present.

Vertebral column composed of eight procoelus presacral vertebrae. Neural arches not imbricate, lacking neural spines; vertebrae II–VIII bearing transverse processes, lacking ribs. Processes of vertebrae II and VII deflected anteriorly, IV and V deflected posteriorly, and III–VI–VIII oriented almost perpendicular to longitudinal axis of the vertebral column. In decreasing size, the lengths of transverse processes are: III>IV=Sacrum>V>VI>VII>II>VIII. Tips of vertebral processes and sacral diapophyses cartilaginous, except those of vertebrae II. Transverse processes of the vertebrae II–III–IV expanded distally, the transverse processes of other vertebrae acute. Sacral diapophyses moderately expanded, posterolaterally oriented. Sacrococcygeal articulation bicondylar. Urostyle robust, bearing a poorly developed dorsal crest, mostly evident in its anterior half. Ilial shaft bearing a dorsolateral crest and a low dorsal protuberance laterally oriented. The ilium forms the anterior margin of the overall round acetabulum. Preacetabulum forming almost a 90º angle with the ilial shaft. Posterior margin of ilia fused to the ischia, ischia fused to pubis, pubis fully calcified, forming the posteroventral margin of the acetabulum.

Discussion

Regarding the type locality, recent information suggested that the name Port Otway is the same as Port Octay, Chile (Frost 2010). However, Port Octay corresponds to a lake harbour at the extreme northwestern corner of Lago Llanquihue in Osorno (40º58’ S – 72º54’ W) (Paynter 1988). Furthermore, Port Otway should not be confused with Otway Sound (53º00’ S – 71º30’ W) located on the Brunswick Peninsula. The location of Port Otway on the Península de Taitao was clearly established by the commander of the US Steamer Albatross (Tanner 1891). The current name of Puerto Almirante Barroso was stated explicitly by Riso Patrón (1924) and subsequent authors. These data, and the additional literature and cartography presented above, allows the correction of the type locality of *Zachaenus roseus*.

Furthermore, almost all the morphological characters noted by Cope (1890) in the description of *Zachaenus roseus*, plus the remaining few skeletal structures recognizable in the holotype (i.e., frontoparietal,

vertebral column, pelvic girdle, and urostyle) overall agree with the osteological re-description of *Eupsophus calcaratus* presented above. The main differences with Cope's description relates to overall size and the reported presence of a "small glandular fold from the posterior part of the eyelid to just above the axilla." The former character can be interpreted as a result of Cope basing his description on a subadult individual of only 23 mm SVL, whereas the latter is interpreted herein as the supratympanic fold characteristic of this species. Thus, we conclude that *Zachaenus roseus* Cope (1890) is a junior synonym of *Eupsophus calcaratus* (Gunther, 1881).

The abbreviated creso-synonymy of *Eupsophus calcaratus*, including all references to *Z. roseus* is:

***Eupsophus calcaratus* (Günther, 1881)**

Cacotus calcaratus Günther, 1881. Proceedings of the Zoological Society of London, 1881:19. Holotype: BM 1868.9.22.8. Type Locality: "Chiloé", Chile.

Borborocoetes calcaratus: Boulenger, 1882:256.

Zachaenus roseus Cope, 1890 "1889". Proceedings of the United States National Museum, 12:142. Holotype: USNM 15126. "Port Otway, Patagonia", here emended to: Puerto Almirante Barroso (= Port Otway), 46º49'–75º21', Península de Taitao, Chile. Boettger, 1890: 260. Berg, 1897:149. Nieden, 1923: 389. Cochran, 1955 "1954":235, 361. Cochran, 1961: 81. Gorham, 1966:181. Lynch, 1971:142. Muller, 1973:138. Gorham, 1974:73. Frost, 1985:349. Sokolov (1988):93. Frank and Ramus, 1995:85. Duellman, 1999:271. Hutchins *et al.*, 2003:464. Veloso *et al.*, 2004. Wrobel, 2004:295. Stuart *et al.*, 2008:741. Frost, 2010.

Eupsophus calcaratus: Capurro, 1958:293.

Eupsophus roseus: (not Duméril and Bibron, 1841) Grandison, 1961:128 (part).

The proposed synonymy of *Zachaenus roseus* with *Eupsophus calcaratus*, restricts the distribution of the genus *Zachaenus*, which can now be considered as endemic to the Atlantic Rainforest of Southeastern Brazil.

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