

Reassessment of the taxonomic status of the genera *Ischnocnema* Reinhardt and Lütken, 1862 and *Oreobates* Jiménez-de-la-Espada, 1872, with notes on the synonymy of *Leiuperus verrucosus* Reinhardt and Lütken, 1862 (Anura: Leptodactylidae)

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Abstract

The taxonomic status of two leptodactylid frog genera is reevaluated. *Ischnocnema* Reinhardt and Lütken, 1862 is considered a junior synonym of *Eleutherodactylus* Duméril and Bibron, and the combination *E. verrucosus* (Reinhardt and Lütken, 1862) is proposed. *Oreobates* Jiménez-de-la-Espada, 1872 is revalidated, and the combinations *Oreobates quixensis* Jiménez-de-la-Espada, 1872, *O. simmonsii* (Lynch, 1974), *O. saxatilis* (Duellman, 1990), *O. sanctaecrucis* (Harvey and Keck, 1995), and *O. sanderi* (Padial, Reichle and De la Riva, 2005) are proposed. *Epsophus verrucosus* Miranda-Ribeiro, 1937 is synonymized with *Eleutherodactylus verrucosus* (Reinhardt and Lütken, 1862).

Key words: Amphibia; Anura; Leptodactylidae; *Ischnocnema*; *Oreobates*; Taxonomy

Introduction

WIDELY disjunct geographical distributions among closely related species are rare in the Neotropics. In general, a more detailed analysis reveals that these species are, in reality, members of distinct evolutionary lineages.

The geographical distribution of the species currently placed in the genus *Ischnocnema* Reinhardt and Lütken, 1862 presents such a gap. One species, *I. verrucosa* (Reinhardt and Lütken, 1862), occurs in Southeastern Brazil, and the other five, *I. quixensis* (Jiménez-de-la-Espada, 1872), *I. simmonsii* Lynch, 1974, *I. saxatilis* Duellman, 1990, *I. sanctaecrucis* Harvey and Keck, 1995, and *I. sanderi* Padial, Reichle and De la Riva, 2005, occur in the upper Amazon Basin in western Brazil, Bolivia, Colombia, Ecuador, and Peru (Gascon, 1995; Frost, 2004).

Examination of the holotype of *I. verrucosa* (Reinhardt and Lütken), of the holotype of its currently synonym *Epsophus verrucosus* Miranda-Ribeiro, 1937, and additional specimens, revealed previously overlooked characters that substantially affect the taxonomic status of the genera *Ischnocnema* and *Oreobates* Jiménez-de-la-Espada, 1872, currently a synonym of the former. In this paper the results of these findings are presented.

Materials and Methods

Acronyms of the collections housing the examined specimens are the following: MNRJ (Museu Nacional, Rio de Janeiro, Brazil), ZMK (Zoologisches Museum, Copenhagen, Denmark), MZUSP (Museu de Zoologia, Universidade de São Paulo, Brazil), ZUEC (Museu de História Natural, Universidade Estadual de Campinas, Brazil), CFBH (Célio F. B. Haddad Collection, Universidade Estadual Paulista, Rio Claro, Brazil), EI (Eugenio Izecksohn Collection, Universidade Federal Rural do Rio de Janeiro, Seropédica, Brazil), and WCAB (Werner C. A. Bokermann Collection, currently in the MZUSP). Specimens examined are referred in the Appendix I.

Abbreviations used in the account below are the following: SVL (snout-vent length); HL (head length); HW (head width); IND (internarial distance); END (eye to nostril distance); IOD (interorbital distance); UEW (upper eyelid width); ED (eye diameter); TD (tympanum diameter); THL (thigh length); TL (tibia length). All measurements were made with calipers and are in millimeters.

Osteology was observed from a cleared and stained female of *Ischnocnema verrucosa* (MNRJ 28340) and characters followed Lynch (1971).

OSTEOLOGY OF *Ischnocnema verrucosa* (Reinhardt and Lütken, 1862)

Osteological features observed in a cleared and stained female of *Ischnocnema verrucosa*, agree to those listed by Lynch (1971) to *Eleutherodactylus*: omosternum present, large, long and narrow, with a calcified style and a cartilaginous, expanded distal portion; maxillary arch toothed; alary process of premaxillae posterodorsal directed, slightly sloping; palatal shelf of premaxilla deep; facial lobe of maxilla deep; nasals large, narrowly separated; nasals not in contact with pterygoids nor maxillae; frontoparietal fontanelle absent; frontoparietals not ornamented; frontoparietals not fused with prootics; epiotic eminences prominent; cristae paroticae relatively broad and stocky; zygomatic ramus of squamosal short, with pointed anteroventral tip, not in contact with maxillae; otic ramus of squamosal long; columela present; prevomers toothed, entire, moderately separated medially; neopalatine long, expanded laterally, widely separated medially, without odontoid ridges; sphenethmoid entire, extending anteriorly; anterior ramus of parasphenoid moderated broad, long, nearly reaching prevomers, not keeled medially;

parasphenoid alae oriented at right angles to anterior ramus, long, overlapped by median rami of pterygoids; pterygoids slender, anterior rami not reaching neopalatines, median rami short and bent; occipital condyles widely separated medially; terminal phalanges clearly T-shaped in toes II–V and fingers III–IV, moderated T-shaped in fingers I and II (character not available to observation in toe I); inner phalanges knobbed; alary process of hyoid plate on narrow stalks, and anterior process on the cornu, long and knobbed on the tip.

The osteological features herein observed in *I. verrucosa* agree with that attributed by Lynch (1971) to the genus *Eleutherodactylus*. Comparing the osteology of *I. verrucosa* with the characters of *I. quixensis* described by Lynch (1971), the most important difference between these species are the T-shaped terminal phalanges in *I. verrucosa*. According to the skull of *I. quixensis* figured by Lynch (1971), *I. verrucosa* also differs from the former by its: palatal shelf of premaxillae more deeply dissected; facial lobe of maxilla not deep posterior to neopalatine; nasals smaller, more separated anteriorly and more distant from the facial lobe of maxillae; frontoparietals more separated anteriorly; cristae paroticae broader; prevomers less separated medially, dentigerous processes larger, slightly overlapping the median tip of neopalatines; median tip of neopalatine pointed; and posterior edge of sphenethmoid reaching the middle of anterior ramus of parasphenoid.

These osteological differences between *I. verrucosa* and *I. quixensis* and similarities between *I. verrucosa* and *Eleutherodactylus* lead to systematic implications herein discussed.

Systematic Account

Genus *Ischnocnema* Reinhardt and Lütken, 1862

Based on a single specimen (currently ZMK 1180), Reinhardt and Lütken (1862) described a new species, *Leiuperus verrucosus*, from near Juiz de Fora, State of Minas Gerais, Southeastern Brazil. In a postscript to the same paper, however, the authors proposed a new genus, *Ischnocnema*, to accommodate that species, under the combination *Ischnocnema verrucosa*. For a summary of the taxonomic history and redescription of this species, see Lynch (1972).

With the synonymization of *Oreobates* Jiménez-de-la-Espada, 1872 to *Ischnocnema*, this genus also included *I. quixensis* (Jiménez-de-la-Espada, 1872), as reviewed by Lynch and Schwartz (1971). Later, Lynch (1974), Duellman (1990), Harvey and Keck (1995), and Padial et al. (2005) described *I. simmonsii*, *I. saxatilis*, *I. sanctaecrucis*, and *I. sanderi*, respectively, completing the six species currently recognized in the genus.

The genus *Ischnocnema* was distinguished from *Eleutherodactylus* by Lynch (1971, 1972) and Lynch and Schwartz (1971) mainly on basis of the shape of the distal phalanges: T-shaped in *Eleutherodactylus*, and knobbed in *Ischnocnema*. The other characters listed

for *Ischnocnema* by Lynch (1971) are included in the variation of *Eleutherodactylus* characters, except by the anterior rami of pterygoids reaching the neopalatines in *Ischnocnema*. Lynch and Schwartz (1971) examined only specimens of *I. quixensis*, but Lynch (1971, 1972) also examined the holotype of *I. verrucosa*, although apparently did not observe the condition of its phalanx. Osteological characters listed by Lynch (1971) to the genus *Ischnocnema* were observed by the author in *I. quixensis*, the sole species of this genus cleared and stained in his work. The osteological features herein observed in *I. verrucosa* agree with that attributed to *Eleutherodactylus* by Lynch (1971) but not with that attributed to *Ischnocnema* by this author. These findings permit the association of *I. verrucosa*, type species of the genus *Ischnocnema*, with the genus *Eleutherodactylus*.

Genus *Oreobates* Jiménez-de-la-Espada, 1872

The genus *Oreobates* was described by Jiménez-de-la-Espada (1872) to accommodate a single new species, *O. quixensis*, which was later redescribed and illustrated (Jiménez-de-la-Espada, 1875). By considering *Oreobates* a junior synonym of *Ischnocnema*, Lynch (1971, 1972) and Lynch and Schwartz (1971) established the combination *Ischnocnema quixensis*. For a summary of the taxonomic history and redescription of this species, see Lynch and Schwartz (1971); for the geographical distribution, see Lynch (1974) and Lynch and Lescure (1980).

The type of *Leiuperus verrucosus* Reinhardt and Lütken, 1862

The holotype of *Leiuperus verrucosus* is a well preserved specimen, considering the time elapsed since its collection. The specimen is uniformly brown, with loreal and arm bars discernible, and with evident dorsal tubercles. The legs are broken at the knees, the chest is dissected with two crossed cuts, the skin of the right side of head is detached, and the right arm is broken but not separated from the body. This specimen (ZMK 1180) was figured and redescribed by Lynch (1972). Measurements of the specimen are presented in Table 1.

The direct comparison of the holotypes of *Leiuperus verrucosus* Reinhardt and Lütken, 1862 and of *Epsophus verrucosus* Miranda-Ribeiro, 1937 (see below) leads to the conclusion they are conspecific. Additionally, the cautious dissection of the tip of their left fourth toe allowed the observation of the T-shaped condition of the distal phalanx in both specimens. These findings permit association of these holotypes with the genus *Eleutherodactylus*.

The type of *Epsophus verrucosus* Miranda-Ribeiro, 1937

One of the problems with the type-specimens of species described by Alípio de Miranda-

Ribeiro is their localization. Most of the amphibians are housed in the MNRJ collection, but several have not been found and are presumed to be lost or destroyed. One of the most important causes of the ambiguity of Miranda-Ribeiro's holotypes is the change of names. Miranda-Ribeiro had the habit of writing and signing the labels of his type-specimens, marking them as "Typo" or "Typos" ("Type" or "Types"). These specimens are surely the types of his species, but the name depicted on the label is not necessarily the published name. Miranda-Ribeiro sometimes selected a name for a species, wrote it on the label, but later he changed his mind, created a new name and published this name without making the adequate correction on the label. These events occurred with the type-specimen of *Epsophus verrucosus* (published subsequently as *Eupsophus verrucosus*; see Bokermann, 1966, Lynch, 1972, Frost, 2004).

The specimen described and figured by Miranda-Ribeiro (1937) as the type for *Eupsophus verrucosus* is currently numbered as MNRJ 0121. However, the label of this specimen has another name than *E. verrucosus*, hand-written by Miranda-Ribeiro but never published, and is invalid for nomenclatural purposes. The collection locality, collector, the mark "Typo", and the posture of the specimen (with the left leg partially extended and the right leg contracted, as figured in the original publication), perfectly identifies this specimen as the holotype of *E. verrucosus*. This action camouflaged the holotype of the species under an unpublished name. Accordingly, P. Miranda-Ribeiro (1953), in his catalogue of the types of the species and subspecies described by his father and housed at the MNRJ collections, cited *E. verrucosus* but did not give a register number for the type-specimen, signifying that he did not locate it.

In the original publication, Miranda-Ribeiro (1937) gave the type-locality for *E. verrucosus* only as "rio Mutum - E. Santo." This locality is in the Municipality of Colatina, State of Espírito Santo, Southeastern Brazil. The Rio Mutum, where the collector, A. Schirch, obtained the specimen, is about 19°35'S, 40°37'W.

Although Miranda-Ribeiro (1937) applied the generic name *Epsophus* (*lapsus pro Eupsophus*), in the combination *E. verrucosus*, examination of the holotype reveals that it is a member of the genus *Eleutherodactylus*. Dissection of the tip of the fourth toe revealed a T-shaped distal phalanx, in spite of the small development of the disks. This character associates the species with *Eleutherodactylus*. Bokermann (1966) already suggested that the species belongs to this genus, and agreed that it is identical with *Ischnocnema verrucosa* (Reinhardt and Lütken) (Lynch, 1972). Although Lynch (1972) stated that Bokermann had directly compared the holotypes of *I. verrucosa* and *E. verrucosus*, it is improbable. Bokermann examined the former, but probably did not examine the holotype of *E. verrucosus* because it was hidden under another name. On the other hand, if Bokermann examined the holotype of *E. verrucosus* in spite of its mislabeling, he reached the same conclusion to that presented above that the two species are identical.

Currently, the holotype of *E. verrucosus* Miranda-Ribeiro is faded, but it is possible to see the pattern of the dorsum of the body and the sides of the head. The tubercles on

dorsum are evident. The dorsal skin on the urostyle region is broken. Measurements of the specimen are presented in Table 1.

TABLE 1. Measurements of the specimens of *Eleutherodactylus verrucosus*. Individual measurements of holotypes: *Leiuperus verrucosus* Reinhardt and Lütken (ZMK 1180) and *Epsophus verrucosus* Miranda-Ribeiro (MNRJ 0121). Measurements of other specimens are present: mean \pm standard deviation (range). For localities and complete specimen list see Appendix I.

	ZMK1180	MNRJ0121	Male (n = 8)	Female (n = 6)
SVL	21.8	21.0	17.3 \pm 0.9(16.1–18.6)	23.8 \pm 1.5(21.2–25.5)
HL	8.2	8.0	7.2 \pm 0.4(6.6–7.8)	9.7 \pm 1.1(8.0–11.0)
HW	9.0	8.0	6.6 \pm 0.4(6.0–7.2)	9.2 \pm 0.5(8.3–9.7)
IND	2.3	1.7	1.6 \pm 0.2(1.3–1.8)	2.2 \pm 0.2(1.8–2.5)
END	2.6	2.5	2.1 \pm 0.1(1.9–2.3)	2.8 \pm 0.2(2.5–3.1)
IOD	2.4	2.3	2.2 \pm 0.2(1.9–2.4)	2.7 \pm 0.3(2.3–3.2)
UEW	2.3	2.3	1.9 \pm 0.1(1.7–2.0)	2.5 \pm 0.2(2.3–2.8)
ED	3.5	3.0	2.7 \pm 0.1(2.5–2.9)	3.5 \pm 0.3(2.9–3.7)
TD	0.8	1.0	1.0 \pm 0.1(0.9–1.2)	1.3 \pm 0.2(1.1–1.6)
THL		10.7	8.6 \pm 0.4(8.0–9.3)	11.4 \pm 0.6(10.7–12.1)
TL	12.2	11.4	8.9 \pm 0.5(8.1–9.5)	11.7 \pm 0.5(11.0–12.5)

Taxonomic Implications

The recognition of *Ischnocnema verrucosa* (Reinhardt and Lütken) as a member of the genus *Eleutherodactylus* implies several taxonomic changes.

The genus *Ischnocnema* (type-species, by monotypy and original designation, *Leiuperus verrucosus* Reinhardt and Lütken, 1862) becomes a junior synonym of *Eleutherodactylus* Duméril and Bibron. The new combination thus established is *Eleutherodactylus verrucosus* (Reinhardt and Lütken, 1862). The species is known from scattered localities in the States of Minas Gerais and Espírito Santo, Southeastern Brazil (Fig. 1). Measurements are presented in Table 1.

On the other hand, the other five species currently included in *Ischnocnema*, *I. quixensis*, *I. simmonsii*, *I. saxatilis*, *I. sanctaecrucis*, and *I. sanderi*, do not belong to *Eleutherodactylus*. The members of these species share a distinctive character, the knobbed distal phalanges, which prevents their inclusion in the latter genus. Since *Ischnocnema* is unavailable, the oldest generic name for these species is *Oreobates* Jiménez-de-la-Espada, 1872 (type-species, by monotypy, *Oreobates quixensis* Jiménez-

de-la-Espada, 1872), here revalidated. The genus includes five recognized species: *O. quixensis* Jiménez-de-la-Espada, 1872, *O. simmonsii* (Lynch, 1974), new combination, *O. saxatilis* (Duellman, 1990), new combination, *O. sanctaerucis* (Harvey and Keck, 1995), new combination, and *O. sanderi* (Padial, Reichle and De la Riva, 2005), new combination. The combined distribution of the species, and so for the genus *Oreobates*, includes part of the upper Amazon Basin, as summarized by Lynch (1974), Lynch and Lescure (1980), and Duellman (1990).

A summary of the taxonomic conclusions obtained is presented below.

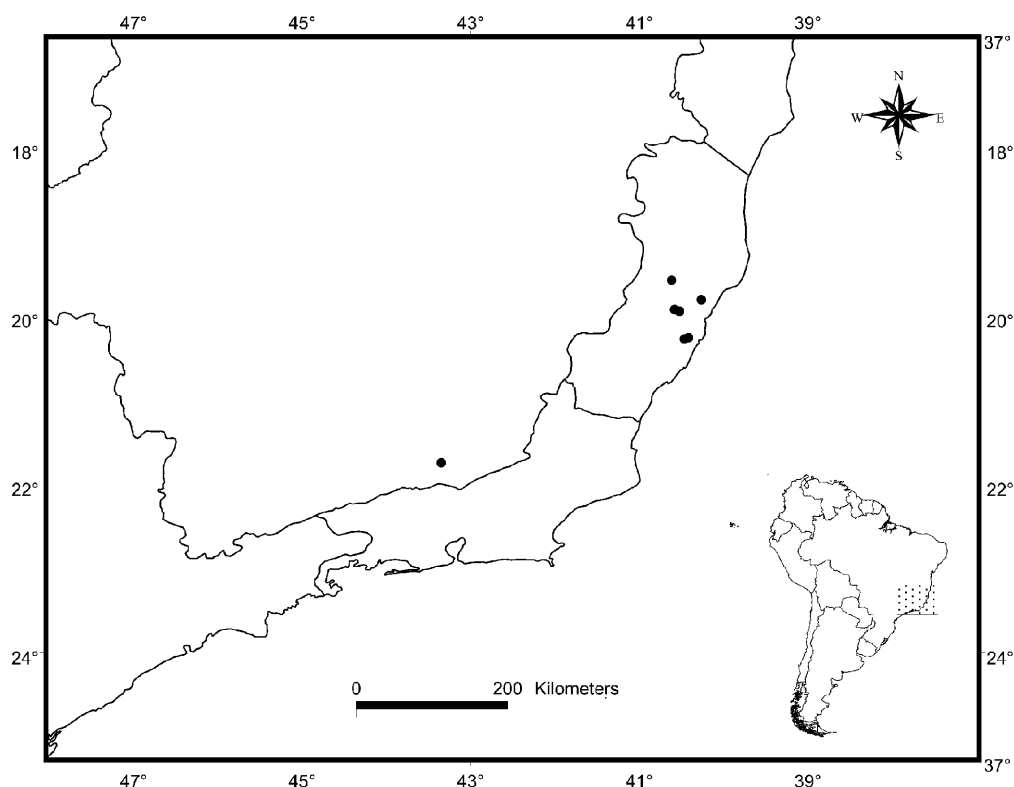


FIGURE 1. Distribution of *Eleutherodactylus verrucosus* in the states of Espírito Santo and Minas Gerais, Southeastern Brazil.

***Eleutherodactylus verrucosus* (Reinhardt and Lütken, 1862)**
 (Figs. 2–3)

Leiuperus verrucosus Reinhardt and Lütken, 1862.

Ischnocnema verrucosa - Reinhardt and Lütken, 1862; Lynch, 1971, 1972; Sazima and Cardoso, 1978; Frost, 1985.

Paludicola verrucosa - Boulenger, 1882; Nieden, 1923.

Pleurodema verrucosa - Parker, 1927; Cochran, 1955; Bokermann, 1966; Gorham, 1966.

Epsophus verrucosus Miranda-Ribeiro, 1937.

Eleutherodactylus verrucosus (Miranda-Ribeiro, 1937) - Bokermann, 1966.

Eupsophus versus Gorham, 1966 [substitute name for *Eupsophus verrucosus* Miranda-Ribeiro, 1937, preoccupied in *Eupsophus* by *Borborocoetes verrucosus* Philippi (= *Eupsophus nodosus* Duméril and Bibron)].

Additionally, we examined and compared the specimens of *Eleutherodactylus verrucosus* with *Eleutherodactylus juipoca* Sazima and Cardoso (MNRJ 4103, holotype) and *Eleutherodactylus octavioi* Bokermann (MZUSP 73670, holotype), both species from Southeastern Brazil and thought to be related to *E. verrucosus* (Lynch, 1972; Sazima and Cardoso, 1978). The three species are perfectly distinguishable, and we consider them valid taxa.

***Oreobates quixensis* Jiménez-de-la-Espada, 1872**

Oreobates quixensis Jiménez-de-la-Espada, 1872.

Hylodes verrucosus Jiménez-de-la-Espada, 1875; Lynch and Schwartz, 1971.

Hylodes philippi Jiménez-de-la-Espada, 1875; Lynch and Schwartz, 1971.

Borborocoetes quixensis - Boulenger, 1882.

Leptodactylus tuberculatus Andersson, 1945; Lynch, 1972.

Eupsophus quixensis - Peters, 1955.

Eleutherodactylus philippi - Gorham, 1966.

Ischnocnema quixensis - Lynch, 1971, 1972; Lynch and Schwartz, 1971; Lynch and Lescure, 1980; Frost, 1985, 2004.



FIGURE 2. *Eleutherodactylus verrucosus* (MNRJ 34899), adult female from Santa Teresa, State of Espírito Santo, Southeastern Brazil.

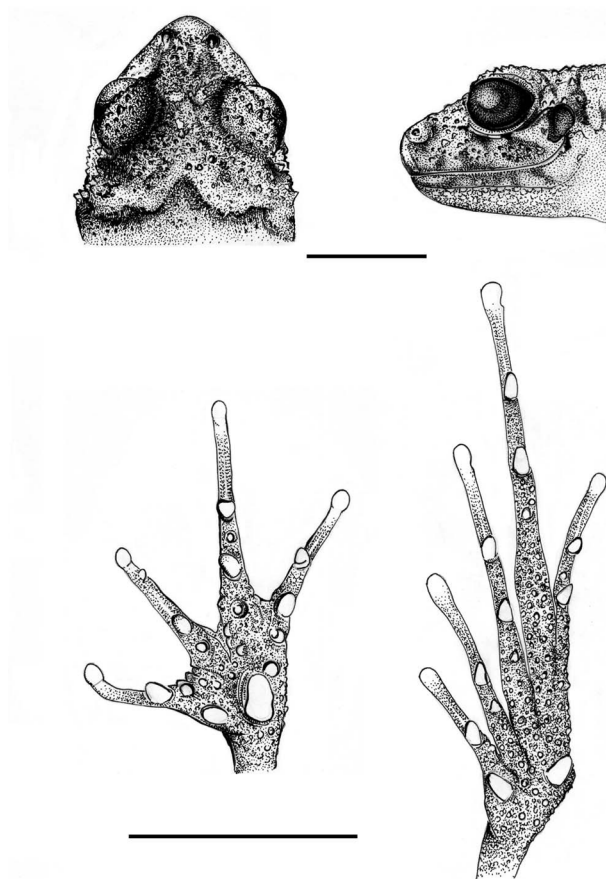


FIGURE 3. *Eleutherodactylus verrucosus*, MNRJ 16137. Dorsal and lateral views of head; ventral views of hand and foot; scale bars represent 5 mm.

***Oreobates simmonsii* (Lynch, 1974), new combination**

Ischnocnema simmonsii Lynch, 1974.

***Oreobates saxatilis* (Duellman, 1990), new combination**

Ischnocnema saxatilis Duellman, 1990.

***Oreobates sanctaecrucis* (Harvey and Keck, 1995), new combination**

Ischnocnema sanctaecrucis Harvey and Keck, 1995.

***Oreobates sanderi* (Padial, Reichle and De la Riva, 2005), new combination**

Ischnocnema sanderi Padial, Reichle and De la Riva, 2005.

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Appendix I

Specimens Examined

Eleutherodactylus verrucosus.- BRAZIL: State of Minas Gerais: Juiz de Fora (ZMK 1180, holotype of *Leiuperus verrucosus*). State of Espírito Santo: Colatina, Rio Mutum (MNRJ 0121, holotype of *Eupsophus verrucosus*); Santa Teresa (MNRJ 16137, 28338-28341, 34899-34901); Cariacica (ZUEC 9188-9189, MNRJ 28413); Aracruz (CFBH 2180, MNRJ 17746-17747).

Eleutherodactylus octavioi.- BRAZIL: State of Rio de Janeiro: Rio de Janeiro, Tijuca (MZUSP 73670, holotype, MZUSP 73560-73562, 73591-73594, 73604-73608, 73630-73635, 73637-73639, 73672, 74425, 74475-74477, paratypes, MZUSP 74429, 120799-120802, MNRJ 3977, 16135-16136, 17190-17191).

Eleutherodactylus juipoca.- BRAZIL: State of São Paulo: Campinas, Souzas (MNRJ 4103, holotype). State of Minas Gerais: Presidente Olegário, Estação Biológica Vereda Grande (MNRJ 16629-16631).