

## Frogs of the Genus *Paratelmatobius* (Anura: Leptodactylidae) with Descriptions of Two New Species

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Two new species of *Paratelmatobius* are described from the Atlantic Forest of São Paulo State, southeastern Brazil. The vocalization, tadpole, and natural history of one new species are described. Natural history observations of *P. poecilogaster* are reported, including the description of a specialized reproductive mode. Diagnoses, measurements, figures, color in life, and distributional data for the species of *Paratelmatobius* are provided.

Dois novas espécies de *Paratelmatobius* são descritas da Mata Atlântica do Estado de São Paulo, Sudeste do Brasil. As vocalizações, o girino e a história natural de uma das espécies novas são descritos. São apresentadas observações sobre a história natural de *P. poecilogaster*, incluindo a descrição de um modo reprodutivo especializado. São apresentadas diagnoses, medidas, figuras, coloração em vida e dados de distribuição para as espécies de *Paratelmatobius*.

THE genus *Paratelmatobius* was described by B. Lutz and Carvalho (1958) to accommodate a new species, *P. lutzii*. In their paper, they presented a diagnosis prepared by A. Lutz of another species of the genus, *P. pictiventris*, with a black-and-white plate (the original plate is a water color). The two specimens referred to this species by A. Lutz were not in the Adolpho Lutz collection (B. Lutz and Carvalho, 1958). However, Cochran (1938), who had previously received these two specimens, assigned them to a new species using the name *Leptodactylus gaigeae* and later (Cochran, 1955) provided a detailed description of this species. Bokermann (1966) was the first to combine the specific name *gaigeae* with the generic name *Paratelmatobius* and synonymized *P. pictiventris* with *P. gaigeae*. Recently, Giaretta and Castanho (1990) described *P. poecilogaster* from Paranapiacaba, southeastern Brazil, and Cardoso and Haddad (1990) redescribed *P. gaigeae* based on specimens from two localities, Paranapiacaba and Boracéia, in the Serra do Mar (coastal range), southeastern Brazil. For this redescription, Cardoso and Haddad (1990) could not examine the type specimens (see below). Thus, currently three species are recognized for the genus: *P. gaigeae* (Cochran, 1938), *P. lutzii* B. Lutz and Carvalho, 1958, and *P. poecilogaster* Giaretta and Castanho, 1990. Specimens of the genus *Paratelmatobius* are rare in herpetological collections; species in this genus are endemic to the Atlantic Forest in southeastern Brazil, being known from few localities in the Serra do Mar and Serra da Mantiqueira. The diagnosis of the genus was provided by B. Lutz and Carvalho (1958) and

Lynch (1971) and further modified by Cardoso and Haddad (1990).

We analyzed museum specimens of the genus *Paratelmatobius* (except for *P. gaigeae*; see below), color slides, or water color plates including the original color plate of *P. pictiventris* (= *P. gaigeae*). In this paper, we provide diagnoses for the species of this genus, describe two new species (including the species previously considered as *P. gaigeae* by Cardoso and Haddad, 1990), and provide information on the natural history of *P. lutzii*, *P. poecilogaster*, and one of the new species.

### MATERIALS AND METHODS

Museum abbreviations of specimens used in the descriptions or examined for comparisons follow Leviton et al. (1985) except for CFBH (Célio F. B. Haddad collection, deposited in the Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, Brazil). Abbreviations used in the measurements of the adults are SVL (snout-vent length), HL (head length), HW (head width), ED (eye diameter), IOD (interorbital distance), TD (tympanum diameter), END (eye-nostril distance), IND (internasal distance), THL (thigh length), TBL (tibia length), and FL (foot length). All measurements are in millimeters. The measurements of the adults follow Duellman (1970) and Cei (1980). For measurements, we used an ocular micrometer in a Zeiss stereomicroscope, except for SVL and total length of tadpoles which were measured with a caliper. Drawings of the adults and tadpole were made using a Zeiss stereomicroscope with a drawing tube. Tooth row formulae of tad-

poles follows Altig (1970). For statistical analyses we used Student's *t*-test (*t*) with significance level of 0.05 (Zar, 1996).

#### SPECIES ACCOUNTS

##### *Paratelmatobius cardosoi* sp. nov.

Figures 1A, 2A, 3A, 4A

*Paratelmatobius gaigeae*: Cardoso and Haddad, 1990:125.

**Holotype**.—MNRJ 18795, an adult male, collected in the pathway to Pedra Lisa waterfall, Paranaipiacaba (approximately 23°45'W; 46°22'S), Município de Santo André, Estado de São Paulo, Brazil, on 18–20 December 1989 by C. F. B. Haddad and A. A. Giaretta.

**Paratopotypes**.—CFBH 862-65 (one juvenile, one adult female, and two adult males), MNRJ 18796, 18908-09 (two adult males and one juvenile, respectively) collected with the holotype; MNRJ 18910-11 (two adult males) collected on 26–27 January 1990 by A. A. Giaretta; MZUSP 65374-75 (two adult males), USNM 286807 (adult male), ZUEC 6683 (adult male) collected on 23 January 1988 by A. J. Cardoso and A. A. Giaretta.

**Diagnosis and comparison with other species**.—A small species of the genus *Paratelmatobius* (males 17.0–17.9 mm SVL) characterized by: snout not flat; snout rounded in lateral view; tympanum visible; vocal slits present; absence of tubercles on the upper eyelid; weakly developed tubercle at base of mandible; dorsolateral fold weakly developed; fingers free, not fringed; nuptial pad with spicules on first finger; first finger longer than second; tip of third finger pointed; foot fringed, not webbed; tips of the toes not dilated; inner surface of the first toe not fringed; flanks rugose; in life ventral surfaces blotched with orange; in preservative, the blotches fade to cream.

*Paratelmatobius cardosoi* differs from *P. gaigeae* by its less flat snout, tympanum visible (Fig. 2A), absence of tarsal ridge, absence of tubercle on the upper eyelid, dorsolateral fold weakly developed (well developed in *P. gaigeae*), fingers not fringed (fringed in *P. gaigeae*; Cochran, 1955), in life belly with orange blotches (red in *P. gaigeae*; Fig. 1B). The new species differs from *P. lutzii* by its smaller size (in *P. lutzii* males and females 19.2–23.3 mm SVL;  $\bar{x}$  = 21.1, SD = 1.28, n = 14), tympanum visible (Fig. 2A–B), flanks rugose, head not flat, vocal slits present (absent in *P. lutzii*), dorsolateral fold weakly developed

(well developed in *P. lutzii*), in males nuptial pad with spicules (in *P. lutzii* nuptial pad without spicules), second finger shorter than first (in *P. lutzii* second finger longer than first; Fig. 3A–B), tip of the third finger pointed (rounded in *P. lutzii*), toes fringed (webbed in *P. lutzii*; Fig. 4A–B), inner surface of the first toe not fringed (webbed in *P. lutzii*), in life belly blotched with orange (ventral surfaces black with white and red stains in *P. lutzii*; Fig. 1C). From *P. mantiqueira*, *P. cardosoi* differs in its larger size (in *P. mantiqueira* males are 14.4–16.7 mm SVL; *t* = 4.42, *P* = 0.001), tympanum smaller (in males, *P. cardosoi* TD/ED 0.47–0.82; in *P. mantiqueira* 0.73–1.2), dorsolateral fold weakly developed (moderately developed in *P. mantiqueira*); tip of the third finger pointed (rounded in *P. mantiqueira*; Fig. 3A,C), a weakly developed tubercle on base of mandible (well developed in *P. mantiqueira*). From *P. poecilogaster*, *P. cardosoi* is distinguished by its smaller size (in *P. poecilogaster* males are 20.0–26.6 mm SVL; Giaretta and Castanho, 1990), tympanum visible (Fig. 2A,D), absence of a small round tubercle on the edge of the upper eyelid (present in *P. poecilogaster*), dorsolateral fold weakly developed (well developed in *P. poecilogaster*), first finger longer than second (first finger shorter than second in *P. poecilogaster*; Fig. 3A,D), toe tips not dilated (dilated in *P. poecilogaster*), tip of the third finger pointed (rounded in *P. poecilogaster*), inner surface of the first toe not fringed (fringed in *P. poecilogaster*; Fig. 4A,D), flanks rugged, in life belly blotched with orange (ventral surfaces orange and red with black and white blotches in *P. poecilogaster*; Fig. 1A,D).

**Description of holotype**.—Body robust (Fig. 1A); head wider than long; snout rounded in dorsal and lateral views (Fig. 2A); eyes large, protuberant; nostrils slightly protuberant, dorsolateral; canthus rostralis weakly distinct, loreal region concave; tympanum weakly visible, medium-sized, diameter about half of eye diameter; supratympanic fold weakly developed; dorsolateral fold weakly developed from behind eye to middle of body; weakly developed tubercle on the base of the mandible; a single, small tooth-like process in front of lower jaw, with socket in between premaxillae; numerous teeth on maxilla; vomerine teeth in two small series, weakly distinct, between and behind choanae; choanae small, oval; tongue medium-sized; vocal slits present; pectoral fold present. Forelimbs robust; fingers short, robust; prepollex absent; finger lengths II < I < IV < III; tips of first, second, and fourth fingers rounded, third finger with pointed tip (Fig. 3A); fingers not webbed nor

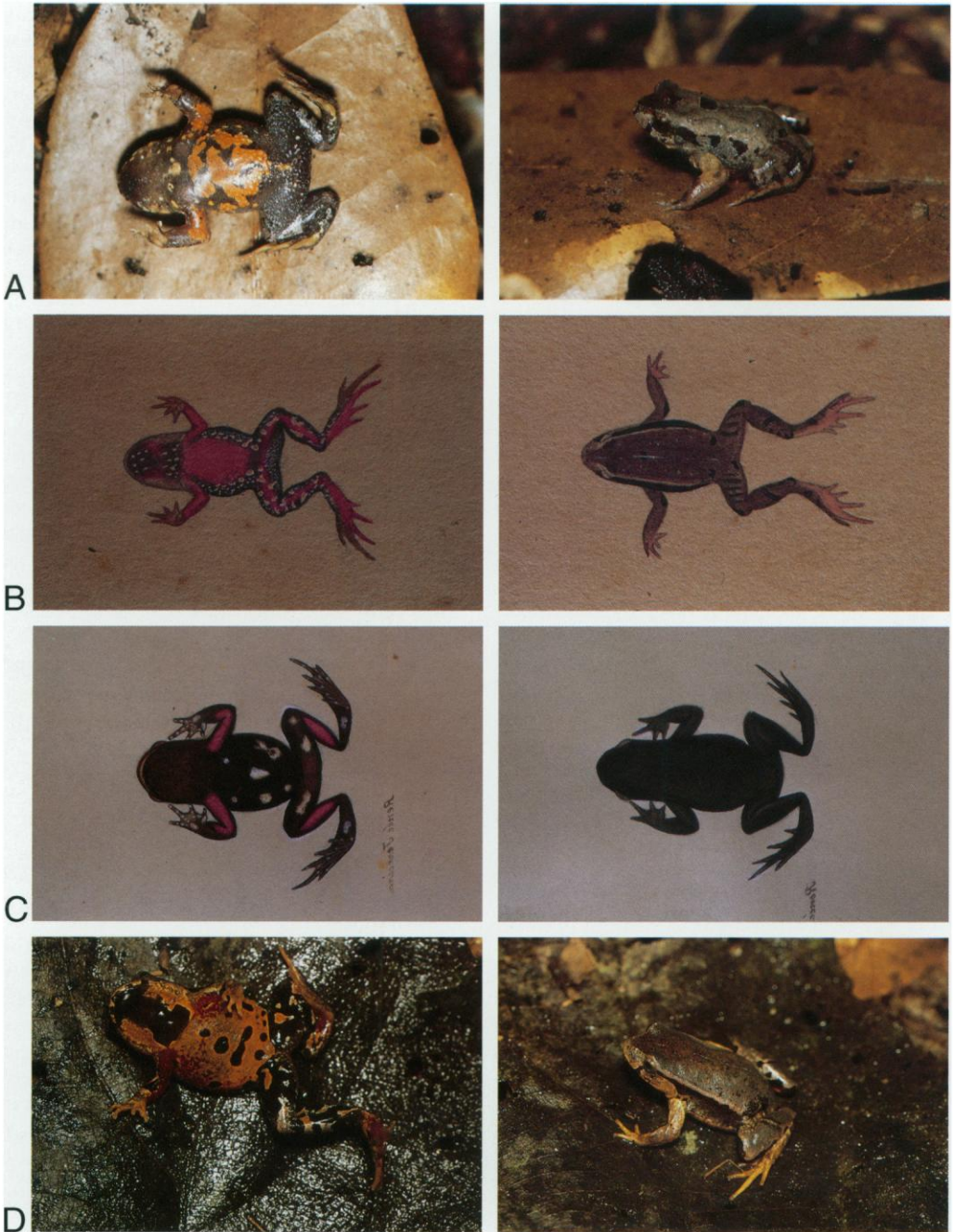
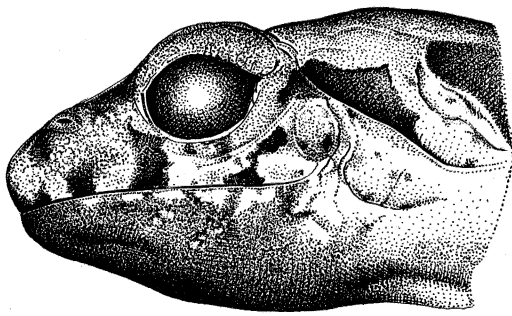


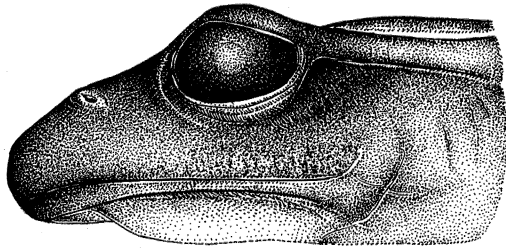
Fig. 1. Ventral and dorsal views of species in the genus *Paratelmatobius*. (A) *Paratelmatobius cardosoi*, topotype; (B) *Paratelmatobius gaigeae*, water color of the type (or types); (C) *Paratelmatobius lutzii*, water color of the holotype, MNRJ 2180; (D) *Paratelmatobius poecilogaster*, topotype, CFBH 0865.

fringed; thumb very robust, with a large brown spinous pad covering most of inner and dorsal surfaces; large subarticular tubercle, nearly triangular on the first finger; rounded basal tubercles on second, third, and fourth fingers;

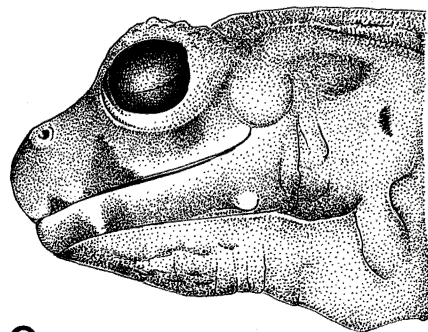
three metacarpal tubercles, outer larger and nearly oval, inner elliptical, and medial nearly trapezoid. Legs moderately slender; toes short, robust; toe tips nearly rounded; toe lengths  $I < II < V < III < IV$ ; toes not webbed; toe sides with



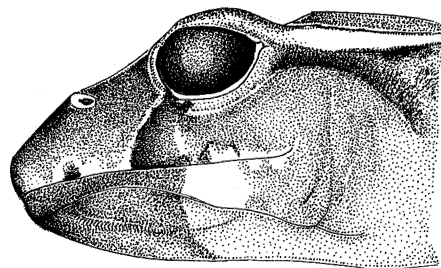
A



B

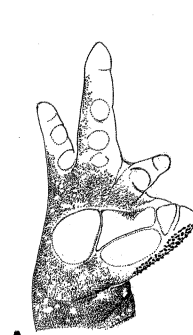


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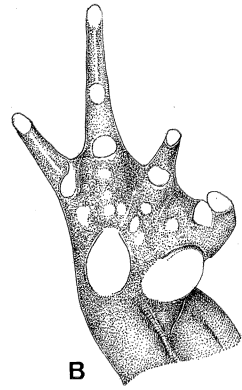


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Fig. 2. Lateral views of the heads of (A) *Paratelmatobius cardosoi*, holotype MNRJ 18795; (B) *Paratelmatobius lutzii*, holotype MNRJ 2180; (C) *Paratelmatobius mantiqueira*, holotype MZUSP 15133; (D) *Paratelmatobius poecilogaster*, paratopotype ZUEC 6839 (scale = 2.0 mm).



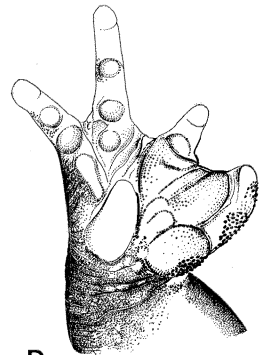
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Fig. 3. Ventral views of the hands of (A) *Paratelmatobius cardosoi*, holotype MNRJ 18795; (B) *Paratelmatobius lutzii*, holotype MNRJ 2180; (C) *Paratelmatobius mantiqueira*, holotype MZUSP 15133; (D) *Paratelmatobius poecilogaster*, paratopotype ZUEC 6839 (scale = 2.0 mm).

developed fringes, fringes joined at the base; preaxil surface of first toe not fringed; subarticular tubercles single, round, and weakly developed; foot with a large elliptical inner metatarsal tubercle and a small protruding round outer metatarsal tubercle (Fig. 4A). Belly and dorsal skin texture nearly smooth; ventral surfaces of legs and sides of body rugose.

*Color in life.*—Dorsum pale gray; dorsal spots, bars, and stripes black; yellow vertebral line; external margin of mandibulae, near articulation with maxillae, with two orange spots; venter gray; throat and ventral surface of thighs gray with yellow dots; belly with large orange spots of irregular shape; large orange spot ventrally, between arm and forearm (Fig. 1A).

*Color of the holotype in preservative.*—Dorsum brown with scattered white dots; a dark inverted

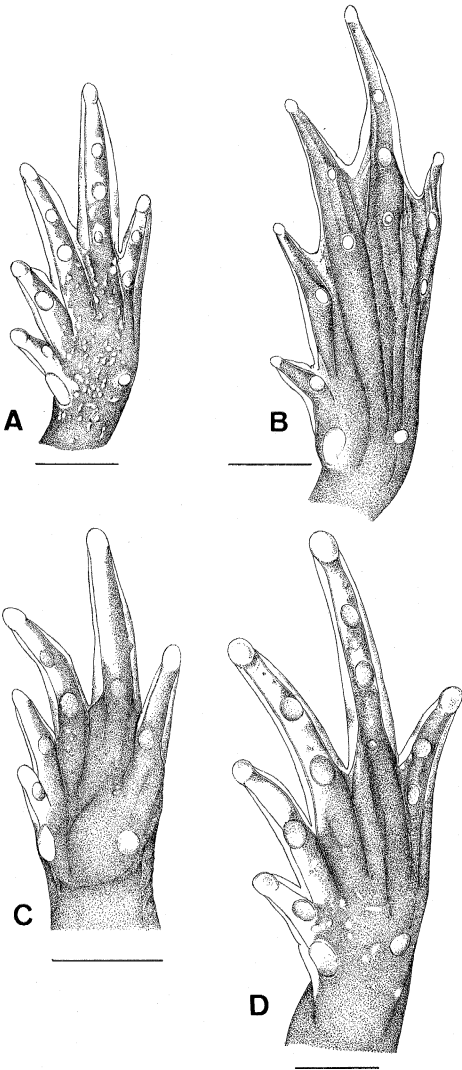


Fig. 4. Ventral views of feet of (A) *Paratelmatobius cardosoi*, holotype MNRJ 18795; (B) *Paratelmatobius lutzii*, holotype MNRJ 2180; (C) *Paratelmatobius manti-queira*, holotype MZUSP 15133; (D) *Paratelmatobius poecilogaster*, paratopotype ZUEC 6839 (scale = 2.0 mm).

triangular interocular spot; dark rectangular spot on scapular region; whitish vertebral line from rectangular spot to vent; three dark blotches on upper lip (Fig. 2A); interrupted dark lateral stripe extending from posterior corner of eye to groin; dark irregular spots above groin; forelimb with dark irregular spots; hind limb with dark transverse stripes; throat brown with white dots of irregular size; belly brown with large cream spots of irregular shape; large white spot ventrally, between arm and forearm.

*Measurements of the holotype.*—SVL 17.3, HL 3.9, HW 6.1, TD 0.9, ED 1.9, IOD 2.6, END 1.7, IND 1.8, THL 6.9, TBL 7.4, FL 7.5.

*Variation.*—In preservative, dorsum brown to grayish brown; cream spots of irregular shape and size, sometimes only one large cream blotch on belly; dark spot on scapular region may be nearly rectangular to triangular; vomerine teeth weakly to well developed; forelimb and thumb slender in females; nuptial pad absent in females; skin texture of flanks weakly rugose to strongly rugose; in female, toes weakly fringed. Measurements (mean, range, SD) of seven males, followed by one female in parentheses: SVL 17.13, 16.1–17.9, 0.60 (18.1); HL 4.48, 3.9–5.0, 0.40 (4.8); HW 6.59, 6.1–7.4, 0.42 (7.6); TD 1.04, 0.9–1.1, 0.11 (indistinct); ED 1.78, 1.4–1.9, 0.21 (1.7); IOD 2.69, 2.6–2.8, 0.10 (3.2); END 1.24, 1.1–1.3, 0.07 (1.3); IND 2.01, 1.7–2.4, 0.33 (1.95); THL 7.52, 6.9–8.0, 0.43 (7.4); TBL 7.78, 7.4–8.3, 0.34 (7.1); FL 7.6, 7.5–7.6, 0.07 (7.4).

*Vocalization.*—Isolated males emit short advertisement calls with a duration of approximately 0.07 sec. This vocalization is composed of two parts; the initial part has pulses of lower frequencies between 1.6 and 2.7 kHz; the final part has pulses of higher frequencies between 2.4 and 3.5 kHz (published sonagram in fig. 8a of Cardoso and Haddad, 1990). Neighboring males can interact vocally by emitting antiphonal calls. In this case, the advertisement calls have a duration of approximately 0.13 sec and frequencies between 3.0 and 4.0 kHz. The notes emitted by two males interacting antiphonally are different from each other; one of the males emits notes with ascending frequencies and the other emits notes with descending frequencies. Interacting males emit notes with a greater number of pulses than isolated males (published sonagrams in fig. 8b–c of Cardoso and Haddad, 1990).

*Tadpole.*—The following description is based on the description published in Cardoso and Haddad (1990). The described tadpole was obtained at the type locality, in developmental stage 37 (Gosner, 1960). Total length 26.4 mm; body length 10.3 mm; body ovoid in dorsal and lateral views; nostrils nearer to eyes than to tip of snout; eyes small (1 mm), dorsolateral; spiracle small (1.5 mm), sinistral, its opening at posterior half of body; cloacal tube median, medium sized, tail lanceolate; dorsal fin slightly higher than ventral (fig. 6 of Cardoso and Haddad, 1990).

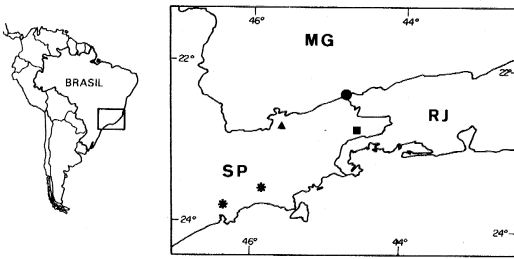


Fig. 5. Geographic distribution of species in the genus *Paratelmatobius*. Asterisk = *Paratelmatobius cardosoi* and *Paratelmatobius poecilogaster*; square = *Paratelmatobius gaigeae*; circle = *Paratelmatobius lutzii*; triangle = *Paratelmatobius mantiqueira*.

Oral disc directed ventrally, bordered by one row of small papillae on posterior labium; supernumerary papillae on corners of oral disc and on anterior labium; papillae absent on a large area of anterior labium; tooth row formula 2(2)/3(1); jaw sheaths developed and finely serrate; anterior jaw sheath U-shaped; posterior jaw sheath V-shaped (fig. 7 of Cardoso and Haddad, 1990).

In preservative, dorsum brown; flanks and snout translucent with brown vermiculations; iris black; throat and belly transparent with scattered brown vermiculations; hind limbs dark-brown with brown transversal stripes. The dark spot on the scapular region is observed in tadpoles after developmental stage 39 (Gosner, 1960).

**Natural history.**—Reproductive activity occurs during the wet season. Males call mainly during the night from the margins of small muddy ponds in forest, forest clearings, or forest edges. Amplexus is axillary and the female deposits approximately 20 eggs. The eggs are deposited scattered on the bottom of muddy ponds or adhered in groups of two to 10 eggs. Eggs are pigmented, with an average diameter of 1.66 mm (SD = 0.09; n = 8). Reproduction may be explosive; it is possible to find large egg aggregations. The eggs hatch into feeding tadpoles that live on the bottom of ponds. When disturbed males of *P. cardosoi* may stay for some seconds with the venter upward, showing the contrasting color pattern of the belly (Fig. 1A).

**Distribution.**—This species is known from the type locality and Boracéia, Salesópolis, São Paulo State (Fig. 5). Both localities are in the Serra do Mar range, southeastern Brazil.

**Etymology.**—The specific name honors the late Adão J. Cardoso (deceased on 20 February

1997) who first collected this species and showed interest in the identity of *Paratelmatobius gaigeae*.

**Comments.**—This species was considered as *P. gaigeae* (Cochran) by Cardoso and Haddad (1990). We observed specimens of *P. cardosoi* on four different field trips: three times at the type locality and on one occasion in Boracéia, Salesópolis, SP. It is widespread but not common at the type locality, occurring in different microhabitats (see natural history).

*Paratelmatobius gaigeae* (Cochran, 1938)

Figure 1B

*Leptodactylus gaigeae* Cochran, 1938:41. Type locality: “Bonito, Serra da Bocaina, near the boundary between Rio de Janeiro and São Paulo” (corrected here to Fazenda do Bonito, Serra da Bocaina, State of São Paulo, Brasil).

*Paratelmatobius pictiventris* A. Lutz in B. Lutz and Carvalho, 1958:240, pl. 2, figs. 5–6. Type locality: “third brook on the way from Bonito to Alambary” (Fazenda do Bonito, Serra da Bocaina, State of São Paulo, Brasil).

*Paratelmatobius gaigeae*: Bokermann, 1966:71.

**Diagnosis and comparison with other species.**—A large species of the genus *Paratelmatobius* (unsexed 19.0 mm SVL; Cochran, 1955) characterized by snout flat; tympanum indistinct (but see comments); small round tubercle on the edge of upper eyelid; first and second fingers of similar size; foot fringed, not webbed; a weak tarsal ridge; ventral and dorsal surfaces smooth (characters based on Cochran, 1955); in life, ventral surfaces red, with white dots on the border; in preservative the red fades.

*Paratelmatobius gaigeae* differs from *P. lutzii* by the presence of a tubercle on the upper eyelid, first and second fingers with similar size (in *P. lutzii* second finger longer than first; Fig. 3B), foot fringed (webbed in *P. lutzii*), in life, ventral surfaces red with white dots on the borders (in life ventral surfaces black with white and red stains in *P. lutzii*; Fig. 1B–C). From *P. mantiqueira*, *P. gaigeae* differs by snout flat (not flat in *P. mantiqueira*), tympanum indistinct (distinct in *P. mantiqueira*), belly with uniform color with white dots on the borders (belly with large cream blotches in *P. mantiqueira*; Figs. 1B, 6). From *P. poecilogaster*, *P. gaigeae* is distinguished by first and second fingers of similar size (second finger longer than first in *P. poecilogaster*; Fig. 3D), toe

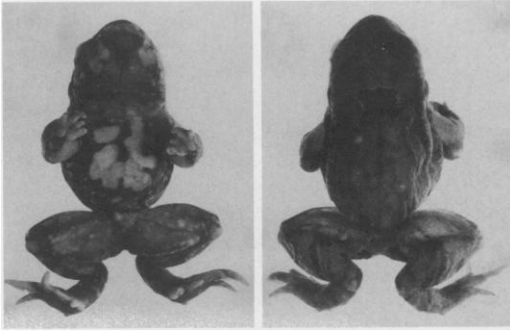


Fig. 6. Ventral and dorsal views of the holotype (MZUSP 15133) of *Paratelmatobius mantiqueira*.

tips not dilated (slightly dilated in *P. poecilogaster*; Fig. 4D), in life, ventral surfaces red, with white dots on the borders (ventral surfaces orange and red with black and white blotches in *P. poecilogaster*; Fig. 1B,D). For comparison with *P. cardosoi*, see above.

**Color in life.**—The following description is based on the original watercolor of *P. pictiventris* (= *P. gaigeae*; Fig. 1B). Dorsum and dorsal surfaces of limbs brown; black stripe on shank; whitish vertebral line and black spot visible in middle of dorsum; black spot on groin; whitish line from upper eyelid to groin; lateral dark brown stripe from eye through flank to groin; elbow black; throat red and dark gray with white dots; ventral surfaces of thigh, tibia, and foot red with white blotches and dots; ventral surfaces of arm and forearm red; belly red bordered by white blotches and dots in black background.

**Color in preservative.**—The following description is based on Cochran (1955): dorsal tone raw umber; brown stripe from eye to center of flank bordering glandular dorsolateral stripe below; dark diagonal stripe in front of eye to border of upper lip; pair of short dark stripes on tip of snout, and few small dark spots along edge of upper lip; some small dark dots (or few apparent) on middorsal line just above shoulder; a wide brown stripe on anterior surface of femur and several very dark brown spots on outer side of shank; lower surfaces of thighs and shanks dark brown with light spots; center of belly dull, immaculate, its edges spotted; throat brown with minute light dots; throat dark with very small white spots; hand and feet dull, lightening on toes and fingers.

**Measurements of the holotype.**—According to Cochran (1955), the holotype, USNM 96759, shows the following measurements: SVL 19.0, HL 6.0,

HW 6.5, THL 7.0, FL 8.0, hand 4.0. See comments.

**Variation.**—In another individual (USNM 96760) the snout is less broadened in dorsal view, and has no trace of a tympanum (Cochran, 1955).

**Natural history.**—Unknown. B. Lutz and Carvalho (1958) comment that on the back of the original plate of *P. pictiventris* (= *P. gaigeae*) A. Lutz wrote that the two specimens were found together under dead leaves. However, on the back of the original plate we did not find any written information about natural history.

**Distribution.**—*Paratelmatobius gaigeae* is known only from the type locality, in the Serra da Bocaina, Serra do Mar range, southeastern Brazil (Fig. 5).

**Comments.**—Lynch (1971) considered *P. pictiventris* as a *nomen nudum*; however, this specific name is available. B. Lutz and Carvalho (1958) published a short diagnosis written by A. Lutz on the back of the original plate of *P. pictiventris*. Herein we present this original color plate (water color plate) of *P. pictiventris* (= *P. gaigeae*) made under the supervision of A. Lutz from one or both available specimens. In the notes of A. Lutz, on the back of this original plate, he did not refer to an external vocal sac as stated by Cochran (1955). Nevertheless, species in the genus *Paratelmatobius* do not have external vocal sacs (Lynch, 1971; present study). Also, Cochran (1955) did not cite a nuptial pad in *P. gaigeae*, a feature of all other species of this genus. So, we do not know the sex of the two specimens studied by A. Lutz (and cited by B. Lutz and Carvalho, 1958) and Cochran (1938, 1955). These two specimens, originally in USNM (see Cochran, 1938, 1955, 1961) and not in MNRJ as cited by Cardoso and Haddad (1990), cannot be found (W. R. Heyer, pers. comm.). The type locality of *P. gaigeae* was visited three times, but we never found specimens.

*Paratelmatobius lutzii* B. Lutz and Carvalho,  
1958

Figures 1C, 2B, 3B, 4B

*Paratelmatobius lutzii* B. Lutz and Carvalho, 1958: 241, pl. 1, figs. 1–4; pl. 2, figs. 1–2; pl. 3–5. Type locality: “Brejo da Lapa, Alto do Itatiaia, State of Rio de Janeiro” (corrected here to Brejo da Lapa, Alto do Itatiaia, municipality of Itamonte, State of Minas Gerais, Brasil).

*Diagnosis and comparison with other species.*—A large species of *Paratelmatobius* (SVL 19.2–23.3 mm) characterized by: snout flat; tympanum indistinct; vocal slits absent in males; dorsolateral fold well developed; absence of tubercle on edge of upper eyelid; absence of tubercle on base of mandible; fingers free, not fringed; nuptial pad on first finger without spicules; first finger shorter than second; tip of the third finger rounded; foot webbed, not fringed; tips of the toes not dilated; inner surface of the first toe webbed; ventral and dorsal surfaces smooth; in life, ventral surfaces black with white and red stains; in preservative, ventral surfaces are black with cream stains.

*Paratelmatobius lutzii* is distinguished from *P. mantiqueira* by its larger size (in *P. mantiqueira* males and females 14.4–19.3 mm SVL), flat snout (not flat in *P. mantiqueira*), tympanum indistinct (distinct in *P. mantiqueira*; Fig. 2B–C), absence of a tubercle at base of mandible (present in *P. mantiqueira*), vocal slits absent in males (present in *P. mantiqueira*), absence of tubercles on upper eyelid (present in *P. mantiqueira*), nuptial pad without spicules (with spicules in *P. mantiqueira*; Fig. 3B–C), foot webbed (fringed in *P. mantiqueira*; Fig. 4B–C). *Paratelmatobius lutzii* differs from *P. poecilogaster* by the absence of the tubercle on the upper eyelid (present in *P. poecilogaster*), foot webbed (fringed in *P. poecilogaster*; Fig. 4B,D), nuptial pad without spicules (with spicules in *P. poecilogaster*), tips of the toes not dilated (dilated in *P. poecilogaster*), in life, ventral surfaces black with white and red stains (ventral surfaces orange and red with black and white blotches in *P. poecilogaster*; Fig. 1C,D). For comparison with *P. cardosoi* and *P. gaigeae*, see above.

*Color in life.*—The following description is based on the water color plate of the holotype (Fig. 1C) and color slides. Dorsum dark brown; in some specimens canthus rostralis, loreal region, and snout are pale green instead of dark brown; throat brown; ventral surface of thigh gray with white blotches; ventral surfaces of tibia, arm, and forearm red; inner carpal surfaces with a gray blotch on a dark brown background; ventral surfaces black with white and red blotches.

*Variation.*—In preservative, dorsum dark brown to light brown; throat brown, sometimes light brown; ventral surfaces with cream stains, of variable shape, sizes, and arrangement; vomerine teeth weakly to well developed; in females, forearms and foot web less developed than in males. Measurements (mean, range, SD) of seven males, followed by eight females in parentheses:

SVL 20.69, 19.3–22.2, 1.11 (21.75, 19.2–23.3, 1.23); HL 6.04, 5.4–7.0, 0.54 (6.13, 5.8–6.5, 0.31); HW 8.19, 7.5–8.6, 0.35 (8.14, 7.3–8.8, 0.55); ED 2.19, 1.8–2.4, 0.20 (2.13, 1.8–2.4, 0.18); IOD 3.25, 2.8–3.7, 0.33 (3.33, 3.0–4.0, 0.35); END 1.43, 1.3–1.7, 0.13 (1.72, 1.4–2.3, 0.28); IND 1.9, 1.9–1.9, 0.0 (1.9, 1.4–2.0, 0.21); THL 9.3, 8.4–10.2, 0.65 (9.3, 8.5–9.9, 0.41); TBL 9.6, 9.3–10.1, 0.36 (9.8, 9.3–10.6, 0.43); FL 11.48, 10.5–12.2, 0.65 (11.6, 10.9–11.9, 0.42).

*Tadpole.*—Heyer (1976) and Wassersug and Heyer (1988) described the presumed tadpole of *P. lutzii*, but the described tadpole is most certainly not a *Paratelmatobius* (see Discussion).

*Natural history.*—The natural history of this species is poorly known. The two dissected females have pigmented ovules. One female had 23 ovules with an average diameter of 1.9 mm (SD = 0.13; n = 10), and another had 31 ovules with average diameter of 2.2 mm (SD = 0.19; n = 9). In the past, specimens of *P. lutzii* were easily observed and collected at Brejo da Lapa, Alto do Itatiaia, sheltered amid mosses and under rocks. The examined specimens were collected in January, February, March, November, and December (wet season) between the years of 1957 and 1974; also specimens were collected in January 1976 (W. R. Heyer, pers. comm.) and January 1978 (ZUEC 8132, and 8137).

*Distribution.*—*Paratelmatobius lutzii* is known only from the type locality at Alto do Itatiaia, in the Serra da Mantiqueira, State of Minas Gerais, Atlantic Forest, southeastern Brazil (Fig. 5).

*Comments.*—The type locality of *P. lutzii* was visited seven times, but we never found specimens. Specimens have not been observed since 1978.

*Paratelmatobius mantiqueira* sp. nov.

Figures 2C, 3C, 4C, 6

*Holotype.*—MZUSP 15133, an adult male, collected at Cidade Azul (approximately 22°51' S; 45°44' W), Município de Campos do Jordão, Estado de São Paulo, Brazil, on 5 November 1953, by C. Gans.

*Paratopotypes.*—MZUSP 15134, 15137, 15139, 15140, 15142 (five adult males), MZUSP 15128–132, 15135–136, 15138, 15141 (nine adult females), all collected with the holotype.

*Diagnosis and comparison with other species.*—The smallest species of the genus *Paratelmatobius* (males 14.4–16.7 mm SVL) characterized by



small size; snout not flat; snout rounded in lateral view; tympanum visible; vocal slits present; tubercles on upper eyelid; well-developed tubercle at base of mandible; dorsolateral fold developed; fingers free, not fringed; nuptial pad on first finger with spicules; first finger longer than second; tip of third finger rounded; foot fringed, not webbed; inner surface of first toe not fringed; tips of the toes not dilated; flanks rugose.

*Paratelmatobius mantiqueira* differs from *P. poecilogaster* by its smaller size (males of *P. poecilogaster* 19.8–20.3 mm SVL), snout not flat, tympanum distinct (indistinct in *P. poecilogaster*; Fig. 2C–D), vocal slits present in males (absent in *P. poecilogaster*), first finger longer than second (first finger shorter than second in *P. poecilogaster*; Fig. 3C–D), tips of the toes slightly dilated (dilated in *P. poecilogaster*; Fig. 4C–D), inner surface of the first toe not fringed (fringed in *P. poecilogaster*). For comparison with *P. cardosoi*, *P. gaigeae*, and *P. lutzii*, see above.

**Description of holotype.**—Body robust (Fig. 6); head wider than long; snout rounded in dorsal and lateral views (Fig. 2C); eyes medium-sized, protuberant; nostrils slightly protuberant, dorsolateral; canthus rostralis weakly distinct, loreal region concave; tympanum visible, nearly round, large; tympanum diameter more than half eye diameter; supratympanic fold weakly developed; dorsolateral fold from the posterior corner of eye to inguinal region; a developed tubercle at base of mandible; a single, small toothlike process in front of lower jaw, with a socket between premaxillae; numerous teeth on maxilla; vomerine teeth in two small series, weakly distinct, between and behind choanae; choanae small, oval; tongue medium-sized; vocal slits present; vocal sac indistinct; pectoral fold present. Forelimbs robust; fingers short, robust; prepollex absent; finger lengths  $II < I < IV < III$ ; tips of fingers rounded (Fig. 3C); fingers not webbed nor fringed; thumb very robust, with large brown spinous pad covering most of inner and dorsal surfaces; nearly round basal subarticular tubercles on second, third, and fourth fingers; two metacarpal tubercles, outer larger and nearly oval, inner nearly elliptical. Legs moderately slender; toes short, robust; toe tips nearly rounded; toe lengths  $I < II < V < III < IV$ ; toes not webbed; toe sides with developed fringes, fringes joined at base; first toe with inner side not fringed; toes with weakly developed, rounded, basal subarticular tubercles; foot with a large, elliptical inner metatarsal tubercle and a small, protruding, round

outer metatarsal tubercle (Fig. 4C). Belly and dorsal skin texture nearly smooth; small tubercles on upper eyelid; ventral surfaces of legs and sides of body rugose.

**Color of the holotype in preservative.**—Dorsum brown; a dark rectangular spot on scapular region; two dark stripes on upper lip (Fig. 6); an interrupted dark lateral stripe extending from posterior corner of eye to groin; dark irregular spots above groin; forelimb with dark irregular spots; hind limb with dark transverse bars; throat brown with white dots of irregular sizes; belly brown with large cream blotches of irregular shapes; a large white spot ventrally, between arm and forearm. Color in life unknown.

**Measurements of the holotype.**—SVL 14.4, HL 4.6, HW 5.7, TD 1.1, ED 1.5, IOD 2.0, END 0.9, IND 1.5, THL 6.1, TBL 6.5, FL 5.6.

**Variation.**—In preservative, dorsum brown to dark brown; cream spots of irregular shape and size, sometimes only one large cream blotch on belly; dark spot on scapular region may be nearly rectangular, triangular, of irregular shape, or absent; snout, upper eyelid, and dorsolateral fold with or without white dots; vomerine teeth weakly to well developed; forelimbs and thumb slender in females; tubercle at base of mandible weakly to well developed; nuptial pad absent in females; in females toes weakly fringed. Measurements (mean, range, SD) of six males, followed by nine females in parentheses: SVL 15.3, 14.4–16.7, 0.93 (16.8, 15.0–19.3, 1.17); HL 4.79, 4.6–5.3, 0.24 (5.08, 4.5–5.8, 0.46); HW 5.9, 5.5–6.2, 0.25 (6.31, 5.9–7.6, 0.52); TD 1.08, 1.0–1.2, 0.08 (1.15, 1.0–1.9, 0.16); ED 1.3, 0.9–1.5, 0.19 (1.45, 0.9–1.8, 0.32), IOD 2.20, 2.0–2.3, 0.14 (2.34, 2.1–2.9, 0.28), END 0.95, 0.8–1.1, 0.10 (0.94, 0.8–1.0, 0.31), IND 1.62, 1.4–1.9, 0.21 (1.74, 1.3–2.3, 0.31), THL 6.31, 6.0–6.6, 0.23 (6.60, 6.1–7.4, 0.40), TBL 6.87, 6.5–7.3, 0.29 (6.81, 6.2–7.5, 0.34), FL 6.04, 5.6–6.5, 0.31 (6.17, 5.5–7.0, 0.43).

**Distribution.**—This species is known only from the type locality in the Serra da Mantiqueira, São Paulo State, southeastern Brazil (Fig. 5).

**Etymology.**—“Mantiqueira” is a Tupi indigenous name, here used as a noun in apposition. Serra da Mantiqueira is the name for the Brazilian mountain range where the new species was collected. Its meaning is “home of the rain” (*amanty* = rain; *querá* = home or a place for stopping overnight).

*Natural history.*—Unknown. The type series was collected in January (wet season). A dissected female (MZUSP 15135) had approximately 40 pigmented ovules with an average diameter of 1.46 mm (SD = 0.04; n = 10).

*Paratelmatobius poecilogaster* Giaretta and Castanho, 1990

Figures 1D, 2D, 3D, 4D

*Paratelmatobius poecilogaster* Giaretta and Castanho, 1990:133. Type locality: "Paranapiacaba" (municipality of Santo André, State of São Paulo, Brazil).

*Paratelmatobius gaigeae*: Heyer et al., 1990:311, figs. 39–40.

*Diagnosis.*—The largest species in the genus *Paratelmatobius* (SVL males 20.0–26.0 mm, and females 25.2–30.1 mm; Giaretta and Castanho, 1990) characterized by snout flat; tympanum indistinct (Fig. 2D); vocal slits absent in males; dorsolateral fold well developed; absence of tubercle at base of mandible; small tubercle on edge of upper eyelid; fingers free, not fringed; nuptial pad on first finger with spicules; first finger shorter than second; tip of third finger rounded; foot fringed, not webbed; inner surface of first toe not fringed; tips of the toes dilated; presence of tubercle on heel; in life, ventral surfaces orange with black, red, and white blotches; in preservative, ventral surfaces cream with black stains. For comparison with other species, see above.

*Color in life.*—The following description is based on color slides (Fig. 1D) and on the original description (Giaretta and Castanho, 1990). Dorsum and dorsal surfaces of limbs brown (in some individuals dorsum green) with green dots that may be fused in a vertebral line of variable size (in some individuals vertebral line is blue); thigh and shank with two fine, dark brown lines; a pink line from back of eye to groin; a lateral dark gray stripe from posterior corner of eye through flank to groin; a dark bar between upper lip and eye (Fig. 2D); throat black on middle and orange on borders; belly orange and red with black and sometimes white blotches; ventral surfaces of thigh and shank black with white and orange blotches; ventral surfaces of arm and forearm red; dorsal surfaces of the digits cream.

*Variation.*—In preservative, dorsum brown to light brown, belly cream with black blotches of variable shape and arrangement; vomerine

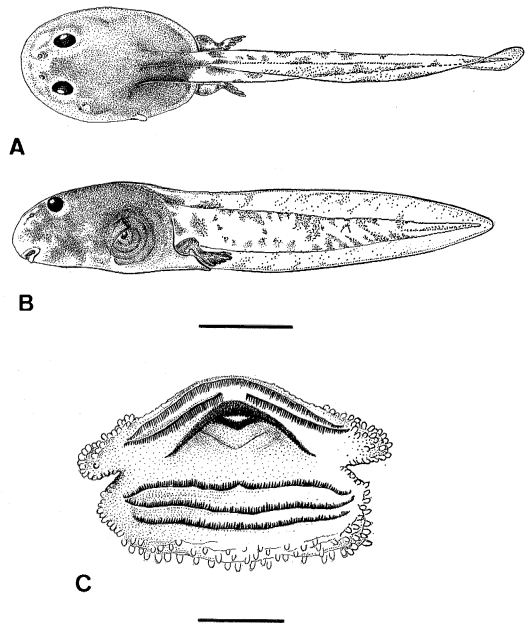


Fig. 7. Tadpole of *Paratelmatobius poecilogaster*, stage 37; (A) dorsal, and (B) lateral views (scale = 5.0 mm); (C) oral disc (scale = 0.5 mm).

teeth weakly to well developed. Measurements (mean, range, SD) of three males, followed by two females in parentheses: SVL 20.13, 19.8–20.3, 0.29 (26.05, 21.8–30.3, 6.01); HL 6.33, 6.1–6.6, 0.27 (7.9, 6.9–8.9, 1.41); HW 8.2, 7.8–8.7, 0.46 (10.1, 9.2–11.0, 1.27); ED 2.04, 1.8–2.2, 0.20 (2.25, 1.9–2.6, 0.49); IOD 3.38, 2.9–3.6, 0.34 (4.15, 3.5–4.8, 0.91); END 1.86, 1.5–2.3, 0.42 (2.05, 1.8–2.3, 0.35); IND 2.12, 1.9–2.2, 0.15 (2.35, 2.0–2.7, 0.49); THL 10.57, 10.2–10.7, 0.27 (12.25, 10.4–14.1, 2.6); TBL 10.62, 10.4–10.9, 0.27 (11.9, 10.6–13.2, 1.84); FL 11.05, 10.6–11.7, 0.57 (12.7, 11.7–13.7, 1.41).

*Tadpole.*—Larvae were obtained from eggs collected at the type locality in Paranapiacaba, Santo André, São Paulo State. The following description is based on a tadpole in developmental stage 37 (Gosner, 1960). Total length 25.8 mm; body length 8.1 mm; body ovoid in dorsal view (Fig. 7A), and depressed/globular in lateral view (Fig. 7B); nostrils nearer eyes than tip of snout; eyes small (0.7 mm), dorsolateral; spiracle small (0.6 mm), sinistral, its opening at posterior half of body; cloacal tube median, medium sized; tail lanceolate; dorsal fin higher than ventral.

Oral disc directed ventrally, bordered by three rows of small papillae on posterior labium; papillae absent on large area on anterior labium; tooth row formula 2(2)/3(1); jaw

sheaths developed and finely serrate; anterior jaw sheath U-shaped; posterior jaw V-shaped (Fig. 7C).

In preservative, dorsum brown; flanks and snout translucent with brown vermiculations; iris black; throat and belly transparent with scattered brown vermiculations.

*Natural history.*—Reproductive activity occurs during the wet season. Males aggregate in the dry bed of temporary rivulets in rough ground; they call mainly during the night from the margins of small subterranean ponds under large boulders, inside the forest. Amplexus is axillary; the eggs are terrestrial, being deposited hanging on humid rocks above the water. The eggs have large and sticky gelatinous capsules that adhere to each other forming an adhered egg mass on the rock surface. In December 1989, one of us (CFBH) observed two egg masses 5 cm apart; one with five and the other with 13 eggs, both deposited on a rock surface that was humid and at an angle of approximately 45° to the water surface. The eggs hatch into feeding tadpoles that drop into and live on the bottom of ponds. Heavy rains inundate the dry rivulets and tadpoles and adults may be carried downstream (Giaretta and Castanho, 1990). During the day, specimens of *P. poecilogaster* may be observed sheltering under rocks, logs, and leaves on the forest floor, near the ponds. When disturbed, individuals of *P. poecilogaster* may stay for some seconds with the venter upwards, showing the contrasting color pattern of the ventral surfaces (Fig. 1D). The vocalizations were described in Giaretta and Castanho (1990).

*Distribution.*—This species is known from Boracéia, Salesópolis (see Heyer et al., 1990, where this species was considered *P. gaigeae*) and from the type locality at Paranapiacaba, Santo André, São Paulo State. Both localities (Fig. 5) are in the Serra do Mar range, southeastern Brazil.

*Comments.*—Heyer et al. (1990) considered this species as *P. gaigeae* (Cochran). Apparently *P. poecilogaster* is very similar to *P. gaigeae*. The two specimens of *P. gaigeae* studied by Cochran (1938, 1955, 1961) are not available for examination (see above); consequently we cannot evaluate the details from Cochran's (1955) description. Therefore, we prefer to consider *P. gaigeae* and *P. poecilogaster* as two distinct species, mainly based on color of the venter in life. The type locality of *P. poecilogaster* was visited three times; we found specimens only in a specific microhabitat (see Natural history) in a small area (approximately 80 m<sup>2</sup>) inside the forest.

## DISCUSSION

In the diagnosis of the genus *Paratelmatobius*, Lynch (1971) cited the presence of the frontoparietal fontanelle and males with nuptial pads on the first two fingers. The four species herein examined (*P. cardosoi*, *P. lutzii*, *P. mantiqueira*, and *P. poecilogaster*) have nuptial pads only on the first finger. The nuptial pad bears spicules in *P. cardosoi*, *P. mantiqueira*, and *P. poecilogaster*. Lynch (1971) based his diagnosis for the genus *Paratelmatobius* on *P. lutzii*, and probably from the data in B. Lutz and Carvalho (1958). B. Lutz and Carvalho (1958) cited and figured a large tubercle (nuptial pad) on the first and second fingers; however, it is present only on the first finger in *P. lutzii* (the specimens figured by B. Lutz and Carvalho were also examined in the present study). Lynch (1971) indicated that the frontoparietal fontanelle is a diagnostic characteristic of the genus *Paratelmatobius*, but Cardoso and Haddad (1990) did not observe this character in *P. cardosoi*. As pointed out by Lynch (1971), *Scythrophrys sawayae* (Cochran) resembles *Paratelmatobius* in external appearance. In life, all species of *Paratelmatobius* are easily distinguished externally from *S. sawayae* by the belly with bright and contrasting colors (belly without bright and contrasting colors in *S. sawayae*).

Heyer (1976) and Wassersug and Heyer (1988) described the presumed tadpole of *Paratelmatobius lutzii*. This singular tadpole is very distinct from tadpoles known for the two other species of *Paratelmatobius* described herein. The presumed tadpole of *P. lutzii* shows a different tooth row formula (2/3; Heyer, 1976) from that observed for *P. cardosoi* and *P. poecilogaster* [2(2)/3(1); Cardoso and Haddad, 1990; Giaretta and Castanho, 1990; this study]. Also, the marginal papillae are not interrupted anteriorly in the presumed tadpole of *P. lutzii* and are interrupted in the tadpoles of *P. cardosoi* and *P. poecilogaster* (Cardoso and Haddad, 1990; Giaretta and Castanho, 1990; this study). The tadpole described by Heyer (1976) as *P. lutzii* is most certainly not a *Paratelmatobius*; in fact Heyer's description may be based on the tadpole of *Hyla gouveai* Peixoto and Cruz (W. R. Heyer, pers. comm.).

The genus *Paratelmatobius* is difficult to study because the species are usually rare, of limited distribution, and occur in small and specific microhabitats in the Atlantic Forest in the Serra do Mar and Serra da Mantiqueira. Three species (*P. cardosoi*, *P. gaigeae*, and *P. poecilogaster*) are known from forests in the highlands of the Serra do Mar range and two (*P. lutzii* and *P. mantiqueira*) in the highlands of Serra da Man-

tiqueira. *Paratelmatobius gaigeae* is only known from the two type specimens which cannot be found; *P. lutzii* is known only from the type locality, from specimens that were common in a limited area of some square meters; *P. poecilogaster* is known from an area of a few square meters at its type locality (pers. obs.), and in Boracéia apparently the situation is similar (Heyer et al., 1990). Only *P. cardosoi* has a more generalized distribution at the two localities from which it is known, occurring near small muddy ponds in forest, forest clearings, or forest edges. The four species of *Paratelmatobius* for which live specimens are known (*P. cardosoi*, *P. gaigeae*, *P. lutzii*, and *P. poecilogaster*) have bright and contrasting color patterns on the ventral surfaces. The function of this color pattern is not known, but possibly it constitutes a warning coloration (see Natural history of *P. cardosoi* and *P. poecilogaster*).

Two species groups can be recognized in the genus *Paratelmatobius*. The *P. cardosoi* group contains *P. cardosoi* and *P. mantiqueira*; this group is characterized by the presence of vocal slits, head not flat, dorsolateral fold not well developed, first finger longer than second, and inner side of the first toe not fringed or webbed. The *P. lutzii* group contains *P. lutzii*, *P. poecilogaster*, and probably *P. gaigeae*; this group is characterized by the absence of vocal slits, head flat, dorsolateral fold well developed, first finger not longer than second, and inner side of the first toe fringed or webbed. The Paraíba valley separates the two mountain ranges (Serra do Mar and Serra da Mantiqueira) where the species in the genus *Paratelmatobius* occur. In the *P. cardosoi* group, this valley separates *P. cardosoi* (in the Serra do Mar) from *P. mantiqueira* (in the Serra da Mantiqueira); in the *P. lutzii* group, the valley separates *P. lutzii* (in the Serra da Mantiqueira) from *P. gaigeae* and *P. poecilogaster* (in the Serra do Mar).

The reproductive mode observed for *P. cardosoi* is the most generalized: eggs and feeding tadpoles in ponds. However, *P. poecilogaster* has a specialized mode: terrestrial eggs on humid rocks near ponds and feeding tadpoles in ponds. Specialized reproductive modes similar to that observed for *P. poecilogaster* are known for phyllomedusine frogs (Lutz and Lutz, 1939), ranid frogs (Alcala, 1962), and telmatobiine frogs (Formas, 1976). Eggs placed on humid rocks are known for other Atlantic Forest leptodactylid frogs, such as *Thoropa* and *Cycloramphus*, but in these cases the tadpoles are semiterrestrial or fully terrestrial (Lutz, 1947, 1948; pers. obs.).

Today, *Paratelmatobius gaigeae*, *P. lutzii*, and *P. mantiqueira* may be considered as missing spe-

cies. The exact microhabitats of *P. gaigeae* and *P. mantiqueira* are not known; however, the exact place of occurrence of *P. lutzii* is well known, and specimens have not been seen since 1978. The highly complex topography of the Atlantic Forest is composed of many different small microhabitats, repeated across the landscape in similar situations, and most Atlantic Forest species have always lived in small populations, in small fragmented habitats (Brown and Brown, 1992). Thus, the possibility exists that *P. gaigeae*, *P. lutzii*, and *P. mantiqueira* have suffered local extinction and are still present in other suitable places of the Atlantic Forest. Reproductive specialization associated with specific microhabitats, as observed for *P. poecilogaster*, may explain the rarity and/or the local extinction of species of *Paratelmatobius*. *Paratelmatobius cardosoi*, which has the most generalized reproductive mode, is the most abundant species.

*Additional specimens examined.*—*Paratelmatobius cardosoi*: MNRJ 4867, ZUEC 6451–54, 6461–63, Boracéia, Salesópolis, SP; ZUEC 8944 (topotype, juv.). *Paratelmatobius lutzii*: EI 2749–50, 6973–79 (topotypes), MNRJ 717, 2180 (holotype), 2181–82 (paratopotypes, juv.), 5799, 17798, 18804–08, 18797, 18816–17, 18818, 18819–20 (topotypes), ZUEC 742, 744, 746, 760, 762, 8132–34, 8136, 8137 (topotypes), Alto Itatiaia, Itamonte, MG. *Paratelmatobius poecilogaster*: CFBH 866, MNRJ 18912 (topotype), ZUEC 6839–41 (paratypes), ZUEC 6810, 9847 (topotypes), CFBH (not numbered lot of tadpoles), Paranapiacaba, Santo André, SP; MZUSP 4063, 37700, Boracéia Salesópolis, SP. *Scythrophrys sawayae*: CFBH 2981 Rio Vermelho, São Bento do Sul, SC; EI 4818–20 Rio dos Cedros, SC; MNRJ 17024, Blumenau, SC; MNRJ 18085–86, Rancho Queimado, SC.

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