Journal of Herpetology, Vol. 37, No. 3, pp. 453–460, 2003

A New Species of Giant Torrent Frog, Genus *Megaelosia*, from the Atlantic Rain Forest of Espírito Santo, Brazil (Amphibia: Leptodactylidae)

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ABSTRACT.—**Herein is described a new species of leptodactylid frog from Pedra Azul, Municipality of Domingos Martins, State of Espírito Santo, southeastern Brazil. The new species is a member of the genus *Megaelosia*, and is characterized by large size; fold of fifth toe not reaching outer metatarsal tubercle; snout rounded in dorsal view and slightly protruding in lateral view; tympanum moderately small; finger tips with scutes fused to the subunguis and toe tips with a pair of scutes free of the subunguis; dorsal skin texture smooth; skin of the flanks without large granules; belly and throat predominantly gray with many, small yellow blotches; and distinct bilateral vocal sacs in males. The tadpole is described. The new species is the northern limit for the genus *Megaelosia*, and reinforces the high endemism and richness of the anuran fauna from Santa Teresa region, State of Espírito Santo, Brazil.**

The subfamily Hylodinae Günther, 1859 (Leptodactylidae) is composed of three genera: *Crossodactylus* Duméril and Bibron, 1841; *Hylodes* Fitzinger, 1826; and *Megaelosia* Miranda-Ribeiro, 1923 (Lynch, 1971; Frost, 1985). The species of these three genera are rheophilic and mainly associated with the Atlantic Rain Forest (Carcerelli and Caramaschi, 1992; Giaretta et al., 1993; Bastos and Pombal, 1995; Nascimento et al., 2001). *Megaelosia* currently includes five recognized species (Giaretta et al., 1993; Giaretta and Aguiar, 1998): *Megaelosia bocainensis* Giaretta, Bokermann, and Haddad, 1993, *Megaelosia boticariana* Giaretta and Aguiar, 1998, *Megaelosia goeldii* (Baumann, 1912), *Megaelosia lutzae* Izecksohn and Gouvêa, 1985, and *Megaelosia massarti* (De Witte, 1930). *Megaelosia* is endemic to Atlantic Rain Forest of the State of Espírito Santo to the State of São Paulo, Brazil (Giaretta et al., 1993; Giaretta and Aguiar, 1998). Specimens of *Megaelosia* are rare in collections because of their restricted distribution, cryptic behavior (Giaretta et al., 1993; Melo et al., 1995), difficulty of collection (Lutz, 1930), and low density. During a survey of the anuran fauna of the Pedra Azul, Municipality of Domingos Martins, located in the mountainous region of the State of Espírito Santo, Brazil, we collected specimens of a new species of the genus *Megaelosia* described herein.

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MATERIALS AND METHODS

Specimens used in the description or examined for comparisons are housed in the Adolpho Lutz collection, deposited in Museu Nacional, Rio de Janeiro, RJ, Brazil (AL-MN); Célio F. B. Haddad collection, deposited in Departamento de Zoologia, Universidade Estadual Paulista, Rio Claro, SP, Brazil (CFBH); Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ); Museu de Zoologia da Universidade de São Paulo, SP, Brazil (MZUSP); and Museu de História Natural, Universidade Estadual de Campinas, SP, Brazil (ZUEC). Specimens examined are listed in Appendix 1.

Measurements (in millimeters), using calipers, follow Cei (1980) and Duellman (1970): SVL (snout–vent length), HL (head length), HW (head width), ED (eye diameter), END (eye–nostril distance), TD (tympanum diameter), IOD (interorbital distance), THL (thigh length), TBL (tibia length), and FL (foot length). Sex was determined by presence or absence of paired vocal sacs. Adult specimens were fixed in 10% formalin and maintained in 70% ethyl alcohol; tadpoles were preserved and maintained in 5% formalin. Drawings of the holotype and tadpole were made using a Zeiss stereomicroscope with a drawing tube. Tadpole staging follows Gosner (1960), and tadpole labial tooth row formula follows Altig (1970). Geographic coordinates were taken with a Garmin II GPS.

Megaelosia apuana sp. nov.

Figures 1–3

Holotype.—MNRJ 26057, adult female, collected at fountainhead of Rio Jucu (20°26′16″S; 41°01′21″W; approximately 1200 m), next to

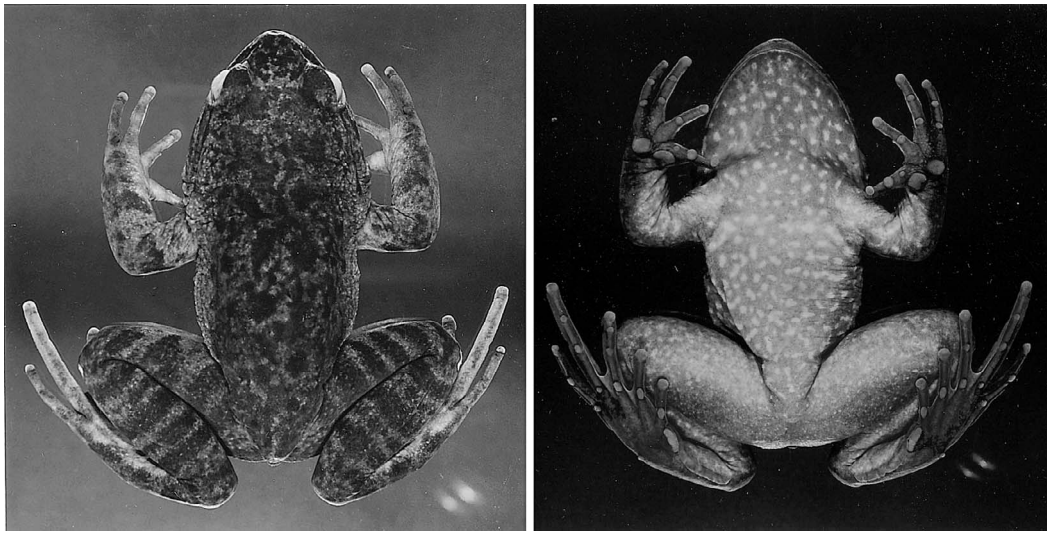

FIG. 1. *Megaelosia apuana*, MNRJ 26057 (holotype), adult female in dorsal and ventral views.

the Parque Estadual da Pedra Azul, Municipality of Domingos Martins, State of Espírito Santo, Brazil, on 13 November 2000 by J. P. Pombal Jr., G. M. Prado, R. Fernandes, and J. L. Gasparini.

Paratopotypes.—CFBH 03568, MNRJ 26058, adult female and male, respectively, collected with holotype; MNRJ 26059, adult male, collected on 21 September 2000 by W. Prado and G. M. Prado.

Diagnosis.—A large member of the hylodinae (males 78.0–97.2 mm SVL) characterized by (1) fold of fifth toe not reaching outer metatarsal tubercle; (2) snout rounded in dorsal view and slightly protruding in lateral view; (3) tympanum moderately small; (4) finger tips with scutes fused to the subunguis and toe tips with a pair of scutes free of the subunguis; (5) dorsal skin texture smooth; (6) skin of the flanks without large granules; (7) belly and throat predominantly gray with many small yellow blotches; and (8) distinct bilateral vocal sacs in males.

Comparison with Other Species.—*Megaelosia apuana* differs from *M. bocainensis* by having a less protruding snout in lateral view (see fig. 1 in Giaretta et al., 1993), less developed scutes on the discs, and smooth dorsal surfaces of the fingers (rugose in *M. bocainenesis*). *Megaelosia apuana* is distinguished from *M. boticariana* by having flanks slightly smooth (rugose in *M. boticariana*; see fig. 1 in Giaretta and Aguiar, 1998), slightly smaller tympanum, and nearly straight loreal region. *Megaelosia apuana* differs from *M. goeldii* by having the fold of fifth toe not reaching the outer metatarsal tubercle (reaching the outer metatarsal tubercle in *M. goeldii*), snout rounded in dorsal view and slightly protruding in lateral view (subacuminate in dorsal view and protruding in lateral view in *M. goeldii*; see fig. 1 in Giaretta et al., 1993), males with vocal sacs (lacking in *M. goeldii*), and finger discs smaller and weakly developed scutes on finger discs (well developed in *M. goeldii*). *Megaelosia apuana* differs from *M. lutzae* by having the snout rounded in dorsal view and slightly protruding in lateral view (acuminate in *M. lutzae*; see fig. 1 in Giaretta et al., 1993), less developed scutes on the discs, and gray belly with many small yellow blotches or spots (marbled in *M. lutzae*, see fig. 2 in Izecksohn and Gouvêa, 1985). The new species can be distinguished from *M. massarti* by its smaller size (SVL 100.3–123.9 mm in *M. massarti*; Giaretta et al., 1993), narrower head, larger vocal sacs in males, and in life gray belly with many small yellow blotches or spots (belly cream, blotches yellowish in *M. massarti*).

Description of the Holotype.—Body robust (Fig. 1); head slightly longer than wide; snout rounded in dorsal view and slightly protruding in lateral view (Fig. 2); nostrils slightly protuberant, directed anterolaterally; canthus rostralis distinct, almost straight; loreal region concave; tympanum distinct, oval, and moderately small, diameter about 33% of the eye diameter; well-developed supratympanic fold, extending from behind of the eye to near arm insertion; toothlike process in front of lower jaw, with socket between premaxillae; numerous well-developed teeth on premaxilla and maxilla; tongue large; vomerine teeth little developed in two small series, between and behind choanae; choanae small. Arms moderately robust; forearms robust; fingers robust (Fig. 3); finger length II < IV ≅ I < III; outer metacarpal tubercle nearly trapezoidal

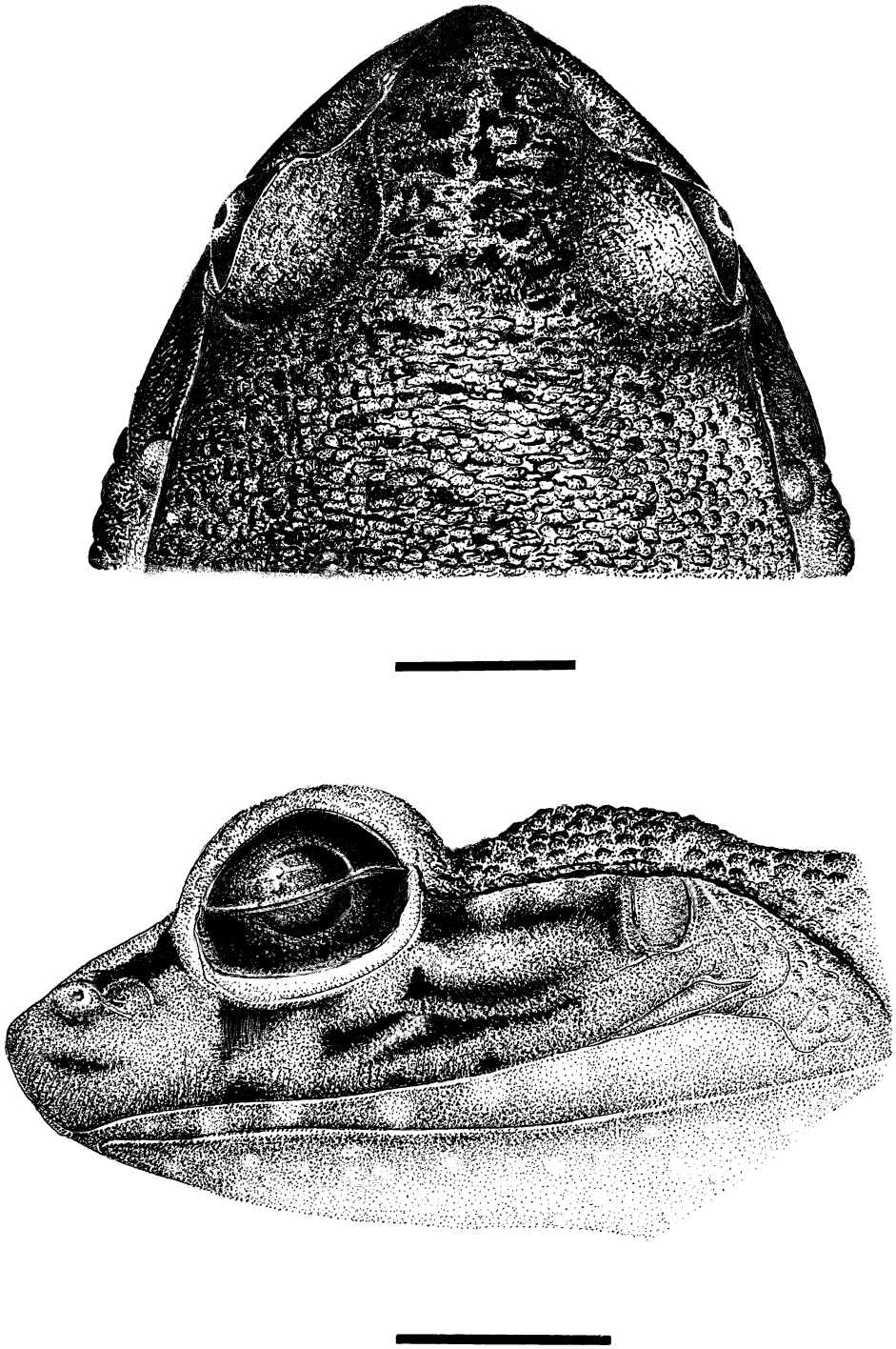

FIG. 2. *Megaelosia apuana*, MNRJ 26057 (holotype). (Upper) dorsal and (bottom) lateral views of head (scale 10 mm).

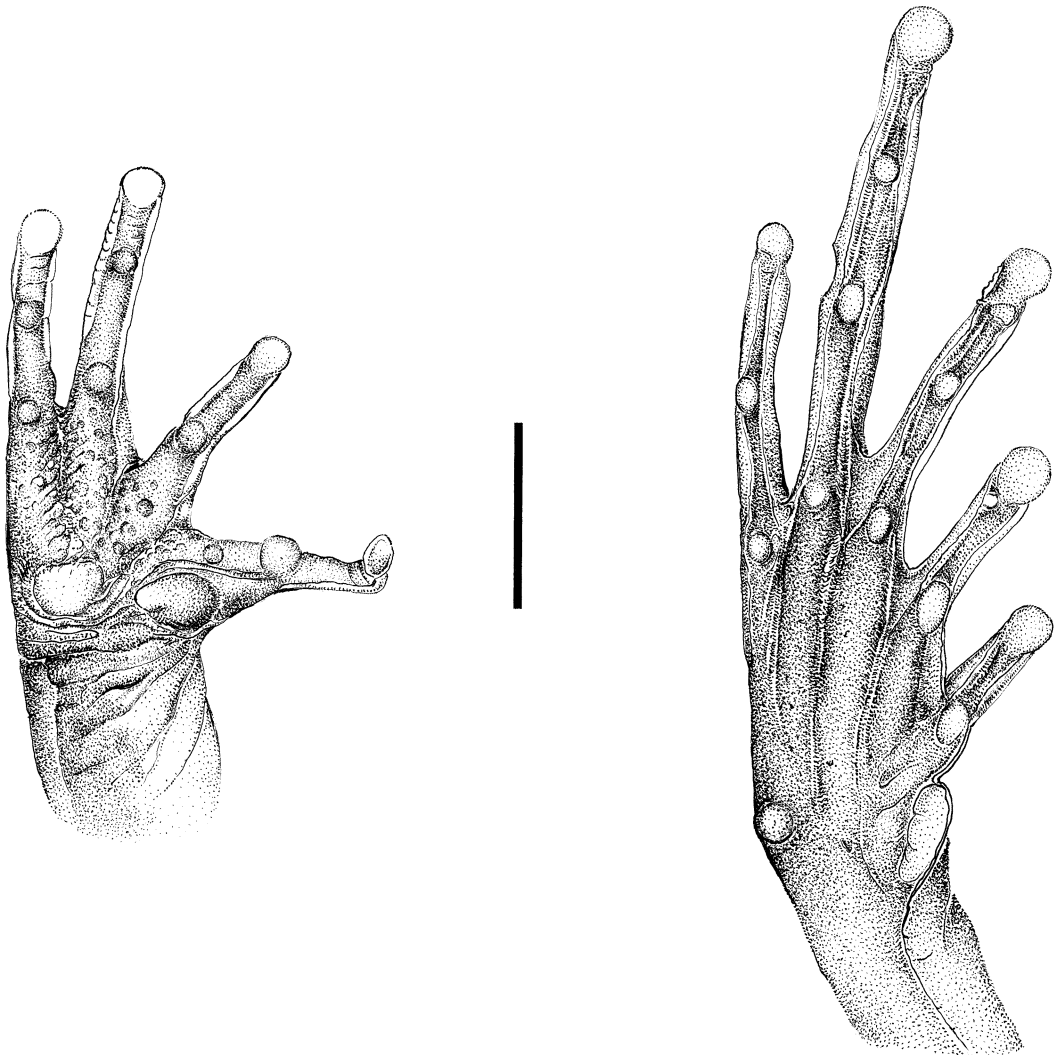

FIG. 3. *Megaelosia apuana*, MNRJ 26057 (holotype). Ventral view of (left) hand and (right) foot (scale 10 mm).

in shape, inner metacarpal tubercle ovoid; a small, rounded, supernumerary tubercle between and above subarticular tubercle and inner metacarpal tubercle; several palmar supernumerary tubercles; subarticular tubercles single, round; fingers weakly fringed laterally; outer fringe absent on basal third of fingers II and III; finger discs small, round; upper surface of finger tips with scutes fused to subunguis. Legs robust; toes robust (Fig. 3); toe length I < II < III ≅ V < IV; inner metatarsal tubercle elongated; outer metatarsal tubercle small, protruding, round; subarticular tubercles single, protruding, round or elongated; toe discs small, round; upper surfaces of toe discs with pair of well-developed scutes, free from subunguis; feet weakly webbed; toes extensively fringed; extensive tarsal fold-flap continuous distally with outer side of first toe; fold of the fifth toe not reaching the outer metatarsal tubercle. Dorsal skin texture smooth; lateral side of head and flanks of body rugged; under surfaces smooth.

Color in Life of the Holotype.—Dorsal surface brownish-green with yellowish blotches; flanks reticulated in pale gray with many small yellow blotches; lips tan, pale gray with yellowish spots; upper surface of thigh and tibia brown with four dark brown transverse bars; forearm brown with one dark brown transverse bar and few dark brown spots; belly and throat predominantly gray with many, small yellow blotches or spots; under surface of thighs and tibia gray with yellowish dots; palmar and plantar surfaces dark gray; iris cooper.

TABLE 1. Measurements (in millimeters) of the six tadpoles of *Megaelosia apuana*, collected at the type locality. The developmental stages follow Gosner (1960).

Stage	Total length	Body length	Body width	Mouth width	Eye diameter	Eye–nostril diameter	Spiracle	Anal tube
25	105.7	48.4	35.7	14.3	3.4	5.6	2.0	6.6
36	107.3	46.2	29.9	12.1	3.3	6.0	2.1	6.1
37	104.5	48.9	32.1	13.5	3.5	5.7	2.1	5.9
37	100.8	48.3	32.3	13.9	4.0	5.5	2.4	6.4
39	110.0	48.2	30.4	11.8	3.8	5.2	2.2	6.0
39	121.9	52.0	34.9	14.1	4.0	6.1	2.4	6.0

Color in Preservative of the Holotype.—Dorsal surface gray; yellow spots of venter became white.

Measurements of the Holotype (mm).—SVL 92.2; HL 40.0; HW 38.6; ED 8.7; END 5.3; TD 2.5; IOD 9.2; THL 46.8; TBL 45.1; FL 46.3.

Variation.—Males with distinct lateral vocal sacs. Dorsal color may be uniform mottled or without a distinct pattern. Size is variable. Measurements (in mm) of the two paratopotypes males are SVL 78.0–97.2; HL 34.0–43.0; HW 32.3–43.3; ED 8.0–8.9; END 5.2–5.4; TD 2.5–2.7; IOD 8.1–10.4; THL 41.2–47.8; TBL 39.7–46.1; FL 38.3–49.0. The female paratopotype measure SVL 94.6; HL 41.2; HW 40.1; ED 9.4; END 5.6; TD 4.0; IOD 9.2; THL 48.8; TBL 46.1; FL 49.8.

Tadpoles.—Tadpoles were obtained at the type locality on 13 November 2000. The measurements of six tadpoles are presented in the Table 1. The following description is based on a tadpole (MNRJ 26056) in developmental stage 37 (Gosner, 1960). Body ovoid in dorsal and lateral views (Fig. 4), widest posteriorly in lateral view; body wider than high; snout rounded, eyes small, dorsolateral; nostrils about midway between the eyes and the tip of snout, directed laterally; spiracle sinistral, opening at the middle of body; cloacal tube short, opening dextral (Fig. 4). Tail with robust musculature gradually tapering, not reaching to tail terminus; dorsal fin as high as ventral fin. Lateral line system on each side of body and tail; ventral line with an asymmetrical arrangement; dorsaly the line extends to posterior supraorbital line. Oral disc directed ventrally (Fig. 4); median region of upper lip lacking papillae; median region of lower lip bordered by one row of papillae; lateral borders with two or three rows of marginal papillae; supplementary papillae present in the corners of the mouth; labial tooth row formula 2(2)/3(1); jaw sheaths weakly developed and not serrate; posterior jaw sheath V-shaped. Body almost black; dorsal and ventral fins translucent with pale brown blotches.

The tadpole of *Megaelosia goeldii* was figured and shortly described by Miranda-Ribeiro (1909, 1923, 1926; in the 1909 paper, it was not associated with any species of anuran) and Lutz (1930). The tadpole of *M. massarti* was described and figured by Giaretta et al. (1993). The tadpole of *M. apuana* is similar to that of *M. goeldii* and *M. massarti*; however, the jaw sheaths are weakly developed and not serrate. Tadpoles of the genus *Hylodes* show a ventral depression that is not found in tadpoles of any species of *Megaelosia*, supporting this character as a synapomorphy of the genus *Hylodes* (Haddad and Pombal, 1995; Pombal et al., 2002).

Natural History.—Adults of *M. apuana* were found in September and November at upper Rio Jucu, near its fountainhead at about 1200 m. Tadpoles were observed inside Parque Estadual da Pedra Azul (approximately 1500 m). These places have running clean, cold water passing between narrow breaches of rock with some lentic water pools. Adults were observed only at night in the water. These frogs were wary and dove in the water when disturbed. Vocalizations are unknown. Tadpoles were observed in the pools mainly at night.

Distribution.—*Megaelosia apuana* is known from the type locality in the mountain region of Espírito Santo. This is the northernmost species in the genus *Megaelosia*.

Etymology.—"*Apuana*" is a Tupi indigenous word, here used as a noun in apposition, meaning agile.

REMARKS

Giaretta et al. (1993) cited one unidentifiable specimen of the genus *Megaelosia* from Municipality of Santa Teresa, State of Espírito Santo. In this specimen (MZUSP 27717), the snout and scutes on the fingers are badly preserved. Both localities, Domingos Martins (Jucu River drainage) and Santa Teresa (Timbuí River drainage), are geographically close, but in distinct drainages. Although both populations may belong to the same species, at this moment we are reluctant in consider the specimen of Santa Teresa as *M. apuana*.

Megaelosia boticariana and *M. apuana* are the most similar species on the basis of external morphology. However, *M. boticariana* is the most southern species, whereas *M. apuana* is the most northern species.

Megaelosia lutzae, *M. massarti*, *M. boticariana* (A. A. Giaretta, pers. comm.), and *M. apuana*

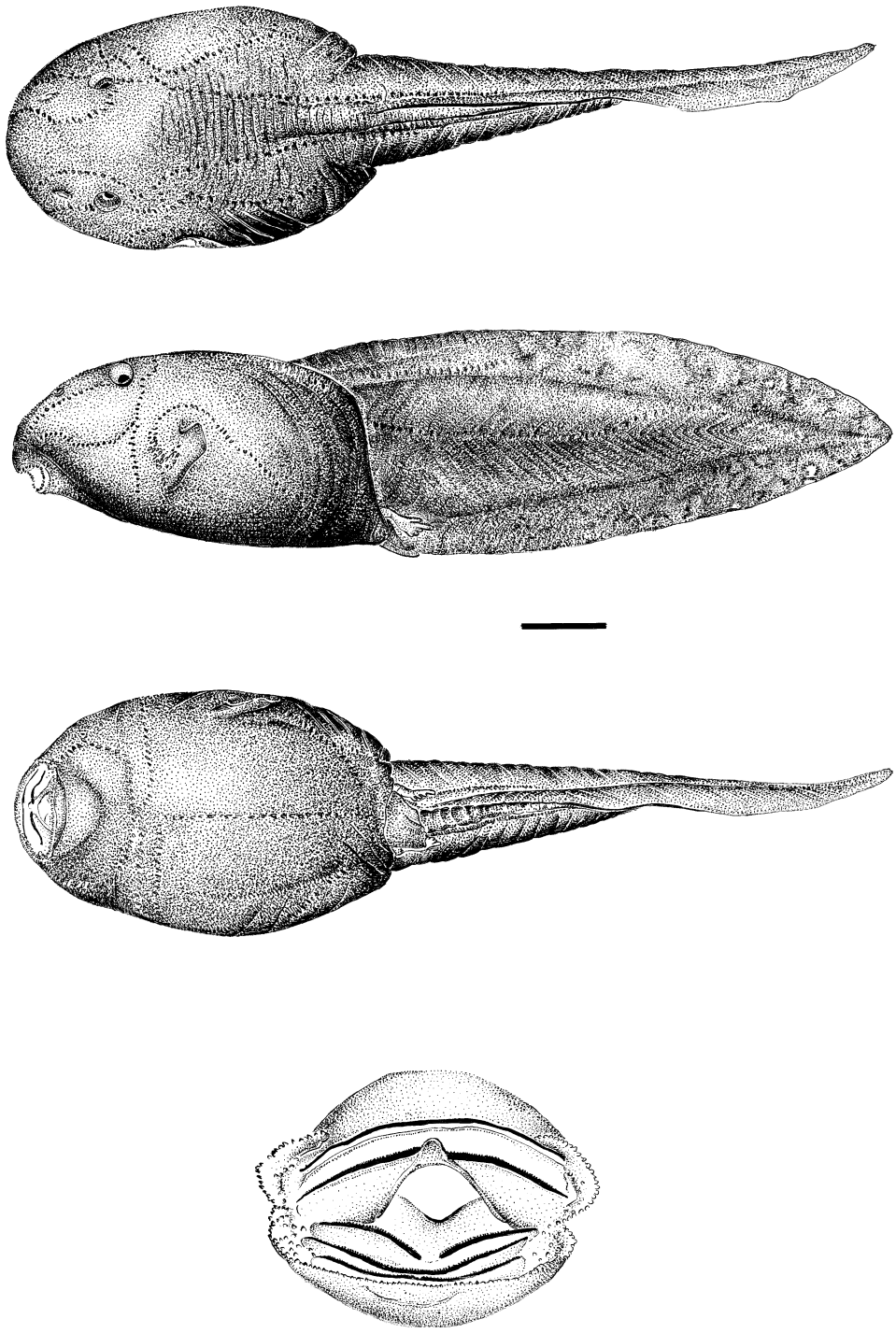

FIG. 4. Tadpole of *Megaelosia apuana*, MNRJ 27333, stage 37: dorsal, lateral, and ventral views (scale 10 mm). Oral disc (scale 2 mm).

show paired lateral vocal sacs, a character shared with the genera *Hylodes*. Apparently only *M. goeldii* lacks vocal sacs (*M. bocainensis* is known only by the female holotype; Giaretta et al., 1993). As in *M. massarti* (Giaretta et al., 1993), vocalization of *M. apuana* was not heard, which suggests that the species calls infrequently if at all.

Specimens of the subfamily Hylodinae are found in water of clean, flowing streams. The adult specimens of the genus *Megaelosia* are mainly diurnal (see Lutz, 1930; Izecksohn and Gouvêa, 1985; Giaretta et al., 1993). Some specimens of *M. massarti* were collected also at night (A. A. Giaretta, pers. comm.). The single specimen of *M. bocainensis* collected was concealed under a rock at the margin of a mountain stream at night (Giaretta et al., 1993); probably this specimen was resting. *Megaelosia apuana* is the only species of the genus known to have exclusively nocturnal activity.

The Atlantic Forest in Brazil is greatly endangered (Dean, 1997), being is the biome with the greatest endemism and richness of anurans the world (Duellman, 1999). The mountain region, in the municipality of Santa Teresa and surrounding areas (including the type locality of *M. apuana*) shows great endemism and richness of anurans. The discovery of *M. apuana* reinforces the importance of the region and the need for preservation of the biodiversity of the Atlantic Forest.

Acknowledgments.—We thank U. Caramaschi, A. A. Giaretta, and C. F. B. Haddad for helpful comments on the manuscript; R. Fernandes, J. L. Gasparini, and W. Prado for assistence in the field; P. R. Nascimento for the line drawings; C. F. B. Haddad, P. R. Manzani, M. T. Rodrigues, I. Sazima, and P. E. Vanzolini for loaned and/or permitting analysis of specimens under their care; C. Melo for help in the laboratory work in MZUSP; IDAF-ES for the logistic support and permission of work in the Parque Estadual de Pedra Azul; and CAPES, CNPq, FAPERJ, FUJB for financial support.

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Accepted: 6 February 2003.

Appendix 1

Additional Specimens Examined.—*Megaelosia apuana*: Espírito Santo, Domingos Martins, Pedra Azul: MNRJ

26056 (lot of tadpoles), 27333 (tadpole). *Megaelosia bocainensis*: São Paulo, São José do Barreiro, Serra da Bocaina: MNRJ 15900 (holotype). *Megaelosia boticariana*: São Paulo, Atibaia, Parque Florestal do Itapetinga: ZUEC 9561 (holotype), ZUEC 9562, 9563 (juvenile) (paratopotypes). *Megaelosia goeldii*: Rio de Janeiro, Nova Friburgo: AL-MN 2865, 3579, 3580, MNRJ 3683, MZUSP 0895, 2149; Petrópolis: MNRJ 27322, 27336 (tadpole); Teresópolis: AL-MN 1959–960, MNRJ 13677, 13684, 27318, 27319–321, 27323, 27324, 27325–326, 27327, 27328–329, 27330–331, MZUSP 1009, 53330–34 (topotypes); São Paulo, Serra da Bocaina: AL-MN 2306. *Megaelosia lutzae*: Rio de Janeiro, Itatiaia, PARNA Itatiaia: MNRJ 4181 (paratopotype), MNRJ 15464 (topotype). *Megaelosia massarti*: São Paulo, Salesópolis, Boracéia: MZUSP 2347; Santo André, Paranapiacaba: CFBH 02058, MNRJ 15463, ZUEC 8849–50 (juveniles), 8516, 9176, 11395, 11396 (juvenile), 11397, 11427 (juvenile), 11553 (topotypes). *Megaelosia* sp.: Espírito Santo, Santa Teresa: MZUSP 27717.

Journal of Herpetology, Vol. 37, No. 3, pp. 460–466, 2003

Monitoring Terrestrial Salamanders: Biases Caused by Intense Sampling and Choice of Cover Objects

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ABSTRACT.—**Arrays of wood cover boards are useful tools for studying and monitoring plethodontid salamander populations. However, little is known about the biases inherent in monitoring data collected from such arrays. We used Red-Backed Salamanders, *Plethodon cinereus*, to test for two potential biases associated with use of wood cover board arrays. First, we tested whether frequent sampling of arrays can cause reduced counts of salamanders, resulting in the appearance of population declines where none exist. Second, we tested whether salamanders found under wood cover boards differed from salamanders found under natural cover objects in terms of sex ratios, stage class ratios, and snout–vent length. We found that sampling cover boards daily substantially reduced salamander counts under cover objects and that this result was pronounced for adults but not for juveniles. We found no decrease in counts with sampling cover boards weekly as compared to sampling every three weeks. With respect to differences between salamanders found underneath cover boards versus natural cover objects, we found that samples from under cover boards contained higher proportions of adults and lower proportions of juveniles and hatchlings than did natural cover objects. This was true in both the spring and fall. There were no differences in sex ratios or in snout–vent length within stage classes for salamanders in cover boards versus natural cover objects. These results suggest that cover boards used for monitoring or for studies of ecology and behavior should be sampled no more than once per week if natural levels of movement and territoriality are desired. Additionally, although cover board arrays may be suitable for tracking relative changes in overall population size, bias among size classes may make cover boards less than ideal tools for studies of salamander demography.**

Long-term monitoring data are critical for assessing the status of populations and the causes of population declines. For birds, more than 35 years of data from the Breeding Bird Survey have produced extensive analyses of patterns of decline and responses to habitat changes (e.g., Sauer and Droege, 1990; James et al., 1996; Villard and Maurer, 1996). For taxa such as amphibians, fewer such datasets are available, and establishing long-term population monitoring programs has become a priority. In North America, programs have been established to monitor populations of aquatic-breeding amphibians using calling surveys (Bishop, 1996; Mossman et al., 1998; Sargent, 2000) and populations of terrestrial salamanders using arrays of artificial cover objects (Droege et al., 1997; Jung et al., 2000). Similar efforts to monitor amphibians are underway in other parts of the world (Young et al., 2001).

Although monitoring data are extremely valuable, reliable data are often difficult to collect. To be useful, monitoring data must be relatively consistent among observers and habitat types, sufficiently powerful to show population

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