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A REMARKABLE NEW GLASS FROG (CENTROLENIDAE: *VITREORANA*) FROM THE NORTHEAST ATLANTIC FOREST, BRAZIL

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ABSTRACT: We describe a new species of glass frog (*Vitreorana*) from Fazenda Novo Pau Brasil, in the Atlantic Forest habitat of northeastern Brazil. Previous to this work, *Vitreorana baliomma* sp. nov. was misidentified as *V. eurygnatha*, from which it can be distinguished by the iris pattern flecked with star-shape melanophores; rudimentary nuptial excrescences formed by glands on the dorsomedial surface of Finger I, with some accessorial glands along its periphery; parietal, urinary bladder, kidneys, and testes peritonea translucent; visceral peritoneum with iridophores covering the pericardium, liver, and gastrointestinal tract. We also provide a brief discussion on its morphological similarities with other *Vitreorana* species.

Key words: Centroleninae; Cochranellini; Eye coloration; Nuptial excrescences; Peritoneum; *Vitreorana baliomma* sp. nov.

FOR DECADES, members of the Neotropical family Centrolenidae (Taylor, 1951), commonly known as glass frogs, have attracted the attention of scientists because of their conspicuous biological and morphological features (Cisneros Heredia and McDiarmid, 2007). This clade comprises about 150 species, most of which inhabit the vegetation along streams in forested areas (Guayasamin et al., 2009; Frost, 2013). The family is found throughout Central America, tropical Andes, Guiana Shield, and the Amazon basin, and a disjoint group occurs in the Atlantic Forest, from southeastern Brazil to Argentina (Heyer, 1985; Guayasamin et al., 2009; Castroviejo-Fisher et al., 2011).

Recently, the phylogenetic relationships and systematics of glass frogs have been the focus of various studies, culminating in several taxonomic changes (e.g., Cisneros-Heredia and McDiarmid, 2007; Guayasamin et al., 2008, 2009). Although recent studies (e.g., Castroviejo-Fisher et al., 2011; Hutter and Guayasamin, 2012) have resolved some taxonomic problems, several issues need to be clarified at the alpha taxonomic level (Cisneros-Heredia and McDiarmid, 2007; Castroviejo-Fisher et al., 2011).

Of these issues, the three species of *Vitreorana* known to occur in the Atlantic Forest—*Vitreorana parvula* (Boulenger, 1895), *Vitreorana uranoscopa* (Müller, 1924), and *Vitreorana eurygnatha* (Lutz, 1925)—persist obscured. This group remains unclarified because of the scarcity of recent taxonomic studies and lack of refined analysis of morphological characters (Cisneros-Heredia and McDiarmid, 2007). These species have been placed in the genus *Vitreorana*, a monophyletic clade informed from molecular evidence, which accommodates species from the Cordillera de la Costa in Venezuela, the Precambrian Shields of South America, the Amazon basin, and the Atlantic Forest domain (Guayasamin et al., 2009). *Vitreorana* is characterized by the following phenotypic characters: (1) white peritoneum covering, totally or partially, the liver; (2) white gastrointestinal peritoneum; (3) green bones in life; (4) a lavender dorsal coloration in preservative; and (5) eggs deposited on the upper or under side of leaves (Guayasamin et al., 2009). Using only morphology, however, this genus cannot be diagnosed from other centrolenid genera, as *Chimerella*.

Studies addressing taxonomic questions on glass frogs from the Atlantic Forest biome were generally based on few specimens available from limited localities from the southeastern and southern portions of that region (Taylor and Cochran, 1953; Heyer, 1978, 1985). Recently, field collections produced range extensions for glass frogs, reporting occurrence for northeastern fragments of

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this biome (Freitas et al., 2004; Carvalho et al., 2005; Freitas et al., 2007; Gouveia et al., 2012); however, because of the lack of morphological information, the taxonomic status of these populations remains unclear (Gouveia et al., 2012).

Herein, we examine aforementioned collected specimens from the northern portion of the Atlantic Forest and describe a new species of *Vitreorana*, previously assigned to *V. eurygnatha*. In addition, we provide a brief discussion on the morphological affinities within *Vitreorana* and standardizations on nuptial excrescences in Centrolenidae.

Materials and Methods

Nomenclature and Conventions

Museum acronyms follow those established by the ASIH (http://www.asih.org/codons.pdf); in addition, the following collections were examined: Coleção Célio F.B. Haddad, Departamento de Zoologia, I.B., Universidade Estadual Paulista, Rio Claro, Brazil (CFBH); Coleção Adolpho Lutz, housed at the Museu Nacional, Rio de Janeiro, Brazil (AL-MN); Coleção da Universidade Federal de Sergipe, Aracaju, Brazil (UFSE). We also examined photos of the holotype of *Vitreorana uranoscopa* (ZSM 81/1921) and the lectotype of *V. parvula* (BMNH 88.2.7.32). Specimens of the new species were fixed in 10% formalin solution and preserved in 70% alcohol (Appendix). Sex and maturity were determined by secondary sexual characteristics (nuptial excrescences, vocal sacs, and slits) and the observation of convoluted oviducts through the transparent ventral skin.

Morphology

Characters followed the descriptions of Lynch and Duellman (1973), Ruiz-Carranza and Lynch (1991), Cisneros-Heredia and McDiarmid (2007), Guayasamin et al. (2009), Castroviejo-Fisher et al. (2011), Hutter and Guayasamin (2012), and citations therein. We followed the terminology developed by Lynch and Ruiz-Carranza (1996) and Glaw and Vences (1997) when describing nuptial excrescences and eye coloration, respectively.

Morphometric characters followed Heyer et al. (1990), Duellman (2001), and Cisneros-Heredia and McDiarmid (2007). We obtained nine measurements using digital calipers (±0.1 mm): (1) snout–vent length (SVL), (2) head length (HL), (3) head width (HW), (4) radio–ulna length (RL), (5) hand length (HaL), (6) femur length (FL), (7) tibia length (TL), (8) tarsal length (TaL), and (9) foot length (FL). With the use of a stereoscopic microscope, we obtained seven additional morphometric variables (±0.05 mm): (10) snout–nostril distance (SND), (11) internarial distance (ID), (12) eye–nostril distance (EN), (14) eye diameter (ED), (15) interorbital distance (IOD), and (16) width of disc of third finger (3WD). All morphometric data from preserved specimens were measured by RP and reported as minimum–maximum (mean ± standard deviation).

Species Description

Vitreorana **baliomma** *sp. nov.* *(Figs. 1A–C; 2D,G)*

Hyalinobatrachium sp. (cf. *eurygnathum*).—Carvalho et al. (2005: 51).

Hyalinobatrachium eurygnathum.—Freitas et al. (2004: 281).

Vitreorana aff. *eurygnatha*.—Gouveia et al. (2012: 16).

Holotype.—MNRJ 46857, adult male collected at Mata de Cabruca, Fazenda Novo Pau Brasil (16°59′22"S; 39°34′58"W; 98 m above sea level (a.s.l.); datum = WGS84), Municipality of Itamaraju, State of Bahia, Brazil, by C. Canedo and F. Falcão, on 2 February 2007.

Paratypes.—MNRJ 37904 and 37905 (cleared and stained), two adult males collected at Parque Nacional Serra de Itabaiana (10°45′S; 37°20′W), Municipality of Areia Branca, State of Sergipe, Brazil, by C.M. Carvalho, on 30 April 1997; MNRJ 35557, adult male collected at Fazenda Palmeiras, Municipality of Itapebi, State of Bahia, Brazil, by M.A. Freitas, on 5 September 2002.

Referred specimens.—Ten males (UFSE 623–628, UFSE 630, and UFSE 632–634) and two females (UFSE 629 and UFSE 631) collected at Parque Nacional Serra de Itabaiana (10°45′S; 37°20′W), Municipality of Areia

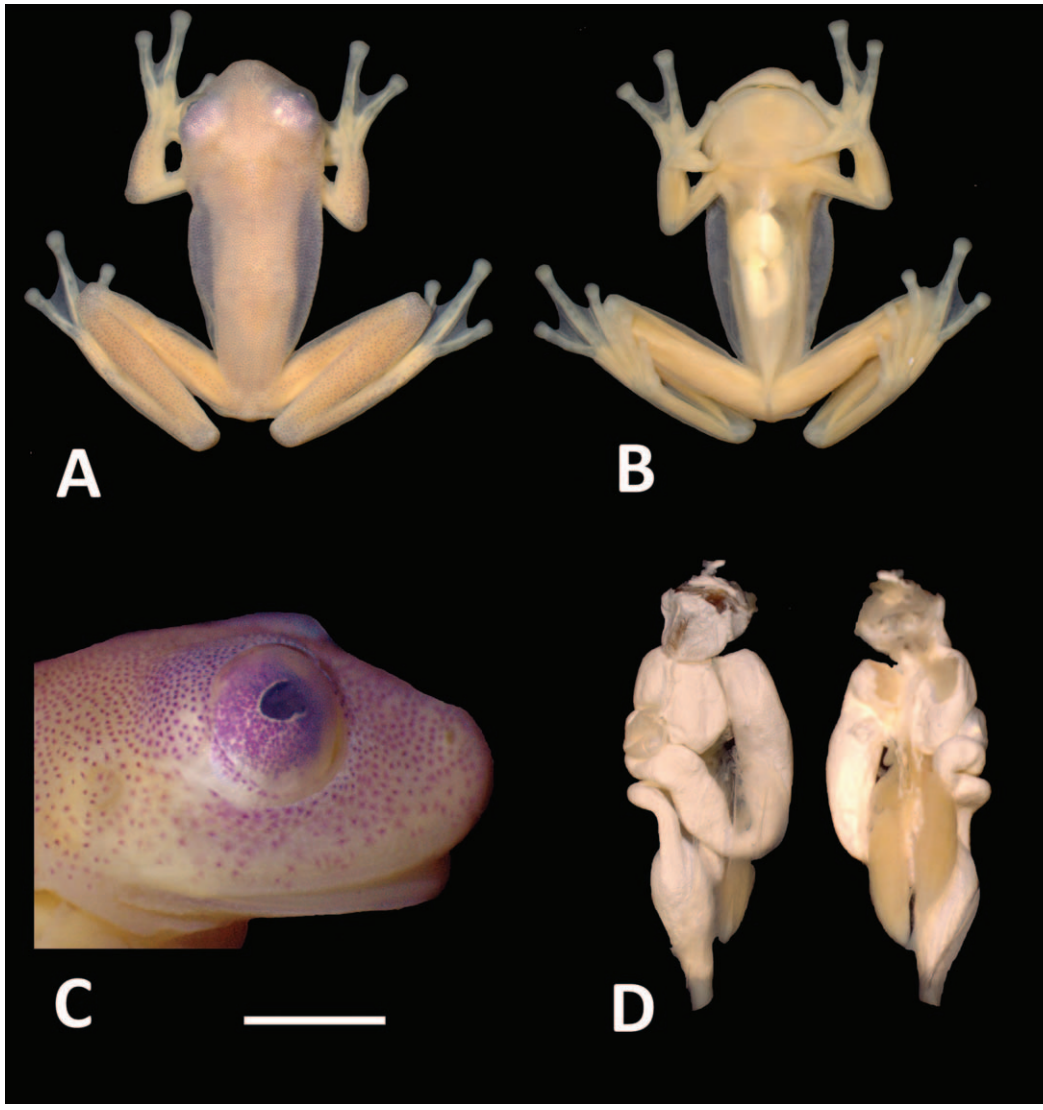

FIG. 1.—(A) Dorsal and (B) ventral views of the holotype of *Vitreorana baliomma* sp. nov. (MNRJ 46857; SVL = 17.9 mm). (C) Lateral view of head of *V. baliomma* sp. nov. (MNRJ 46857, holotype; scale bar = 4 mm). (D) Ventral (left) and dorsal (right) views of internal organs of the paratype of *V. baliomma* sp. nov. (MNRJ 37905).

Branca, State of Sergipe, Brazil, by S. Gouveia and R. Faria from May through August 2006.

Diagnosis.—*Vitreorana baliomma* sp. nov. can be distinguished from all other related and similar species by the following combination of characters: (1) vomerine teeth absent; (2) snout truncate in dorsal view, rounded in profile; (3) tympanum rounded, nonpigmented, outline barely visible, supratympanic fold poorly developed around the upper portion of tympanum to the shoulder; (4) dorsal skin texture smooth; (5) cloacal ornamentation comprised of a flap above the cloacal opening and a patch of small tubercles around it, all similar in size, white pigmentation scarce and only visible under magnification; (6) parietal peritoneum translucent (P0 condition), iridophores covering pericardium, hepatic peritoneum, gall bladder, and gastrointestinal tract (V5 condition; Fig. 1D), peritoneum of

urinary bladder, kidneys, and testes translucent; (7) bulbous liver (H2 condition); (8) adult males lacking humeral spine; (9) webbing formula of fingers III (1^{+}–3^{-}) (1–3) IV; (10) webbing formula of toes I (1–2^{-}) (1–2^{-}) II (0–2^{-}) (1–2^{-}) III (1–2^{-}) (2–3^{-}) IV (2–3^{-}) (1^{-}–2^{-}) V; (11) outer tarsal and ulnar folds slightly visible and outlined by white pigment, visible only under magnification; (12) rudimentary nuptial excrescences formed by aggregation of glands on dorsomedial surface of Finger I, forming a poorly defined pad, with some accessorial glands on its periphery reaching the ventral surface of digit (similar to rudimentary Type I), concealed prepollex; (13) first finger longer than second; (14) eye diameter larger than width of disc on Finger III; (15) in life, leaf green dorsum with minute white punctuations; (16) in preservative, background coloration cream, small and star-shape lavender melanophores uniformly distributed on dorsal surface; (17) in life, tunic around the eye white, iris periphery tan, iris area flecked of golden melanophores, pupil peripheral area tan, and horizontal halter-like dark pupil; in preservative, tunic around the eye cream, iris periphery cream, iris area flecked of lavender starred melanophores, pupil periphery white, black and horizontal halter-like pupil; (18) hands and feet yellowish green, melanophores usually absent from fingers and toes, when present, restricted to dorsal portion of Finger IV and toes IV and V; (19) small male size (Table 1). Below, we compare the diagnostic characters of the new species against all species members of *Vitreorana*, in addition to the similar species *Chimerella mariaelenae*.

Vitreorana baliomma sp. nov. is diagnosed from *Vitreorana* species from Atlantic Forest (*V. eurygnatha*, *V. uranoscopa*, and *V. parvula*) by having a thin layer of iridophores covering the stomach and intestines (in *V. eurygnatha*, *V. uranoscopa*, and *V. parvula*, iridophores are absent from stomach and intestines); in males, rudimentary nuptial excrescences formed by glands on the dorsomedial surface of Finger I, with some accessorial glands along its periphery (Fig. 2D; in *V. eurygnatha*, *V. uranoscopa*, and *V. parvula*, a large aggregation of glands forming a defined pad covering approximately the dorsomedial surface of the first phalange in the thumb—Fig. 2E,F); kidneys, urinary bladder, and testes lacking iridophores layer (in *V. eurygnatha*, *V. uranoscopa*, and *V. parvula*, kidneys, urinary bladder, and testes white); and iris pattern flecked by lavender star-shape melanophores (Fig. 2G; in *V. eurygnatha*, *V. uranoscopa*, and *V. parvula*, iris pattern is encircling black or lavender reticulations; Fig. 2H,I).

TABLE 1.—Measurements (mm) of morphometric variables obtained from 16 specimens of *Vitreorana baliomma* sp. nov.[a]

Variable[a]	Mean	Standard deviation	Range
SVL	19.1	1.5	16.4–21.2
HL	6.7	0.5	6–7.6
HW	7.3	0.5	6.5–8.3
RL	3.7	0.4	3.2–4.4
HaL	6.2	0.4	5.6–6.8
FL	11.3	0.5	10.5–12.2
TL	10.9	0.6	9.9–11.6
TaL	6	0.4	5.5–6.9
FL	8.8	0.6	7.7–9.5
SND	1.2	0.2	0.8–1.8
ID	2.2	0.2	1.8–2.7
EN	2.6	0.4	2.2–3.2
ED	4.4	0.4	3.8–5
IOD	5.2	0.7	4.2–6.5
3WD	1.5	0.3	0.9–1.9

[a] SVL = snout–vent length, HL = head length, HW = head width, RL = radio–ulna length, HaL = hand length, FL = femur length, TL = tibia length, TaL = tarsal length, FL = foot length, SND = snout–nostril distance, ID = internarial distance, EN = eye–nostril distance, ED = eye diameter, IOD = interorbital distance, and 3WD = width of disc of third finger.

Vitreorana baliomma sp. nov. differs from *Vitreorana helenae* by the absence of iridophores on the parietal peritoneum (in *V. helenae*, parietal peritoneum with iridophores covering anterior third); in life, dorsum uniformly leaf green with minute white punctuations (in *V. helenae*, in life, dorsum pale lime spotted by groups of dark purple melanophores); bulbous liver (in *V. helenae*, trilobate liver); snout rounded in profile (in *V. helenae*, snout sloping in profile); and cloacal ornamentation comprised of a patch of small tubercles, all similar in size, white pigmentation scarce and visible under magnification (in *V. helenae*, cloacal ornamentation comprised of paired, enlarged round tubercles ventral to cloacal opening).

The new species is distinguished from *Vitreorana gorzulae* by the absence of iridophores on the parietal peritoneum (in *V.*

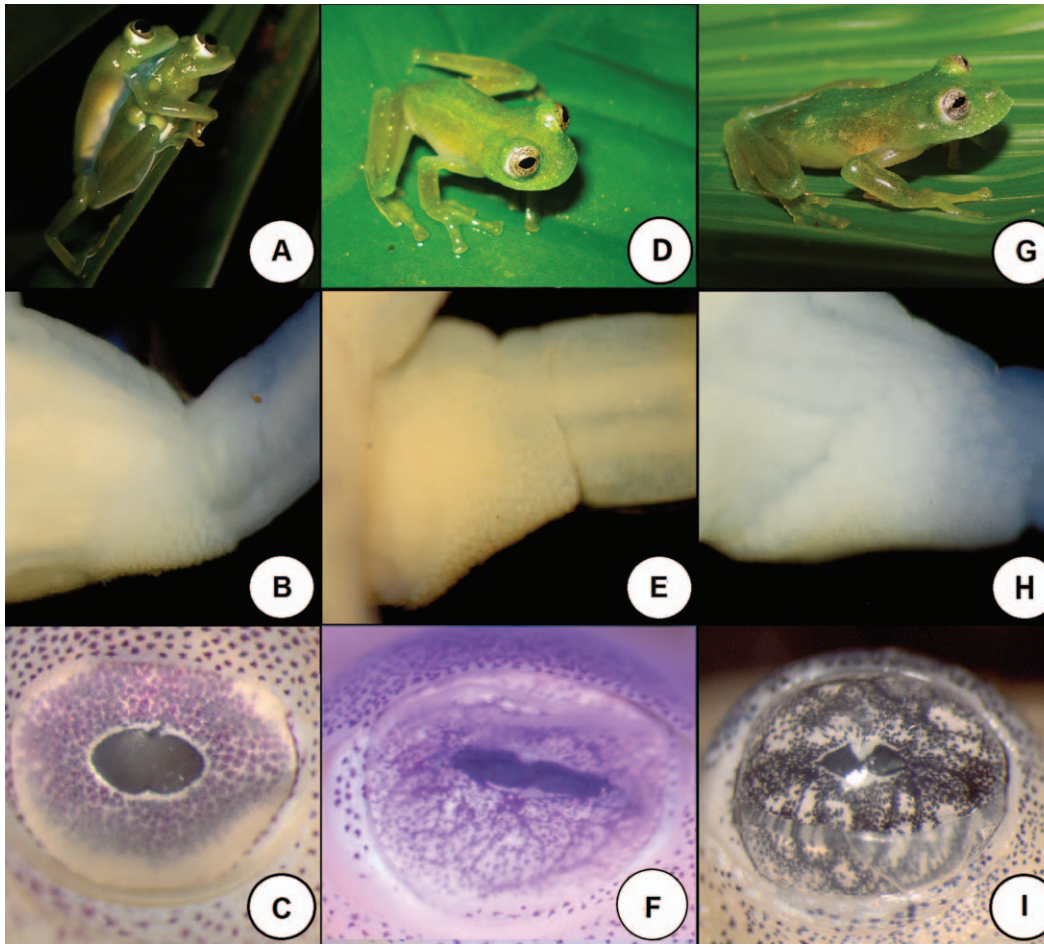

FIG. 2.—Comparative images of *Vitreorana* species from the Atlantic Forest: (A) living amplectant pair of *Vitreorana baliomma* sp. nov. from Serra de Itabaiana, State of Sergipe (UFSE 630–631; photo: Sidney Gouveia); (B) nuptial pad and (C) iris detail (MNRJ 46857, holotype). (D) Male *V. eurygnatha* from State of São Paulo (noncollected specimen; photo: Renato Gaiga); (E) nuptial pad and (F) iris detail (MZUSP 105231). (G) Male *V. uranoscopa* from Floresta da Tijuca, State of Rio de Janeiro (MNRJ 77352; photo: RP); (H) nuptial pad and (I) iris detail (MNRJ 79412).

gorzulae, anterior third of parietal peritoneum covered by iridophores); in adult males, prepollex and prepollical spines absent (in adult males of *V. gorzulae*, prepollex enlarged and prepollical spine projecting medially but not exposed); first finger longer than second (in *V. gorzulae*, first finger shorter than second); absence of noticeable humeral crest or spine in adult males (adult males of *V. gorzulae* have humeral crests and nonprojecting spines on the humerus); and bulbous liver (in *V. gorzulae*, trilobate liver).

Compared to *Vitreorana castroviejoi*, *V. baliomma* sp. nov. differs in having a translucent parietal peritoneum (in *V. castroviejoi*, anterior third of parietal peritoneum white); by the absence of prominent prepollical bulges or projected spines (in *V. castroviejoi*, prominent prepollical bulges and prepollical spines medially projected); in life, dorsum uniformly leaf green with minute white punctuations (in *V. castroviejoi*, dorsal surfaces yellow spotted); and bulbous liver (in *V. castroviejoi*, lobed liver).

Vitreorana baliomma sp. nov. differs from *V. oyampiensis* by the absence of iridophores on the parietal peritoneum (in *V. oyampiensis*, anterior third of parietal peritoneum covered

by iridophores); hepatic peritoneum completely covered by iridophores (in *V. oyampiensis*, translucent hepatic peritoneum or iridophores covering only anterior part of liver); in adult males, absence of distinct prepollex (in *V. oyampiensis*, distinct prepollex on the base of thumb); bulbous liver (in *V. oyampiensis*, lobed liver); and in preservative, dorsum uniformly lavender or with minute white punctuations (in *V. oyampiensis*, dorsum lavender with black or dark purple spots).

Vitreorana baliomma sp. nov. is distinguished from *Vitreorana antisthenesi* by having, in life, uniformly leaf green dorsum with minute white punctuations (in *V. antisthenesi*, dorsum spotted by yellow maculae); males slightly smaller, SVL 16.4–21.2 mm (in *V. antisthenesi*, larger males SVL 21.4–27 mm); iris flecked by star-shape melanophores (in *V. antisthenesi*, iris pattern consisting of purple or lavender reticulations); in preservative, upper lip nonpigmented (in *V. antisthenesi*, upper lip evident and highlighted by white pigment); rudimentary nuptial excrescences formed by glands on the dorsomedial surface of Finger I, with some accessorial glands on its periphery (in *V. antisthenesi*, a large aggregation of glands forming a defined pad covering approximately the dorsomedial surface of the first phalange of the thumb); and snout rounded in profile (in *V. antisthenesi*, snout truncate in profile).

Vitreorana baliomma sp. nov. is diagnosed from *Chimerella mariaelenae* by the absence of humeral spine in males (in males of *C. mariaelenae*, humeral spine prominent); in life, dorsum uniform green or with small white punctuations (in *C. mariaelenae*, dorsum pale green with dark macules); in males, rudimentary nuptial excrescences formed by glands on the dorsomedial surface of Finger I, with some accessorial glands along its periphery (in males of *C. mariaelenae*, nuptial pad comprised of a large cluster of glands on dorsomedial surface of Finger I), and cloacal ornamentation comprised of a flap above the cloacal opening and a patch of small tubercles around it, all similar in size, white pigmentation scarce and only visible under magnification (in *C. mariaelenae*, cloacal ornamentation comprised of a pair of large, round, flat tubercles on ventral surfaces of thighs).

Description of holotype.—Adult male, SVL 17.9 mm. Body moderately slender; head length smaller than head width; HL 36.9% and HW 38% of SVL; snout truncate in dorsal view, rounded in profile; *canthus rostralis* indistinct, loreal region slightly concave; nostrils not protuberant, closer to the tip of snout than to eye; eyes large, directed anterolaterally at an angle of 45°; ED 63.2% of HW; supratympanic fold present, barely visible around the upper portion of tympanum to the shoulder; tympanum rounded, outline slightly visible; vomerine teeth absent; premaxillary and maxillary teeth present; choanae large, elliptical; tongue elongated, free laterally and posteriorly; vocal slits short, extending laterally from the edge of tongue to the articulation of jaws; vocal sac single, subgular. Arms slender, with few minute melanophores on the dorsal portion; forearm thicker than arm, with abundant melanophores on dorsal surface; humeral spine or crests not visible externally; ulnar ridges present, low, not forming folds; white pigment scarce, visible under magnification; relative finger lengths II $<$ I $<$ IV $<$ III; adhesive discs expanded, almost rounded, discs of Finger I and II smaller than others, 3DW equals 8.4% of SVL; membrane formula on hand I vestigial II 2–vestigial III 2^{+}–1^{-} IV. Palmar tubercle rounded, evident; thenar tubercle absent; subarticular tubercles simple, rounded; supernumerary tubercles on the palmar surface barely noticeable; nuptial excrescences consist of a small aggregation of nonkeratinized glands on dorsomedial surface of Finger I, pale or cream colored, forming an underdeveloped pad, with some accessorial glands on its periphery reaching the ventrolateral surface of the digit (similar to rudimentary Type I); prepollex concealed. Legs slender, long; FL 59.2% of SVL and TL 56.4% of SVL; outer tarsal and foot ridges present, not forming folds, white pigment slightly visible under magnification; relative toe lengths I $>$ II $>$ III $\approx$ V $>$ IV; adhesive discs of toes rounded, Toe I smallest, Toe II small, the others medium-sized; webbing formula I 2–2^{-} II 1^{+}–2 III $1^{1/3}$–2^{+} IV 2^{+}–1 V; outer tarsal tubercle absent; inner metatarsal tubercle elongated, weakly developed, equivalent to one sixth of Toe I; subarticular tubercles simple, small, rounded;

supernumerary tubercles absent. Cloacal ornamentation composed of a dorsal flap, and a patch of small tubercles around the cloacal opening, all similar in size; white pigmentation scarce, visible under magnification. Dorsal surfaces smooth; gular region and ventral portion of upper limbs smooth; venter and ventral surface of hind limbs slightly granular with small rounded granules, all of similar size.

Measurements of holotype (in mm).—SVL 17.9; HL 6.6; HW 6.8; RL 3.2; HL 6.8; FL 10.6; TL 10.1; TaL 5.5; FL 8.9; SND 1.4; ID 2.7; EN 2.3; ED 4.3; IOD 6.0; 3WD 1.5.

Color of holotype in preservative.—Dorsal background cream; a few minute, lavender, star-shaped melanophores concentrated on orbital region and uniformly distributed on other dorsal surfaces of head, dorsum, and limbs. Tunic around the eye cream, iris periphery cream, iris area flecked of lavender starred melanophores, pupil periphery white, black and horizontal halter-like pupil; ventral surfaces cream, immaculate. Internal organs pigmented white and visible through transparent skin (heart, liver, and gastrointestinal tract).

Color in life.—Our description is based on a photo of amplectant pair (UFSE 630–631; Fig. 2A) from Serra de Itabaiana, State of Sergipe. Dorsal surfaces leaf green punctuated by sparse white dots; flanks, hands, and feet light green with yellowish shades. Upper lip, outer tarsal and ulnar ridges outlined by white pigment; tunic around the eye white, iris periphery tan, iris area flecked of golden melanophores, pupil peripheral area tan, and horizontal halter-like black pupil. Ventral surfaces light green, allowing the visualization of internal organs (pericardium, liver, and gastrointestinal tract) pigmented in white by an iridophore layer visible through skin.

Variation.—Two analyzed specimens from Serra de Itabaiana show the iris and dorsal coloration of melanophores gray instead of lavender. Also, the ventral region is more translucent than the other specimens examined. We attributed these differences to excessive light exposure. Furthermore, three well-preserved specimens from Serra de Itabaiana show white dots distributed along dorsum visible under magnification. Morphometric variation is summarized in Table 1. Gouveia et al. (2012) observed that females (SVL = 20.55 ± 0.8 mm; $n = 6$) are larger than males (SVL = 18.18 ± 0.6 mm; $n = 6$).

Etymology.—The specific epithet *baliomma* is a feminine adjective derived from the Greek nouns *Balios* meaning "spotted" and *Omma* meaning "eye." The name of this new species refers to the distinctive punctuated pattern on the iris, unique among the *Vitreorana* species described from the Atlantic Forest.

Distribution.—*Vitreorana baliomma* is known from the northern portion of the Atlantic Forest biome, in ombrophilous formations (sensu Veloso et al., 1991). In addition to type-locality, the new species has been collected in Municipality of Itapebi, State of Bahia, and in Parque Nacional da Serra de Itabaiana, Municipality of Areia Branca, State of Sergipe (Fig. 3). The new species is allopatric from other members of *Vitreorana*, except *V. eurygnatha*, with which it is sympatric in southern Bahia. However, our data do not allow us to infer syntopic localities between these species.

Natural history.—The type-locality is a forested fragment with strong anthropogenic influence. Much of the original vegetation has been selectively removed for cacao cultivation. In cacao plantations, sporadic emergent trees are preserved to shade the understory cacao plants (a pattern locally known as "*cabruca*"; Canedo et al., 2004). Males of *V. baliomma* sp. nov. were observed vocalizing perched on vegetation along a permanent creek at *cabrucas*. On one occasion, 5–6 males were observed vocalizing at heights from 1 to 1.8 m above the water, on upper surfaces of leaves (C. Canedo, personal communication).

Gouveia et al. (2012) provided ecological data for the population of Serra de Itabaiana (referred to as *Vitreorana* aff. *eurygnatha*). According to those authors, *V. baliomma* sp. nov. occurs in clumped distributions along streams, forming groups of 2–4 individuals. Perched males call from dorsal surfaces of leaves of riverine understory from 0.3 to 4 m in height. Amplectant pairs deposited egg clutches (10–25 eggs) preferentially on upper surfaces of leaves; however, egg masses were also observed on lower surfaces.

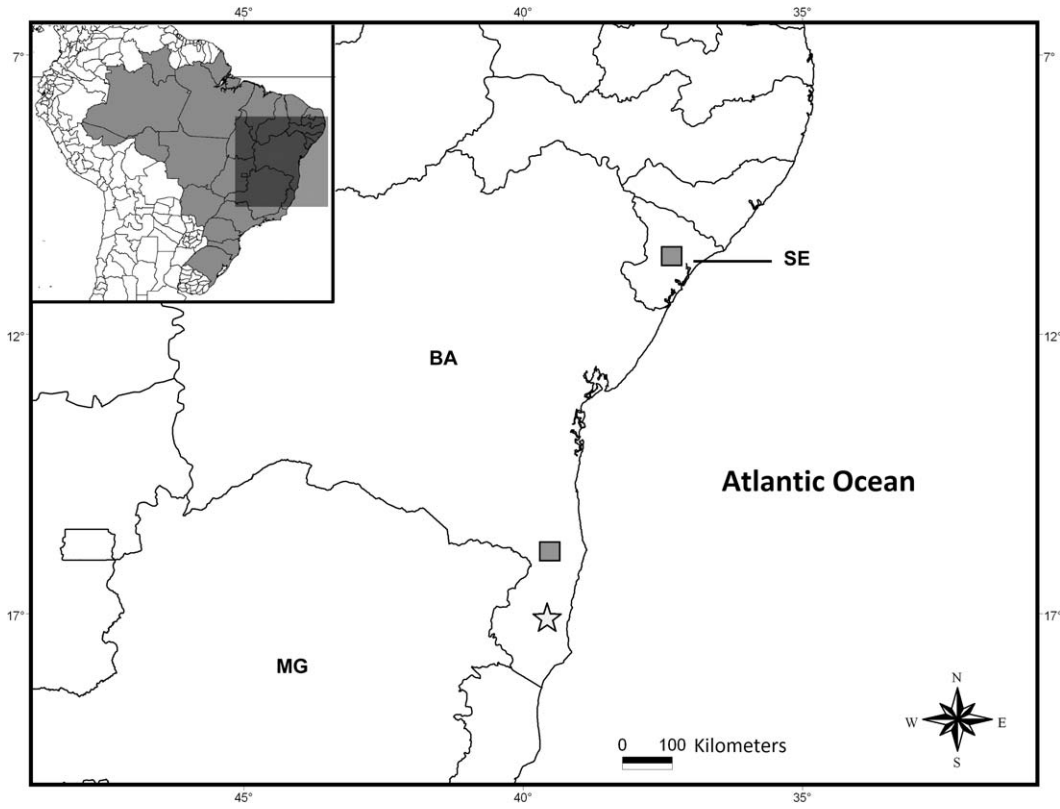

FIG. 3.—Geographic distribution of *Vitreorana baliomma* sp. nov. in Brazil (shaded area of inset). Star = type-locality; shaded squares = additional localities of occurrence of *V. baliomma* sp. nov.

Remarks.—We tentatively assign the new species to the genus *Vitreorana* because it exhibits most of diagnostic traits for the genus, as semisolid iridophores layer on liver and gastrointestinal tract visible by transparency, green bones in life, lavender coloration in preservative (see Guayasamin et al., 2009). Currently, this genus is defined by ambiguous morphological synapomorphies and lacks a more detailed morphologic definition within Centrolenidae, making the assignment of the genus without molecular evidence difficult. The interpretations of these ambiguous traits could support the insertion of this new species in the genus *Teratohyla* or *Chimerella*. Based on biogeographical affinities, however, we prefer to keep this new species in the genus *Vitreorana* until new studies emerge assessing the molecular data set of *V. baliomma* sp. nov., or improve the morphological characterization of higher taxa of Centrolenidae, thus corroborating the placement of *V. baliomma* sp. nov. in this genus.

DISCUSSION

Prior to this study, all species of glass frogs from the Atlantic Forest shared a condition of an iridophore layer that covers the pericardium, liver, urinary bladder, kidneys, and testes; and is absent from the stomach and intestines. As described here, however, *V. baliomma* presents a different pattern, where iridophores cover the pericardium, liver, stomach, and intestines, and are absent from the urinary bladder, kidneys, and testes (similar to the pattern described for *V. gorzulae*). To date, general external and internal morphological features suggest that *V. baliomma* resembles congeneric species from the Cordillera de la Costa in Venezuela, Guiana Shield, and the Amazonian basin, and probably is sister to *V. gorzulae*. We encourage

future researchers to investigate the phylogenetic relationships of glass frogs in order to clarify the position of the new species within *Vitreorana* and Centrolenidae.

Glass frogs exhibit a wide diversity of nuptial excrescences that have been studied by many researchers (Flores, 1985; Lynch and Ruiz-Carranza, 1996; Cisneros-Heredia and McDiarmid, 2007). Most Brazilian glass frogs were neglected in these studies, however, and few descriptions are available for their nuptial excrescences, as well as any ontogenetic shifts, or intra- and interspecific variation, in this trait. Flores (1985) and Lynch and Ruiz-Carranza (1996) referred to a reduced or rudimentary type of nuptial pad for Atlantic Forest glass frogs underlying Type I and Type II, informally named as rudimentary or reduced Type I, which we attribute to *V. baliomma*, despite the presence of some accessorial glands along ventrolateral base of thumb (see Fig. 2D). Notwithstanding, all examined specimens of *V. uranoscopa* and *V. eurygnatha* show different nuptial excrescences (Fig. 2E,H), forming a densely packed pad which covers almost the entire surface of the first phalange in the thumb; thus fitting in the typical Type I nuptial excrescence, following Flores (1985) and Lynch and Ruiz-Carranza (1996). Still, most of classifications proposed for nuptial excrescences of Centrolenidae lack a comprehensive survey of all taxa within the clade (Flores, 1985; Lynch and Ruiz-Carranza, 1996; Cisneros-Heredia and McDiarmid, 2007). Further studies should consider the external morphology of nuptial excrescences in Centrolenidae, in addition to using other approaches, such as micro-ornamentation, histological, and glandular surveys. These approaches have been useful for other anuran groups (e.g., Luna et al., 2012).

Several studies assessing vertebrate diversity of the Atlantic Forest biome indicate an intricate pattern of endemism, which can be separated latitudinally and longitudinally along climatic conditions, vegetation, and geographical formations (Costa, 2003; Santos et al., 2007; Silva et al., 2012). Therefore, *V. baliomma* might have a geographic distribution that is constrained to the northern portion of the Atlantic Forest. Increased sampling efforts in these areas might reveal the presence of this species in other forest fragments.

Since the works of Taylor and Cochran (1953) and Heyer (1978, 1985), Atlantic Forest glass frogs have not been the main focus of any published study dealing with Centrolenidae. In view of newly collected specimens, the description of *V. baliomma* sp. nov. highlights the need for more studies assessing the systematics of *Vitreorana* from Atlantic Forest habitats in Brazil and Argentina in order to clarify the taxonomic status of populations, the species relationships within the genus, and to provide an improved morphological characterization of currently recognized species.

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Appendix

Specimens Examined

Vitreorana oyampiensis.—Brazil: Pará: MNRJ 48270 Porto Trombetas, FLONA Sacará-Taquera, Municipality of Oriximiná; MNRJ 47899 Porto Trombetas, Sacará-Monte Branco; MNRJ 52867–52869 Plato Sacará, FLONA Sacará-Taquera, Porto Trombetas, Municipality of Oriximiná. Amazonas: MNRJ 4557 Igarapé Acará, Reserva Ducke, Municipality of Manaus; MZUSP 105136–105138 Reserva Ducke, Municipality of Manaus; MZUSP 60166–60168 Reserva INPA WWF, Municipality of Gavião.

Vitreorana eurygnatha.—Brazil: São Paulo: AL-MN 973–975 syntypes; MNRJ 73167–73185 Fazenda do Bonito, PARNA Serra da Bocaina, Municipality of São José do Barreiro; MZUSP 105224–105231 Campo de Fruticultura, Municipality of São José do Barreiro; MNRJ 17649, CFBH 269, 362, 1854 Fazendinha São Luís, Municipality of Ribeirão Branco; MNRJ 34758 Estação Biológica de Paranapiacaba, Municipality of Santo André; MZUSP 53052–53059 Fazenda do Veado, Municipality of Bananal; MZUSP 15153–15180 Cidade Azul, Municipality of Joanópolis; MZUSP 104856–104867, 105399–105402

Fazenda Lagoinha da Serra, Municipality of Campos do Jordão. Rio de Janeiro: MNRJ 2178, 73107, 73162, MZUSP 53350–53357 Municipality of Teresópolis; MNRJ 32872 Represa do Guinle, Municipality of Teresópolis; MNRJ 52690–52692, 73166, PARNA Serra dos Órgãos, Municipality of Teresópolis; MNRJ 78575 Municipality of Petrópolis; MNRJ 73163–73165, 73422 Municipality of Itatiaia; MNRJ 51575 Macieiras, PARNA Itatiaia, Municipality of Itatiaia; MNRJ 51801–51810, 52699–52701, 73128–73134 Tijuca, Municipality of Rio de Janeiro.

Vitreorana uranoscopa.—Brazil: Santa Catarina: MZUSP 35429–35436 Municipality of Novo Horizonte; CFBH 5280–5282, 5284 Bairro Lençol, Municipality of São Bento do Sul. Minas Gerais: CFBH 16534 Pousada Floresta, Municipality of Itamonte; MZUSP 135659, 133838, PARNA Caparaó, Municipality of Vale Verde; MZUSP 145472 Municipality of Conceição do Mato Dentro; MNRJ 56300, 77778–77780 Ponte para o Belchior, Reserva Particular do Patrimônio Natural da Serra do Caraça, Municipality of Catas Altas; MNRJ 30606–30607 Serrinha, Municipality of Mariana; MNRJ 23125 Mata da Mutuca, Municipality of Nova Lima; MNRJ 24688 Estação Biológica Mata do Sossego, Municipality of Simonésia. Rio de Janeiro: MNRJ 78040–78043 Lídice, Municipality of Rio Claro; CFBH 19256, 19279 PARNA Serra da Bocaina; MNRJ 73012 Parque Natural Municipal da Taquara, Municipality of Duque de Caxias; MNRJ 32873, 72450, 75389–75390, PARNA Itatiaia, Municipality of Itatiaia; MNRJ Represa do Guinle, Municipality of Teresópolis; MNRJ 46680, 64815–64816, 77352–77362, PARNA Tijuca, Municipality of Rio de Janeiro. São Paulo: MZUSP 104892–104895, CFBH 869, 1528, Paranapiacaba, Municipality of Santo André; MZUSP 136535–136537 Parque Estadual Carlos Botelho, Municipality of São Miguel Arcanjo; MNRJ 63951–63954 Rubião Júnior, Municipality of Botucatu; MNRJ 32510–32511 Estrada de Botucatu, Municipality of Botucatu; CFBH 2252 Picinguaba, Municipality of Ubatuba; CFBH 6208 Núcleo Santa Virgínia, PESM, Municipality of São Luís do Paraitinga.