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# Redescription and variation of *Hyophryne histrio* Carvalho, 1954, an enigmatic microhylid frog from the Atlantic Rainforest of Brazil

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**Abstract.** *Hyophryne histrio* was described in 1954 as a new species and placed in its own genus based on a single juvenile specimen from Ilhéus, State of Bahia, northeastern Brazil. This species was known only from the holotype until 1999 when a series of specimens was collected 50 km from the type-locality. Herein, we provide a redescription of the species based on this new material and present new information on morphological variation in order to help with the recognition of this poorly known species. The diagnostic characters are: occipital skin fold present, interdigital membranes between the toes well developed, dark venter with white blotches, an arrow-shaped dorsal color pattern that begins just after the occipital fold, and a distinct pale line between the venter and dorsum. Dermal spines, which were found in all males and vary in the number of spines and location, are reported for the first time in this species; gravid females have dermal spines only in the pericloacal region. We also compare *Hyophryne histrio* to all other Neotropical microhylid genera.

*Keywords*: *Ctenophryne*, Gastrophryninae, Northeastern Brazil, *Stereocyclops*, taxonomy.

## Introduction

Microhylidae is the fourth largest anuran family containing 487 species distributed through America, Subsaharan Africa, India, and Korea to northern Australia (Frost, 2011). However, microhylid frogs are not a dominant component of New World anuran fauna, where there are 64 species in 20 genera, including nine monotypic genera. These New World species are terrestrial and exhibit various degrees of fossoriality and their secretive habits may be responsible for the limited knowledge of many species (Wild, 1995).

In a seminal revision work of New World microhylids, Carvalho (1954) described a new genus and species *Hyophryne histrio*, based on a young female specimen from Fazenda Repartimento, municipality of Ilhéus, State of Bahia, northeastern Brazil (fig. 1). The venter of the holotype was dissected for examination of the pectoral girdle. After subsequent examination, the pectoral girdle became disarticulated (fig. 1). No additional specimens were available for study until 1999 when 42 specimens were obtained in pitfall traps at Reserva Una (15°10′S, 39°31′W), municipality of Una, State of Bahia, 50 km S from the type-locality (Dixo, 2004). Carvalho (1954) provided a diagnosis for the new genus *Hyophryne* based mainly on osteological characters. Although osteological characters were not studied in this new material, it was still possible to relate these recently collected specimens with the monotypic genus described by Carvalho (1954) based on the broader diagnosis of the species and examination of the holotype.

Carvalho (1954) considered *Hyophryne* as having characters intermediate in form between *Stereocyclops* and *Ctenophryne*. However, he thought *Hyophryne* was more closely related to *Stereocyclops*, only differing from the latter in aspects of the pectoral girdle (fig. 1 in Carvalho, 1954) and unspecified cranial characters. The two species of *Stereocyclops* are found in eastern Brazil, *S. incrassatus* Cope and *S. parkeri* Wettstein (Frost, 2011). *Stereocyclops incrassatus* is sympatric with *Hyophryne histrio* (Faria et al., 2007). There are also two recognized species of *Ctenophryne*: *Ctenophryne geayi* Mocquard is widely distributed in the Ama-

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zon Basin in Brazil, Guiana, Venezuela, Surinam, Ecuador, and Peru (Frost, 2011), whereas *Ctenophryne minor* Zweifel and Myers is restricted to Cauca, in Colombia (Zweifel and Myers, 1989).

The phylogenetic position of *Hyophryne histrio* is unclear partly because many character states are unknown for the taxon due to the paucity of material (Zweifel, 1986; Wild, 1995). Recent phylogenetic analyses (Frost et al., 2006; Van der Meijden et al., 2007) relied primarily on molecular data, and none of these studies included *Hyophryne.*

Herein, we redescribe *Hyophryne histrio* and report new findings on this species' morphological variation based on new material. We also add new information to the original diagnosis of Carvalho (1954) and detailed comparisons with other New World microhylid genera.

## Material and methods

Description of external morphology follows Zweifel (1986) and Canedo et al. (2004).Webbing formula follows Savage and Heyer (1997). Numeration of fingers from the inner to the outer finger was II, III, IV and V. Institutional abbreviations include those at http://www.asih.org/codons.pdf, except for Célio F.B. Haddad Collection housed at Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil (CFBH). Material examined is in Appendix.

Morphometric measurements were taken with a digital caliper to the nearest 0.1 mm and follows Duellman (1970): snout-vent length (SVL), head width (HW), head length (HL), eye diameter (ED), interorbital distance (IOD), internarial distance (IND), eye-nares distance (END), thigh length (THL), tibia length (TL), foot length (FL), and tibia-thigh length combined (TTL). These measures and body proportions were assessed statistically with a T-test for homocedastic samples of different sizes and df = 42.

Comparisons were made with specimens representing all New World microhylid genera (Appendix), with the exception of *Relictivomer* (see comments on the validity of this taxon in Frost, 1985 and Zweifel, 1986). Some published taxonomic descriptions were also used and are as follows: *Chiasmocleis*: Cruz et al. (1997), Peloso and Sturaro (2008); *Elachistocleis*: Lavilla et al. (2003), Caramaschi (2010); *Otophryne*: Campbell and Clarke (1998), MacCulloch et al. (2008); *Melanophryne*: Lehr and Trueb (2007); *Altigius*: Wild (1995); *Adelastes*: Zweifel (1986); *Synapturanus*: Pyburn (1975); *Syncope*: Nelson (1975), Duellman and Mendelson (1995), da Silva and Meinhardt (1999). Detailed comparisons with *Stereocyclops incrassatus*, *S. parkeri*, *Ctenophryne geayi*, and *C. minor* are provided because both genera were considered to be closely related to *Hyophryne* by Carvalho (1954). Information about *C. minor* is based on Zweifel and Myers (1989).

## Results

### Hyophryne histrio *Carvalho, 1954 (figs 1 and 2)*

#### *Holotype*

MNRJ 2776, juvenile female, Fazenda Repartimento, municipality of Ilhéus, State of Bahia, Brazil, March 1944, collected by João Geraldo Santos (fig. 1). Carvalho (1954) in the original description cited the holotype specimen as MN 1010, but this was done in error because both the holotype label and Museu Nacional amphibian collection catalogue list the specimen as MNRJ 2776. The specimen catalogued as MNRJ 1010 is instead a *Physalaemus* sp. from Barreiras, State of Bahia.

#### *Referred specimens*

Brazil: State of Bahia, Municipality of Una, Reserva Una (females) MNRJ 28565, 12 October 1999; MNRJ 28566-67, 13 October 1999; MNRJ 28568, 21 November 1999; MNRJ 28569 and 28570, 25 November 1999; MNRJ 28571, 03 February 2000; MNRJ 28573, no data; MZUSP 132327, 132333-34, 132336, 24 January to 29 February 2000; MZUSP 132338, 132342, 132344, 132346, 132348-49, 132351, 132354, 11 October to 26 November 1999; 138055, 04-27 February 2000; 138152, no data; (males) MNRJ 28572, 03 February 2000; MZUSP 132328, 132329-32, 132335, 24 January to 29 February 2000; 132337, 132339, 132340, 132343, 132345, 132347, 132352-53, 132355-59, 11 October to 26 November 1999.

#### *Diagnosis*

(1) medium-size SVL (males 24.3-38.5 mm, females 24.6-43.2 mm); (2) oval body; (3) head wider than long; (4) occipital fold present; (5) tympanum indistinct; (6) head truncate in dorsal view and slightly protruding in lateral view;

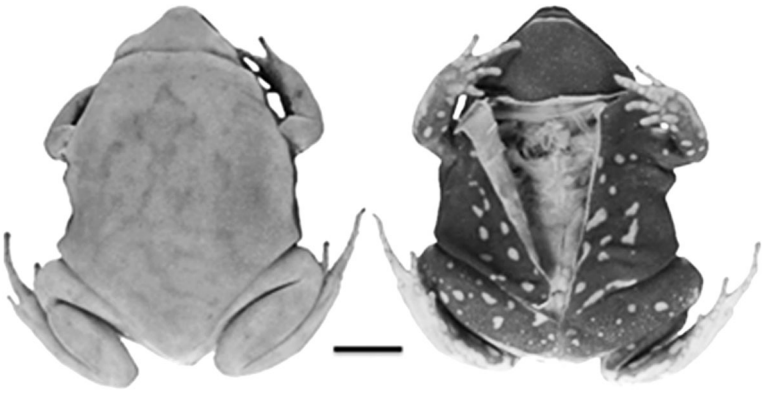

**Figure 1.** Holotype of *Hyophryne histrio* (MNRJ 2776). Scale bar = 5 mm.

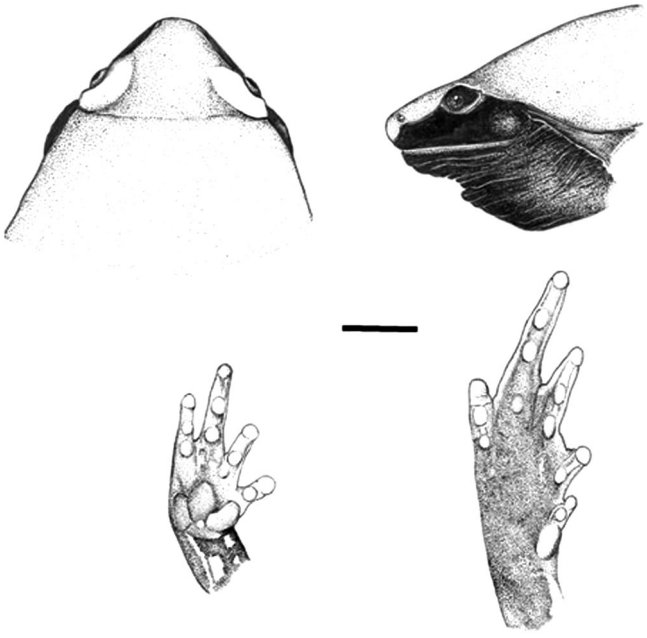

**Figure 2.** *Hyophryne histrio*, MNRJ 28565, female. Dorsal and lateral view of head, ventral view of hand and foot. Scale bar = 5 mm.

(7) toes fringed and with webbing; (8) robust hand with first finger much shorter than others; (9) adult males have dermal spines throughout the body; (10) males with vocal slits and vocal sacs; (11) two palatal folds present, the first one just slightly smaller than the second one, and the last is crenulated; (12) males without nuptial pads; (13) gravid females have dermal spines only in pericloacal region; (14) dark venter with white rounded or elongated blotches; (15) dorsum lighter than the venter, with an arrow-shaped dorsal pattern, starting after the occipital fold; and (16) pale line passing through the lateral of body separating venter and dorsum.

*Comparisons*

*Hyophryne histrio* is distinguished from *Adelastes*, *Arcovomer*, *Dasypops*, *Dermatonotus*, *Elachistocleis*, *Gastrophryne*, *Hamptophryne*, *Melanophryne*, *Myersiella*, *Stereocyclops*, *Synapturanus*, and *Syncope* by the presence of

well developed toe webbing. *Hyophryne histrio* differs from *Adelastes*, *Arcovomer*, *Chiasmocleis*, *Melanophryne*, *Otophryne*, and *Syncope* by the presence of an occipital fold. *Hyophryne histrio* is different from *Adelastes*, *Altigius*, *Myersiella*, *Otophryne*, *Synapturanus*, and *Syncope* by the presence of dermal spines on the body surfaces. *Hyophryne histrio* is distinct from *Otophryne*, *Synapturanus*, and *Syncope* by its tympanum not externally visible (not visible also in *Synapturanus salseri* and *Syncope carvalhoi*). *Hyophryne histrio* differs from *Ctenophryne*, *Melanophryne*, *Nelsonophryne*, and *Synapturanus* by the absence of nuptial pads in males (present in *Ctenophryne geayi* as a fine-grain whitish pad on the first two or three fingers, in *M. barbatula* and in the two species of *Nelsonophryne* as a thicker granulose whitish pad covering the first two or three fingers; all species of *Synapturanus* have a glandular pad on the wrist). *Hyophryne histrio* is distinguished from *Melanophryne* and *Nelsonophryne* by the presence of vocal slits and vocal sacs (not informed in the descriptions of *Adelastes*, *Altigius*, and *Otophryne*). *Hyophryne histrio* differs from the species of *Stereocyclops* (*S. parkeri* and *S. incrassatus*) and *Ctenophryne* (*C. geayi* and *C. minor*) by having a truncate snout shape in dorsal view and slightly protruding in lateral view (rounded in both views in *Stereocyclops*; acuminate in dorsal view and protruding in lateral view in *C. geayi*; no information on *C. minor*); *H. histrio* and *Stereocyclops* have nostrils on the tip of snout (further away from the tip in *Ctenophryne geayi*, no information on *C. minor*); *H. histrio* and *S. parkeri* have an arrow-shaped mark starting just posterior to the occipital fold as a dorsal pattern (unicoulored dorsum with no specific pattern in *Ctenophryne*; two irregular thick lines extend from eyes to the inguinal region in *S. incrassatus*); *H. histrio* and *C. geayi* may show a light, not very conspicuous vertebral line (not reported for *C. minor*; *Stereocyclops* may exhibit not only a vertebral line, but ventral, pectoral and femoral lines as well, and when occurring they are all present); *H. histrio* and *C. geayi* have well developed toe webbing (less developed in *C. minor* where it is poorly developed between Toe I and II and between II and III; poorly developed in *Stereocyclops*); *H. histrio* and *Ctenophryne geayi* have white rounded or elongated blotches as ventral pattern (pale blue blotches in life in *C. minor*; *Stereocyclops* has uniform venter without blotches); females of *H. histrio* and *Stereocyclops* may have dermal spines around the cloacal opening (females of *C. geayi* may have spines but less conspicuous and only in the posterodorsal area of thighs, not reported for *C. minor*); *H. histrio* and *Ctenophryne* have a light straight and continuous line or stripe separating the color of venter and dorsum, well marked in the head (not every specimen of *Stereocyclops* has this line evident, if present it may be more irregular and this delimitation is much less conspicuous in the head); *H. histrio* and *C. geayi* have a robust hand with the finger II much shorter than finger III (*Stereocyclops* and *C. minor* have a slender hand; *Stereocyclops* have finger II only slightly smaller than finger III); *H. histrio*, *Stereocyclops*, and *C. minor* have simple tubercles (*C. geayi* has two double tubercles on toes III and IV).

*Redescription*

Head length 20% of SVL (16-25%); short snout; dorsal view of head almost rounded with a truncate snout and slightly protruding in lateral view; nostrils located on tip of snout, laterally directed (fig. 2); internarial distance approximately 22% of head width in males (20-27%) and 21% in females (18-24%); *canthus rostralis* poorly defined; loreal region oblique; small eyes, not prominent, eye diameter approximately 19% of head width in males (16-22%) and 18% in females (15-20%); interorbital distance approximately 57% of head width (50-63%); eye-nostril distance approximately 22% of head length (18-27%); occipital fold present; supratympanic fold from the posterior corner of eye to just before the insertion of the arm; tympanum indistinct; tongue large, without poste-

rior notch, attached anteriorly and free posteriorly, with a dorsal-posteriorly located concavity; choanae small, rounded and widely distant; maxillary teeth and vomerine odontoids absent; two palatal folds present located posteriorly, the anterior one slightly smaller than the posterior and the posterior is crenulated; males with vocal slits located anteriorly on the mouth floor under the tongue; vocal sac not expanded externally, single and subgular. Fingers short and robust; finger tips small and rounded; relative length of fingers: II < III < V < IV; inner metacarpal tubercle small and elliptical; outer metacarpal tubercle large, ovoid and divided in two parts in most of the specimens ($n$ = 24, 56%), or just bifid ($n$ = 19, 44%); subarticular tubercles well developed, rounded; supernumerary tubercles absent; nuptial pads absent in males; interdigital membrane absent in hands; fingers fringes more developed in males than in females (fig. 2). Legs robust, shank and thigh length together 80% of SVL in males (70-87%) and 78% in females (71-85%); foot length 46% of SVL in males (41-50%) and 44% in females (38-50); foot length slightly greater than shank and thigh length; shank and thigh approximately the same length; relative length of toes: I < II < V < III < IV; inner metatarsal tubercle elliptical and well developed; outer metatarsal tubercle absent; subarticular tubercle well developed, rounded; proximal tubercle of toe IV may be present and well developed ($n$ = 16, 37%), poorly developed ($n$ = 17, 40%) or absent ($n$ = 10, 23%); supernumerary tubercles absent; fringes on toes well developed; interdigital membrane present and well developed in males and females (fig. 2), webbing formula: I (0-1)-(2-2½) II (1-1½)-(2½-3½) III $2^{+}$-3½ IV ($4^{-}$-4)-(1½-2) V; body surface smooth; a narrow dermal fold above the cloaca opening present in most of the specimens (absent in seven specimens); males with 27.6 mm of SVL or larger have dermal spines that may cover the entire body ($n$ = 16, 80% of males), generally more concentrated in the gular region ($n$ = 9, 45% of males) or less abundant and only present on fringes of fingers and toes or sparse in the venter ($n$ = 7, 35%); gravid females only exhibit dermal spines in the pericloacal region ($n$ = 13, 54% of females).

*Colour in life*

Dorsum yellow-lime (Carvalho, 1954), yellow, orange, green, beige or dark-brown (Dixo, 2004); iris silver dorsally and black ventrally (Carvalho, 1954).

*Colour in preservative*

Dorsal coloration varies from dark to light brown, sometimes beige, with the darker dorsal coloration more common ($n$ = 18, 42%), followed by medium brown ($n$ = 14, 32%) and light brown ($n$ = 11, 26%). Small dark blotches and speckles are sparse on the dorsum, less conspicuous when the dorsum is darker. The dorsal arrow-shaped blotch is more evident when the dorsum is lighter, or may be ill-defined. A broad transverse stripe in each leg is present in some individuals ($n$ = 11, 26%). The venter is dark, almost black, with large white rounded or elongated blotches that vary in number and size. The gular region of adult males is darker than in females and lacks the small white speckles present in females. Palmar, plantar regions, and subarticular tubercles may vary in color from cream to dark brown. The subarticular tubercles may be bordered by a dark line. The white line separating the dorsal and ventral coloration may be broad or thin and indistinct in those with a pale brown or beige dorsum. An inconspicuous mid-dorsal stripe is present in four individuals (MZUSP 132345, 132349, 132353 and 132354, 9%).

Females ($n$ = 24) are significantly larger than males ($n$ = 20) in SVL ($P$ = 0.06), HL ($P$ = 0.02), HW ($P$ = 0.02), IOD ($P$ = 0.02), END ($P$ = 0.05), but some body proportions are significantly larger in males: ED/HW ($P$ = 0.01), IND/HW ($P$ = 0.01), FL/SVL ($P$ = 0.01), and TTL/SVL ($P$ = 0.05) (see table 1). Males and females also differ in the

**Table 1.** Measurements (mm) and body proportions (%) of *Hyophryne histrio* (mean ± standard deviation and range).

| | Males ($n = 20$) | Females ($n = 24$) | Holotype |
|---|---|---|---|
| SVL | 33.1 ± 3.9 (24.3-38.5) | 35.9 ± 5.6 (24.6-43.2) | 27.2 |
| HL | 6.5 ± 0.6 (4.7-7.2) | 7.0 ± 0.8 (5.3-8.4) | 5.8 |
| HW | 12.3 ± 1.3 (9.4-14.2) | 13.5 ± 1.7 (9.3-15.7) | 12.2 |
| ED | 2.4 ± 0.3 (1.7-2.8) | 2.4 ± 0.3 (1.8-3.1) | 2.1 |
| IOD | 7.0 ± 0.7 (5.6-8.0) | 7.6 ± 0.9 (5.7-8.9) | 6.7 |
| IND | 2.7 ± 0.3 (2.0-3.4) | 2.8 ± 0.3 (2.1-3.3) | 2.4 |
| END | 2.8 ± 0.3 (2.1-3.3) | 3.0 ± 0.4 (2.2-3.7) | 2.5 |
| THL | 13.5 ± 1.9 (9.5-16.2) | 14.2 ± 2.1 (9.3-17.0) | 12.0 |
| TL | 12.9 ± 1.5 (9.6-14.6) | 13.7 ± 2.0 (9.5-16.3) | 11.0 |
| FL | 15.3 ± 1.9 (10.9-17.3) | 15.8 ± 2.3 (11.0-18.4) | 12.0 |
| HL/SVL | 20 ± 2 (17-25) | 20 ± 2 (16-23) | 21 |
| ED/HW | 19 ± 2 (16-22) | 18 ± 2 (15-20) | 17 |
| IOD/HW | 57 ± 3 (50-63) | 57 ± 3 (51-62) | 55 |
| IND/HW | 22 ± 1 (20-27) | 21 ± 2 (18-24) | 19 |
| END/HW | 22 ± 2 (20-27) | 22 ± 2 (20-26) | 43 |
| FL/SVL | 46 ± 2 (41-50) | 44 ± 3 (38-50) | 44 |
| TTL/SVL | 80 ± 4 (70-87) | 78 ± 4 (71-85) | 85 |

distribution of dermal spines and the amount of fringes on fingers, as well as the presence or absence of vocal slits and sacs. Variation in toe webbing did not exhibit sexual dimorphism, as is seen in some other microhylid genera such as *Chiasmocleis* (Cruz et al., 1997). Variation in color pattern was observed in the species, including a light to dark brown dorsum, different forms of the dorsal arrow-shaped blotch, and variation in the amount and form of the white ventral blotches (see fig. 3), however none of this color variation was related to sexual dimorphism. Males ($n = 20$) vary in total length from 24.3 to 38.5 mm, but only specimens larger than 27.6 mm have spines. The amount and location of spines vary in those males even when they exhibit similar body lengths and were collected in the same period. Nevertheless, great amount of spines through all body and the darkness of the gular region appear only in animals larger than 33.6 mm of SVL. All females with SVL larger than 35.5 mm have eggs, with exception of MZUSP 132333, 138055 (MNRJ 28571; MZUSP 138152 and 132342 were not dissected). All gravid females had spines in the pericloacal area. The ovarian eggs were bicolored. One female (MNRJ 28564, 42 mm SVL) presented approximately 590 eggs, 220 in the right side and 370 in the left side, from 1.3 to 1.5 mm of diameter. Other female (MZUSP 138155, 42 mm of SVL) presented approximately 1190 eggs, 650 in the right side and 540 in the left side, from 1.3 to 1.5 mm). In some females, the skin around the cloacal opening may be whitish with glandular appearance.

*Distribution and habitat*

*Hyophryne histrio* is now known from four localities in the State of Bahia in northeastern Brazil: Ilhéus, the type-locality (Carvalho, 1954); Una (15°10′S, 39°31′W) (Dixo, 2004); Itambé (15°16′S, 40°27′W), the most inland record (Argôlo, 2005); and Nova Viçosa (17°52′S, 39°23′W), the southern-most record (map in Targino and Wild, 2009). Extensive sampling with pitfall traps with drift fences in Jussari and Uruçuca, (municipalities in State of Bahia), near Ilhéus and Una, where *H. histrio* is known to occur, did not produce *H. histrio* (Dixo, 2004).

*Hyophryne histrio* collected in Una occured in a variety of habitats including primary forest interior and edge, forest fragment interior and edge, secondary forest, and cacao plantations or "*cabrucas*" (Dixo, 2004).

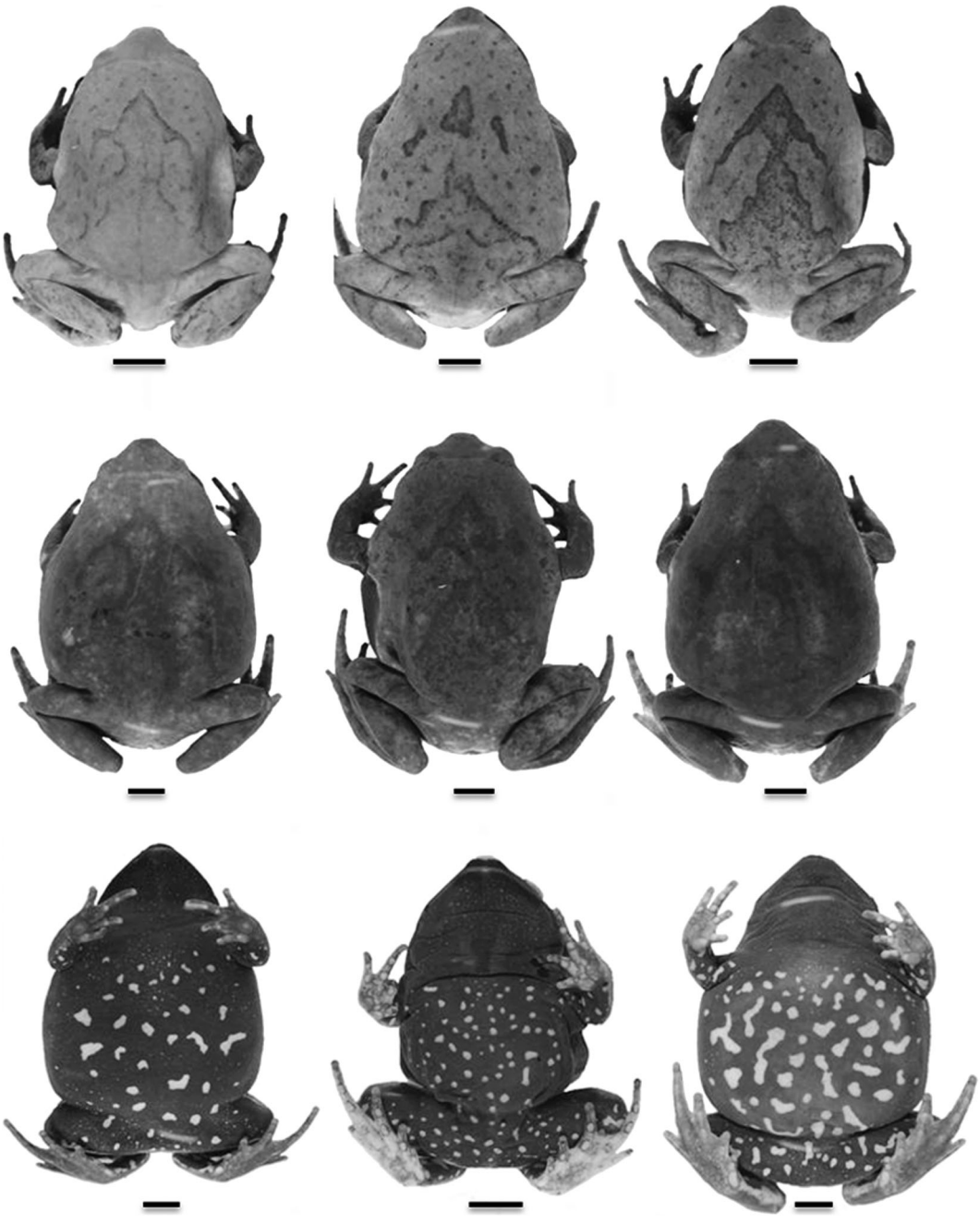

**Figure 3.** Variation of the dorsal and ventral pattern of *Hyophryne histrio*. From top to bottom, left to right: MNRJ 28567, 28569, 28572, 28565, 28571, 28573, 28566, 28567 and 28565. Notice the degree of light to dark brown dorsum, distinction and different format of the arrow-shaped dorsal pattern, and variation in the number and format of the ventral white blotches. Scale bar = 5 mm.

The collection localities for *H. histrio* suggest that this species has a moderately large distributional range, since they encompass all South Bahia (see Targino and Wild, 2009). In at least one of these localities, Una, this species was locally abundant, with 42 specimens collected

(Faria et al., 2007), while in the other localities the sample size is restricted to one specimen (Ilhéus, Itambé and Nova Viçosa). Nevertheless, sampling in Una was made only by pitfall traps and no specimen was found on the forest leaf litter or in temporary ponds (Dixo, 2004). Tadpoles and vocalizations remain unknown.

## Discussion

The characters in Carvalho's (1954) diagnosis that help differentiate *Hyophryne histrio* from other microhylid species are: body stouter, head broader than long, snout prominent with tip rounded, toes broader at the base with webs extending along the margins of toes to form fimbriations, palatal region with two folds, the first shorter than second and lying between the openings of the Eustachian tubes, the second fold broad, its posterior edge free and crenulate. The description of coloration also makes reference to an irregular, roughly arrow-shaped dark mark on dorsum, lower surfaces black with several large light spots concentrated on belly and in pectoral region and a few on arms and legs, and a sharp line of juncture between the light upper color and the dark inferior color. The diagnosis made in this study was reformulated to incorporate these characters used by Carvalho (1954) that were considered useful to distinguish the species as well as some new features observed to be diagnostic such as: the size of the species for males and females, presence of dermal spines, presence of occipital fold, tympanum not distinct, and information about males such as presence of vocal sacs and absence of nuptial pads. In the original description, there were no comparisons with other microhylid genera, except for some unspecified osteological characters.

*Hyophryne histrio* may be considered a medium sized frog, with a broad head and a rotund body (e.g., species of *Ctenophryne* and *Stereocyclops*), which contrasts with the pointed small heads present in *Elachistocleis*, *Myersiella*, and *Synapturanus*. *Hyophryne histrio* also has an occipital fold, as do 12 of the 20 recognized genera of America, as well as some asiatic genera (Parker, 1934). We observed the occipital fold in *Hamptophryne* and *Stereocyclops*, although Zweifel (1986) and Lehr and Trueb (2007), respectively, concluded that such a fold is absent in these genera. We suggest the possibility that the distinctiveness of the fold may be in some cases an artifact of preservation. Nelson (1972) suggested that this fold may be associated with the myrmecophagous habit, which is common in the family, as it may protect the eyes from ants. He says the fold may be less conspicuous in frogs that haven't been disturbed.

Although considered locally abundant, *H. histrio* was only collected by pitfall traps, and aspects of its natural history were never observed (Dixo, 2004). American microhylids usually are explosive breeders that reproduce in ponds, have exotrophic tadpoles with posteromedial spiracle, lateral eyes and no keratinized parts in the mouth (e.g. *Stereocyclops parkeri*, Wogel et al., 2000; *Hamptophryne boliviana* and *Ctenophryne geayi*, Schlüter and Salas, 1991; *Chiasmocleis carvalhoi*, Wogel et al., 2004). *Otophryne* and *Nelsonophryne* are exceptions within american microhylid tadpoles, the first one presenting keratinized teeth and very long, sinistral spiracle (Wassersug and Pyburn, 1987), the second one presenting dorsal eyes and spiracle in the level of intestine, in a more anterior position (Donnely et al., 1990). Also, *Myersiella* and *Synapturanus* present a low number of white eggs with terrestrial development and specialized tadpoles that hatch in an advanced stage (Izecksohn et al., 1971; Menin et al., 2007). The large number of small, bicolored ovarian eggs found in some females of *H. histrio* is consistent with the presence of exotrophic tadpoles that may follow the general microhylid patterns (e.g. Schlüter and Salas, 1991; Wogel et al., 2000, 2004).

Minute dermal spines are structures widely distributed among New World microhylids. The function of the spines is unknown, but Lehr and Trueb (2007) suggested that they may be as-

sociated with defense against predators or for courtship behavior. Although not cited by Lehr and Trueb (2007), we observed spines in *Arcovomer* and *Hamptophryne*. Apparently, these structures are absent only in *Adelastes*, *Altigius*, *Myersiella*, *Otophryne*, *Synapturanus*, and *Syncope*. Sexual dimorphism has also been reported in the presence and distribution of these spines (e.g. Parker, 1934; Nelson, 1972; Zweifel, 1986; Zweifel and Myers, 1989; Cruz et al., 1997; Lehr and Trueb, 2007). Males are observed to have a greater number of spines, which are distributed all over the body. In contrast, females have fewer spines, which are restricted to just some bodily areas such as the pericloacal region, tympanum, dorsum or limbs. Moreover, variation in spine number also exists among species, with some species reported to have more spines than others (Cruz et al., 1997). Males of *Hyophryne histrio* have more spines than females, and they are distributed throughout all body surfaces, whereas in females, when present, spines occur only around the cloacal opening. Variation also exists in the presence, amount, and distribution of these spines among males, as they can be absent (e.g., smaller specimens), present only in localized areas such as gular region and fringes of the fingers and toes, or covering the entire body surface. This variation was not associated with snout-vent length or period of the year, but since they were not collected in a reproductive state it is not possible to exclude the relation of these structures to reproduction. The presence of spines around the cloaca opening only in gravid females may reinforce the assumption of these structures may be related to reproductive activities.

The genus *Hyophryne* was included in two phylogenetic analyses of New World microhylids (Zweifel, 1986; Wild, 1995). In both studies, *Hyophryne* represented a taxon with several unknown character states. Zweifel (1986) used eight characters, assumed the monophyly of the New World microhylid clade, and used a hypothetical ancestor as a root. Wild (1995) used the same protocol but added six larval characters to the eight characters used by Zweifel (1986). In the latter analysis, *Hyophryne* was found to be the sister group of *Hamptophryne*, and both formed a sister group to *Stereocyclops*. *Hyophryne histrio* has not been included in any recent analysis with denser taxonomic sampling and without the assumptions of the previous analyses. Futures studies will help to establish its phylogenetic position within the Microhylidae.

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## Appendix

*Comparative material examined*

*Arcomover passarellii*: Brazil: Espírito Santo, Linhares CFBH 2700, 2181, MNRJ 22834, 35022-35023; Rio de

Janeiro, Rio das Ostras MNRJ 34590; Arraial do Cabo MNRJ 43399.

*Chiasmocleis avilapiresae*: Brazil: Mato Grosso, Aripuanã MNRJ 44231-44330.

*Chiasmocleis capixaba*: Brazil: Bahia, Nova Viçosa MNRJ 18924-19025, 19052-19274.

*Chiasmocleis carvalhoi*: Brazil: Bahia, Porto Seguro MNRJ 28962; Rio de Janeiro, Magé MNRJ 55160-55166; Macaé MNRJ 47477, 47377; Cachoeira de Macacu MNRJ 53464, 49302; São Paulo, Ubatuba MNRJ 48415.

*Chiasmocleis leucosticta*: Brazil: São Paulo, Ribeirão Branco MNRJ 17900-17904.

*Chiasmocleis schubarti*: Brazil: Espírito Santo, Linhares MNRJ 22959-22961; Aracruz MNRJ 17539-17545.

*Ctenophryne geayi*: Brazil: Amazonas, Barcelos MNRJ 36190; Mato Grosso, Aripuanã MNRJ 44208-44212; Pará, Paragominas MNRJ 23844.

*Dasypops schirchi*: Brazil: Espírito Santo, Linhares MNRJ 22682-22716.

*Dermatonotus muelleri*: Brazil: Bahia, Itajibá MNRJ 19297-19301; Boa Nova MNRJ 46525; Sergipe, Brejo Grande MNRJ 34128-34129.

*Elachistocleis bicolor*: Brazil: Paraná, Bituruna MNRJ 3909, 6932-6947.

*Elachistocleis cesarii*: Brazil: Goiás, Santa Teresa MNRJ 53149-53150; Minas Gerais, São João de Nepomuceno MNRJ 49639-49642; Faria Lemos MNRJ 41599-41600.

*Hamptophryne boliviana*: Brazil: Acre, Marechal Thaumaturgo MNRJ 28923; Amazonas, Médio Javari MNRJ 52479.

*Hypopachus variolosus*: San Salvador: El Salvador MZUSP 77593-77595; Mexico: Morelos MZUSP 77590-77592; Nayarit MZUSP 77259.

*Gastrophryne carolinensis*: United States: Florida MZUSP 5753-5754, 82446-82448, 14406, 14411; South Carolina, Richmond MZUSP 5184-5186.

*Myersiella microps*: Brazil: Rio de Janeiro, Cachoeira de Macacu MNRJ 47146, 49311; Ilha Grande MNRJ 47967-47968; Rio de Janeiro MNRJ 27544-27546, 27640; Teresópolis MNRJ 27548.

*Nelsonophryne aterrima*: Costa Rica: Cartago MNRJ 59144-59146; San Jose MNRJ 59147.

*Nelsonophryne aequatorialis*: Ecuador: Azuay MNRJ 59148-59149; Loja MNRJ 59150-19151.

*Stereocyclops incrassatus*: Brazil: Bahia, Una MNRJ 28574-28583; Uruçuca MNRJ 52875-52876; Espírito Santo, Linhares MNRJ 22810-22814.

*Stereocyclops parkeri*: Brazil: Rio de Janeiro, Cachoeira de Macacu MNRJ 54768; Casimiro de Abreu MNRJ 54021-54022; Duque de Caxias MNRJ 4336-4342; Rio de Janeiro MNRJ 54539, 39091; Macaé MNRJ 43987; Saquarema MNRJ 25446-25447.

*Synapturanus mirandaribeiroi*: Brazil: Amazonas, Oriximá MNRJ 47917-47920, 48144, 52829-52833, 52912-17.