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The occurrence of unpigmented mature oocytes in *Hypsiboas* (Anura: Hylidae)

RENATO C. NALI¹, JULIÁN FAIVOVICH² & CYNTHIA P. A. PRADO³

¹) Programa de Pós-graduação em Ciências Biológicas (Zoologia), Universidade Estadual Paulista “Júlio de Mesquita Filho”, Rio Claro, São Paulo, Brazil

²) División Herpetología, Museo Argentino de Ciencias Naturales-CONICET, Ángel Gallardo 470, C1405DJR, Buenos Aires, Argentina & Departamento de Biodiversidad y Biología Experimental, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires

³) Departamento de Morfologia e Fisiologia Animal, FCAV, Universidade Estadual Paulista “Júlio de Mesquita Filho”, Jaboticabal, São Paulo, Brazil

Corresponding author: RENATO C. NALI, e-mail: r_nali@yahoo.com.br

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The genus *Hypsiboas* is composed of 90 species distributed in Central and South America from Nicaragua to Argentina, as well as on Trinidad and Tobago (FROST 2014). Previous studies on the reproductive biology of species in this genus have reported that female mature oocytes or eggs generally have pigmented animal poles (Tab. 1), which has been generally suggested as a protection of the exposed embryos from solar radiation (WELLS 2007).

The Hispaniolan green treefrog, *Hypsiboas heilprini* (NOBLE, 1923) (Fig. 1A) is a vulnerable species assigned to the *Hypsiboas albopunctatus* group (HEDGES et al. 2004, FAIVOVICH et al. 2005), and occurs in the Dominican Republic and Haiti (Hispaniola). While its tadpole was described by NOBLE (1927), its reproductive biology remains largely unknown even after 90 years since its original description (SCHWARTZ & HENDERSON 1991, LANDESTOY 2013). Herein, we report on the analysis of the ovaries of a gravid female of *Hypsiboas heilprini*, collected in Haiti in October 2007 and deposited as number CUMV 15991 at the Cornell University Museum of Vertebrates, Ithaca, NY, USA. The ovaries contained 332 unpigmented mature oocytes (Fig. 1B) with a mean diameter of 2.38 ± 0.10 mm (range = 2.19 – 2.51 mm; N = 25 oocytes), as measured under a Leica stereomicroscope with photo-capturing software (Leica Application Suite).

The presence of unpigmented oocytes is a rare character state for the genus *Hypsiboas*. Currently, the only other species reported to have them are *H. lemai* (DUELLMAN 1997), *H. nympha*, and *H. roraima* (FAIVOVICH et al. 2006;

Tab. 1) from the *Hypsiboas benitezi* group (FAIVOVICH et al., 2005), with stream-associated reproduction.

Hypsiboas is included in the well-supported clade Cophomantini (FAIVOVICH et al. 2005). In this clade unpigmented oocytes or eggs are known to occur in *Aplastodiscus*, *Hyloscirtus*, and most *Myersiohyala* (FAIVOVICH et al. 2013). However, with the exception of *Aplastodiscus* (HARTMANN et al. 2004, HADDAD et al. 2005, ZINA & HADDAD 2007) and a species of *Hyloscirtus* (*H. platydactylus*, LA MARCA 1985), little is known about their reproductive modes. In *Aplastodiscus*, the eggs are deposited inside subterranean nests constructed by the males in the muddy side of streams and ponds, where larvae spend the early stages of their development (HARTMANN et al. 2004, HADDAD et al. 2005, ZINA & HADDAD 2007). In *Hyloscirtus platydactylus*, the unpigmented eggs are deposited on leaves and maternal care might be present (LA MARCA 1985).

Among the few *Hypsiboas* known to have unpigmented eggs, observations for *H. lemai* suggest that eggs are normally deposited on the vegetation overhanging streams, from where the tadpoles would drop and develop in the water (DUELLMAN 1997). For *H. heilprini*, previous studies and our observations indicate that eggs are deposited in concealed and protected places, such as the wall of a streamside cave or other natural caves (SCHWARTZ & HENDERSON 1991, LANDESTOY 2013). Considering the limited knowledge on the diversity of the reproductive biology of other Cophomantini with unpigmented eggs, the record of this species depositing its eggs in hidden places is

Table 1. Occurrence of egg/oocyte pigmentation in species of the genus *Hypsiboas*.

Species	Pigmented animal pole	Reference
<i>H. heilprini</i>	–	This study
<i>H. lemai</i>	–	DUELLMAN 1997
<i>H. nympa</i>	–	FAIVOVICH et al. 2006
<i>H. roraima</i>	–	FAIVOVICH et al. 2006
<i>H. aguilari</i>	+	LEHR et al. 2010
<i>H. albomarginatus</i>	+	L. O. M. GIASSON, pers. comm.
<i>H. albopunctatus</i>	+	MUNIZ et al. 2008
<i>H. atlanticus</i>	+	CAMURUGI & JUNCÁ 2013
<i>H. bischoffi</i>	+	HADDAD 1991
<i>H. boans</i>	+	DUELLMAN 1978, BURGER et al. 2002
<i>H. caipora</i>	+	ANTUNES 2007
<i>H. calcaratus</i>	+	DUELLMAN 1978
<i>H. cinerascens</i>	+	DUELLMAN 1978, TELLES et al. 2013
<i>H. cipoensis</i>	+	ETEROVICK et al. 2002
<i>H. cordobae</i>	+	FERNANDEZ 1927
<i>H. crepitans</i>	+	HOOGMOED & GORZULA 1979
<i>H. curupi</i>	+	GARCIA et al. 2007
<i>H. faber</i>	+	MARTINS et al. 1998
<i>H. fasciatus</i>	+	DUELLMAN 1978
<i>H. geographicus</i>	+	KENNY 1969, DUELLMAN 1978, LIMA et al. 2006
<i>H. goianus</i>	+	MENIN et al. 2004
<i>H. hutchinsi</i>	+	PYBURN & HALL 1984
<i>H. joaquina</i>	+	KWET et al. 2010
<i>H. lanciformis</i>	+	DUELLMAN 1978
<i>H. latistriatus</i>	+	ORRICO et al. 2007
<i>H. leptolineatus</i>	+	KWET et al. 2010
<i>H. lundii</i>	+	C. S. RIBEIRO, pers. comm.
<i>H. marginatus</i>	+	KWET et al. 2010
<i>H. marianitae</i>	+	DUELLMAN et al. 1997
<i>H. picturatus</i>	+	E. E. TAPIA & L. A. COLOMA, pers. comm.; HOOGMOED 1979
<i>H. poaju</i>	+	GARCIA et al. 2008
<i>H. polytaenius</i>	+	LUTZ 1973
<i>H. prasinus</i>	+	HADDAD 1991
<i>H. pulchellus</i>	+	BARRIO 1962
<i>H. punctatus</i>	+	KENNY 1969, DUELLMAN 1978
<i>H. raniceps</i>	+	C. P. A. PRADO, pers. obs.
<i>H. riojanus</i>	+	CARUSO 1949
<i>H. rosenbergi</i>	+	KLUGE 1981
<i>H. rufitelus</i>	+	DUELLMAN 1970
<i>H. sibleszi</i>	+	HOOGMOED 1979
<i>H. wavrini</i>	+	MARTINS & MOREIRA 1991

reminiscent of the reproductive strategy of *Aplastodiscus*, although in the latter nests are generally constructed by males (e.g. HADDAD et al. 2005). Future observations will hopefully provide more details.

Hypsiboas heilprini has been consistently recovered as the sister taxon of all other species of the *H. albopuncta-*

tus group (FAIVOVICH et al. 2005, 2013, WIENS et al. 2006, 2010, PYRON & WIENS 2011) although usually with low support values. Its phylogenetic relationships indicate that unpigmented eggs evolved independently from those present in species of the *H. benitezi* group.

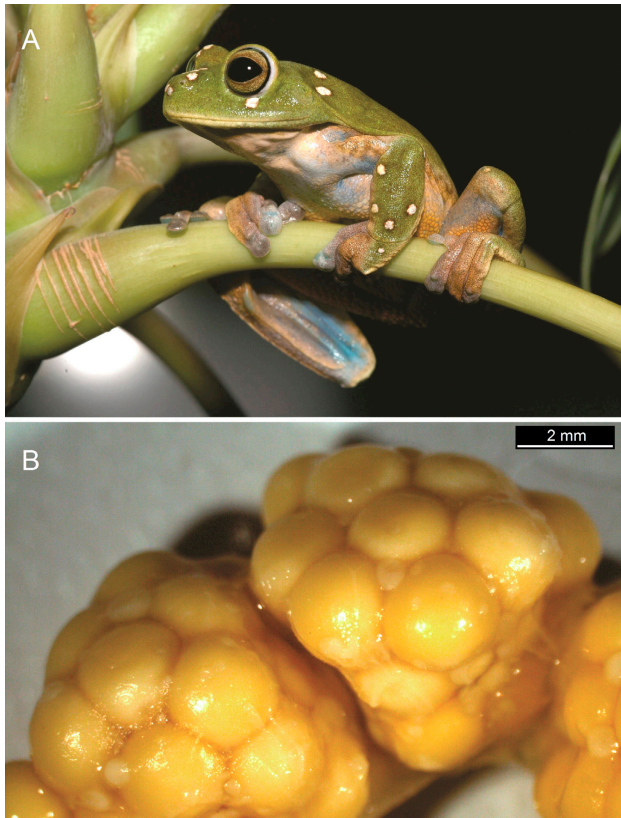


Figure 1. (A) Hispaniolan green treefrog, *Hypsiboas heilprini* (photograph by H. W. GREENE) and (B) segment from a female's ovary (accession number CUMV 15991), showing both mature and immature unpigmented oocytes.

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References

- ANTUNES, A. P. (2007): Descrição taxonômica e história natural de uma nova espécie de *Hypsiboas* do alto da Serra de Paranaipacaba, estado de São Paulo. – Unpublished Master's Dissertation (in Portuguese), Universidade Estadual Paulista, SP, Brazil.
- BARRIO, A. (1962): Los Hylidae de Punta Lara, provincia de Buenos Aires. – *Physis*, **23**: 129–142.

- BURGER, J., W. ARIZABAL & M. GOCHFELD (2002): Nesting behavior of a gladiator frog *Hyla boans* in Peru. – *Journal of Herpetology*, **36**: 640–648.
- CAMURUGI, F. & F. JUNCÁ (2013): Reproductive biology of *Hypsiboas atlanticus* (Anura: Hylidae). – *Herpetology Notes*, **6**: 489–495.
- CARUSO, M. A. (1949): Sobre el ciclo sexual anual de algunos "Hylidae" del norte Argentino ("*Phyllomedusa sauvagii*" e "*Hyla raddiana*"). – *Acta Zoologica Lilloana*, **8**: 83–103.
- DUELLMAN, W. E. (1970): Hylid frogs of Middle America. – *Monographs of the Museum of Natural History, University of Kansas*, **1–2**: 1–753.
- DUELLMAN, W. E. (1978): The biology of an equatorial herpetofauna in Amazonian Ecuador. – *Miscellaneous Publications of the Museum of Natural History of the University of Kansas*, **65**: 1–352.
- DUELLMAN, W. E. (1997): Amphibians of La Escalera region, southeastern Venezuela: taxonomy, ecology, and biogeography. – *Scientific Papers, Natural History Museum, University of Kansas*, **2**: 1–52.
- DUELLMAN, W. E., I. DE LA RIVA & E. R. WILD (1997): Frogs of the *Hyla armata* and *Hyla pulchella* groups in the Andes of South America, with definitions and analyses of phylogenetic relationships of Andean groups of *Hyla*. – *Scientific Papers of the Natural History Museum, The University of Kansas*, **3**: 1–41.
- ETEROVICK, P. C., I. S. BARROS & I. SAZIMA (2002): Tadpoles of two species in the *Hyla polytaenia* species group and comparison with other tadpoles of *Hyla polytaenia* and *Hyla pulchella* groups (Anura, Hylidae). – *Journal of Herpetology*, **36**: 512–515.
- FAIVOVICH, J., C. F. B. HADDAD, P. C. A. GARCIA, D. R. FROST, J. A. CAMPBELL & W. C. WHEELER (2005): Systematic review of the frog family Hylidae, with special reference to Hylinae: Phylogenetic analysis and taxonomic revision. – *Bulletin of the American Museum of Natural History*, **294**: 1–240.
- FAIVOVICH, J., J. MORAVEC, D. F. CISNEROS-HEREDIA & J. KÖHLER (2006): A new species of the *Hypsiboas benitezii* group from the western Amazon basin (Amphibia: Anura: Hylidae). – *Herpetologica*, **52**: 96–108.
- FAIVOVICH, J., R. W. MCDIARMID & C. W. MYERS (2013): Two new species of *Myersiophyla* (Anura: Hylidae) from Cerro de la Neblina, Venezuela, with comments on other species of the genus. – *American Museum Novitates*, **3792**: 63 pp.
- FERNANDEZ, K. (1927): Sobre la biología y reproducción de batracios argentinos (segunda parte). – *Boletín de la Academia Nacional de Ciencias en Córdoba*, **29**: 271–238.
- FROST, D. R. (2014): Amphibian Species of the World: an Online Reference. Version 6.0 (25 January 2014). – Electronic Database accessible at <http://research.amnh.org/herpetology/amphibia/index.html>. American Museum of Natural History, New York, USA.
- GARCIA, P. C. A., J. FAIVOVICH & C. F. B. HADDAD (2007): Redescription of *Hypsiboas semiguttatus*, with the description of a new species of the *Hypsiboas pulchellus* group. – *Copeia*, **2007**: 933–951.
- GARCIA, P. C. A., O. L. PEIXOTO & C. F. B. HADDAD (2008): A new species of *Hypsiboas* (Anura: Hylidae) from the Atlantic Forest of Santa Catarina, Southern Brazil, with comments on its conservation status. – *South American Journal of Herpetology*, **3**: 27–35.

- HADDAD, C. F. B. (1991): Ecologia reprodutiva de uma comunidade de anfíbios anuros na Serra do Japi, Sudeste do Brasil. – Unpublished PhD Thesis (in Portuguese), Universidade Estadual de Campinas, SP, Brazil.
- HADDAD, C. F. B., J. FAIVOVICH & P. C. A. GARCIA (2005): The specialized reproductive mode of the treefrog *Aplastodiscus perviridis* (Anura: Hylidae). – *Amphibia-Reptilia*, **26**: 87–92.
- HARTMANN, M. T., P. A. HARTMANN & C. F. B. HADDAD (2004): Visual signaling and reproductive biology in a nocturnal treefrog, genus *Hyla* (Anura: Hylidae). – *Amphibia-Reptilia*, **25**: 395–406.
- HEDGES, B., S. INCHAUSTEGUI, M. HERNANDEZ & R. POWELL (2004): *Hypsiboas heilprini*. – in: IUCN 2012: IUCN Red List of Threatened Species. Version 2012.2. – www.iucnredlist.org. Accessed on 11 March 2013.
- HOOGMOED, M. S. (1979): Resurrection of *Hyla ornatissima* Noble (Amphibia, Hylidae) and remarks on related species of green tree frogs from the Guiana area. Notes on the herpetofauna of Surinam VI. – *Zoologische Verhandlungen* **172**: 1–46.
- HOOGMOED, M. S. & S. GORZULA (1979): Checklist of the savanna inhabiting frogs of the El Manteco region with notes on their ecology and the description of a new species of treefrog. – *Zoologische Mededelingen*, **54**: 183–216.
- KENNY, J. S. (1969): The Amphibia of Trinidad. – *Studies on the fauna of Curaçao and other Caribbean islands*, **108**: 1–78.
- KLUGE, A. G. (1981): The life history, social organization, and parental behavior of *Hyla rosenbergi* Boulenger, a nestbuilding gladiator frog. – *Miscellaneous Publications University of Michigan, Museum of Zoology*, **160**: 1–170.
- KWET, A., R. LINGNAU & M. DI-BERNARDO (2010): Anfíbios da Serra Gaucha Sul do Brasil. – Tübingen: Brasilien Zentrum der Universität Tübingen.
- LA MARCA, E. (1985): Systematics and ecological observations on the Neotropical frogs *Hyla jahni* and *Hyla platydactyla*. – *Journal of Herpetology*, **19**: 227–237.
- LANDESTOY, M. A. (2013): Observations on the breeding behavior of the Hispaniolan green treefrog, *Hypsiboas heilprini*. – *IRCF Reptiles & Amphibians*, **20**: 160–165.
- LEHR, E., J. FAIVOVICH & K.-H. JUNGFER (2010): A new Andean species of the *Hypsiboas pulchellus* group: Adults, calls, and phylogenetic relationships. – *Herpetologica*, **66**: 296–307.
- LIMA, A. P., W. E. MAGNUSSON, M. MENIN, L. K. ERDTMANN, D. J. RODRIGUES, C. KELLER & W. HÖDL (2006): Guia de sapos da Reserva Adolph Ducke – Amazônia Central. – Manaus: Editora Attema.
- LUTZ, B. (1973): Brazilian species of *Hyla*. – Austin: University of Texas Press.
- MARTINS, M. & G. MOREIRA (1991): The nest and the tadpole of *Hyla wavrini* Parker (Amphibia, Anura). – *Memórias do Instituto Butantan, São Paulo*, **53**: 197–204.
- MARTINS, M., J. P. J. POMBAL, & C. F. B. HADDAD (1998): Escalated aggressive behaviour and facultative parental care in the nest building gladiator frog, *Hyla faber*. – *Amphibia-Reptilia*, **19**: 65–73.
- MENIN, M., R. A. SILVA & A. A. GIARETTA (2004): Reproductive biology of *Hyla goiana* (Anura, Hylidae). – *Iheringia, Série Zoologia*, **94**: 49–52.
- MUNIZ, K. P. R., A. A. GIARETTA, W. R. SILVA & K. G. FACURE (2008): Autoecologia de *Hypsiboas albopunctatus* (Anura, Hylidae) em área de Cerrado no sudeste do Brasil. – *Iheringia, Série Zoologia*, **98**: 254–259.
- NOBLE, G. K. (1927): The value of life history data in the study of evolution of the Amphibia. – *Annals of the New York Academy of Sciences*, **30**: 31–128.
- ORRICO, V. G. D., M. M. MONGIN & A. M. F. T. DE CARVALHO-E-SILVA (2007): The tadpole of *Hypsiboas latistriatus* (Caramaschi and Cruz, 2004), a species of the *Hypsiboas polytaeni* (Cope, 1870) clade (Amphibia, Anura, Hylidae). – *Zootaxa*, **1531**: 25–37.
- PYBURN, W. F. & D. H. HALL (1984): A new stream-inhabiting treefrog (Anura: Hylidae) from southeastern Colombia. – *Herpetologica*, **40**: 366–372.
- PYRON, R. A. & J. J. WIENS (2011): A large-scale phylogeny of Amphibia including over 2,800 species, and a revised classification of extant frogs, salamanders, and caecilians. – *Molecular Phylogenetics and Evolution*, **61**: 543–583.
- SCHWARTZ, A. & R. W. HENDERSON (1991): Amphibians and Reptiles of the West Indies: Descriptions, Distributions and Natural History. – Florida: The University of Florida Press.
- TELLES, D.O.C., S. A. F. VAZ & M. MENIN (2013): Reproductive biology, size and diet of *Hypsiboas cinerascens* (Anura: Hylidae) in two urban forest fragments in Central Amazonia, Brazil. – *Phyllomedusa*, **12**: 69–76.
- WELLS, K. D. (2007): The ecology and behavior of amphibians. – Chicago: The University of Chicago Press.
- WIENS, J. J., C. H. GRAHAM, D. S. MOEN, S. A. SMITH & T. W. REEDER (2006): Evolutionary and ecological causes of the latitudinal diversity gradient in hylid frogs: treefrog tree unearths the roots of high tropical diversity. – *The American Naturalist*, **168**: 579–596.
- WIENS, J. J., C. A. KUCZYNSKI, X. HUA & D. S. MOEN (2010): An expanded phylogeny of treefrogs (Hylidae) based on nuclear and mitochondrial sequence data. – *Molecular Phylogenetics and Evolution*, **55**: 871–882.
- ZINA, J. & C. F. B. HADDAD (2007): Courtship behavior of two treefrog species, *Aplastodiscus arildae* and *A. leucopygius* (Anura: Hylidae), from the Atlantic rainforest, southeastern Brazil. – *Herpetological Review*, **38**: 282–285.