

THE NEST AND THE TADPOLE OF *HYLA WAVRINI*, PARKER (AMPHIBIA, ANURA)

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ABSTRACT: The recently ressurected *H. wavrini* was observed at several localities in Brazilian Amazonia. Males call in apparent aggregations from the ground to 6 m above ground at the margins of streams, rivers, and lakes in "igapó" and "várzea" (inundation forests of black and white water, respectively) habitats, apparently throughout the year. At the Reserva Biológica Rio Trombetas, Pará, Brazil, we found that *H. wavrini* builds nests for egg deposition like the other species of the *H. boans* group. The four nests found were less elaborated than those of *H. boans*, *H. faber*, and *H. rosenbergi* and were observed within small pools below trees at the margins of an "igapó" lake. Tadpoles leave the nests in five days and larval period is apparently very short, probably related to the high density of predatory fishes in the lake. Tadpoles are similar to those of the other species of the *H. boans* groups, have cryptic coloration, and live in very shallow waters where they hide beneath the detritus layer. An encounter call was emitted by a male when a playback of the advertisement call was played close to it; this and the spacing observed among calling males suggest that *H. wavrini* males are territorial, such as those of the well studied *H. faber* and *H. rosenbergi*. Although sympatric in several Amazonian localities, *H. boans* and *H. wavrini* were never found syntopic probably due to habitat separation (*H. boans* breeds in streams in forests not subjected to seasonal floods).

KEYWORDS: Amphibia, *Hyla wavrini*, reproduction.

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Recebido para publicação em 19.2.1991 e aceito em 05.6.1991

INTRODUCTION

The *Hyla boans* group (nest building gladiator frogs^{11,12}) encompasses large species of *Hyla*, some of them known to construct sand or clay nests where eggs are laid (see brief reviews in ^{5,11,18,19}). Awaiting a taxonomic revision of the species related to *H. boans* and those of the closely allied *H. circumdata* group, we conservatively consider in the *boans* group only those species known to build nests for egg deposition (see ^{18,19}).

A large species of the *H. boans* group quite distinct in morphology, calls, and calling habitat from the widespread Amazonian *H. boans* was observed by us in several Amazonian localities in the recent years. This lead us to suspect that this frog was a distinct species. Independently M.S. Hoogmoed (pers. comm.) concluded that these and other specimens from several Amazonian localities were actually *Hyla wavrini* Parker, 1936, and recently resurrected this name⁹. This author distinguished *H. wavrini* from *H. boans* by using several morphological and calling characteristics (see table 2 in⁹).

Hyla wavrini males call from low perches in "igapó" and "várzea" habitats (see Methods) where they were suspected to reproduce (⁹; pers. obs.). However, Hoogmoed⁹ found no nest or egg clutch of *H. wavrini* in several localities he observed calling males, and suggested that "it seems (...) likely that eggs are directly deposited on or in the water"⁹. Recently we found a calling aggregation of *Hyla wavrini* at the Reserva Biológica do Rio Trombetas, Pará, Brazil, where we found egg clutches, nests, and tadpoles of this species. We here present additional observations on calling habitat of *H. wavrini*, describe its nests and tadpoles, and compare them with those of related species.

METHODS

Observations on calling sites of *H. wavrini* were made at several Amazonian localities (table 1), all of them in "igapó" and "várzea" (inundation forests of black and white water, respectively¹⁴) habitats. Observations and collections at the Reserva Biológica do Rio Trombetas (1°22'S, 56°52' W, elev. ca. 50 m) were made from 27 October to 4 November and 3 and 4 December, 1990. The study site was Lagoinha, a medium sized (ca. 3 ha), shallow "igapó" lake connected to the Rio Trombetas during high waters and becomes isolated during the dry season (August-October); the lake is located about 300 m behind the buildings of the reserve. Observations on nests, tadpoles, and calling males were made in diverse periods of the day (from 0800h to 2200h). We marked the calling sites of 13 males at night and looked for nests and egg clutches at these sites by day. In one nest (with eggs deposited in the night of 28/29 October) we collected samples of premetamorphs in 29 and 30 October and 1 November and fixed them in 5% formalin. Eggs and embryos were measured to the nearest 0.1 mm under a dissecting microscope. Tadpoles were collected by day at the margins of the lake and fixed in 5% formalin. To confirm tadpole identification, three individuals in stages 41-43 were maintained in laboratory until metamorphosis. Developmental stages of tadpoles are those of Gosner⁸. Specimens from all localities cited here are deposited in the herpetological collections of Departamento de Ecologia, Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil.

FIGURE CAPTIONS

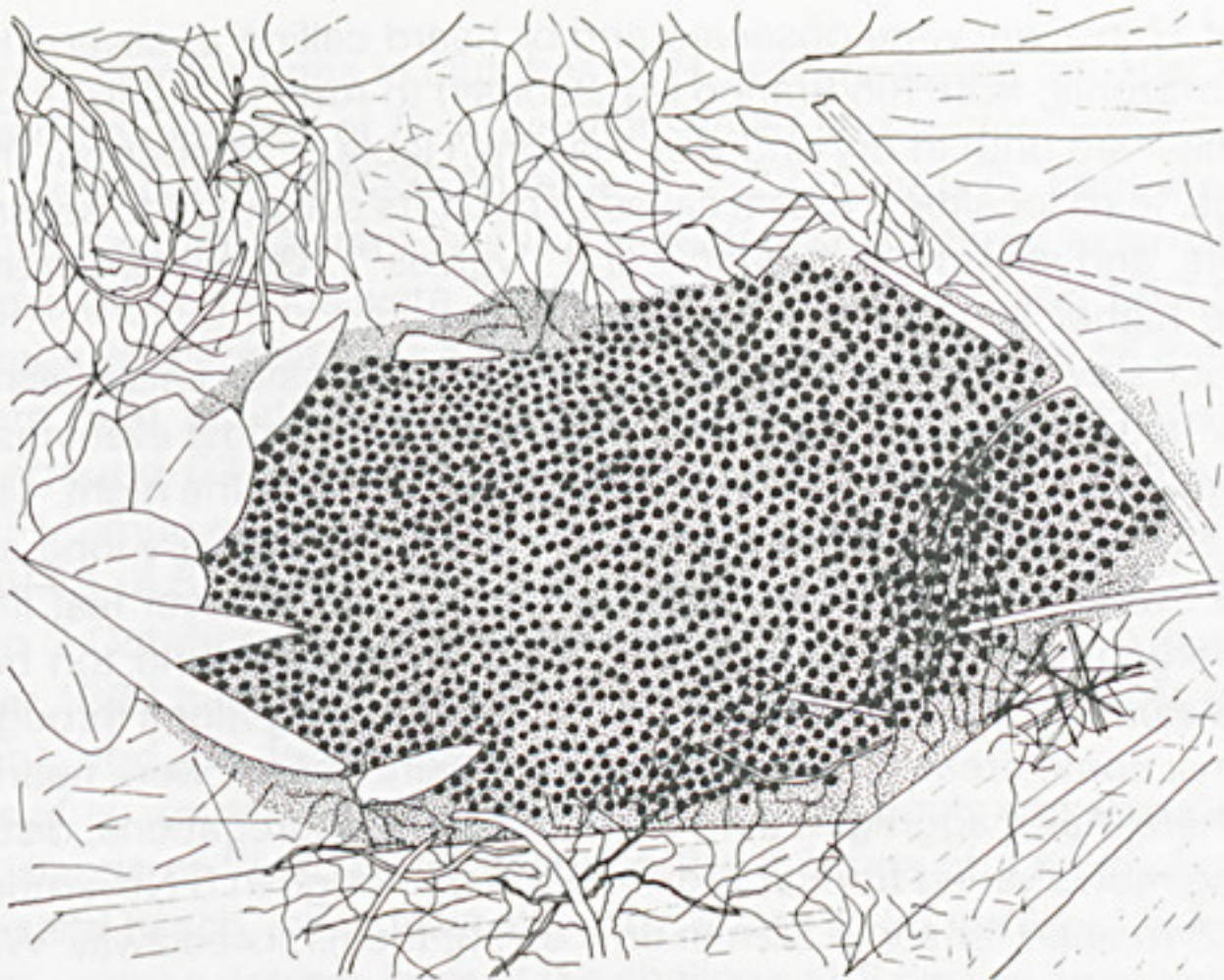


FIG. 1 — Schematic representation of a nest of *Hyla wavrini* (diameter ca. 40 cm) found within roots and leaf litter below an island of “igapó” trees at lake Lagoinha, Reserva Biológica Rio Trombetas, Pará, Brazil. Finely dotted areas represent water; larger dots represent eggs. Drawn after a photograph.

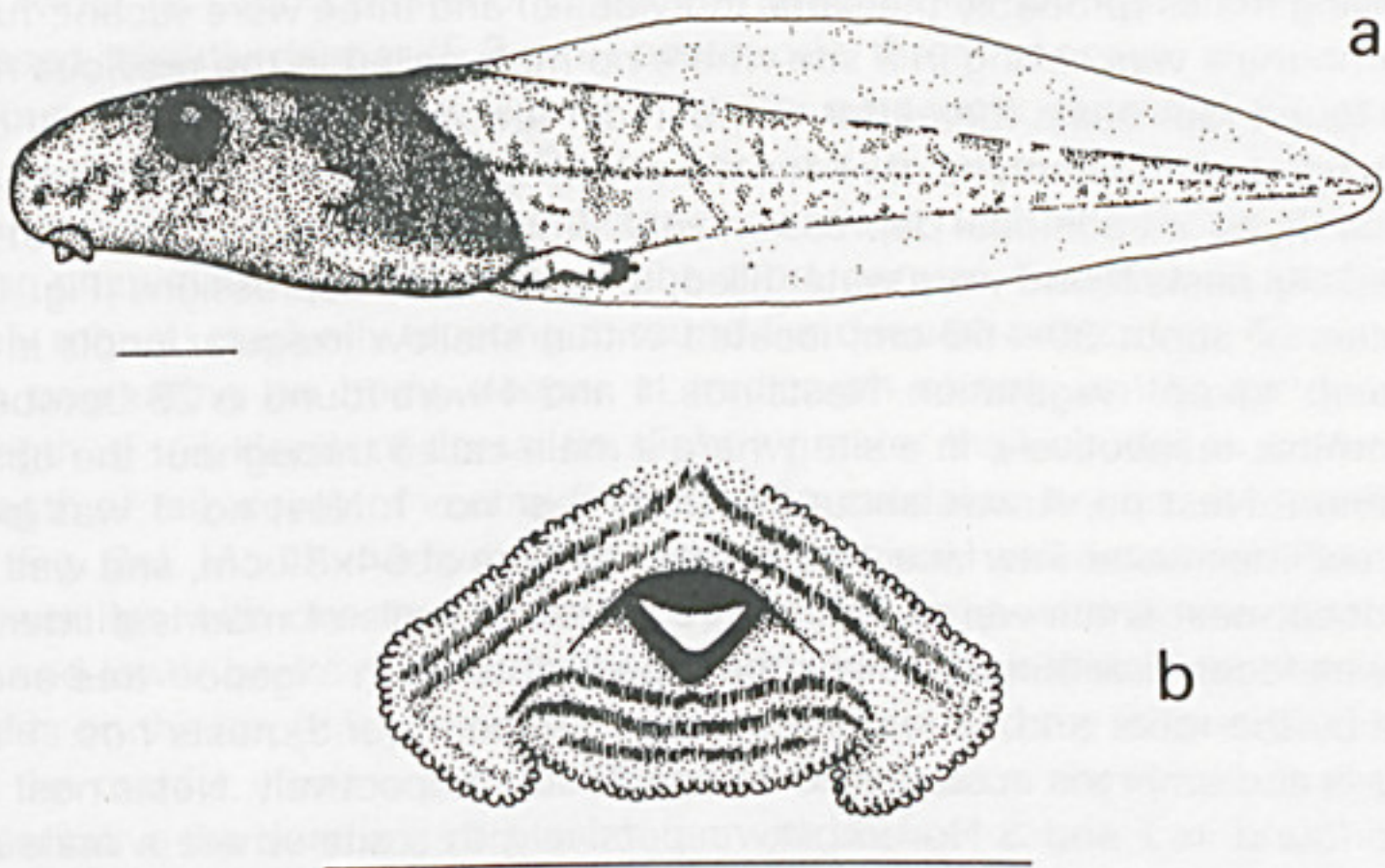


FIG. 2 — Lateral view (a) and mouth (b) of a *Hyla wavrini* tadpole (stage 37) collected at lake Lagoinha, Reserva Biológica Rio Trombetas, Pará, Brazil. Horizontal bars correspond to 3 mm.

RESULTS

Males of *H. wavrini* were observed and/or heard calling at several localities in Brazilian Amazonia, from Rio Branco (Amazonas) to Amapá (Table 1); calling activity was observed both in dry and wet seasons (Table 1) throughout this geographical range. In all localities, males called in habitats subjected to seasonal floods (lakes, rivers, and streams in "igapó" and "várzea"). Densities of calling males seem to be higher in lakes than in rivers or streams.

During our stay at the Rio Trombetas, *Hyla wavrini* males called all nights. Calling activity began at 1730h (ca. 30min before dusk) on most evenings and, after a peak at approximately 1900-2000h, diminished through the night. Males called at 80-90 calls per minute, although some of them emitted very long and spaced calls in the evening hours. Males called from the ground (over leaf litter or partially submerged in shallow small pools) to 6 m above ground (on branches of "igapó" trees) nearly regularly spaced in apparent aggregations throughout "igapó" margins; some areas where calling males were absent were nearly identical to those where males aggregated. In these apparent aggregations, distances between calling males varied from approx. 4-15 m, although in 3 November two males called 1.5 m apart for some 30 min until one of them moved away. When calling close to each other, males alternated their calls. In 31 November we recorded a long series of the advertisement call of a male and made playbacks some 2 m from the same. At the first playback the male immediately emitted a series of 35 encounter calls (Wells, 1977) with shorter and, apparently, lower pitched notes than those of the advertisement call. Further playbacks to this and another male failed to elicit responses other than call alternation.

On 1st November, of thirteen calling sites marked in the previous nights, 10 had calling males (probably the same individuals) and three were vacant; furthermore one male was calling in a site where no male called in the previous nights.

We found four nests (hereafter numbered 1-4 according to day of first observation) with pre-metamorphs of *H. wavrini* at calling sites marked in previous nights (besides these, an additional depression very similar to a nest was found at a calling site). All nests found were water filled, roughly round depressions (Fig. 1) with diameters of about 30-50 cm, located within shallow irregular pools in small islands of "igapó" vegetation. Nests nos. 1 and 4 were found in 29 October and 4 November, respectively, in a site where a male called throughout the observation period. Nest no. 4 was about 1m from nest no. 1. Nest no. 1 was located in the leaf litter-water interface, had a water surface of 54x37 cm, and was some 4 cm deep; nest limits were easily noted by rough walls of mud leaf litter. Nest no. 4 was located within partially submerged roots of an "igapó" tree and was limited by the roots and by leaf litter (Fig. 1). When found, nests nos. 1 and 4 had eggs and embryos in stages 10-11 and 17-18, respectively. Nests nos. 2 and 3 were found in 1 and 3 November, respectively, in a site where a male called also throughout the observations. Nest no. 3 was nearly 2.5 m from nest no. 2. They were both located in the leaf litter within irregularly shaped depressions and had almost no walls in their limits. When found, both nests nos. 2 and 3 had embryos in stages 21-23. In 3 November we found a water filled depression that was very similar to the nests above: a round ca. 40 cm diameter depression limi-

ted by muddy and leaf litter walls (some 1-2 cm high) located in the leaf litter-water interface. A tadpole of *H. wavrini* (ca. 30 mm) in stage 25 was found in this nest.

We did not counted eggs in clutches of *H. wavrini* during our stay at Trombetas. However the clutches of *H. wavrini* observed had evidently more eggs than those of *H. faber* (range 1614-3576 eggs, $x = 2276$ eggs¹⁸). Eggs are black and surrounded by two transparent jelly-like capsules. Diameter of external capsules, internal capsules, and eggs were 3.2-3.5 mm, 2.2-2.4 mm, and 1.6-1.8 mm, respectively. Eggs are deposited as a roughly round monolayer film on the water surface and are hold together by their sticky capsules. Supposing that eggs are deposited around 0300h (the mean time of egg deposition in the related *H. rosenbergi*¹²), embryos collected in a clutch of 28/29 October (nest no. 1) were in stages 18-19 (4.5-4.9 mm) in ca. 40 h and in stages 23-24 (8.2-9.2 mm) in ca. 90 h. In 3 October, all tadpoles had abandoned nest no. 1. A nest found in 4 December 1990 had 1056 embryos in stages 20-22, one tadpole in stage 25 (ca. 25 mm), and five freshwater shrimps.

Tadpoles of *H. wavrini* were found in shallow small pools and abandoned nests within the islands of "igapó" trees and in the margins of a sandy beach at the lake. At the sand beach, individuals of diverse sizes (10-35 mm) and stages (25-42) flushed from under a detritus layer at the shallows (1-2 cm) as an observer walked near the margins; after swimming a few centimeters these tadpoles retreated under debris or stopped unretreated. Dorsal coloration in cryptic and tadpoles are hardly found when immobile on the bottom.

The following description is based on a "typical" tadpole (INPA 1371, collected at Lagoinha, Rio Trombetas, Pará, Brazil, in 30 November 1990) in developmental stage 37. Body length 12.7 mm; total length 34.7 mm; body in dorsal view ovoid, wider (8.1 mm) posteriorly; body in lateral view elongate, dorsoventrally depressed, slightly deeper (5.3 mm) posteriorly, throat concave; snout in dorsal view rounded, in lateral view slightly truncate; eyes large, dorsolateral, facing laterally; distance between eyes 2.8 mm, from eye to nostril 0.9 mm; eye diameter (2.1 mm) slightly greater than the distance between nostrils; spiracle sinistral, its opening on midline (Fig. 2a); cloacal tube short, conical. Caudal musculature moderately robust, gradually tapering to round tip; deepest point of tail 6.1 mm; dorsal fin originating on body, deeper at midlength of tail; ventral fin deeper at midlength of tail; depth of dorsal fin slightly greater than caudal musculature at midlength of tail; depth of ventral fin similar to caudal musculature at midlength of tail (Fig. 2a). Mouth medium sized, ventro-terminal; well developed lips, upper and lower lips with one row of small papillae; lower lip with symmetrical folds; upper and lower beaks narrow, finely serrate; lower beak V-shaped; two rows of denticles on the upper lip, the outermost continuous and the innermost interrupted at the middle; three continuous rows of denticles on the lower lip (Fig. 2b). In preservative the dorsum is brownish tan with darker reticulation; throat and anterior part of belly like dorsum, posterior part of belly whitish, slightly translucent; caudal musculature and fins cream with irregular brown reticulation. In life the body, caudal musculature, and fins are a little greenish.

Three metamorphosing tadpoles (stages 43-45) had snout-vent length (SVL) of 14, 15, and 17 mm. Recently metamorphosed *H. wavrini* has a brown dorsum very similar to the colors of adults.

TABLE 1
 Localities and dates of observations on calling activity
 of *Hyla wavrini* males. The driest months of each locality are indicated.

Locality	Date	Driest months
Rio Branco near mouth, Amazonas (AM)	08 Jun 1989	Aug-Sep
Paraná Amajaú, AM	10 Jun 1989	Aug-Sep
Rio Jauaperi, AM	07 Jun 1989	Aug-Sep
Anavilhanas, Rio Negro, AM	22-24 Mar 1988	Jun-Oct
Rio Cuieiras, AM	10 Aug 1986	Jun-Oct
Manaus, AM	20 Nov 1990	Jun-Oct
Rio Trombetas, Pará (PA)	27 Oct to 04 Dec 1990	Aug-Oct
Alter do Chão, PA	17 Sep and 29 Nov 1988	Aug-Oct
Igarapé do Bispo, Amapá	22 Jul 1989	Sep-Nov

DISCUSSION

Hyla wavrini is widespread in northern Amazonia, occurring from Taracuá, Rio Uaupés, Amazonas⁹, throughout the Amazon Basin, reaching Igarapé do Bispo, just south of Macapá, Amapá (pers. obs.). At the present state of knowledge, its range seems to be within that of *H. boans* (see fig. 1 in⁹) which occurs in southern Central America and throughout Amazonia. In fact, both species are sympatric at several Amazonian localities (⁹; pers. obs.), although they were never found to be syntopic. *Hyla boans* breeds in "terra firme" (forests not subject to inundations) streams while *H. wavrini* breeds at lakes, streams, and rivers in "igapó" and "várzea" habitats. This habitat separation may prevent syntopy and, consequently, hybridization. Another difference between these two related species is that *H. boans* breeds during the dry season (²²; pers. obs.) while *H. wavrini* seems to breed both in the dry and wet seasons (this study).

The spacing observed among calling males, their apparent fidelity to calling sites, and the presence of an encounter call in the vocal repertoire indicate that *H. wavrini* males are territorial. Hoogmoed⁹ observed scars, probably caused by prepollical spines, in the dorsum of a male *H. wavrini* and speculated that males of this species may fight as in *H. faber* and *H. rosenbergi*, the only two well studied species of the *boans* group^{12,16,18,19}. Thus, as for nest building behavior, fighting behavior may be widespread in the *boans* group; suggestively, Kluge^{11,12} treats the *H. boans* group as "nest building gladiator frogs".

The habit of building nests for egg deposition was observed in *H. biobeba*¹⁰, *H. boans*^{3,4,5,13}, *H. faber*^{7,15,17,18,19}, *H. pardalis*¹⁶, *H. rosenbergi*¹², and *H. wavrini* (this study). The nests of *H. wavrini* described herein have walls less elaborated than those of *H. boans* (pers. obs.), *H. faber* (e.g., fig. 6 in¹⁹, and *H. rosenbergi* (e.g., fig. 27 in¹²). However, Kluge¹² and Martins¹⁸ suggest that the material used to build nests and, consequently, their architecture, in *H. rosenbergi* and *H. faber*, respectively, is related to the nature and hardness of the substrate (e.g., some *H. faber* males build nests just by pushing away the aquatic vegetation in pond margins¹⁸).

The developmental rate of *H. wavrini* initial premetamorphic stages observed at Trombetas is faster than those observed by Martins¹⁸ for *H. faber* and by Kluge¹² for *H. rosenbergi*. Furthermore, metamorphosing young *H. wavrini* (SVL

14-17 mm) are smaller than those of *H. rosenbergi* (SVL 19-22 mm) and *H. faber* (SVL 31-37 mm). These differences suggest that total developmental period of *H. wavrini* is shorter than those of the latter species (40 days in *H. rosenbergi*¹²; 8-9 months in *H. faber*¹⁸). Rapid developmental period may increase the probability of tadpoles escaping predation and/or water drying in temporary ponds, but in permanent ponds it may also permit escape from large predators²¹. We observed high density of fishes at Lagoinha (probably because of the low waters, see²⁰). Short developmental period associated with the defensive tactics (crypsis, hiding behaviour, and preference for very shallow water) observed in *H. wavrini* tadpoles may reflect the high density of predators in the habitats where tadpoles grow.

In general, the tadpoles of *Hyla wavrini* are similar to those known for the other members of the *boans* group. Major differences for tadpoles in similar stages are the following: the tadpoles of *H. biobeba* are larger (66 mm in stage 37²), have two rows of papillae bordering upper and lower lips, and no fold and four rows of denticles in the lower lip, the innermost interrupted at midlength; the tadpoles of *H. boans* are slightly larger (43 mm in stage 38⁶) and have four rows of denticles in the lower lip; those of *H. faber* are larger (80 mm in stage 37¹⁸); those of *H. pardalis* are slightly larger (43 mm in stage 38¹), have no row of papillae in the upper lip, and the innermost row of denticles in the lower lip is interrupted at midlength; and those of *H. rosenbergi* have four rows of denticles in the lower lip.

Additional observations on the reproductive biology of *H. wavrini* and *H. boans*, ideally at localities where the two species are sympatric (see⁹), would clarify how these two closely related species face the constraints associated to their different breeding habitats (inundation forests and streams in "terra firme", respectively).

ACKNOWLEDGEMENTS

We thank Silvia Egler, Marcelo Gordo, Célio Haddad, and J. P. Pombal Jr. for helpful suggestions on earlier drafts of the manuscript; IBAMA for permission to work at Trombetas; and CNPq for financial support to M. Martins.

RESUMO. *Hyla wavrini*, espécie recém-revalidada, foi observada em diversas localidades da Amazônia brasileira. Machos cantam em aparentes agregações, do chão até 6 m de altura, em margens de riachos, rios e lagos em ambientes de igapó e várzea (florestas inundáveis de água preta e água branca, respectivamente), aparentemente durante todo o ano. Na Reserva Biológica Rio Trombetas, Pará, Brasil, observamos que *H. wavrini* constrói ninhos para a desova, como as outras espécies do grupo *H. boans*. Quatro ninhos encontrados eram menos elaborados que aqueles de *H. boans*, *H. faber* e *H. rosenbergi* e estavam entre pequenas poças sob árvores nas margens de um lago de igapó. Os girinos abandonam os ninhos em cerca de cinco dias e o período larvário é aparentemente muito breve, provavelmente devido à grande densidade de peixes predadores no lago. Os girinos são semelhantes àqueles das outras espécies do grupo *H. boans*, têm coloração críptica e vivem em águas muito rasas onde se escondem sob uma camada de detritos. Um "grito de encontro" foi emitido por um macho quando um "playback" do canto de advertência foi tocado próximo a ele; este fato e o espaçamento observado entre machos que cantavam sugerem que machos de *H. wavrini* são territoriais, como em duas espécies próximas,

bem estudadas, *H. faber* e *H. rosenbergi*. Embora simpátricas em diversas localidades da Amazônia, *H. boans* e *H. wavrini* não foram encontradas em sintopia, provavelmente devido à separação por habitats (*H. boans* reproduz-se em riachos de florestas não sujeitas a inundações periódicas).

UNITERMOS: Amphibia, *H. wavrini*: reprodução.

REFERENCES

1. BOKERMANN, W. C. A. Observações sobre "*Hyla pardalis*" Spix (Anura, Hylidae). *Rev. bras. Biol.*, 28:1-5, 1968.
2. BOKERMANN, W. C. A. & SAZIMA, I. Anfíbios da Serra do Cipó, Minas Gerais, Brasil. 1 — Espécies novas de "*Hyla*" (Anura, Hylidae). *Rev. bras. Biol.*, 33:329-336, 1973.
3. CRUMP, M. L. Reproductive strategies in a tropical anuran community. *Misc. Publ. Mus. Nat. Hist. Univ. Kans.*, 1:1-68, 1974.
4. DUELLMAN, W. E. The hylid frogs of Middle America. *Mus. Nat. Hist. Univ. Kans. Monogr.*, 1:1-753, 1970.
5. DUELLMAN, W. E. Nest building hylid frogs. *HISS News-J.*, 1:72-75, 1973.
6. DUELLMAN, W. E. The biology of an equatorial herpetofauna in Amazonian Ecuador. *Misc. Publ. Mus. Nat. Hist. Univ. Kans.*, 65:1-352, 1978.
7. GOELDI, E. A. Contributions to the knowledge of the breeding habits of some frogs (Hylidae) of the Serra dos Órgãos, Rio de Janeiro, Brazil. *Proc. Zool. Soc. Lond.*, p. 89-97, 1895.
8. GOSNER, K. L. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica*, 16:183-190, 1960.
9. HOOGLMOED, M. S. Resurrection of *Hyla wavrini* Parker (Amphibia: Anura: Hylidae), a gladiator frog from northern South America. *Zool. Meded.*, 64:71-93, 1990.
10. JIM, J. Aspectos ecológicos dos anfíbios registrados na região de Botucatu, São Paulo (Amphibia, Anura). São Paulo, 1980. [Tese de Doutorado — Universidade de São Paulo.]
11. KLUGE, A. G. The gladiator frogs of Middle America and Colombia; a reevaluation of their systematics (Anura: Hylidae). *Occas. pap. Mus. Zool. Univ. Mich.*, 688:1-24, 1979.
12. KLUGE, A. G. The life history, social organization, and parental behavior of *Hyla rosenbergi* Boulenger, a nest building gladiator frog. *Misc. Publ. Mus. Zool. Univ. Mich.*, 160:1-170, 1981.
13. LAMOTTE, M. & LESCURE, J. Tendances adaptatives a l'affranchissement du milieu aquatique chez les amphibiens anoures. *Terre Vie*, 31:225-311, 1977.
14. LEOPOLDO, P. R.; FRANKEN, W.; SALATI, E.; RIBEIRO, M. N. Towards a water balance in the central Amazonian region. *Experientia*, 43:222-233, 1987.
15. LUTZ, B. Fighting and an incipient notion of territory in male tree frogs. *Copeia*, p. 61-63, 1960.
16. LUTZ, B. The clay nests of *Hyla pardalis* Spix. *Copeia*, p. 364-366, 1960.
17. LUTZ, B. *Brazilian species of Hyla*. Austin, University of Texas, 1973. 290p.
18. MARTINS, M. História natural do Sapo Ferreiro (*Hyla faber* Wied) na região de Campinas, Estado de São Paulo. Campinas, 1990. [Dissertação de Mestrado - Universidade Estadual de Campinas.] 140p.
19. MARTINS, M. & HADDAD, C. F. B. Vocalizations and reproductive behaviour in the Smith Frog, *Hyla faber* Wied (Amphibia: Hylidae). *Amphib.-Reptilia*, 9:49-60, 1988.
20. SAZIMA, I. & POMBAL JR., J. P. Mutilação de nadadeiras em acarás, *Geophagus brasiliensis*, por piranhas, *Serrasalmus spilopleura*. *Rev. bras. Biol.*, 48:477-483, 1988.
21. WILBUR, H. M. Complex life cycles and community organization in amphibians. In: PRICE, P. W., SLOBODCHIKOFF, C. N., GAUD, W. S. *A new ecology; novel approaches to interactive systems*. New York, John Wiley, 1984. p. 195-224.
22. ZIMMERMAN, B. L. & BOGART, J. P. Vocalizations of primary forest frog species in the central Amazon. *Acta Amazonica*, 14:473-519, 1984.