

Diel activity of the tadpoles of *Hyla hylax* (Anura: Hylidae) at Boracéia, Southeastern Brazil

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Behavioral ecological data on anuran larvae are critical to conservation practices because success of the larval phase strongly influences adult recruitment; anuran mortality is typically highest during the tadpole stage (Heyer, 1973, 1979; Crump, 1982). The larvae sometimes show ecological adaptations related to predation avoidance (Wassersug, 1971; Heyer *et al.*, 1975), such as schooling behavior (Wild, 1996), and increased feeding and thermoregulation efficiency (Mullaly, 1953; De Vlaming and Bury, 1970; Beiswenger, 1975, 1977). Data on tadpole diel cycles are rare and derived mainly from laboratory observations on phototaxis. Usually, tadpoles are diurnal in warm ponds and nocturnal in cold streams (Duellman and Trueb, 1994), but Wild (1996) demonstrated that several Amazonian tadpoles are nocturnal in ponds. There are no data on Atlantic rainforest species. Herein, I present data on the diel activity of *Hyla hylax* tadpoles and their potential aquatic predators. These observations are based on diurnal and nocturnal samples taken in a forest stream of Boracéia, southeastern Brazil.

Hyla hylax is a medium-sized treefrog (10 males, 55–62 mm; 2 females, 60–63.4 mm SVL) included in the *H. circumdata* Group that inhabits the Atlantic rainforest of southeastern Brazil (Heyer, 1985; Heyer *et al.* 1990). Adult males call at night from the ground, bushes, bromeliad tubes at variable height, or rock crevices near forest streams (Heyer *et al.*, 1990; pers. obs.). At Boracéia the breeding season of this species lasts from August to February (Bertoluci and Rodrigues, 2002). The repro-

ductive mode of *H. hylax* is unknown, but tadpoles are easily found in several small forest streams in the study site throughout the year (Bertoluci 1997; Figure 1).

Field work was carried out at the Boracéia Biological Station, a 16,450-ha Atlantic rainforest reserve in southeastern Brazil (23° 38'S, 45° 52'W). Boracéia is situated within the Tropical Atlantic Morphoclimatic Domain (Ab'Saber, 1977) at about 900 m above sea level (see Heyer *et al.*, 1990 for a map). Descriptions of several aspects of the local vegetation can be found in Travassos and Camargo (1958), Heyer *et al.* (1990), Wilms (1995) and Wilms *et al.* (1996). The average annual rainfall between 1973 and 1994 was 2024 mm and the mean temperature for the same period was 17.9°C (DAEE, 1994).

The anuran fauna of Boracéia is highly diverse and comprises 66 species belonging to the families Brachycephalidae (1 species), Bufonidae (3), Centrolenidae (2), Hylidae (29), Leptodactylidae (30), and Microhylidae (1) (Heyer *et al.*, 1990; Bertoluci, 1997). By the late 1970s, several population declines and local extinctions were detected at Boracéia (Heyer *et al.*, 1988, 1990); the status of the fauna was updated by Bertoluci and Heyer (1995) and Bertoluci (1997).

In determining the diel activity cycle of *Hyla hylax* tadpoles, I assumed that the number of tadpoles captured in a trap is directly correlated to the degree of their activity. I sampled a small stream from October 11 to October 14, 1995, using double-entry funnel-traps constructed with 2-l plastic bottles (10 cm diameter and 33 cm long). The stream consisted of interconnected puddles with rocky or sandy bottoms covered with dead leaves and sticks.

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The study plot was 60 m long, 1.3 m wide, and had a maximum depth of 22 cm. Ten diurnal (0600–1800h) and ten nocturnal (1800–0600h) samples were obtained from the same puddles. The diurnal sampling was initiated 24 hours after the end of the previous nocturnal sampling. Unbaited traps were positioned on the stream bed because *Hyla hylax* tadpoles are benthic (pers. obs.). Potential tadpole predators (larval Odonata, Coleoptera and larval and adult Heteroptera) were captured in the same traps. Voucher specimens were deposited in the herpetological collection of the Universidade Federal de Minas Gerais (UFMG). Voucher specimens of the invertebrates were deposited in the entomological collection of Museu de Zoologia da USP. In order to test if there was a difference between the numbers of tadpoles captured during each period, I performed a Student's *t*-test with variances separately estimated for heterocedasticity (Zar, 1984).

A total of 29 tadpoles of *Hyla hylax* and 33 individual potential predators was captured in the traps at night. Only four tadpoles and no predators were captured by day. There was a significant difference between the numbers of tadpoles captured in each period (*t* for separate variances = 2.98; *df* = 10; *P*-value 0.013) (Figure 2).

The predominantly nocturnal activity of *Hyla hylax* tadpoles corroborates the observations made in *Crossodactylus dispar* (Bokermann, 1963), *Ascaphus truei* (DeVlaming and Bury, 1970), *Hyla nanuzae*, a species also included in the *Hyla circumdata* Group (Bokermann and Sazima, 1973), along with several species of *Hyla*, *Plectrohyla*, *Ptychohyla*, and *Telmatobius* tadpoles developing in cold streams (Duellman and Trueb, 1994). Because the water temperature in the stream varies little between day and night year-round (pers. obs.), this pattern probably is not related to an increase of feeding or thermoregulation efficiency. Instead, the nocturnal activity of these tadpoles may represent an adaptation to avoid diurnal, visually oriented predators (e.g., birds). My data reveal that tadpole predators in that streams also are more active by night. It seems likely that the tadpoles might depend on their disruptive coloration as camouflage, as suggested by Altig and Channing (1993); moreover their highly

developed tail musculature suggests that they may use swimming speed to minimize predation. Further data are needed to determine diel cycles of tadpoles in different habitats and their significance to larval survivorship.

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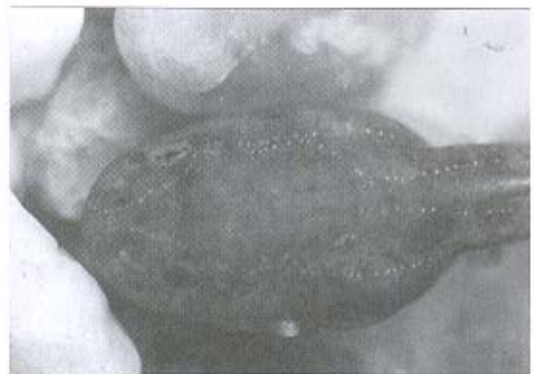


Figure 1 - Tadpole of *Hyla hylax* from Boracéia, Southeastern Brazil, in lateral (a) and dorsal (b) views.

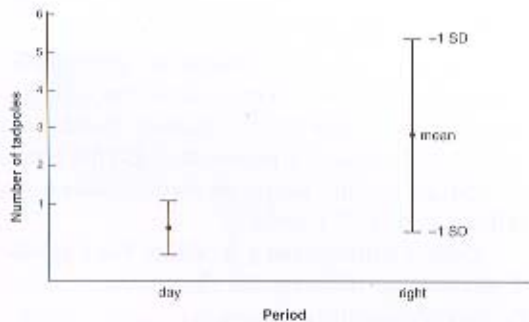


Figure 2 - Mean (\pm SD) number of tadpoles trapped in 10 funnel-traps during the day (0600–1800) and during the night (1800–0600) in a forest stream at Boracéia, Southeastern Brazil.

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