ators at Ellenton Bay did not form an association between flags and the eggs they consumed. Our results suggest that observed predation rates of flagged turtle nests are probably similar to rates of predation of unflagged nests. The use of flagging presumably does not affect nest survivorship.

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Breeding Behavior of the Pumpkin Toadlet, *Brachycephalus ephippium* (Brachycephalidae)

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Brachycephalids are restricted to Brazilian coastal rain forest from eastern to southern Brazil (Frost, 1985; Duellman and Trueb, 1986). Two genera and three species are currently recognized (Frost, 1985; Heyer et al., 1990), but additional species will likely be added as systematic studies of the group progress (Heyer et al., 1990; Haddad and Sazima, 1992).

Brachycephalus ephippium is a small (ca. 18 mm SVL), yellow to orange colored frog (hence the suggested common name) living amidst leaf litter in forested elevations from 750 to 1200 m above sea level (Sebben et al., 1986; Haddad and Sazima, 1992). Although the pumpkin toadlet can be locally abundant, natural history information on the habits of this anuran is scarce and limited to anecdotal reports (Duellman and Trueb, 1986; Heyer et al., 1990). Here we report on breeding behavior of *B. ephippium*, including activity, vocal and visual advertisements, and agonistic encounters.

Preliminary fieldwork was done sporadically from September 1987 to October 1990. Further field data were regularly taken at 2–3 d intervals during the rainy season from November 1990 to April 1991. The study area is within a residual, semideciduous forest at the Serra das Cabras, São Paulo, southeastern Brazil (ca. 22°52′S, 46°49′W, 1100 m). Study sites are humid and shaded places on the banks of a small stream running amidst and under large granitic boulders covered by ferns and mosses. The substrate is covered with leaf litter, interspersed with saplings, ferns, and occasional rotting logs.

Focal-animal and all occurrences samplings were used for behavioral records (Lehner, 1979). Experimental manipulation consisted of introducing adult males and females into the territory of resident males, and presentation of a mirror to wandering females and resident males. Vocalizations were recorded with a Nagra E tape recorder and Sennheiser ME 80 microphone at tape speed of 19 cm/sec. Tapes were analyzed on a MacIntosh Classic coupled to MacRecorder^{R} Sound System Pro. Relative air humidity was measured at 6 cm above the surface. Snout-vent length (SVL) of adults and egg diameters were measured with calipers to the nearest 0.1 mm. Vouchers are in the Museu de História Natural, Universidade Estadual de Campinas (ZUEC).

Pumpkin toadlets are active by day on the forest floor during the rainy season. Both males and females walk slowly on the leaf litter, and occasionally on low perches (up to 50 cm) when relative humidity approaches 100%. During the dry season the frogs shelter beneath leaf litter and under logs. Relative humidity of the air was the main factor related to the number of active individuals (Spearman $r_s = 0.5806$, $N = 33$, $P < 0.001$, range = 87–100%). Air temperature was not significantly correlated with number of active individuals ($r_s = -0.326$, $N = 33$, $P > 0.05$, range = 18.5–25 C). Males ($\bar{x}$, ±SD, 14.33 ± 0.58 mm SVL, range = 13.2–15.4 mm, N = 15) were significantly ($t = 7.22$, $P < 0.001$) smaller than females (16.66 mm ± 0.9, range = 16.0–17.9 mm, N = 12). The diurnal activity and the bright color of *B. ephippium* are supposedly related to warning coloration or aposematism (Haddad and Sazima, 1992). The presence of ephippiotoxin, a tetradotoxin-like compound in the skin of the pumpkin frog (Sebben et al., 1986) lends support to the warning coloration hypothesis. On the other hand, contrasting colors and postural displays in anurans may be related to conspecific visual communication (e.g., Wells, 1980a, b) and the presence of the combination of vivid color and several displays in *B. ephippium* (see below) merits further consideration.

Males hold territories during the rainy season and

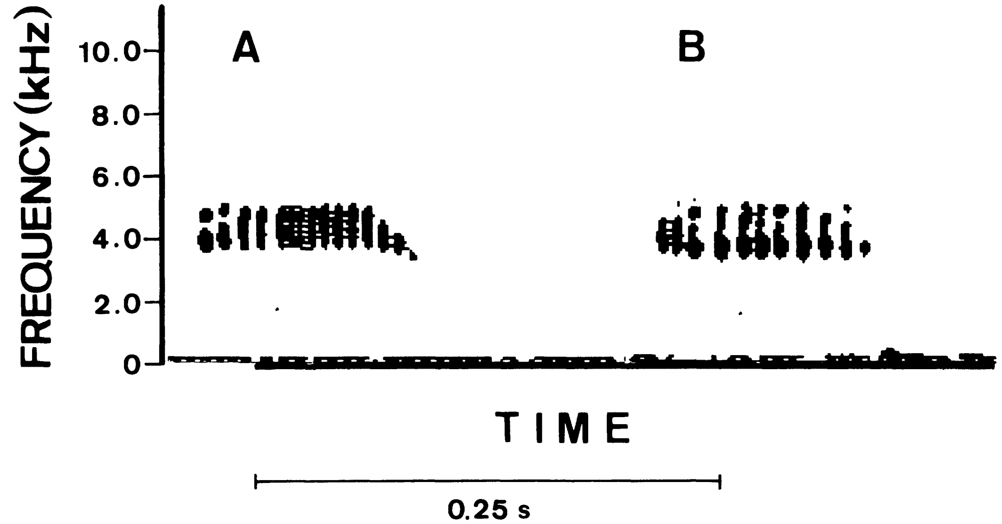

FIG. 1. Notes of the advertisement call of *Brachycephalus ephippium* recorded on 3 January 1991. (A) Note with descending frequency; (B) the commonest note with nearly constant frequency. Air temperature 21.5 C.

advertise by vocal and visual signals. The advertisement call is a long, low intensity buzz lasting 2 to 6 min, with the emphasized frequencies ranging from 3.4 to 5.3 kHz. Each note (Fig. 1) is composed of 5-15 pulses ($\bar{x}$ = 12, ±1.96, N = 57), lasting 93-125 msec ($\bar{x}$ = 112, ±6.5, N = 19), with intervals of 123-149 msec ($\bar{x}$ = 134, ±6.8, N = 18). We observed variations in the notes, according to their positions in the call. The first notes are shorter with 5-6 pulses, and the following notes have descending frequency (Fig. 1A). The commonest notes have about 10 pulses, nearly constant frequency (Fig. 1B), and are emitted after the descending frequency. Calling males adopt a "high posture," possibly due to their enlarged vocal sac extending to the chest (Fig. 2A). When a resident male was approached by another individual, the resident vocalized and performed a series of up-and-down movements of the arm in front of the eye (Fig. 3).

Five natural male-male encounters ended with the intruder retreating without actual physical contact; these contests were apparently resolved with use of vocal and visual advertisement by the resident male. Thus, acoustic and visual signals may prevent further escalation in territorial contests, a function demonstrated for other anurans (Wells, 1977). On the other hand, males introduced in the territories of residents (N = 12) were pursued and embraced (Fig. 2B). Mounted on the intruder, the resident tried to push it out; the mounted intruder frequently kicked the resident and attempted to break free. Residents won all the contests; intruders retreated after the males separated.

Introduced females (N = 2) also elicited displays by resident males but no contact occurred and females left without being pursued. A mirror placed in front of eight territorial males elicited visual displays (N = 7) and occasional attacks toward the reflected image (N = 2), but no vocalization. Mirror presentation to two females elicited visual display by one of them.

Visual communication in anurans is believed to have evolved in noisy environments where acoustic signals would be less effective (Heyer et al., 1990). Although the habitat of *B. ephippium* is relatively quiet, this frog has a low intensity advertisement call, which seems weaker than background noises (e.g., rustling leaves). Decibel values (dB) of background noise exceeded that of the toadlet call, even at small ranges (80 cm). This latter trait and the diurnal activity may be related to the occurrence of visual communication in the pumpkin toadlet. Visual communication plays an important role in the social behavior of some ecologically similar harlequin frogs, *Atelopus* (Jaslow, 1979; Crump, 1988).

Wells (1977) proposed three main functions for territoriality in frogs: defence of areas containing resources needed for survival, such as foraging sites, oviposition sites, and courtship areas. Territories of *B. ephippium* may function as courting and oviposition sites, which would explain the vigorous actions of the resident males toward intruders (see Jaslow, 1979; Martins and Haddad, 1988 for such behavior in other frog species).

Wiping of the head with forelimbs by a male introduced into the territory of another male elicited territorial display in the resident. The pumpkin toadlet often cleans itself by wiping its head and body with its limbs. The up-and-down arm display of *B. ephippium* may be derived from cleaning behavior (on the other hand, similar movements may be used to achieve different functions, see Eibl-Eibesfeldt, 1975).

Duellman and Trueb (1986) stated that amplexus in brachycephalids is axillary. We observed eleven amplectant pairs of *B. ephippium*, and in all instances amplexus was inguinal; the male walking behind the female (Fig. 2C), as previously illustrated in Halliday and Adler (1986). In two instances we observed other males trying to displace the male from an amplectant pair. During these struggles the amplectant male

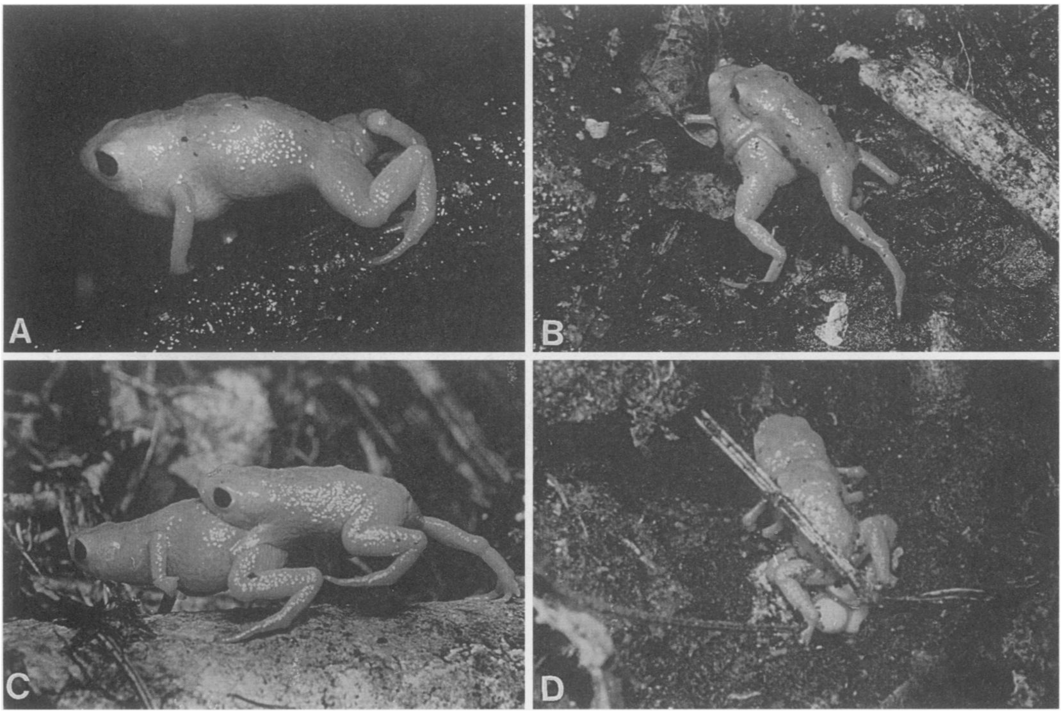

FIG. 2. (A) Calling male *Brachycephalus ephippium* (note vocal sac extending to the chest); (B) two male *B. ephippium* during an agonistic contest, the resident embracing the intruder; (C) inguinal amplexus of *B. ephippium*, male walking behind the female; (D) oviposition posture of *B. ephippium* (note male embracing the female's belly, and the large eggs).

kicked its opponents and emitted a release call, a common response in bufonids (Davies and Halliday, 1978; pers. obs.).

One instance of oviposition was recorded in November at mid-morning (ca. 0900 h). The pair was sheltered beneath a decomposing log on the ground, and the male changed its position from inguinal to a nearly axillary amplexus (Fig. 2D). In *Alytes* (Discoglossidae) males also shift from inguinal to axillary amplexus during oviposition (Marquez and Verrell, 1991). This shift in *B. ephippium* may allow for an adequate positioning of the vents in the amplectant pair and thus maximize fertilization of the relatively large eggs (see below). We also suggest that the initial inguinal amplexus in *B. ephippium* favors movement amidst the leaf litter, in a manner similar to that reported for the microhylid *Myersiella microps*, also a leaf-litter frog (Izecksohn et al., 1971). When adopting an inguinal position, the perimeter of the amplectant pair is no larger than that of the female itself.

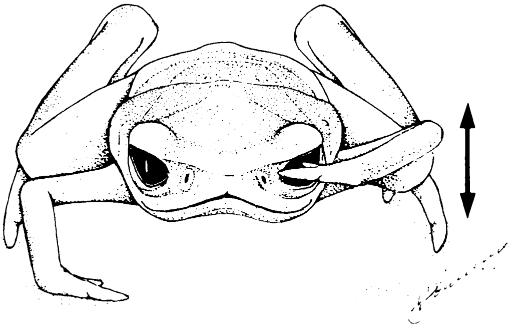

FIG. 3. Resident male of *Brachycephalus ephippium* displaying toward intruder male (arrow indicates up-and-down arm movements).

The clutch that we observed deposited contained five eggs, and oviposition lasted ca. 30 min. The freshly-laid eggs were yellowish-white; diameters ranged 5.1–5.3 mm. After the male left the oviposition site, the female covered the surface of all eggs with soil particles. She pressed and rolled each egg against the ground using her hindfeet, until the eggs were almost indistinguishable from the litter background. The second clutch was found under a log on 19 February 1991, and each egg was well covered by soil particles. Soil particles may improve the concealment of the eggs, although both clutches recorded in the field were found in situations where such "camouflaging effect" would seem unimportant. Soil particles may prevent desiccation of the egg. One egg clutch observed in situ hatched in 64 d. The hatchlings were light brown with darker mottling, and two of them measured 5.25 and 5.45 mm.

Although *B. ephippium* is currently the best known brachycephalid, it is difficult to generalize for Brachycephalidae as a group. The two other species, *B. nodoterga* and *Psyllophryne didactyla*, are cryptically colored. Cryptic coloration may indicate divergence in communication and reproductive behavior.

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Egg and Clutch Size of the Viviparous Australian Skink, *Pseudemoia pagenstecheri* and the Identity of Species with Type III Allantoplacentae

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Many closely related small Australian skinks have variously been referred to the genus *Leiolopisma* (Greer, 1974). Attempts to identify different lineages within the group (e.g., Greer, 1974, 1982; Rawlinson, 1974) have now culminated in the genus being split into five genera (Hutchinson et al., 1990). This lineage of skinks is particularly important in our understanding of the placental structure of reptiles (Weekes, 1935; Blackburn, 1993) and has been the foundation for speculation on the evolution of chorioallantoic placentation within the Class Reptilia (Harrison and Weekes, 1925; Weekes, 1930, 1935). Definition of two of the four recognized chorioallantoic placental categories (Blackburn, 1993) is based on these skinks (Weekes, 1930, 1935; Blackburn, 1993). Details of one of the most complex placental types, Type III of Weekes (1935) and of Blackburn (1993), are based upon work done on *"Lygosoma (Liolepisma) entrecasteauxi"* (Harrison and Weekes, 1925; Weekes, 1930). Matrotrophic provisioning of embryos also has been implied, based on the relatively small size of the eggs of *"L. entrecasteauxi"* compared to oviparous species of similar size (Weekes, 1930). Subsequently, one population studied by Weekes (1929) has been shown to rely heavily on matrotrophy for embryonic growth (Stewart and Thompson, 1993).

Recently, *"L. entrecasteauxi"* was recognized as a complex of three species assigned to the genus *Pseudemoia*, *P. entrecasteauxii*, *P. pagenstecheri* and *P. cryodroma* (Hutchinson and Donnellan, 1992). The descriptions of chorioallantoic placentation in *"L. entrecasteauxi"* (Harrison and Weekes, 1925; Weekes, 1930) were based on specimens collected from two locations. The earlier work used specimens from Barrington Tops, New South Wales (Harrison and Weekes, 1925), and thus must have been *P. pagenstecheri* because this locality is outside the geographic ranges of *P. entrecasteauxii* and *P. cryodroma* (Hutchinson and