INTRODUCTION

Basic data on habitat, behavior, and reproduction are lacking for most Neotropical frog species and even higher taxonomic groups (Crump 1974; Haddad and Prado 2005), particularly for those restricted to the Atlantic Forest. Basic reproductive features are the basis of comparative studies on evolution of major natural history features (Harvey and Pagel 1998), such as the interspecific relationship between body size and egg number/size (Salthe and Duellman 1973, Crump 1974, Stearns 1992). Here, we present data on habitat, reproductive behavior and quantitative parameters such as adult sizes, egg numbers/sizes of ten sympatric frogs of an altitudinal Atlantic Forest site in Southeastern Brazil.

MATERIALS AND METHODS

The present study was carried out in the Parque Florestal do Itapetinga (PFI) and adjacent areas (approx. 23º15’S; 46º45’W, 900-1300 m alt., 1400-1700 mm rain/year), Atibaia municipality, Mantiqueira range in the State of São Paulo, Southeastern Brazil. Secondary semi-deciduous forest covers continuous 1,800 ha (Meira-Neto et al. 1989, Giaretta et al. 1999), and peripheral open areas include pastures and agricultural fields. The regional climate is seasonal, with a dry/cold season from April to September (with occasional frosts in July) and a wet/warm season from October to March. The precipitation can be zero in some months of the dry/cold season. Natural bodies of water are perennial forest rivulets which can enter open deforested areas, and seasonal oxbow ponds. Currently there are two man made lakes (< 50 x 20 m) in the area. The clean watered forest rivulets (maximum 1.5 m wide) run either over/among granitic rocks or sand.

Field data collection was performed weekly between June 1992 and June 1993; irregular trips from 1994-2005 provided additional data. In the field we recorded daily and annual time of vocal activity, annual time of occurrence of egg-bearing females and/or egg clutches, and calling sites. Data on leaf litter frogs were also based on the specimens reported in Giaretta et al. (1997) and Giaretta et al. (1999). Reproductive parameters, such as egg number, were based on gravid females collected in the field and preserved in 5% formalin. Ovarian eggs were considered mature by comparison with eggs found in clutches or when females presented concurrently hypertrophied ovaries and oviducts (Rough 1951, Crump 1974). Size measurements were made with a caliper to the nearest 0.1 mm. For most species, samples of eggs and tadpoles were kept in aquaria until metamorphosis for specific identification. Voucher specimens are housed in the Museu de História Natural da Universidade Estadual de Campinas (ZUEC), Campinas, São Paulo, Brazil.

RESULTS

Adult females varied in size from around 20mm (Ischnocnema parva) to 65 mm (Odontophrynus cf. maisuma), and bore from around 15 (Ischnocnema juipoca) to 3000 (O. cf. maisuma) eggs/female (Table 1). Eggs were particularly large among Ischnocnema species (1.6 – 2.7 mm) and in Crossodactylus sp. (2.3 mm) (Table 1). In our sample, sexual dimorphism in size was observed in most species, being particularly pronounced among the Ischnocnema species (Table 2).

Considering the six species with at least three females available for analysis (Table 2), we observed a positive correlation (p < 0.05) between female size and fecundity just for Ischnocnema guentheri (r = 0.58; p = 0.005; N = 21) and Crossodactylus sp. (r = 0.95; p = 0.048; N = 4).

The tadpoles of all species with indirect development can be regarded as exotrophic benthic (McDiarmid and Altig 1999).

Remarks on habitat and reproductive behavior:

Ischnocnema guentheri (Steindachner 1864). Habitat-leaf litter (N = 15) (see also Heyer et al. 1990); annual pattern of vocalization- wet/warm season; vocalization period- crepuscular/nocturnal (N = 20 days) or during diurnal rain showers (N = 10 days); site of vocalization-perched on low (< 1.5 m) vegetation (N = 6 individuals).

Ischnocnema juipoca (Sazima and Cardoso 1978). Habitat- low (< 1.5 m) bushes (mostly grass) in open areas (N = 20 individuals) or rarely forest border (N =
Table 1. Egg number and egg size of ten frog species from Atibaia (São Paulo, Brazil). SD = standard deviation; N = analysed females. Ten measured eggs/female.

| Family         | Species                        | N  | Eggs/ Female | Mean | SD  | Mean ovarian egg diameter (mm) | Egg color |
|----------------|--------------------------------|----|--------------|------|-----|--------------------------------|-----------|
| Brachycephalidae | *Ischnocnema guentheri*          | .21| 35           | 5    | 2.7 | whitish                        |           |
|                | *Ischnocnema juipoca*           | .6 | 15           | 4    | 2.4 | whitish                        |           |
|                | *Ischnocnema parva*             | .22| 20           | 4    | 2.3 | whitish                        |           |
|                | *Ischnocnema sp.*               | .2 | 16           | 0    | 1.6 | whitish                        |           |
| Cyclorampihidae | *Odontophrynus cf. maisuma*      | .3 | 2980         | 444  | 1.1 | black                          |           |
|                | *Proceratophrys boiei*          | .5 | 1296         | 284  | 1.8 | dark gray                      |           |
| Hylodidae      | *Crossodactylus sp.*            | .4 | 70           | 8    | 2.3 | whitish                        |           |
|                | *Hylodes aff. sazimai*          | .1 | 109          | -    | 1.0 | whitish                        |           |
|                | *Physalaemus cuvieri*           | .1 | 474          | -    | 1.0 | whitish                        |           |
|                | *Physalaemus olfersii*          | .1 | 648          | -    | 1.1 | whitish                        |           |

1 individual); annual pattern of vocalization: wet/warm season; vocalization period: crepuscular/nocturnal (N = 20 days) or during diurnal rain showers (N = 15 days); site of vocalization: on the ground or perched on low (< 50 cm) vegetation (N = 5 individuals).

*Ischnocnema parva* (Girard 1853). Development mode: direct (Figure 1) (see also Lutz 1944); oviposition site: terrestrial (N = 1); habitat: leaf litter (see also Heyer et al. 1990); annual pattern of vocalization: restricted to the wet/warm season; vocalization period: crepuscular/nocturnal (N = 20 days) or during diurnal rain showers (N = 10 days); site of vocalization: leaf litter (N = 10 individuals).

*Ischnocnema sp.* (cf. *spaniols*, [Heyer 1985]). Habitat: leaf litter (N = 4 individuals); annual pattern of vocalization: restricted to the wet/warm season (N = 10 days); vocalization period: crepuscular/nocturnal (N = 20 days) or during diurnal rain showers (N = 10 days); site of vocalization: perched on low (< 1.0 m) vegetation at the forest border (N = 3 individuals).

*Odontophrynus cf. maisuma* (Rosset 2008). Habitat: terrestrial, in open areas (N = 6 individuals); annual pattern of vocalization: sporadic and unpredictable in summer or winter (N = 5 events); vocalization period: nocturnal (N = 7 days); site of vocalization: beside creeks at open areas.

*Proceratophrys boiei* (Wied, 1825). Development mode: feeding aquatic larvae (N = 20 tadpoles); oviposition site: unknown, possibly in forest creeks, where an amplexant pair and tadpoles were found; adult habitat: leaf litter (see also Giaretta et al. 1998); annual pattern of vocalization: all around the year; vocalization period: diurnal (N = 25 different days); site of vocalization: possibly in forest creeks; vocalization period: crepuscular/nocturnal.

*Crossodactylus sp.* (ex gr. *gaudichaudii* Duméril and Bibron 1885). Development mode: feeding aquatic larvae (N = 50 tadpoles); adult habitat: leaf litter along creeks (20 individuals); annual pattern of vocalization: all around the year; vocalization period: diurnal (N = 25 different days); site of vocalization: beside forest creeks (N = 16 individuals); additional remark: males keep and defend underwater galleries they dig in creeks (N = 3) to which they conduct receptive females (N = 1).

*Hylodes aff. sazimai* Haddad and Pombal Jr. 1995. Development mode: feeding aquatic larvae (N = 5 tadpoles); adult habitat: leaf litter along forest creeks (N = 25 individuals) and leaf litter (N = 3 individuals); annual pattern of vocalization: restricted to the wet/warm season; vocalization period: diurnal (N = 26 days); site of vocalization: beside forest creeks (N = 10 individuals).

*Physalaemus cuvieri* Fitzger. 1826. Development mode: feeding aquatic larvae; egg-laying site: floating foam nest in lakes or ponds (N = 3); adult habitat: collected around pond margins (N = 2), in open areas; annual pattern of vocalization: restricted to the wet/warm season (N = 25 days); vocalization period: crepuscular/nocturnal (N = 15 days); site of vocalization: in the water, in

**Figure 1.** The terrestrial egg clutch and direct development of *Ischnocnema parva*. A - Late embryos inside the eggs; B - Newly hatched juveniles. Specimens from Ubatuba, São Paulo.
Among frogs, intraspecific variation in body size often accounts for little of the variation in egg number (Crump 1974, present work); besides size, we suggest that the number of reproductive events a female experiences within a season certainly is an important parameter to be considered in this relationship. Phylogeny (Lynch 1974, present work); besides size, we suggest that the number of reproductive events a female experiences within a season certainly is an important parameter to be considered in this relationship. Phylogeny (Lynch 1974, present work); besides size, we suggest that the number of reproductive events a female experiences within a season certainly is an important parameter to be considered in this relationship. Phylogeny (Lynch 1974, present work); besides size, we suggest that the number of reproductive events a female experiences within a season certainly is an important parameter to be considered in this relationship. 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