It's not easy being red and blue: Distribution of the poison dart frog, *Dendrobates pumilio*, along a successional gradient

Justin E. Campbell, P. Bjorn Erickson, Christina L. Glastris, Shane R. Heath, and Rafael D. Rosengarten

Abstract: Dendrobates pumilio is a colorful frog of the Atlantic tropical lowland forest, which uses the vegetative understory as a site for mate courtship, reproduction, and food foraging. We observed differences in *D. pumilio* density between different forest types. We hypothesized that the factors affecting frog distribution, such as food availability, leaf litter, and understory structure, will vary among successional habitats, and predicted that frog abundance would increase with these resources across habitats. We measured frog abundance, insect abundance, leaf litter, and understory density in forests at five different successional stages from first-year growth to primary forest. We found no effect of either leaf litter or ant abundance on *D. pumilio* distribution. Frogs were most abundant in habitats with the densest understory vegetation, suggesting the availability of calling sites may be important for frog habitat selection.

Key Words: calling sites, poison arrow frog, strawberry dart frog, territoriality

Introduction

Dendrobates pumilio, commonly known as the poison dart frog, is a small diurnal amphibian which inhabits the Caribbean lowlands of Central America. This species uses the vegetative understory and leaf litter as sites for mate courtship, reproduction, and food foraging. *D. pumilio* becomes arboreal only during the breeding season when females transfer newly hatched tadpoles into water-filled bromeliads (Donnelly 1989).

Past studies in Costa Rica have shown experimentally that the amount of leaf litter and the abundance of bromeliads has a strong effect on the density of *D. pumilio* (Donnelly 1989); both are used by developing larvae. Vegetative understory may also be a reproductive resource used in habitat selection, because frogs perch on various structures up to 2 m from the ground to call mates and establish territories (Crump 1983). Additionally, studies have shown that these territories occur in areas of high relative ant abundance (Donnelly 1991).

We quantified differences in vegetative structure, ant abundance, and leaf litter in a forest succession, from recently cut to primary forest. We hypothesized that these factors influence *D. pumilio* distribution, and predicted that *D. pumilio* density would be greatest where vegetative structure, ants, and leaf litter were relatively abundant.

Methods

We sampled in five habitats on trails surrounding Estación Biologica La Selva, Costa Rica: 0 - 1 year successional, 4 - 5 year successional, 13 - 18 year old secondary forest, a cacao plantation abandoned in 1968 and primary forest. On 15 and 16 February 2001 we searched for *D. pumilio* by turning over all leaf litter in 65 1 m^2 plots in each of the five habitats. We counted frogs, and also understory plants in the height categories 0 - 1 m and 1 - 2 m. The abundance of 0 - 1 m tall plants in the plot was categorized as 0 - 25 stems, 25 -50, and > 50; 1 - 2 m tall stems were counted individually. To measure leaf litter, we tossed an 18 cm diameter hoop quadrat into the forest haphazardly for 15 plots, and collected all leaf litter within the hoop. An 8 cm diameter pitfall trap was placed where the hoop had fallen to measure insect abundance; these were collected after 24 h.

We weighed leaf litter wet and dry. We

classified all insects collected in pitfall traps as ants, large other, or small other. Frog abundance was compared across the successional gradient, as was vegetation density in each height category, by chi-squared analysis.

Results

Abundance of frogs varied significantly among habitats ($\chi^2 = 26.92$, df = 4, P < 0.0001). We found 13 frogs in the 0 - 1 year growth, eight in the 4 - 5 year growth, 14 in the abandoned cacao plantation, 16 in the secondary growth, and none in the primary forest (Fig. 1). The density of 0 - 1 m tall plants and 1 - 2 m tall plants differed significantly between habitats (0 - 1 m: $\chi^2 = 103.29$, df = 8, P < 0.0001; 1 - 2 m: $\chi^2 = 40.372$, df = 8, P < 0.0001). Both size classes were most dense in the 0 - 1 year growth, and decreasingly dense in the secondary growth, cacao plantation, 4 - 5 year growth, and primary forest, respectively (Figs. 2 and 3).

Ant abundance differed significantly between habitats ($\chi^2 = 10.74$, df = 4, P = 0.03), but the pattern did not match that of frog abundance. Leaf litter biomass did not vary significantly between sites (ANOVA, F = 1.29, df = 74, P = 0.28).

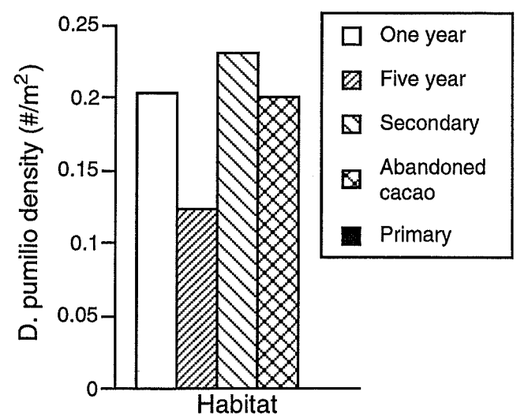

Fig. 1. Mean density of *Dendrobates pumilio* in the five habitats along a forest succession at La Selva, Costa Rica (n = 65 per habitat). Frogs were not found in our study plots in primary forest.

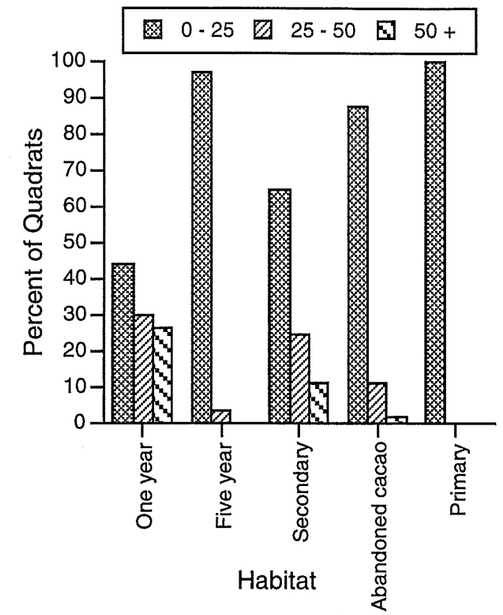

Fig. 2. Relative densities (stems / m^2) of plants less than 1 m tall in five habitats at La Selva (n = 65 per habitat).

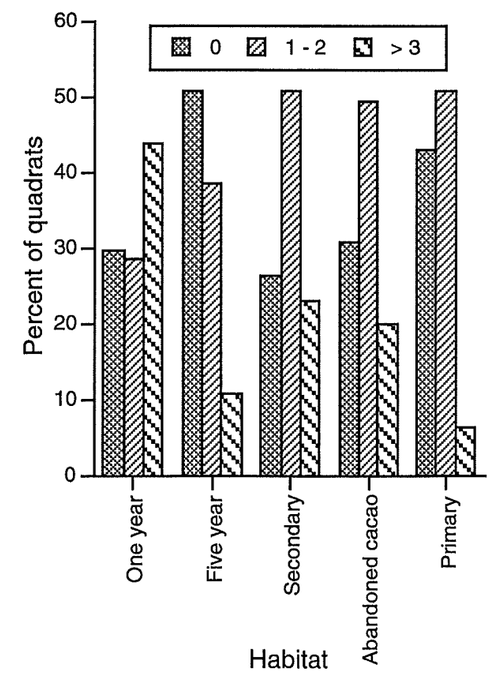

Fig. 3. Relative densities of plants 1 - 2 m tall in five habitats at La Selva (n = 65 for each habitat).

Discussion

Habitat structure appears to influence the distribution of *D. pumilio*, with more frogs in areas with denser understory vegetation. The lack of a clear relationship between frog abundance and ant or leaf litter abundance, however, suggests that neither of these resources are limiting in the La Selva preserve, and they are unlikely to be major factors driving frog distribution.

Past research has reported multiple factors affecting *D. pumilio* distribution, including bromeliad density and calling sites (Donnelly 1989, Pröhl and Hödl 1999), indicating that habitat choice is a complex process and is determined by no single factor. Our data show that frog density is higher in the denser understories of the secondary growth, cacao, and 0 - 1 year successional forests, but very low in the primary forest. We suggest that calling sites are more available in these habitats with dense vegetation near the ground, which may contribute to the higher abundance of frogs found there. Further, we suggest that there may be a tradeoff: understory density increases the number of calling sites but also could muffle the audibility of calls. Further study may be able to better define calling sites and investigate their influence on *D. pumilio* habitat selection.

Literature Cited

Crump, M. L. 1983. *Dendrobates granuliferus* and *Dendrobates pumilio* (Ranita Roja, Rana Venenosa, Poison Dart Frogs). Pp. 396-397 *in* D. H. Janzen editor. Costa Rican Natural History. University of Chicago Press. Chicago, IL, USA.

Donnelly, M. 1989. Demographics effects of reproductive resource supplementation in a territorial frog, *Dendrobates pumilio*. Ecological Monographs 59:207-221.

Donnelly, M. 1991. Feeding Patterns of the Strawberry Poison Frog, *Dendrobates pumilio* (Anura: Denrobatidae). Copeia 3:723-730.

Pröhl, H., and W. Hödl. 1999. Parental investment, potential reproductive rates, and mating system in the strawberry dart-poison frog, *Dendrobates pumilio*. Behavioral Ecology and Sociobiology 46:215-220.