

Home, sweet home! Spatial memory in *Dendrobates pumilio*

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Abstract: It has been hypothesized that *Dendrobates pumilio* has spatial memory, i.e. it can recognize and remember its local environment. We removed male and female frogs from their territories and found no gender-based differences in homing ability. Although frogs returned from distances up to 5 times their territory diameter, results suggest that spatial memory is most effective within approximately 6 m.

Key Words: amphibians, homing ability

INTRODUCTION

Many territorial animals rely on the ability to recognize and remember the physical characteristics of their surroundings. Spatial memory allows organisms to navigate visually from one place to another, which provides potential advantages in foraging, territory defense, and parental care. The strawberry poison dart frog, *Dendrobates pumilio*, is an example of an organism that employs spatial memory. A high percentage of males return to their territories after being moved several meters away (Leenders 2001). McVey (1981) found evidence of homing ability in both males and females.

To successfully rear her tadpoles, a female *D. pumilio* must accurately navigate to and from a specific location. After their eggs hatch, female *D. pumilio* transport each tadpole to a separate leaf axil of a water-filled plant and return periodically to lay unfertilized eggs, which serve as a food source for the larvae (Savage, 2002). We hypothesized that females would have enhanced spatial memory compared to males who do not feed offspring. Therefore, we predicted that, when displaced, more females would return to their territories than males. We also predicted that spatial memory would be limited by distance because the information that must be stored and processed presumably increases with area (i.e. with the square of distance). In addition, as distance from the center of the territory increases, the energetic costs of

returning may outweigh the costs of finding a new territory. Therefore, we predicted that frogs would have a lower return rate when taken a further distance from their territories.

METHODS

On 15 February 2003, we captured 18 frogs (*Dendrobates pumilio*) along the STR, CEN, CES, and SOR trails at La Selva Biological Station, Costa Rica. Nine frogs were female, and nine were male. We first identified the sex, then measured snout vent length (SVL) and femur length, and weighed each frog. We noted distinctive color patterns, sketched ventral and dorsal markings, and used these to identify individual frogs. Based on previous studies by McVey (1981), we estimated each territory as a 2.5 m diameter circle around the point where the frog was initially seen. After removing the frog from its territory, it was released 3, 6, or 9 m directly north of the assumed territory center, with three replicates of each distance for each sex.

On the mornings of 15 and 16 February 2003, we returned to each of the 18 territories and searched in a 2.5 m diameter circle centered at the original point from which the frogs were moved. When a frog was recaptured, we examined its markings, and re-measured SVL, femur, and weight. We noted if the same frog returned to its territory, and also if other frogs were found within the same territory.

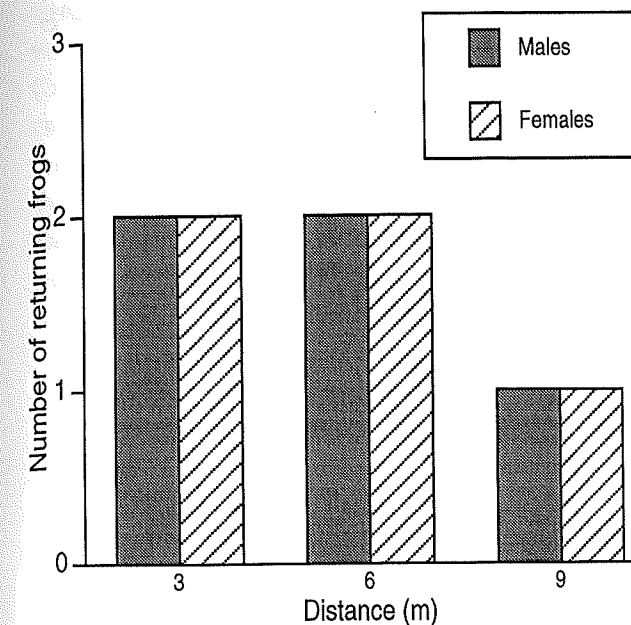


FIG. 1. The number of male and female frogs returning to their territories from various distances after displacement. A total of 10 frogs returned within 48 hours, out of the 18 experimentally displaced. Data are from La Selva Biological Station, Costa Rica.

RESULTS

Of the 18 frogs relocated, 10 frogs (56%) returned to their territories within 48 hours. These frogs found their territories quickly, as 90% of recaptured frogs returned to their territories within 24 hours. Our results did not show any gender-based differences in spatial memory, since an equal number ($n = 5$) of males and females returned (Fig. 1). Furthermore, there was only a marginally significant effect of distance (Kruskal-Wallis, $X^2 = 5.0$, $df = 2$, $P = 0.08$); 67% of frogs returned from distances of 3 and 6 m, while only 33% returned from the 9 m distance.

DISCUSSION

Dendrobates pumilio clearly exhibited homing behavior and the use of spatial memory. When removed from their territory, about half of the frogs were able to find their way back within 24 hours. This percentage may, in fact, be higher as frogs may

have returned and we were simply unable to find them. However, we found no gender-based differences in the homing ability of these frogs; males and females are apparently equally equipped with spatial memory. Females need spatial memory to feed their tadpoles, but males maintain their territories throughout the year, and this may be equally demanding of spatial memory.

Males and females were able to return from distances up to 5 times the territory diameter. However, more frogs returned from shorter distances, suggesting that there are indeed limits to the frog's spatial memory, within the range of distances we tested. In the future, displacing frogs farther than 9 m might help determine the absolute limits to their spatial memory. We also suggest that the question is of sufficient interest to warrant a study with greater replication to confirm the trends we observed here.

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