Defensive Behavior in *Rana areolata* and *Hyla avivoca*

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Agonistic behavior patterns have been reported recently for a number of anurans in several families (e.g., Duellman, 1966; Brattstrom and Yarnell, 1968; Rivero and Esteves, 1969; Villa, 1969). The functions of these patterns have usually been interpreted as being territorial during breeding activities or as protection from predators. *Rana areolata* might be expected to have aggressive behavior patterns for protection in the burrow against predators and accidental intruders. Male *Hyla avivoca* call from elevated perches that they occupy repeatedly each night, and agonistic behavior was observed between such males.

Materials and Methods

Rana areolata from near breeding choruses at State College, Oktibbeha County, Mississippi, were tested. A 65 diameter glass tube projecting at a 20° angle through the floor of a large wooden box served as an artificial burrow. Except for an observation slit that could be covered by an opaque sheath, the tube was painted black. Soil was placed on the floor of the box. Resident frogs (three different individuals) readily ate small crayfish and appeared well adjusted. After a week acclimation period, a shrew (*Blarina brevicauda*), mouse (*Peromyscus leucopus*), snakes (*Natrix rhombifera, Agkistrodon piscivorous*), and other *R. areolata* were guided down the burrow with at least a day between tests. Each intruder was used several times. Other specimens were grouped in 20-gal aquaria.

Male-male interactions between calling *Hyla avivoca* were observed near State College, Mississippi.

Results

As soon as the shrew approached the frog in the burrow, the frog inflated, tilted the body forward so the head was nearly vertical to the substrate, and lunged at the shrew. The frog moved forward rather than move to the end of the burrow, but did not attempt to bite. Multiple lunges followed, depending on the prox-

imity of the intruder, or the frog stood quietly in the tilted posture. Loud screams typically accompanied the lunges and the shrew immediately exited from the burrow. A dead shrew elicited a similar response. Two of the frogs reacted more violently than the other.

When confronted by the mouse or either species of snake, the frog moved to the end of the burrow, inflated, and sat quietly with its head tilted down. Contact by any of the animals did not elicit the overt behavior above. When other frogs were introduced, the resident showed little response, but if the frogs were maintained in a group, each individual seen chose a favored resting place that did not contact another frog if space allowed. Several times during a feeding frenzy, a frog went beneath a piece of cardboard that was the hiding place of a large male; usually the intruder would exit rapidly, often in reverse, and the resident often followed to the edge of the cardboard. Food was not involved.

If a specimen fresh from the field or one that had been allowed to live in the artificial burrow was placed in the open, it routinely assumed the posture shown in Fig. 1 when harrassed. Grouped specimens seemed to lose this response quickly. Particularly touchy individuals would behave thusly if one waved a hand over them three feet away, while others needed to be touched. Contact on the side caused the frog to tilt toward the contact point, and contact on the head caused the frog to tilt the head down, stretch the rear legs posteriorly, and lunge when touched. No sound or biting was noticed.

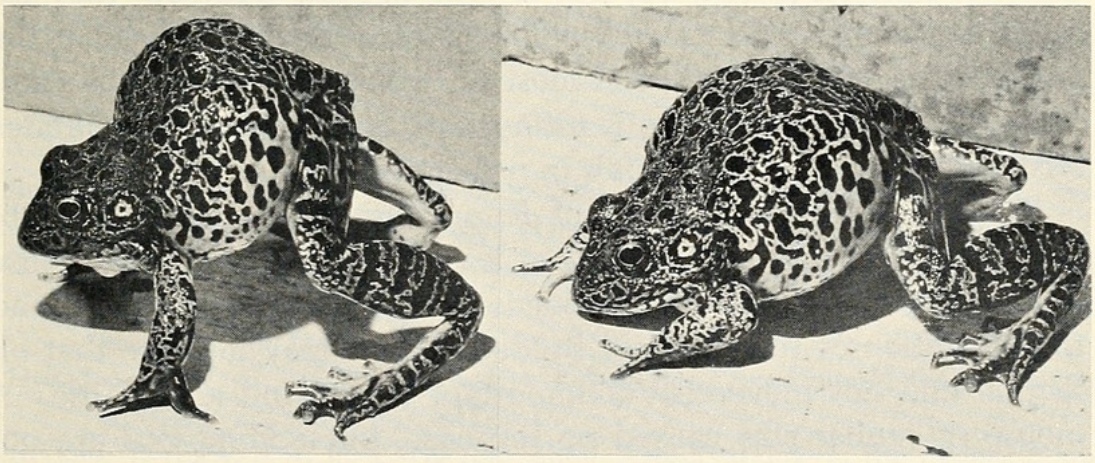

Fig. 1. Defensive behavior in *Rana areolata*. Position assumed at approach by shrew (left) and mouse or snakes (right).

On two occasions, the calling perch of the male *Hyla avivoca* was invaded by another male; fighting ensued and in both cases the resident won and the intruder retreated. In the first incidence, the resident became aware of the other from about 18 inches away, switched from a normal call to a short trilling chirp, oriented toward the other frog, and approached him. Without contact, the resident seemingly recognized the intruder as non-female and initiated a grappling fight that start with an amplectic-type grasp around the head from the frong. He chirped continually and jerked the frog with his front legs about once every 5-10 seconds. The intruder tried to escape, the pair fell about 10 inches to a lower branch, and the intruder finally escaped. The resident returned to near his original post and began calling within 4 min. The total encounter lasted about 8 min.

The second fight was similar, although the resident often seemed to be losing the fight, and the total fight lasted about 15 min. Grasping with the front legs, jerking the intruder with the front legs, kicking with the back legs, and chirping were prominent components of the fight. The intruder in each case seemed to be primarily concerned with getting away.

DISCUSSION

Rana areolata resembles only *R. pipiens* behaviorly. Most individuals are caught crossing roads to breeding choruses, and when approached they seem complacent and often crouch with the forelegs over the eyes. If handled gently, they continue this posture even after being picked up, but if they became alarmed, they escaped in frantic leaps or kick wildly if restrained. Perhaps in the grassy areas where they spend most of their time they rely on camouflage, and the crouching position and dorsal pattern facilitates this; observations of individuals in pens bear this out.

Blarina enter the burrows of *R. areolata* frequently and probably would not hesitate to attack at least a small frog. The response of the frog indicates this intruder is not a welcome symbiont, and the elicitation of the behavior by dead shrew may indicate that olfaction and not movement is important in causing a response. A mouse of similar size caused no response, but *Peromyscus* are not noted carnivores and lack salivary venom. It seems the frog would respond to the snakes, but perhaps a motionless frog is less attrac-

tive to the snake (Diefenbach and Emslie, 1972). In such an inflated position at the end of the burrow, the frog presents large areas of the glandular dorsolateral folds to the predator as well as being turgid and difficult to grasp in the confines of the burrow.

The response of individuals in the open to motion overhead may indicate birds (such as marsh hawks, *Circus*) are common predators. If crouching and camouflage fails, the frog stands high on its legs to increase its apparent size and attempts to place large glandular areas in the line of attack of the predator.

In summary, this solitary species has defensive behavior patterns directed at predators and conspecifics. Perhaps the behavior would have been more intense had the test animals not been breeding, a time when at least the later behavior would have to be nullified. The defensive stance is similar to that of *Leptodactylus pentadactylus* (Villa, 1969), also a burrow-inhabiting species. No defensive postures could be elicted from *Scaphiopus holbrooki*. *Rhinophrynus dorsalis* that had been allowd to burrow would react when harrassed. They spread the hind legs straight behind, stood high on the front legs, and bent the head vertically between the legs. This posture plus the inflated body nearly hid the head. Neither of these species was tested with predators.

The behavior of the male *H. avivoca* likely serves as a spacing mechanism around the pond; at this small pond there is a large population of *H. avivoca*, and they are concentrated primarily in small patches of button bush. The chirping call is typical of this species when another frog of similar size approaches and may serve to orient the female during the last few feet. *H. cinerea* and *Gastrophryne carolinensis* have a similar call.

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Quart. Jour. Florida Acad. Sci. 35(4) 1972 (1974)