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NONDIFFERENTIAL PREDATION SUSCEPTIBILITY AND BEHAVIORAL SELECTION IN THREE COLOR MORPHS OF ILLINOIS CRICKET FROGS, *Acris crepitans*

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ABSTRACT

Predation susceptibility and selected behavioral responses were evaluated as potential targets on which selection might act to maintain the balanced polymorphism in cricket frogs, *Acris crepitans*. There were no significant differences in predation susceptibility, substrate and water preference or shoreline distribution among red, green or gray striped frogs from southern and central Illinois.

INTRODUCTION

The cricket frog, *Acris crepitans*, exhibits a genetically based color polymorphism and displays a green, red or gray vertebral stripe. Green stripe is dominant to the nongreen condition (i.e., red or gray) and red is dominant to gray (Pyburn, 1961a; 1961b). The species occurs from northeastern Mexico to southern Wisconsin and east to the Atlantic Coast and is adapted to various local temperature and moisture conditions ranging from semidesert to swamp. Factors determining morph frequency in different geographical locations have been the subject of considerable speculation (Pyburn, 1961a; Wendelken, 1968; Nevo, 1973; Milstead et al., 1974). Demonstration of adaptive or nonadaptive value of color morphs would provide insights into the concept of amphibian polymorphism. In this study, I investigated possible morph differences in predation susceptibility on various substrates and selected behavioral attributes (substrate and water preference and shoreline distribution) on which selection might act to maintain the balanced polymorphism in Illinois cricket frogs.

MATERIALS AND METHODS

Predation Susceptibility

Predation susceptibility was tested in a 20-gallon aquarium (33 cm wide, 61 cm long) with different substrates. Garter snakes *(Thamnophis sirtalis* and *T. radix)*, northern water snakes *(Natrix sipedon)*, and

juvenile bullfrogs *(Rana catesbeiana)*, all reported (Carpenter, 1952; Lewis, 1962; Fitch, 1965; Wendelken, 1968) or observed to eat *Acris* were used as predators. Aquaria bottoms were covered with mud, grass, leaves or rocks and a bowl (21 cm diam., 6.5 cm deep) of water was buried to its rim in the center. Aquaria sides were painted to match substrate color and large mesh cheesecloth covered the top. Substrates were obtained from the same locations as prey and, thus, reflected natural habitat colors. Cricket frogs were collected from (1) Six Mile Creek, Woodford County, 8 miles northwest of Normal, (2) Dawson Lake, McLean County, 15 miles southeast of Bloomington, both in central Illinois and (3) the La Rue Pine Hills Swamp, Union County, 8 miles southeast of Grand Tower in southern Illinois. Prey were placed in the chamber in varying morph frequencies and after 30 min., a predator was introduced.

Two 60-watt bulbs were suspended overhead in all tests except controls which were run in the dark. Duration of each test varied with predator feeding rate and prey (frog) population size. The latter was varied to determine effects of prey density. Snakes were used individually, and one complete test consisted of one snake feeding for 1 hr. Bullfrogs were used as a group and one complete test consisted of eight predators feeding for 20 hr on small prey populations (<36), or for 2, 3 or 4 days on large prey populations (>52). In each case the number of frogs eaten for each color class was compared with that in the initial prey population by chi-square.

Substrate Preference

Substrate preference of escaping frogs was determined for each morph in a 20-gal aquarium bisected at one end by a vertical plexiglass sheet. The resulting two sections were provided with a mud, grass or water substrate. A small five sided cardboard "starting chamber" was placed 15 cm in front, with an open side toward the divider. The rear of the starting chamber had a small circular opening through which frogs from Dawson Lake (central Illinois) and Pine Hills (southern Illinois) were individually inserted, head first. Frogs were forced to exit through the open front by prodding from the rear opening. Thus, test animals were given a choice between one of two substrates. After 20 frogs of each morph from both central and southern Illinois were tested and their choices recorded, substrate positions were reversed and tests repeated. Results of each run (original and reciprocal) were combined to give 40 possible choices/morph for each substrate combination. Similar tests were performed *in situ* on the mud bank of a farm pond in McLean County about 5 miles southwest of Bloomington (central Illinois). Exit from the starting chamber was parallel to the shoreline. Frogs were collected, placed in the starting chamber and induced to leave. Their initial escape toward grass or water was recorded. Potential differences among morphs were compared by chi-square.

Water Preference

To test Wendelken's (1968) contention that red striped frogs were more likely to enter water for escape, the following test was performed.

A 20-gal aquarium was arranged with water and soil at opposite ends to simulate a pond with a gradually sloping bank. Thirty frogs of each morph from Pine Hills (southern Illinois) and Dawson Lake (central Illinois) were placed individually on mud at the edge of, and facing, the water and induced to enter. The number of frogs that entered the water and dove to the bottom versus those that entered and immediately returned to shore was recorded. Potential differences among morphs were compared by chi-square. Submergence times of divers were measured to the nearest second with a stopwatch and differences among morphs tested by analysis of variance. The test procedure was repeated *in situ* with 25 frogs of each morph at a farm pond in central Illinois.

Distribution Perpendicular to Shore

To determine if *Acris* color morphs were differently distributed perpendicular to the water line, collections were made in three transects parallel to the shore (i.e., at the water line, on the mud bank, and in grass) at two localities in central and one in southern Illinois. Potential differences among morphs were compared by chi-square.

Human Disturbance

Behavioral differences among morphs after human disturbance were investigated in the natural habitat by a method similar to Wendelken's (1968). Initial morph frequencies were obtained by slowly walking the shore and recording the number of frogs in each color class. Frogs were then induced to hide by rapidly walking back and forth, parallel to the shore and kicking rocks, sticks and tufts of grass. After 15 min., morph frequencies were again determined and compared to the first by chi-square. The procedure was repeated at 15 different localities in Illinois during the spring of 1970.

RESULTS

Seven trials, including a control, were run on mud, grass or leaves with initial prey populations of 53 or more animals. Although prey populations were reduced 52-77%, chi-square tests showed no significant differences ($P > 0.05$) between the ratio of morphs eaten and that of initial populations. The same was observed for 36 trials, including seven controls run on mud, rock, grass or leaves, with prey populations of 35 or less which were reduced 15-77%. Prey density had no apparent affect on differential predation.

Seven trials including three different substrate combinations (mud or grass, mud or water, grass or water) presented to southern and central Illinois cricket frogs failed to reveal significant differences among morphs ($P > 0.05$). The same was true for water preference tests with frogs from the same locations. Frogs generally preferred mud or water to grass. However, frogs entering water were reluctant to dive and most immediately returned to shore. The number of divers was 2-3 times greater in the natural habitat than in laboratory tests. However in all tests, number of divers was less than the number returning to shore. Submergence

time of divers ranged from 45 to 72 sec and was longer in the natural habitat. Analysis of variance showed no significant differences ($P>0.05$) among morphs.

Ten comparisons among the ratio of morphs in shoreline transects (sample size ranged from 64 to 642 frogs) and morphs sampled before and after human disturbance (initial sample sizes at 15 localities in Illinois ranged from 15-77 frogs) revealed no significant differences ($P>0.05$).

DISCUSSION

The lack of significant differences among *Acris* morphs to evade predation on various substrates suggests visual selection by predators may not be a factor in maintaining this polymorphism. My data and the lack of differential predation in experiments with birds (Wendelken, 1968) present an argument against the visual selection hypothesis. Pyburn (1961a) suggested visual selection by predators on terrestrial frogs favored gray morphs on a mud bank and red and green morphs when vegetation was abundant. However, Wendelken (1968), investigating visual selection with great-tailed grackles, *Cassidix mexicanus*, as predators, found no support for Pyburn's hypothesis.

Wendelken's (1968) study revealed potential behavioral differences among morphs. Red striped frogs apparently entered the water more often and remained longer to escape predation. Wendelken also performed two "walking experiments" similar to my human disturbance experiments and verified a behavioral difference. However, my behavior and "walking experiments" failed to indicate morph specific behavioral differences in Illinois populations.

Nevo (1973) presented evidence that selection may act on morph associated physiological factors. He found extra large (2.0-2.5 g) gray morphs from Texas were more resistant to desiccation than red morphs. However, Gray (1977) recorded no morph associated differences in desiccation rate and other physiological characteristics in Illinois. Milstead (1974) hypothesized apostatic selection in maintaining color polymorphism in *A. crepitans*.

Selective value of *Acris* color morphs has been attributed to protective coloration or certain cryptic physiological or behavioral differences controlled by pleiotropic genes. However, in the absence of conclusive evidence, the selective value of color and pattern variations and extent of physiological or behavioral differences among morphs must be evaluated throughout the species range to ascertain the adaptive value of this polymorphism.

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