INNATE RESPONSE OF THE SAN FRANCISCO GARTER SNAKE AND THE ALAMEDA WHIPSNAKE TO SPECIFIC PREY ITEMS

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Abstract: Newborn San Francisco garter snakes (*Thamnophis sirtalis tetrataenia*) exhibit a highly directed feeding response towards small frogs and selected salamander species. However, their response to other common garter snake food items such as worms, slugs, and small fishes is minimal, and feeding skills for these items must be acquired through trial and error learning. In a similar manner, hatchling Alameda whipsnakes (*Mastacophis lateralis euryxanthus*) exhibit an immediate feeding orientation toward small lizards. Other potential food items in their habitat such as grasshoppers, newborn mice, and young frogs consistently elicit no direct feeding response. Such innate feeding responses may accrue to these species a distinct competitive advantage for their young when their preferred prey species are abundant. However, in times of preferred prey scarcity, the lack of a more universal feeding response may be a disadvantage in the face of competition with the young of other snake species. This in turn may account for the general scarcity of such endangered and threatened reptiles with highly specialized feeding habits.

During the past several decades numerous laboratory studies have been conducted on food preferences in snakes (Burghardt 1967, 1968, 1971; Arnold 1978). Few of these however, have attempted to make direct correlations of their findings with specific field situations and natural food abundance. The purpose of this study is to examine the innate prey preference responses for the young of one state and one federal listed endangered snake, the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) and the state listed threatened the Alameda whipsnake (*Mastacophis lateralis euryxanthus*) in order to see how such responses coupled with food availability during the weeks and months after birth or hatching may partially account for the marked scarcity of these two reptiles.

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METHODS AND MATERIALS

Natal San Francisco garter snakes (SFGSs) were obtained when a captive female from a habitat site in Millbrae, California gave birth in the laboratory. The natal SFGSs were maintained on red angleworms with an occasional supplement of mosquito fish (*Gambusia affinis*) prior to the food preference tests. Our tests in previous years found these foods to be of moderate preference by young SFGSs and they were also easily obtainable throughout the year. Natal Alameda whipsnakes (AWs) were captured in the field with a modified version of the drift fence-trap method reported by Fitch (1951). They were maintained on hatchling northwestern fence lizards (*Sceloporous occidentalis occidentalis*), the only readily available food which they would accept.

All snakes were maintained in 10 gallon, mesh top glass terrarium with pea gravel substrate at a room temperature of 20°C. The addition of electrical "hot rocks" to each terrarium created a thermal mosaic (20-35°C) in which the snakes could choose an optimal thermal regime for efficient digestion. This allowed for the testing of SFGSs on a daily basis and the AWs two to three times weekly.

The prey items for the preference tests were chosen by making a thorough examination of natural habitats to determine most of the possible food items that were available during the weeks and months after birth and hatching. Prey preference tests for SFGSs were conducted by presenting each a cotton swab or live prey item to post absorptive snakes. Cotton swabs for the scent tests were soaked in petri dishes containing warm tap water and a prey species for 30 min. Then the prey was stroked several times with the saturated swab. Each swab was presented one centimeter in front of the snake's snout. If no response occurred within 30 seconds, the swab was touched to the snake's snout. Burghardt (1967, 1971) used a similar technique and relied on the frequency of tongue vibrations as an indicator of comparative food preference. However, we observed that increased tongue flicking often led to the rejection of an item without any attempt to strike at or grasp it. We therefore interpreted tongue flicking as an exploratory behavior which may or may not lead to feeding.

Preference responses for SFGSs were assayed by recording the time interval between the initial head orientation toward the swab and the initial strike. Occasionally snakes assumed a defensive posture of flattening the head and striking at the swab. Strikes that were deemed defensive were not scored. An attempt to use the cotton swab method with AWs proved unsuccess-

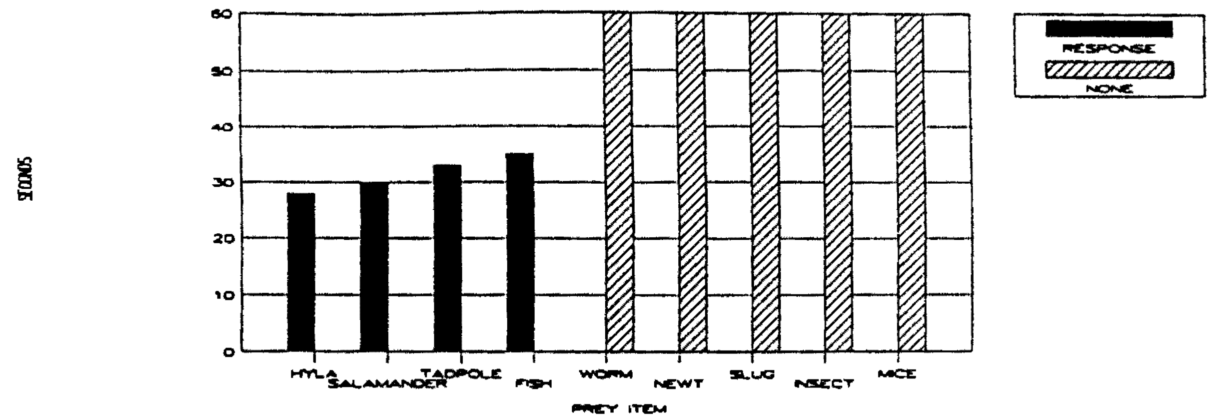

Fig. 1. Strike response time and nonresponse of natal SFGS to prey scent impregnated cotton swabs presented for one minute at 1 cm in front of snout.

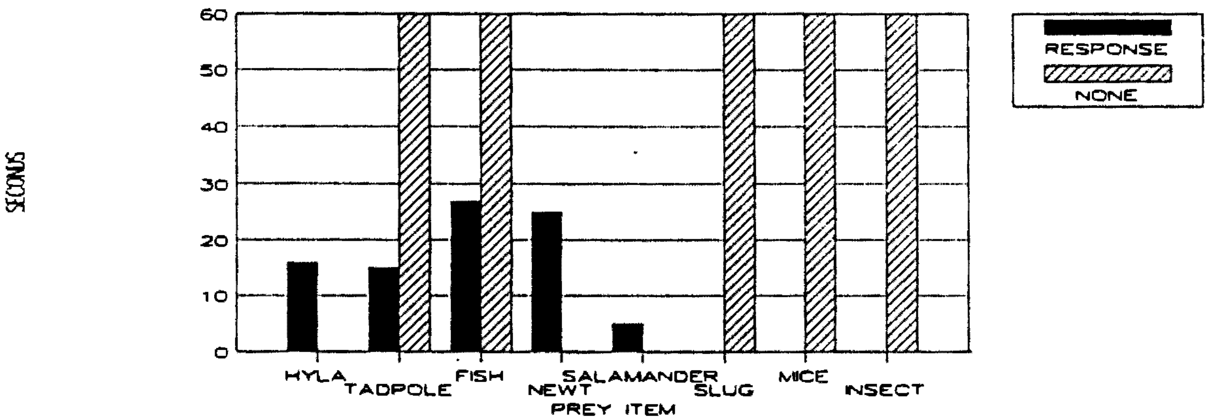

Fig. 2. Strike response time and nonresponse of natal SFGS to all possible prey items other than worms in their marsh/pond habitat. Dual test for tadpoles and fish were in shallow (1 cm) and deep (5 cm) of water.

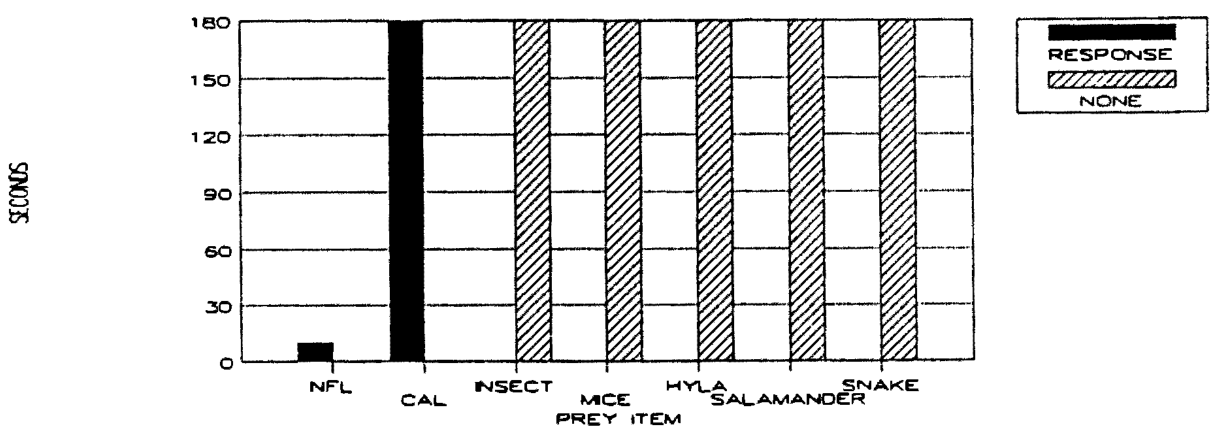

Fig. 3. Strike response time and nonresponse of hatchling AWs to all possible prey items in their coastal scrub habitat. (NFL = Northwestern fence lizard; CAL = California alligator lizard).

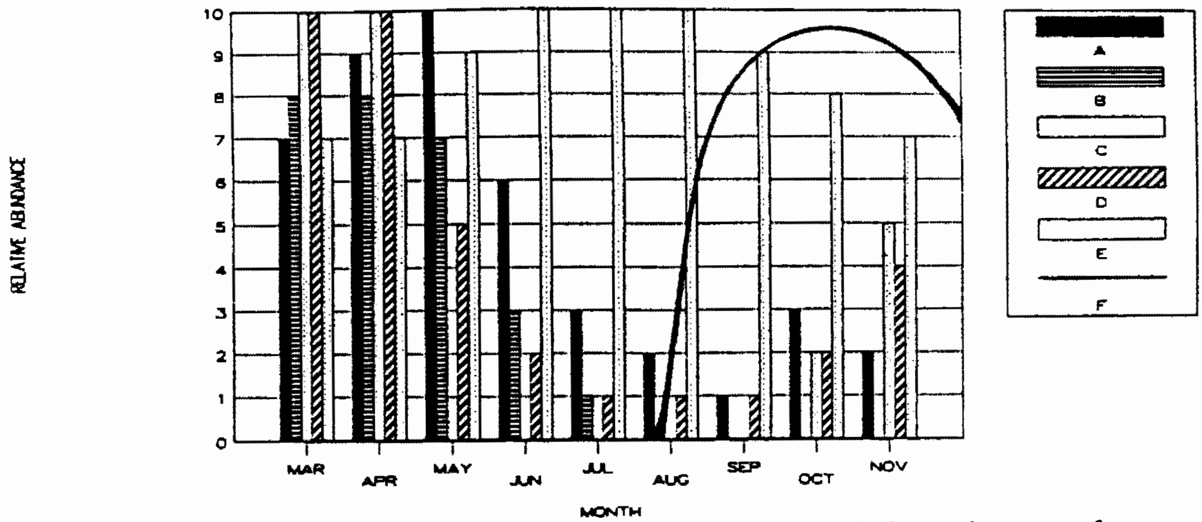

Fig. 4. Relative abundance of natal SFGS and prey items. The line indicates the onset of newborn SFGS.

A. Hyla regilla
B. Hyla regilla tadpoles
C. California Slender Salamander
D. Worms
E. Fish
F. Natal SFGS

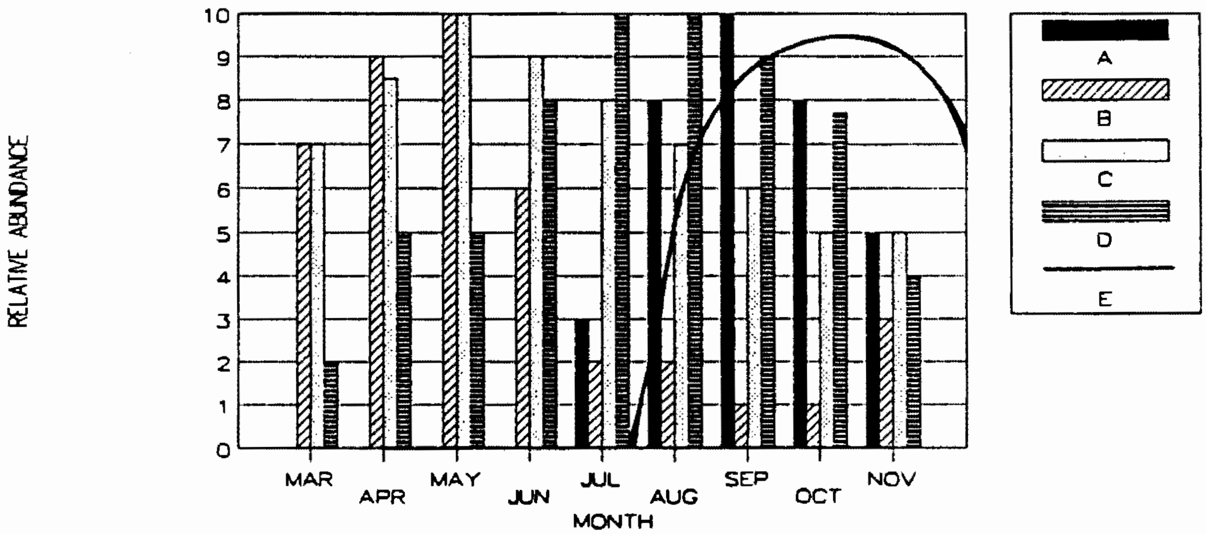

Fig. 5. Relative abundance of hatchling AWs and prey items. The line indicates the onset of hatchling AWs.

A. Hatchling lizards
B. Hyla regilla
C. Newborn mice
D. Large insects
E. Hatchling AWs

natural habitat, the preferred and consumable prey species are the northwestern fence lizard and Skilton skink (*Eumeces skiltonianus skiltonianus*). In previous informal observations and testing, the latter also elicited a feeding response on every trial. In the same tests both Pacific tree frogs and California slender salamanders were approached with rapid tongue flicking and were eaten only after extensive exposure. This behavior suggests that as in the case with the SFGSs, some secondary prey items may be eaten after much trial and error learning under captive conditions where the prey cannot escape the continuous investigations of the predator. In contrast to such exploratory feeding is the AW's almost immediate strike response to lizards which is not preceded by any tongue flicking or probing. The snake's head simply orients toward the lizard, and when it moves, it is grasped and eaten, a sequence which exemplifies the classic sign stimulus/releaser mechanism response.

When the innate food preferences of these two reptiles are coupled with the yearly food availability in their natural habitats, the ecological results of food specialization may be seen. Note in Figure 4 that the preferred amphibian prey of the SFGS is either at an annual low point (Pacific treefrogs) or unavailable (California slender salamander) during the two months after the birthing period. If heavy late rainfall in a particular year promotes foraging activity of metamorphed Pacific treefrogs during late summer, its availability may be adequate to ensure a successful year class of SFGSs. However, if drought conditions force all Pacific treefrogs into estivation by mid-summer, it is conceivable that no adequate food is present and most of the year class starves. We believe that the past four years of drought have produced this very scenario at the Millbrae habitat site.

The food availability for hatching AWs appears a little less severe. Figure 5 shows that their preferred prey, hatchling northwestern fence lizards, appear on the environmental scene in concert with hatchling AWs. However, should the year class of that one specific prey be scarce on a given year or should sympatric generalist feeders such as the western yellow-bellied racer (*Coluber constrictor mormon*) and California kingsnake (*Lampropeltis getulus californiae*) feed heavily on this lizard because of scarcity of other prey, then the AW year class will suffer.

Given this line of reasoning we suggest that innate food niche specialization may be a major factor in determining the relative abundance of a species or subspecies. It seems more than a coincidence that the only protected snake species in the greater Bay Area are also the most specialized feeders as yet studied in this region. When designing restoration and enhancement plans for such species, plans which concentrate on the promotion of the preferred prey are of prime importance.

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