



ALLEN
PRESS



Prey Movement and Predatory Behavior of Juvenile Western Yellow-Bellied Racers,
Coluber constrictor mormon

Author(s): Harold A. Herzog, Jr. and Gordon M. Burghardt

Source: *Herpetologica*, Sep., 1974, Vol. 30, No. 3 (Sep., 1974), pp. 285-289

Published by: Allen Press on behalf of the Herpetologists' League

Stable URL: <https://www.jstor.org/stable/3891836>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at <https://about.jstor.org/terms>



Allen Press and Herpetologists' League are collaborating with JSTOR to digitize, preserve and extend access to *Herpetologica*

JSTOR

Softshell turtles presently studied fed well during winter months yet had lower protein concentrations than fall turtles. This parallels the findings of Hutton (1960) and Masat and Musacchia (1965) and excludes the possible effect of feeding behavior. It appears that turtles have endogenous protein cycles that fluctuate with season. The ecological and physiological implications of this are yet to be understood.

Acknowledgments.—I thank Dr. W. G. Degenhardt for use of herpetological facilities at the University of New Mexico. Dr. John Garcia provided valuable assistance in the collection of specimens.

LITERATURE CITED

- GORNALL, A. G., C. J. BARDAWILL, AND M. M. DAVID. 1949. Determination of serum proteins by means of the biuret reaction. *J. Biol. Chem.* 177:751-766.
- HUTTON, K. E. 1960. Seasonal physiological changes in the red-eared turtle, *Pseudemys scripta elegans*. *Copeia* 1960:360-362.
- , AND C. J. GOODNIGHT. 1957. Variations in the blood chemistry of turtles under active and hibernating conditions. *Physiol. Zool.* 30:198-207.
- LEGLER, J. M. 1960. A simple and inexpensive device for trapping aquatic turtles. *Utah Acad. Sci. Proc.* 3:63-66.
- MASAT, R. J., AND X. J. MUSACCHIA. 1965. Serum protein concentration changes in the turtle, *Chrysemys picta*. *Comp. Biochem. Physiol.* 16: 215-225.

Received: 23 July 1973

Accepted: 6 October 1973

Department of Biology, University of New Mexico, Albuquerque, New Mexico 87106. (PRESENT ADDRESS: Department of Biology, Marshall University, Huntington, West Virginia 25701)

PREY MOVEMENT AND PREDATORY BEHAVIOR OF JUVENILE WESTERN YELLOW-BELLIED RACERS, *COLUBER CONSTRICTOR MORMON*

HAROLD A. HERZOG, JR. AND GORDON M. BURGHARDT

ABSTRACT: Juvenile yellow-bellied racers (*Coluber constrictor mormon*) were presented with moving (live) and nonmoving (dead) crickets. All subjects demonstrated a preference for moving crickets in a simultaneous choice situation. In a successive choice situation, nonmoving crickets were attacked as often as moving prey, but with longer latencies. Behavioral descriptions of prey attack are reported which indicate different patterns of predatory behavior to live and dead crickets.

AN increasing number of studies have demonstrated the importance of the various sensory modalities in predatory behavior of snakes. Much of this work has focused on chemoreception (Burghardt, 1970) and thermoreception (Gamow and Harris, 1973). Relatively little is known about the role of vision and prey movement in the activation and orientation of predatory behaviors in various species of snakes, although some studies have been performed and anecdotal observations reported.

Gettkandt (1931) concluded that "regularity" of movement was the most important visual factor in the feeding behavior of

Natrix natrix and *Zamenis flagelliformis* (now *Masticophis flagellum*) and that shape, size, and color were of minor importance. Kahmann (1932) demonstrated that quick prey movement was sufficient to activate appetitive behaviors in normal *Natrix natrix* and in animals with cauterized Jacobson's organs. Burghardt (1966) supported this with observations on naive newborn *Thamnophis sirtalis*; however, no overt attacks were found unless chemical cues from prey were present. Kahmann (1934) concluded, on the basis of behavioral and anatomical observations of a considerable number of species (including *Coluber*), that movement

played the major role in alerting a snake and in orienting prey attack. Diefenbach and Emslie (1971) accounted for the tendency of *Elaphe climacophora* to strike live mice at the head by demonstrating that the head was the body part showing maximum movement. MacDonald (1973) concluded that movement both facilitates prey location in *Constrictor constrictor*, and aids in eliciting attack. Smith and Watson (1972) found that movement and proximity of mice were more important than color or contrast in *Elaphe guttata*. Wells et al. (1971) classified eight species of colubrid and crotaline snakes as olfaction-oriented or vision-oriented on the basis of relative size of neuroanatomical structures, but they made no attempt to assess behaviorally this dichotomy.

Burghardt (1964) demonstrated the importance of prey movement in lizards by simultaneously presenting moving and non-moving *Tenebrio* beetle larvae of various sizes. It was felt that a similar technique could be used to evaluate the importance of prey movement in activation and orientation of predatory behavior in snakes. In the experiments reported here, juvenile *Coluber constrictor mormon*, a diurnal species categorized by Wells et al. (1971) as vision oriented, were tested for prey preference in situations involving: (1) simultaneous and (2) successive choice of moving and non-moving (dead) crickets. Informal observations by W. S. Brown (pers. comm.) and in our laboratory, indicated that prey movement seemed particularly important in the feeding behavior of this snake. Thus our prediction was that preference for moving prey would be indicated by choice, shorter attack latencies, and greater number of attacks. Insects constitute the major diet for all age classes of *C. c. mormon* (Brown, 1973).

GENERAL METHODS

Five young *Coluber constrictor mormon* were offered dead and live crickets (*Acheta domestica*) simultaneously (Experiment 1) and successively (Experiment 2). The five snakes tested in Experiment 1, August 1972

progeny of females from northern Utah, were 61 to 65 days of age at the first day of testing. They weighed 5.7–7.7 g and measured 22.8–24.4 cm in snout-vent length. Three of these snakes were used in Experiment 2. The snakes had been maintained exclusively on live crickets except for an occasional newborn mouse prior to the experiments. They were housed in individual glass aquaria, 35 × 20 × 25.5 cm, with sand substrates. Each snake was visually isolated from all others by cardboard partitions placed between the cages. Temperature was maintained between 26–28 C, and the animals were exposed to a 12-hour day-night cycle from an overhead fluorescent light. In both experiments the dead crickets were killed by immersion in hot water (approximately 65 C) for one minute, and they were blotted dry. All tests were conducted in the snakes' home cages.

EXPERIMENT 1

Method.—Each snake was exposed to one live and one dead cricket in the following manner. If the snake was near the center of the cage, it was gently oriented toward the closest corner with a white card (20.4 × 12.7 cm). The two prey items were placed dorsal side up in the center of the cage 2 to 3 cm apart while the card was interposed between the snake and the prey items. The card was then lifted giving the snake access to the prey items. Each subject was tested six times at 4-day intervals. During the first three tests, the remaining prey item was removed from the cage after the initial prey had been ingested. During the last three tests, the remaining prey was left in the cage overnight.

Results.—In all trials every snake first attacked the live cricket with the exception of one snake which did not attack either prey on the first day of testing. Thus, in a total of 30 choice situations, the moving prey was attacked first on 29 occasions, while the nonmoving prey was never attacked first. On the 3rd test day, the live cricket was attacked by one snake but escaped, and the dead cricket was sub-

sequently located and swallowed. This incident indicated to us that dead prey would be swallowed on occasion, and we subsequently allowed the dead crickets to remain in the cages overnight to determine whether the snakes would regularly eat dead prey. Dead crickets were eaten 9 times over 15 presentations (60%) with four of the five snakes eating a dead cricket on one or more test days.

EXPERIMENT 2

Method.—To determine whether the snakes would eat nonmoving prey without prior exposure to moving prey, three snakes used in Experiment 1 were first presented with a dead cricket in the manner described above, and 30 min later presented with a live cricket. Attack latencies were timed with a stopwatch on all trials from the moment the card was lifted to the moment that the chosen prey was seized with the open jaws. If the snake did not attack a prey item within 30 min, it was given a latency of 1800 s for the purposes of data analysis, although all prey were left in the cage overnight. The snakes were tested seven times in this manner. The first four tests were spaced at 4-day intervals, but it was suspected that this was too frequent to allow for complete digestion as two crickets were being eaten on most test days by each animal. Therefore, the last three tests were spaced 6 days apart.

Results.—There was no difference in the total number of times the dead prey and live prey were attacked within the first 1800 s (dead = 17, live = 18). However, there were differences in the attack latency to the prey items (\bar{X} attack latency to dead crickets = 749.7 s, \bar{X} attack latency to live crickets = 306.1 s). The highly variable scores were transformed on a log scale and a one-tailed *t*-test of the subject means showed the difference was significant ($t = 3.70$, $P < .05$).

OBSERVATIONS AND DISCUSSION

The first experiment established that young *C. c. mormon* will take live in prefer-

ence to dead crickets. Experiment 2 established that young *C. c. mormon* are capable of locating and attacking nonmoving prey in the absence of any "priming" or arousal factor caused by prior exposure to moving crickets. However, learning cannot be ruled out as having influenced these results since (a) the racers had prior experience with live crickets and (b) conditioned associations could have been established to the manipulations involved in the presentation of stimuli. Nonetheless, the results hold even if the ontogeny of the discrimination is less obvious.

When a snake was presented with a live cricket, it would orient toward the cricket as soon as the prey moved. The snake would then pursue the cricket around the cage, making strikes which would frequently miss the prey. While attempting to evade attack, a cricket would sometimes stop and remain motionless for a period of time. When this occurred, the snake would seem to lose visual orientation on the prey and would begin apparently random searching movements. Even if the snake's head was within 1–2 cm of a live but immobile cricket, the snake was often unable to make an accurate attack. Successful attacks on a live cricket almost always occurred while the cricket was in motion. This indicates that visual cues elicited the strike and not chemical ones "stirred up" by the prey movement. On the other hand, chemoreception cannot be ruled out, from these data, as a necessary factor. Indeed Burghardt and W. S. Brown (pers. observ.) tested newly hatched unfed *C. c. mormon* on a variety of prey extracts prepared with 60 C water, including crickets, and found evidence for initial discriminations based on chemical cues alone.

While it is possible that killing crickets in hot water may have reduced the quantity of chemical cues emanating from them in the present experiment, the fact that the snakes readily attacked dead prey when encountered indicated that the chemical stimuli involved in mediation of the attack response were still present. It is therefore

not felt that differences in olfactory cues were sufficient to account for the difference obtained in attack latency and in preference to live prey.

While a snake was pursuing a live cricket *in vacuo* feeding movements occasionally occurred. The snake would inadvertently bite an inappropriate object during the prey attack, usually a lump of sand or its own body. The snake would then begin a series of rhythmic, alternating movements of the open jaws which appeared almost identical to normal swallowing movements except that nothing was present in the jaws. Unlike classical examples of vacuum activities (Tinbergen, 1951) which may have no apparent releasing stimuli, the swallowing movements were clearly in response to contact with stimulus objects however inappropriate at a time when the animal was actively engaged in predatory behavior. This phenomenon does indicate the stereotyped nature of the behavioral sequence involved in swallowing. It is similar to the constriction reported in a newborn *Elaphe v. vulpina* in response to a stream of prey odor laden air by Burghardt and Abeshaheen (1971).

An attack sequence for dead prey was typically different from that for live prey. A snake would begin the searching movements, tongue-flicking at the substrate after the card was lifted. It would not orient immediately upon dead crickets as it did live prey. Thus the attack latencies for dead crickets reflect search time. The snakes had difficulty in accurately locating live but motionless crickets (even at short distances), but they were fully capable of locating and attacking dead crickets within the same distance. Observations by W. S. Brown (pers. comm.) on *C. c. mormon* kept in a more naturalistic environment indicate that adult snakes also have different feeding patterns toward dead and live crickets. His snakes seemed to investigate dead crickets more thoroughly with the tongue, though dead crickets were readily eaten.

These observations are consistent with

the view of Kahmann (1934) that in snakes, if prey movement stops, contact with the prey is interrupted. Hence it may very well be that live prey that freeze are more likely to escape predation than prey that either are nonmoving for long periods (e.g. dead) or are in relatively constant motion. The behavior of the prey needs to be studied as closely as that of the predator.

Acknowledgments.—We thank William S. Brown for providing the snakes, his personal observations, and for valuable comments on the manuscript. This research was supported in part by Grant MH-15707 from the National Institute of Mental Health awarded to the junior author.

LITERATURE CITED

- BROWN, W. S. 1973. Ecology of the racer, *Coluber constrictor mormon* (Serpentes, Colubridae), in a cold temperate desert in northern Utah. Ph.D. thesis. University of Utah, Salt Lake City. 208 p.
- BURGHARDT, G. M. 1964. Effects of prey size and movement on the feeding behavior of the lizards *Anolis carolinensis* and *Eumeces fasciatus*. *Copeia* 1964:576–578.
- . 1966. Stimulus control of the prey attack response in naive garter snakes. *Psychon. Sci.* 4:37–38.
- . 1970. Chemical perception in reptiles, p. 241–308. In J. W. Johnston, Jr., D. G. Moulton, and A. Turk [eds.] *Communication by chemical signals*. Appleton-Century-Crofts, New York.
- , AND J. P. ABESHAHEEN. 1971. Responses to chemical stimuli of prey in newly hatched snakes of the genus *Elaphe*. *Anim. Behav.* 19:486–489.
- DIEFENBACH, C. O., AND S. G. EMSLIE. 1971. Cues influencing the direction of prey ingestion of the Japanese snake, *Elaphe climacophora* (Colubridae, Serpentes). *Herpetologica* 27:461–466.
- GAMOW, R. I., AND J. F. HARRIS. 1973. The infrared receptors of snakes. *Sci. Am.* 228:94–100.
- GETTKANDT, A. 1931. Die Analyse des Funktionskrieses der Nahrung bei der Kutscherpeitschenschlange *Zamenis flagelliformis* L. nebst Ergänzungsversuchen bei der Ringelnatter *Tropidonotus natrix* L. *Z. Vergl. Physiol.* 14:1–39.
- KAHMANN, H. 1932. Sinnesphysiologische Studien an Reptilien—I. Experimentelle Untersuchungen über das Jacobsonische Organ der Eidechsen und Schlangen. *Zool. Jb. Abt. Allg. Zool. Physiol.* 51:173–238.

- . 1934. Zur Biologie des Gesichtssins der Reptilien. Zool. Anz. 108:311–325.
- MACDONALD, L. 1973. Attack latency of *Constrictor constrictor* as a function of prey activity. Herpetologica 29:45–48.
- SMITH, G. C., AND D. WATSON. 1972. Selection patterns of corn snakes, *Elaphe guttata*, of different phenotypes of the house mouse, *Mus musculus*. Copeia 1972:529–532.
- TINBERGEN, N. 1951. The study of instinct. Clarendon Press, Oxford.
- WELLS, K. E., H. M. SMITH, AND R. C. SPAUR. 1971. Correlation of certain ophidian sensory modalities with gross brain proportions. J. Herpetol. 5:200–204.

Received: 10 August 1973

Accepted: 13 October 1973

Department of Psychology, University of Tennessee, Knoxville, Tennessee 37916
(PRESENT ADDRESS OF HERZOG: Department of Behavioral and Social Sciences, Mars Hill College, Mars Hill, North Carolina 28754)

ON THE LEPTODACTYLID FROG CALLED
ELEUTHERODACTYLUS PALMATUS (BOULENGER)
AND THE STATUS OF *HYLODES FITZINGERI* O. SCHMIDT

JAY M. SAVAGE

ABSTRACT: The large upland arboreal Atlantic slope Costa Rican frog usually called *Eleutherodactylus palmatus* is shown to be without a valid name. It is redescribed and named *Eleutherodactylus andi* sp. nov. based on a type from Costa Rica: Provincia de San Jose: 0.8 km N juncture Rio Clara and Rio La Hondura, 1500 m. The names *Hyla grisea* Hallowell, *Craugaster pulchrigulus* Cope, and *Leiyla güntnerii* Keferstein are shown to have been based upon examples of *E. andi*'s lowland ally *Eleutherodactylus fitzingeri*. Because the holotypes of these four names are lost or destroyed, a single specimen (LACM 76859) is designated as the neotype of each name to insure absolute and objective nomenclatural stability. The name *Hylodes palmatus* Boulenger is a composite, originally based upon examples of *Eleutherodactylus fitzingeri* and *E. rugulosus*. Action in this paper makes *H. palmatus* a strict synonym of the latter species.

TAYLOR (1952:744, Fig. 32) in the most recent review of the frog genus *Eleutherodactylus* in Costa Rica recognized a large, long-legged, broad-disked form, with large bright yellow spots on the posterior thigh surface, a dark-brown throat with distinct median cream stripe and extensive dark-brown ventral markings, taken from a bromeliad about 5 m above the ground at Provincia de Alajuela: Isla Bonita (1200 m), as *Eleutherodactylus palmatus* (Boulenger, 1882). Taylor questioned the use of this name for his specimen but realized that it was conspecific with the species figured as *Liohyla güntneri* by Güntner (1900:220, pl. 66, Figs. A,A').

As the result of my recent work leading to a revision of the *Eleutherodactylus rugulo-*

sus group (Savage, 1974) and as part of my continuing effort to unravel the complexities of the species problem in the genus, I have followed Taylor's cue in reviewing the status of material referred to *Eleutherodactylus palmatus* or conspecific with it.

NOMENCLATURE HISTORY

In 1864–65 Professor Karl von Seebach (1865a, 1865b) visited Costa Rica where he collected amphibians for the Museum der Universität Göttingen. Among von Seebach's frogs, Wilhelm Keferstein (1868a, 1868b) discerned what he believed to be a new genus and species that he called *Leiyla güntnerii* based on a single specimen from "Costa Rica."

Boulenger (1882) placed Keferstein's spe-