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# Defensive Behavior of Cottonmouths (*Agkistrodon piscivorus*) toward Humans

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**Venomous snakes are often perceived as aggressive antagonists, with the North American cottonmouth having a particularly notorious reputation for such villainy. We designed tests to measure the suite of behavioral responses by free-ranging cottonmouths to encounters with humans. When confronted, 23 (51%) of 45 tested tried to escape, and 28 (78%) of 36 tested used threat displays and other defensive tactics; only 13 of 36 cottonmouths bit an artificial hand used in the tests. Our findings challenge conventional wisdom about aggressive behavior in an animal perceived as more dangerous than it is. Changing irrational negative attitudes about venomous snakes is a necessary step toward quelling the recently documented global decline in reptiles.**

VENOMOUS snakes have a reputation among the general public as being aggressive when approached by humans (Klauber, 1972). Attitudes about potential harm from hostile behavior of venomous snakes extend to some biologists, including even a suggestion that natural selection has operated through ''biocultural evolution'' in developing an innate predisposition by humans to learn to fear snakes (Wilson, 1993). A pervasive belief in the southeastern United States is that the cottonmouth (*Agkistrodon piscivorus*), a common venomous snake around many aquatic areas, is dangerous not only because of its venom and violent temper (Ernst and Barbour, 1989) but because it will bite whenever possible and even attack or chase people (Blythe, 1979).

In contrast to the attitudes of anxiety and fear toward venomous snakes by most people, some herpetologists have maintained, beginning almost a century ago (Ditmars, 1907), that the image of some or all venomous snakes as aggressors toward humans is greatly overstated, with escape or efforts to go undetected being the most likely behavioral responses (Shine, 1991; Greene, 1997). New Guinea natives have been suggested to show a learned response in distinguishing between dangerous and harmless snakes but not to possess ''an irrational innate fear'' (Diamond, 1993). Despite the contention by some herpetologists that cottonmouths are not aggressive when encountered in the field (Wright and Wright, 1957; Gloyd and Conant, 1990) and that the primary purpose of venom is to subdue prey (Campbell and Lamar, 1989), misgivings about the species persist among the general public and many scientists.

Humans have been used to represent generalized threat stimuli by simulating a predator to elicit defensive behaviors in snakes (Scudder and Chiszar, 1977; Goode and Duvall, 1989; Greene, 1989), and tests of the effects of temperature and other factors on defensive responses by snakes have been conducted (Scudder and Chiszar, 1977; Goode and Duvall, 1989). Nonetheless, quantitative measurements for purposes of determining the response of venomous snakes to humans are limited (Whitaker and Shine, 1999), and the suite of behavioral responses of cottonmouths to direct physical contact with humans has not been reported.

The objective of our study was to test the defensive responses of free-ranging cottonmouths confronted by a human aggressor. We use this test to determine whether conventional wisdom about aggressive behavior in this species is warranted. Information about the validity of real versus perceived threats by venomous snakes is necessary to address irrational negative attitudes and to help quell the recently documented global decline in reptiles (Gibbons et al., 2000).

## Materials and Methods

Cottonmouths are ideal subjects for a study of behavioral responses to encounters by humans because (1) they can be found in high densities in many areas of the southeastern United States (Ernst and Barbour 1989), (2) preconceived notions exist that suggest that cottonmouths are among the most aggressive of North American venomous snakes (Blythe, 1979; Ernst, 1992; Rubio, 1998), and (3) they exhibit a suite of measurable defensive behaviors suitable for tests in the field.

We searched the Savannah River floodplain swamp on the U.S. Department of Energy's Savannah River Site (Gibbons et al., 1997) in South Carolina for cottonmouths during spring

and early summer of 1997 and 1998 and the summer of 2000. We examined defensive behavior of wild cottonmouths in response to a human aggressor by subjecting them to one or more of three different treatments. When we encountered a cottonmouth in the field, we approached the snake and either (1) stood beside it with a ''snakeproof'' boot touching its body, (2) stepped on the snake at midbody with enough force to restrain but not injure it, or (3) picked up the snake at midbody with a pair of 1-m snake tongs (Whitney Tongs) with a grasping handle that was modified to resemble a human arm and hand. A leather glove was fitted over the end of the tongs, with one extension covered by the thumb and the other by the middle finger. Hence, the glove could be closed around the snake's body. A padded shirt sleeve was used to cover the remainder of the rod up to the handle. Each treatment was carried out for 20 sec, and the behavior of each snake was recorded.

For each treatment on each snake tested, we recorded whether it attempted to escape by crawling or swimming away, exhibited other defensive behaviors (vibrated tail, released musk, gaped, feigned a bite by striking but not closing the mouth), or bit the boot or model hand. An audio tape recorder was used to describe events during each encounter, and the majority of encounters were videotaped. After testing, the sex, size (snout–vent length to nearest centimeter), and body temperature (to nearest C using a cloacal thermometer) were determined for most snakes.

## Results

We recorded responses to a total of 80 encounters of 45 snakes (12 females, 16 males, 17 of undetermined sex) in the field. Of these, nine escaped (immediately entered water) when first observed or approached and were not available for further testing. Of the remaining 36 snakes, we initially stood beside 13, stepped on 12, and picked up 11. Of those that we stood beside, 10 were then stepped on, and of those stepped on initially or secondarily, 15 were picked up, resulting in total sample sizes of 13 (stood beside), 22 (stepped on), and 36 (picked up).

Body size ranged from 20–101 cm (mean = 59 cm, $n = 40$). Cloacal body temperatures ranged from 17–27 C (mean = 24 C, $n = 25$). No relationships were observed among the behavioral responses of individuals and their sex, size, or body temperature; hence these variables were omitted from further analyses.

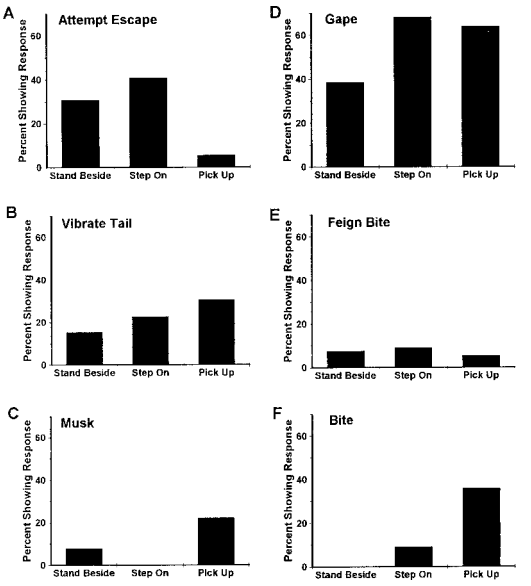


Fig. 1. Defensive responses of wild cottonmouths (*Agkistrodon piscivorus*). Bars indicate the proportion of individuals that responded in a particular manner for each of the three different treatments: stand beside ($n = 13$), step on ($n = 22$), and pick up ($n = 36$).

Of the 13 individual cottonmouths that we initially stood beside (Fig. 1), four attempted to escape, five gave some form of defensive display, and none tried to bite, although one individual feigned a bite during a strike. Only two of the individuals performed more than one defensive display.

Of the 22 that were stepped on either initially or secondarily, 15 gave defensive displays, including two that feigned bites. One bit the boot. Nine of those stepped on were attempting to escape by crawling away. Of the 36 individuals that were picked up, 13 (36%) bit the artificial hand near the point of contact with the snake's body. The probability of a cottonmouth biting, regardless of the testing procedure, was less than the probability of it not biting (chi-square = 15.05, df = 2, $P < 0.005$).

## Discussion

Our observations strongly support the contention of Pope (1958) that ''snakes are first cowards, then bluffers, and last of all warriors.'' Upon being seen, nine (20%) of the individuals fled into nearby water, apparently sensing that immediate escape was possible and a safe route was accessible. Such flight behavior by cottonmouths was noted by Ditmars (1907), who stated that ''snakes that observed us when some lit-

tle distance away, made for the water and escaped. . . .'' Ernst (1992) likewise reported that cottonmouths try to escape when first disturbed.

Mouth gaping, the bluffing behavior from which the name ''cottonmouth'' originates, was observed by us in 64% of the individuals that did not flee. In addition, 33% vibrated the tail, and 24% emitted a detectable musk. The open-mouthed behavior is presumed to be a true threat display to warn a predator that a bite is imminent. Tail vibration has been regarded as a warning signal in rattlesnakes (*Crotalus*; *Sistrurus*; Greene, 1988) and presumably serves the same function in cottonmouths that it does in many other snakes. The musky odor is presumed to be a means by which an individual presents itself as a distasteful meal prior to attack by a predator.

No relationship between body temperature of the snake and a tendency to bite was apparent in our study. Likewise, in a study of prairie rattlesnakes (*Crotalus viridis viridis*), males and non-gravid females showed no temperature-related change in defensive behavior, although a negative relationship was observed between temperature and defensive response in gravid females (Goode and Duvall, 1989).

Most venomous snakebites in the United States occur when someone picks up a snake or attempts to kill it (Ernst and Zug, 1996). Our results with cottonmouths quantify and support this assertion. Such ''illegitimate'' snakebites (''those sustained by individuals who knowingly place themselves at risk''; Minton, 1987) may be induced only after considerable harassment to the snake. Of the 11 snakes in our study picked up without previously being stepped on, only one bit the glove, suggesting that the preceding harassment (stepped beside or on) provoked the highest incidence of biting.

The cost to a snake of biting and injecting venom into a human antagonist has not been quantified, but certain unfavorable consequences are obvious. Engaging in a fight with a larger animal constitutes unnecessary exposure that could lead to injury or death for the snake. Even if an effective bite were delivered, the time to incapacitate an animal as large as a human would still permit time to injure or kill the snake. Therefore, once a snake perceives it has been detected and has no ready escape route, threats or other defensive displays designed to ward off an attacker should be favored by natural selection over actual biting.

In the current study, little or no evidence of venom was present on the glove following most of the bites. Some venomous snakes can control the amount of venom injected based on prey size (Hayes, 1995), suggesting that snakes can conserve venom when biting. Such control can presumably be exercised during defensive biting, with the act of biting serving as a threat display itself, without the injection of venom. Such behavior may explain the high frequency of ''dry bites'' in which little or no venom is injected into human victims (Parrish et al., 1966). However, we maintain that escape by snakes from human confrontation by some means other than biting is the most prudent.

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## Literature Cited

Blythe, C. 1979. Poisonous snakes of America: what you need to know about them. Branch-Smith, Inc., Fort Worth, TX.

Campbell, J. A., and W. W. Lamar. 1989. The venomous reptiles of Latin America. Comstock Publishing Associates, Ithaca, NY.

Diamond, J. 1993. New Guineans and their natural world, p. 251–271. *In:* The biophilia hypothesis. S. R. Kellert and E. O. Wilson, (eds.). Island Press, Washington, DC.

Ditmars, R. L. 1907. The reptile book. Doubleday, Page, and Co., New York.

Ernst, C. H. 1992. Venomous reptiles of North America. Smithsonian Institution Press, Washington, DC.

———, and R. W. Barbour. 1989. Snakes of eastern North America. George Mason Univ. Press, Fairfax, VA.

———, and G. R. Zug. 1996. Snakes in question. Smithsonian Institution Press, Washington, DC.

Gibbons, J. W., V. J. Burke, J. E. Lovich, R. D. Semlitsch, T. D. Tuberville, J. R. Bodie, J. L. Greene, P. H. Niewiarowski, H. H. Whiteman, D. E. Scott, J. H. K. Pechmann, C. R. Harrison, S. H. Bennett, J. D. Krenz, M. S. Mills, K. A. Buhlmann, J. R. Lee, R. A. Seigel, A. D. Tucker, T. M. Mills, T. Lamb, M. E. Dorcas, J. D. Congdon, M. H. Smith, D. H. Nelson, M. B. Dietsch, H. G. Hanlin, J. A. Ott, and D. J. Karapatakis. 1997. Perceptions of species abundance, distribution, and diversity: lessons from

four decades of sampling on a government-managed reserve. Environ. Manage. 21:259–268.

———, D. E. Scott, T. Ryan, K. Buhlmann, T. Tuberville, J. Greene, T. Mills, Y. Leiden, S. Poppy, C. Winne, and B. Metts. 2000. The global decline of reptiles, déjà vu amphibians. BioScience 50:653–666.

Gloyd, H. K., and R. Conant. 1990. Snakes of the *Agkistrodon* complex. Society for the Study of Amphibians and Reptiles, St. Louis, MO.

Goode, M. J., and D. Duvall. 1989. Body temperature and defensive behavior of free-ranging prairie rattlesnakes, *Crotalus viridis viridis*. Anim. Behav. 38: 360–62.

Greene, H. W. 1988. Antipredator mechanisms in reptiles, p. 1–152. *In:* Biology of the Reptilia. Vol. 16. C. Gans and R. B. Huey (eds.). Alan R. Liss, Inc., New York.

———. 1989. Defensive behavior and feeding biology of the Asian mock viper, *Psammodynastes pulverulentus* (Colubridae), a specialized predator on scincid lizards. Chinese Herpetol. Res. 2:21–32.

———. 1997. Snakes: the evolution of mystery in nature. Univ. of California Press, Berkeley.

Hayes, W. K. 1995. Venom metering by juvenile prairie rattlesnakes, *Crotalus v. viridis*: effects of prey size and experience. Anim. Behav. 50:33–40.

Klauber, L. M. 1972. Rattlesnakes: their habits, life histories, and influence on mankind. Univ. of California Press, Los Angeles.

Minton, S. A. 1987. Poisonous snakes and snakebite in the U.S.: a brief review. Northwest Sci. 61:136–137.

Parrish, H. M., J. C. Goldner, and S. L. Silberg. 1966. Poisonous snakebites causing no venenation. Postgrad. Med. 39:265–269.

Pope, C. H. 1958. Snakes alive and how they live. Viking Press, New York.

Rubio, M. 1998. Rattlesnake: portrait of a predator. Smithsonian Institution Press, Washington, DC.

Scudder, K. M., and D. Chiszar. 1977. Effects of six visual stimulus conditions on defensive and exploratory behavior in two species of rattlesnakes. Psychol. Rec. 3:519–526.

Shine, R. 1991. Australian snakes: a natural history. Reed Books, Sydney, New South Wales, Australia.

Whitaker, P. B., and R. Shine. 1999. Responses of free-ranging brown snakes (*Pseudonaja textilis*, Elapidae) to encounters with humans. Wildl. Res. 26: 689–704.

Wilson, E. O. 1993. Biophilia and the conservation ethic, p. 33–34. *In:* The biophilia hypothesis. S. R. Kellert and E. O. Wilson (eds.). Island Press, Washington, DC.

Wright, A. H., and A. A. Wright. 1957. Handbook of snakes of the United States and Canada. Vol. II. Comstock Publ. Assoc., Ithaca, NY.

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