

Habitat Utilization and Behavior of the Mohave Rattlesnake (*Crotalus scutulatus scutulatus*)

Michael Cardwell

INTRODUCTION

Mohave rattlesnakes (*Crotalus scutulatus scutulatus*) produce one of the most toxic venoms of all Nearctic crotaline snakes, although the toxic constituents vary significantly among geographic populations (Glenn and Straight 1982). They are common animals in many parts of the Mohave Desert and thus account for a significant percentage of human/rattlesnake encounters in places where human activity coincides with their range; they are undoubtedly responsible for a significant percentage of the rattlesnake bites in these areas. Factors influencing venom evolution, distribution, and variations in population density have not been identified. Moreover, perception by the public, as well as by some emergency medicine professionals, regarding this species often includes irrational fear based on misunderstanding and myth.

According to Klauber (1956), *C. s. scutulatus* "is probably most common in level areas having light brush cover" and "seem to have no particular need for rocks." Throughout much of the range of *C. s. scutulatus* in California, the dominant flora is creosote bush (*Larrea tridentata*) and the terrain is mostly devoid of rock outcroppings and other significant topographic features.

The Mohave Desert is characterized by longer periods of freezing temperatures and less summer rainfall than the Sonoran Desert to the south but shorter periods of freezing weather than the Great Basin Desert to the north (Baldwin, et al 2002). Nonetheless, freezing temperatures are common during winter months, occasionally remaining at or below 0°C for days at a time (pers obs).

The behavior and habitat utilization of several other Nearctic crotaline species have been (and are being) studied in detail, including *C. viridis* (Duvall et al 1990), *C. cerastes* (Secor 1992), *C. horridus* (Brown 1993), *C. molossus* (Greene 1997), *C. tigris* (Goode, pers com), *C. atrox* (Schuett and Repp, pers com), *C. ruber* (Brown, pers com) and *C. helleri* (Dugan, pers com). However, no such study has been undertaken regarding *C. scutulatus*.

Other Nearctic crotaline species have been found to frequently utilize permanent winter refugia, often in rock outcroppings. Some of these species demonstrate a propensity to utilize a single communal winter refuge throughout their lives, having been born at or near the site and returning to it each winter.

C. s. scutulatus, however, is abundant in habitat where permanent refugia are generally not available, yet freezing winter temperatures are common. Communal winter denning is not documented for this species. The only apparent refugia accessible for thermal shelter are the relatively temporary burrows of rodents, primarily kangaroo rats (*Dipodomys* sp.) and antelope ground squirrels (*Ammospermophilus leucurus*) and, less abundantly, the larger burrows of kit foxes (*Vulpes macrotis*) and desert tortoises (*Xerobates agassizii*).

Before more definitive work can progress to identify factors influencing venom toxicity, distribution and population density, baseline data must be established for this species. These data include home range size, home range fidelity, refuge selection and other habitat preferences, foraging behavior and diet, thermal ecology, reproductive behavior, *et cetera*.

HYPOTHESES

1. *C. s. scutulatus* is dependent upon rodent (*Dipodomys* and *Ammospermophilus*) burrows for both daily and annual winter refugia.
2. *C. s. scutulatus* utilizes various refugia for winter dormancy during successive years without necessarily returning to the same site.
3. The home range utilized by *C. s. scutulatus* is more variable than those of other Nearctic crotaline species that are constrained by returning annually to the same winter refuge.

MATERIALS AND METHODS

A study site has been selected in the western Mohave Desert near Victorville, San Bernardino County, California, at a median elevation of about 975 m, in creosote bush scrub where *C. scutulatus* is known to be abundant.

The floral community has been surveyed and the substrate type assessed. Potential prey species and animals responsible for constructing burrows within the study area have been identified by personal observation and by trapping.

Noteworthy geographic locations are recorded with data obtained from a hand-held Global Positioning System receiver (GPS-12XL and GPS-72, both by Garmin International Inc., Olathe, KS, USA) and plotted with topographic mapping software (Terrain Navigator, version 5.01, by Maptech®, Andover, MA, USA).

Environmental temperatures are estimated from data recorded near the center of the study area at hourly intervals in well ventilated shade ~1 cm above the substrate and in an artificial rodent burrow ~1 m underground (HOBO® Water Temp Pro data loggers by Onset Computer Corp., Bourne, MA, USA). Temperatures at individual observations of rattlesnakes are determined with a quick-reading Hg thermometer placed ~1 cm above the substrate (cloacal thermometer by Miller & Weber, Inc., NY, USA) and wind speed is determined with a hand-held anemometer (Kestrel 1000 by Nielsen-Kellerman, Chester, PA, USA).

A series of baseline morphological data are recorded for each Mohave rattlesnake located at the study site. These data include mass, snout-vent length, tail length, sex (determined by probing), various scale counts and rattle dimensions. Samples of blood (from venipuncture of the caudal vein or cardiac puncture) and venom (from biting a membrane-covered beaker) are collected from selected specimens. To facilitate subsequent identification, study animals (except pregnant females) are injected with a 14 mm passive integrated transducer (PIT tag) programmed with a unique identification code (Avid Identification Systems, Norco, CA, USA) and have color-coded acrylic paint injected into the proximal hollow segments of the rattle. Each specimen is also photographed to document anomalies of the caudal rings, dorsal markings and crown squamation. Specimens are removed from the field for this processing and, except for venom collection, it is done under the same anesthesia protocol as used for transmitter implantation (see below).

VHF radio transmitters with thermal sensors (model SI-2T by Holohil Systems Ltd., Ontario, Canada) are implanted intraperitoneally in fourteen specimens utilizing the anesthesia and surgical techniques described by Reinert and Cundall (1982), Reinert (1992), and refined by Hardy and Greene (1999 & 2000). Both 9.0 g and 13.5 g transmitter configurations were used initially but the larger transmitters were found to be less reliable and were replaced with 9.0 g units. Transmitter mass does not exceed 5% of body mass (Reinert 1992; Hardy and Greene 1999). Specimens are maintained in containers and handled with equipment that has been disinfected with 10% hypochlorite bleach solution to guard against introduction of foreign pathogens into the wild rattlesnake population. A TR-4 receiver and RA-2AK hand-held direction-finding antenna (Telonics, Inc., Mesa, AZ) are used to find the radio-tagged animals.

Per Hardy and Greene (2000), specimens are released at their capture sites as soon as possible following complete recovery from anesthesia, ideally within twenty-four hours of capture.

Seven male and seven female *C. s. scutulatus* are telemetered, with the goal of collecting at least two years' data from a minimum of five snakes of each sex, allowing for natural mortality, transmitter failures, etc. A subsequent effort to differentiate between females of various reproductive states is anticipated.

Each time a Mohave rattlesnake is observed, a standardized data set is recorded to include behavior and habitat utilization, especially use of refugia and seasonal and environmental preferences for behaviors such as foraging, ecdysis, courtship, gestation and parturition. Body temperatures are calculated from transmitter pulse intervals. Home range is estimated utilizing fixed kernel analysis (Seaman and Powell 1996) with The Home Ranger software (Version 1.5; Ursus Software, Revelstoke, BC, Canada).

Statistical analyses and hypothesis testing is accomplished with SPSS software (Student Version 10.0; SPSS, Chicago, IL, USA)

Diet is determined by direct observation and study of feces and stomach/intestinal contents of road kills.

TIME-TABLE

2001	2002	2003	2004
collect all necessary supplies, equipment & permits by 1 Aug 01			
implant transmitters & track two specimens before the end of the 2001 season			
obtain 12 additional transmitters by 1 April 02			
	implant 12 additional specimens during 2002		
	track and record data from \geq five specimens of each sex \geq 24 months for each animal		
		replace transmitters as battery life requires	

LITERATURE CITED

- Baldwin, B. G., Boyd, S., Ertter, B. J., R. W. Patterson, T. J. Rosatti, D. H. Wilken (eds). 2002. *The Jepson Desert Manual*. Berkeley: Univ. Calif. Press.
- Brown, W. S. 1993. *Biology, Status, and Management of the Timber Rattlesnake (Crotalus horridus): A Guide for Conservation*. Lawrence (KS): Society for the Study of Amphibians and Reptiles.
- Duvall, D., M. J. Goode, W. K. Hayes, J. K. Leonhardt, D. G. Brown. 1990. Prairie rattlesnake vernal migration: Field experimental analysis and survival value. *National Geographic Research*. 6(4):457-469.
- Glenn, J. L., R. C. Straight. 1982. The rattlesnakes and their venom yield and lethal toxicity. In: Tu, A. T. (ed). *Rattlesnake Venoms, Their Actions and Treatment*. New York: Marcel Dekker.
- Greene, Harry W. 1997. *Snakes: The Evolution of Mystery in Nature*. Berkeley: Univ. Calif. Press.
- Hardy, D. L. Sr., H. W. Greene. 1999. Surgery on rattlesnakes in the field for implantation of transmitters. *Sonoran Herpetologist* 12(3):25-27.
- Hardy, D. L. Sr., H. W. Greene. 2000. Inhalation anesthesia of rattlesnakes in the field for processing and transmitter implantation. *Sonoran Herpetologist* 13(10):109-113.
- Klauber, L. M. 1956. *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind*. 2 vols. Berkeley: Univ. Calif. Press.
- Reinert, H. K. 1992. Radiotelemetric field studies of pit vipers: data acquisition and analysis. In: Campbell, J. A., E. D. Brodie Jr. (eds) *Biology of the Pit Vipers*. Tyler (TX):Selva Press.
- Reinert, H. K., D. Cundall. 1982. An improved surgical implantation method for radio-tracking snakes. *Copeia* 1983(3):702-705.
- Seaman, D. E., R. A. Powell. 1996. An evaluation of the accuracy of kernel density estimators for home range analysis. *Ecology* 77(7):2075-2085.
- Secor, S. M. 1992. A preliminary analysis of the movement and home range size of the sidewinder, *Crotalus cerastes*. In: J. A. Campbell and E. D. Brodie, Jr. (eds.) *Biology of the Pit vipers*. Selva, Tyler Texas.