

**EFFECTS OF RATTLESNAKE (*CROTALUS VIRIDIS OREGANUS*)
ENVENOMATION UPON THE MOBILITY AND DEATH RATE OF
LABORATORY MICE (*MUS MUSCULUS*) AND WILD MICE
(*PEROMYSCUS MANICULATUS*).**

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Abstract

Previous investigators have reported significant differences in distance traveled by wild mice compared to laboratory mice (*Mus musculus*) following envenomation by adult rattlesnakes. This study found significant difference in death rate between laboratory mice (*Mus musculus*) and wild mice (*Peromyscus maniculatus*) following envenomation but no poststrike differences in distance traveled. Further, no significant differences in strike performance were found between envenomated wild mice from two distinct habitats, one devoid of rattlesnakes and one approximately 30 km away, where rattlesnakes (*Crotalus viridis oreganus*) are common. We did find broad variations in distance traveled and latency to death. Such variation in envenomation performance suggests that there is great uncertainty about strike results. The prey may die quickly, close to the snake, or scamper off a considerable distance. The chemoreceptive abilities of adult rattlesnakes must be designed to accommodate these variations during prey capture.

The feeding behavior of rattlesnakes typically involves location, strike, release, and subsequent recovery of prey (Klauber, 1972; Chiszar and Radcliffe, 1976; Chiszar et al., 1981). Envenomation not only kills the prey, but it must also result in immobilization of the prey within the recovery range of the snake (Chiszar et al., 1977; Estep et al., 1981; Golan et al., 1982). Measurements of this envenomation effectiveness show that different species of mice have different susceptibilities to the same venom (Minton, 1969; Russell, 1980; Dewit, 1982). These differences seem especially evident between wild and laboratory mice (Hayes and Galusha, 1984). The first purpose of this study then was to determine if differences of death rate and immobilization distances occur in laboratory compared to wild mice struck by the rattlesnake, *Crotalus viridis oreganus*. Further, differences in natural predation pressure by rattlesnakes might result in different susceptibilities by prey to the bite. Thus the second purpose of this study was to see if differences within wild mice exist between those from mice populations *with* and those *without* rattlesnake predation pressure.

Materials and Methods

Subjects. Twelve rattlesnakes (*Crotalus viridis oreganus*) were used in the study. Subjects were both male and female adult snakes, ranging in size from 35 cm to 65 cm. All of the rattlesnakes had been held in captivity for a minimum of one year, and were fed laboratory-reared rodents (*Mus musculus*) on a bi-monthly schedule. Snakes were housed individually in glass terraria (50 x 27 x 30 cm) with newspaper floor coverings and glass water dishes. Daily photoperiods began at 0800 hrs. and ended at 2000 hrs. The temperature of the room was held relatively constant at all times (27.5° C ± 2).

Procedures. Each snake was run in three trials (treatments). During each trial the snake was placed into a circular arena (diameter 134 cm, depth 46.5 cm) and allowed to acclimate for five minutes. Overhead room lights were off and the test arena was illuminated by two lamps on opposing sides of the arena, each with a 75 watt bulb. Following acclimation, a pre-weighed mouse was introduced via forceps to an opposite side of the arena from the snake. Upon introduction of the mouse, an overhead VHS video system recorded ensuing events. Later review of the recordings was used to determine death rate time (from strike to last muscular twitch) and distance traveled by the mouse following envenomation. A 10 cm square grid system was drawn upon the butcher-paper floor covering of the arena. From review of the video, the path followed by the mouse was traced and the total distance (to nearest cm) scored.

Each snake was administered three treatments each separated by at least seven days. In one treatment, laboratory white mice (*Mus musculus*) were presented as prey; in the second and third treatments wild mice (*Peromyscus maniculatus*) were presented, one having been live-trapped in an area devoid of rattlesnakes and the other from an area 30 km away where this rattlesnake species is common. Ponderosa pine (*Pinus ponderosa*) and sagebrush (*Artemisia tridentata*) predominate in each habitat, respectively. All wild mice were live trapped no more that 10 days prior to use, and all mice were of mixed sex, ranging in size from 13–27.5 gm. Each snake was permitted as many strikes as necessary until successful envenomation. Thereafter, the snake was removed from the arena so as to prevent any further interaction between the predator and prey. Treatments were thus administered in a randomized block design and the results statistically examined via ANOVA (SAS statistical package, Proc GLM, Fisher's least significant difference).

Results

Wild mice from areas without rattlesnakes and wild mice from areas with rattlesnakes exhibited no differences in poststrike death rates ($P > .21$, 156.2 vs 79.3 s) or distances traveled ($P > 0.07$, 501.9 vs 229.0 cm) following envenomation. However, laboratory mice took longer to die than the lumped groups of wild mice but traveled statistically equivalent poststrike distances (Table 1, Prey 1 vs Prey 2 & 3). A somewhat surprising comparison emerged between the two types of wild mice compared individually to the laboratory mice. Wild mice from areas without rattlesnakes died as quickly and traveled equivalent distances to laboratory mice. But wild mice from areas with rattlesnakes died faster and traveled shorter poststrike distances (Table 1, Prey 1 vs Prey 3).

Table 1. Death rates and distances traveled by laboratory mice (Prey 1) and by wild mice from habitats without (Prey 2) and with (Prey 3) rattlesnakes.

	Death rate			Distance	
	N	mean(s)	range(s)	mean (cm)	range (cm)
Prey 1	12	297.4*	16-909	388.8	0.0-630.0
Prey 2	12	156.3*	30-486	501.9	74.0-1534.2
Prey 3	12	79.3	30-486	229.0	12.0-400.0
Prey 2	12	156.3	30-486	501.9	74.0-1534.2
Prey 3	12	79.3	7-371	229.0	12.0-400.0
Prey 1	12	297.4*	16-909	388.8	0.0-630.0
Prey 2 & 3	24	117.8*	7-486	364.4	12.0-1534.2
Prey 1	12	297.4*	16-909	388.8**	0.0-630.0
Prey 3	12	79.3*	7-371	229.0**	12.0-400.0

GLM: * $P < .05$ ** $P < .005$

Discussion/Conclusions

Our results differ from studies by others (Hayes and Galusha 1984), who did find that after envenomation by adult rattlesnakes (*Crotalus viridis oreganus*), wild mice (*Mus musculus*) traveled significantly farther than adult laboratory mice (*M. musculus*). We found no such significant poststrike difference in *distance* traveled. The significant difference we found was in *death rate* between laboratory and wild mice. Discrepancies between our results and others might be attributable to several differences in experimental design. Further, the site of envenomation was not controlled in our study or theirs, and represents but one factor producing differences in envenomation effectiveness (Kardong, 1986a).

Comparing wild mice types separately to laboratory mice, we discovered that wild mice from areas with rattlesnakes died faster and ran shorter poststrike distances than laboratory mice. Curiously, such significant differences did not emerge between wild mice from rattlesnake-free areas and laboratory mice. The two areas are about 1000 m different in elevation, one Ponderosa pine (rattlesnake-free) the other sagebrush (rattlesnakes). Perhaps different ecological settings for the two populations of wild mice produce mice with different susceptibilities to rattlesnake envenomations.

However, we feel that the differences between our results and other studies are not due substantially to differences in experimental design. Instead, the statistical differences are more likely the result of the substantial normal variation in envenomation effectiveness. Even within our own study where we used the same rattlesnake species and same prey species, and where testing procedures were standardized, we still discovered considerable variation in strike performance whether measured by either latency to death or by distance traveled after envenomation. Possible sources of such variation have received attention (Kardong, 1986b).

If we had run many more repetitions of our feeding trials, then additional statistical significance might have emerged in the larger data set. But, it is not the absence of significant differences we wish to emphasize. Rather we wish to draw attention to the great individual variation in strike performance. Apparently such variation is part of the normal uncertainty following the predatory strike. Sometimes the prey dies quickly close to the snake; other times it scampers a great distance (up to 1534 cm). This variation in envenomation effectiveness seems to characterize rattlesnake predatory behavior (our study and others). Consequently, the predatory behavior and hunting strategy of the rattlesnake might be expected to be designed to address this variation or uncertainty in envenomation success.

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