# **Rattlesnake**
## **Viperidae Family**
## ***Crotalus and Sistrulus***

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**Introduction**

When most humans hear any rattling sound in nature, one thing comes to mind: there is a rattlesnake nearby. Flee for safety! Rattlesnakes, *Crotalus* and *Sistrulus*, are infamously perceived as evil predators that crave a bite of human flesh. Interestingly enough, human nature and societal influence have given all snakes the reputation of being dangerous, harmful, and poisonous predators.

In 1998, Rubio brings about evidence of human fear and common misperceptions resulting in the persecution and even death of more snakes than any other living creature. While some religious cultures regard some members of Serpentes as figures of worship, most cultures treat them as enemies or weapons. For instance, during the late 1980's crack cocaine epidemic, a suspected house in Colorado was raided. As a result, a stash was discovered being guarded vigilantly by nothing other than the large Western Diamondback Rattlesnake.

Congruent with the belief that rattlesnakes are harmful predators, *Crotalus* and *Sistrulus* have developed specific adaptations contributing to their overall success of prey capturing and survival. Nevertheless, some prey counteract with defense mechanisms, which then cause rattlesnakes to retreat.

Their unique characteristics, sensory adaptations and abilities to tackle environmental pressures have made rattlesnakes interesting creatures for herpetologists to study.

**History**

Rattlesnakes are known as members of the Viperidae family and Crotalinae subfamily, also commonly known as pit-vipers. The Crotalinae subfamily accounts for the rattlesnake and approximately fifteen other genra distributed widely in America and southern Asia (Stafford, 2000). In fact, herpetologists hypothesized Viperidae snakes to have originated in Africa and later migrating to Asia, specifically parts of India (Douglas et.al, 2006). In 1997, Rubio states that there have been debates upon discovering the true taxonomy for rattlesnakes because the pit-viper subfamily is not exclusive only to rattlesnakes. Some herpetologists hypothesize that pit-vipers have evolved from Colubridae, which is the largest and most diverse snake family.

These taxonomy debates become even more ambiguous, as herpetologists hypothesize that Viperinae are paraphyletic. If this is true, Viperinae did not arise from a single common ancestor and thus adding additional complications to the research on the true relationship. There is no fossil evidence demonstrating the relationship between pit-vipers and other vipers, but there is currently agreement among most zoographers that they indeed correlate (Rubio, 1998).

Klauber, a research associate for the Museum of Natural History, discovered in 1956 that more primitive rattlesnakes were larger in size- but their rattles were less defined, smaller, and nearly silent (Rubio, 1998). For example, the bushmaster or *Lachesis muta,* a pit-viper found in tropical America has a common origin with other crotalines but is more primitive. Bushmasters are unique in that they are oviparous, rather than viviparous, thus also providing evidence to its less derived phylogeny. *L. muta* is the longest snake of any living viper, growing up to twelve feet in adulthood. Physically, they are related to rattlesnakes by possessing similarly blunted tails, but no rattle (Rubio, 1998). Although this provides some clues to the taxonomy of Viparidae, much more research is needed to overcome the challenges of discovering the true relationship among pit-vipers.

**Identification**

Rattlesnakes are highly variable in their size and weight. While the pygmy rattlesnake reaches no longer than two feet in length and no more than four ounces, the eastern diamondback can grow to eight feet and weigh around twenty pounds (Behler, 2007). Similar to nearly all other snakes, the Viperidae have an outermost layer of skin consisting of a continuous sheet of keratin; this outer layer sheds from time to time, allowing for growth (Stafford, 2000). In terms of coloration, most rattlesnakes are typically brown or grey, though some may have bright yellow or burnt orange marks. Patterns can be identified as blotched, usually with hexagons along the dorsal center and a dark streak shown from each eye to the angle of the jaw (Behler, 2007) However, while rattlesnakes can be recognized with their stout bodies and flattened, triangular, lance-shaped heads, the most defining external feature by far is not one that needs to be seen. From birth, rattlesnakes possess a small rattle called a prebutton, which is shed a few days after and replaced with their first rattle segment called the “button” (Behler, 2007). Should further evidence be needed in identification, yet another defining feature of rattlesnakes is the facial pits at the side of the head, lined with heat-detecting receptors (Behler, 2007).

**Thermoregulation**

Almost all reptiles and amphibians are ectothermic, meaning their body temperature is controlled by adjusting their activity patterns throughout the day. Thermoregulation is critical to the life of a rattlesnake, as their ability to be active during crucial parts in the day influences their success in maintaining heat balance (Stafford, 2000). This also allows rattlesnakes to utilize the heterogeneity within their niche, regulating body temperatures by moving around various microhabitats in their environment (Krochman and Bakken, 2003).

The thermoregulation adaptation is critical to the Viparidae's interaction with predators and their behavioral reaction to extreme climates. Pit-vipers use this behavior to their advantage as their hearing and vision abilities are not very defined. With respect to hearing, they have no external ear or eardrum, but are able to detect vibrations through their stapes, a bone of the inner ear (Stafford, 2000). Since their sensitivity to thermal radiation is so strong, it also compensates for a lack in true vision: their eyes, no longer a required adaptation, can only detect movement (Stafford, 2000). One advantage to thermoregulation behavior is an ability to locate thermally favorable microhabitats by temperature gradients. For instance, the Western Diamondback Rattlesnake is a pit-viper that lives in both desert and grassland areas. With the climate having the potential to become so extreme, they can escape excessive heat. This is done by moving towards shaded areas, commonly found within burrows or in the crevices between rocks (Krochmal and Bakken, 2003). However, in 2001, Navas and Bevier state that this can consequently limit both the time and place of all activities, inevitably impacting even essential behaviors like courtship (Krochman and Bakken).

**Sensory Adaptations**

Pit-vipers are primarily characterized by possessing sensory organs located in their facial region between the nostril and eye (Rubio, 1998). These facial pits help detect favorable site selection through the changes in heat and temperature of the external environment (Krochmal and Bakken, 2003; Elbert and Westoff, 2006). In addition, facial pits enable rattlesnakes to locate and capture prey when foraging. These pit organs possess highly adapted infrared receptors, responsive to even the slightest thermal fluctuations (Elbert and Westhoff). Clearly, this sensory adaptation is more beneficial than perfect eye sight and hearing.

The facial pit sensory adaptation not only enables rattlesnakes to escape predators, but also gives them unparalleled skill to target and capture prey, even in absence of any visual cues (Elbert and Westhoff, 2006). To locate wounded prey, snakes use the chemical trail left by the struck animal, a process known as strike-induced chemosensory searching (SICS) (Clark, 2006). Kalbur et al. reported in 1990 that snakes in natural conditions, rather than in laboratory conditions, yielded limited sample sizes and rendered their behavior unobservable, as environmental pressures overly influence their behavior in the wild (Clark, 2006).

In 2007, Rundus found, through observing California ground squirrels, that they display a tail flagging defense along with an infrared component, exploiting the extremely sensitive infrared sensory system of rattlesnakes. This allows the squirrels to dodge pit-vipers, as the snakes are placed on the defensive and tend to retreat from being in the vicinity of the burrows with the squirrel pups. Squirrels have also developed a number of behavioral and physiological defenses against snakes, including the ability to neutralize rattlesnake venom, proficiency in confronting snakes, and of course the tail flagging technique.

This tail flagging technique was also tested with the gopher snakes, which have diets identical to rattlesnakes, but lack pit-glands. It was then discovered that chipmunks and ground squirrels are able to differentiate between both snake predators, producing an infrared signal only to rattlesnakes, since they are the only snakes capable of detecting it (Rundus, 2007). Therefore this behavior, exhibited by squirrels and chipmunks, has no affect on gopher snakes; however, this squirrel technique has proven harmful only to pit-viper foraging snakes and has no effect on pit-viper basking snakes (Clark 2006).

**Prey Selection**

In relation to crocodiles, most rattlesnakes are "sit and wait predators," meaning a majority of their time and energy is spent in capturing their prey. However, rattlesnakes are rather selective in the site chosen to catch prey (Clark, 2004). For instance, Timber rattlesnakes are more likely to select sites that are located near areas in which they have had previous feeding experiences. Evidence has shown that rattlesnakes with more feeding experience have more modified prey preferences (Clark, 2004). In addition, rattlesnakes are less likely to pursue fast, active mammals, as animals such as squirrels are more capable of releasing defense signals (Clark, 2005). In order to obtain prey, venomous snakes usually feed by striking and injecting venom: moments after the venom has been injected, the prey is released and able to flee until immobilized by the venom (Clark, 2006). After the prey is released by the rattlesnake, it is then detected through the chemical trail the prey leaves, with a sensory adaptation that has been noted above (Clark, 2006).

Primarily, snakes feed on lizards, but can also feed on birds and small mammals (Parker and Anderson, 2007). However, the diet of pit-vipers also depends on their size. While most rattlesnakes feed on rodents, such as mice, rats, and chipmunks, larger rattlesnakes can prey on bigger rodents, including squirrels, prairie dogs, rabbits, and juvenile groundhogs (Behler, 2007). When capturing mammals such as mice, rattlesnakes exhibit tongue-flicking techniques, as the snake may need to reposition the mouse because the head must be primarily ingested. In swallowing prey like mice, it has been observed that the rattlesnake moves its mouth towards the head of the prey (Ashton, 2001). It is easier to ingest the prey headfirst and avoids any potential harm prey can exhibit onto the snake should the head not be swallowed first. Again, the tongue flicking technique may be used as both a way to locate the head and selection of prey through chemical cues (Ashton, 2001).

**Reproduction**

Chemical cues are not only essential when rattlesnakes are capturing prey, but during reproduction. During mating, females release a chemical scent called a pheromone, indicating that she is ready to mate. After receiving that signal, the male rattlesnake follows the scent trail and then begins courtship. Males exhibit tactile techniques, such as crawling alongside the female and nudging her body with his head before copulation (Beher, 2007).

Rattlesnake females usually have about four to twelve young, but large species can give birth to more than twenty at a time. The young are born during August and October, depending on habitat conditions (Beher, 2007). Parker and Anderson reported that most rattlesnakes do not live in extreme habitats, as they retreat to their dens and hibernate if the conditions are intolerable. In the Temperate Zone, most rattlesnakes are characterized by having frequent, smaller clutches that reproduce slower than snakes living in severe climate conditions. Late reproductive maturity, multi-year reproductive cycles, and reduced clutch sizes are responsible for the relatively low population densities since there is ample prey and favorable microhabitats. This contributes to the reproductive success and steady growth of many juvenile rattlesnakes.

However, the reproductive success within a species cannot remain constant from year to year without available resources and stable microhabitats. Estimating reproductive cycles based on simple algorithms is therefore unreliable because reproductive frequency is largely determined by foraging success and the ability to replenish necessary fat reserves. Just as individuals within a population compete for available resources, there is more competition for mating among males in a restricted population. They speculate that, in these small, isolated populations, brothers compete, whereas sisters do not. Therefore, these adaptation adjustments have resulted in these skewed sex ratios to prevent sibling competition for mates (Parker and Anderson, 2007).

Nevertheless, these skewed sex ratios are more so the result of reproduction among female rattlesnakes. Interestingly enough, the cost of caring for their young is expensive for mothers undergoing reproduction. Gravid females or mothers exhibiting parental care have the tendency to be less active than non-gravid females and males. The reproduction of gravid females varies from year to year based on resource availability.

Contrary to gravid females, males have significantly larger activity ranges and move farther. Nongravid females moved significantly father than gravid females throughout the season (Parker and Anderson, 2007). Klauber et al. reported in 1972 that for *C. o. concolor* the sex ratio of females to males at birth is 2:1. Klauber then recognized in 1972 that sex ratios become skewed as a result of higher adult female mortality (Parker and Anderson, 2007), thus implying that *Crotalus* follows the hypothetical type I survivorship curve. Because of the large amount of gravid females treated as opportunistic prey for certain carnivores, snakes can also contribute to the overall stabilization of the ecosystem by providing food for their predators.

**Habitat**

With all of these factors and adaptations in mind, the type of environment mainly influences the type of behaviors rattlesnakes exhibit. For instance, if environmental conditions are too stressful, many snakes resort to dormancy. Hibernation is essential to surviving overwinter, as it prevents susceptibility to low temperatures inherit without the ability to generate metabolic heat (Harvey and Weatherhead, 2006). Rattlesnakes tend to hibernate in old root systems, rock crevices in forested areas, and rodent burrows (Harvey and Weatherhead, 2006). However, snakes such as the Eastern Massasauga Rattlesnakes have been threatened due to their habitat loss throughout most of their range. These rattlesnakes are experiencing limited hibernation site availability in the Bruce Peninsula, which calls for attention regarding conservation and protection of this area (Harvey and Weatherhead, 2006).

Nevertheless, though hibernation somewhat prevents death from overwintering, emerging out of hibernation does pose a threat for some rattlesnakes. Snakes still have lower body temperatures upon releasing themselves from hibernation, which lowers the rate of their activity. This increases their susceptibility to predation because their ability to fight or flee from predators is reduced (Harvey and Weatherhead, 2006).

More importantly, the number one threat to rattlesnakes is not their susceptibility to predation after hibernation, but the destruction of their habitats. Because of roads, farms, housing developments, and shopping malls, rattlesnakes find it more difficult to mate, obtain food, and discover breeding sites (Behler, 2007). Ultimately, conversationalists and public officials must work together to reduce the negative impacts human development and invariable habitat fragmentation has on rattlesnake species.

**Conclusion**

Taking into account the phenomenal adaptations and characteristics Viperidae exhibit, it is evident that they are unmatched creatures. Rattlesnakes draw meaningful connections in the food chains and are able to aid in maintaining control and balance of all living things. Since they primarily eat small mammals, they are able to keep a number of destructive rodents in check (Rubio, 1998). Their ability to dominate among other predators within an environment contributes to species diversity in a population.

While most humans fear the presence of a rattlesnake and are manipulated to believe that they are exploitable creatures with their use amounting to nothing but a fashion statement, their actual economic significance lies in their continued existence (Rubio, 1998). Hunters, who sell the snake skins for the production of boots and belts, and the consumers who buy these products, are not recognizing rattlesnakes' overall importance and impact on the ecosystem (Behler, 2007). Herpetologists, on the other hand, are aware of their influence on other organisms and continue to research the background of their overwhelming diversity. Although the actual Viperidae taxonomy is not quite clear, the study of their molecular, behavioral, and physiological characteristics can provide clues to fill in the gaps among hypothesized relationships. Nevertheless, insight must be gained in order to understand the evolutionary significance of these rattlesnakes and their overall progression and influence on biodiversity.

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