

THE scorpion, *Mesobuthus caucasicus*, is a venomous species of the family Buthidae, the largest, most widely distributed scorpion family. This species inhabits the deserts of Asia from the Caucasus (Armenia, Azerbaijan and Georgia) to Iran and Central Asia (Uzbekistan and Kazakhstan). A close relative, *Mesobuthus eupeus*, has been found at 50°N in Kazakhstan.

Mesobuthus scorpions experience temperature fluctuations from -31°C to 50°C, periods of extreme drought and food scarcity in deserts like the Kyzylkum and Betpak-Dala. They survive these harsh conditions by means of physiological, morphological and behavioural adaptations.

Desert scorpions like *M. caucasicus* can withstand high diurnal temperatures (up to 50°C) and low nocturnal temperatures (well below 0°C). They are able to “supercool”: the water in their bodies remains liquid below its normal freezing point of 0°C. The hard, impermeable exoskeleton (outer shell) allows scorpions to withstand low relative humidity by preventing dehydration, and confers their unique ability to fluoresce under long-wave ultraviolet light, due to the presence of two compounds (beta-carboline and 7-hydroxy-4-methylcoumarin) in the cuticle. Desert scorpions can endure up to 18 months without food or water and remain underground for up to nine months in a state of diapause (suspended animation). Some fossorial (burrowing) species can withstand up to 48 hours submerged underwater during times of flooding.

Mesobuthus caucasicus is nocturnal, sheltering by day in the relative cool of underground burrows that it constructs before dawn in the sandy ground. It will also shelter under stones or bushes, or use the burrows of other animals. Commonly found on sand dunes, *M. caucasicus* is morphologically adapted for walking on and burrowing in loose sand. Modified “combs” of hairs on the legs assist in the excavation of burrows.

Under suitable conditions, *M. caucasicus* emerges from below ground to hunt, feed and find mates. It is active on warm, moonless nights when there is a higher abundance of insect prey and a lower risk of predation by vertebrate predators. Its simple eyes detect luminosity, but little else. It relies on ultra-sensitive slit organs in the legs, on fine hairs called trichobothria on the pedipalps (claws), and on the pectines, comb-like organs on the undersurface of its body – found only in scorpions – to detect vibrations and air currents caused by approaching prey, predators and mates.

M. caucasicus makes the most of every opportunity to feed. It is a generalist, opportunistic predator, eating anything it can overpower. Typical prey includes other terrestrial arthropods, especially insects and arachnids, as well as scorpions of the same or different species. Prey is attacked and killed using the chelate pedipalps (claws) and venomous sting at the end of the post-abdomen (“tail”). As in other scorpions, the venom is used to kill or paralyse

prey and as a defence against predators. It is a mixture of compounds (neurotoxins, enzyme inhibitors, and so on) each causing a different effect and possibly targeting a specific animal. Each compound is made and stored in a pair of venom glands and released through a pair of pores on the sting. Venom is conserved by reserving the sting for large and/or struggling prey and by regulating the amount and content of venom injected.

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text LORENZO PRENDINI, PHD

THE SCORPION KING

Among the most long-lived terrestrial arthropods



The Asian forest scorpion (*Heterometrus longimanus*) are large black scorpions native to Southern Asia. It is often confused with a closely related species known as the Malaysian Forest Scorpion (*Heterometrus spinifer*). As well, both physically reflect the Emperor Scorpion (*Pandinus imperator*), a very large, impressive and hardy scorpion from tropical Africa.

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Photo: Ines/James Garbutt



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1 | An Asian Forest Scorpion, *Heterometrus* sp., found in Southeast Asia

2 | A whip scorpion found in the Shenhua Mountain, Miaoli County, Taiwan

3 | Large tropical black Asian forest scorpion (*Heterometrus spinifer*) sp. Kumai, Kalimantan, Indonesia, Borneo. The exoskeletal skin of many scorpions takes on an unusual property as it hardens; it fluoresces brightly under ultraviolet light

4 | A venomous scorpion hunting for prey in Bingin, Bukit Peninsula, Bali

5 | A scorpion on a rock in a Borneo cave

The pedipalps are used to manipulate prey, the chelicerae (jaws) to tear pieces off for digestion. Digestion is external: digestive juices from the gut are egested onto food, digested liquid sucked into the gut, and indigestible solid matter discarded. *M. caucasicus* may consume large quantities of food at a sitting. It has an efficient food storage organ, a low metabolic rate and a relatively sedentary lifestyle. Little waste – mostly insoluble nitrogenous compounds such as xanthine, guanine and uric acid – is excreted. These factors allow *M. caucasicus* to survive long periods without food or water, up to three years in some of its relatives.

M. caucasicus may be abundant in suitable habitat. Densities of one per square metre have been reported for the deathstalker (*Leiurus quinquestriatus*), a related species from the deserts of North Africa and the Middle East. These scorpions are dominant predators in arid ecosystems, controlling invertebrate populations and providing important prey for other organisms. Cannibalism and predation by other scorpion species may be their most important sources of mortality, but other invertebrates (e.g., centipedes) and vertebrates (e.g., owls, mongooses, possums, rodents and lizards) are also important predators. Mortality is particularly high among males due to increased mobility during the breeding season and cannibalism by females.

As with most scorpions, *M. caucasicus* is solitary, aggressive and cannibalistic, even towards its own kin. Courtship and mating is a complex affair. The male must convince the female that he is a potential mate, not potential prey. He locates and identifies females of the same species using pheromones, vibrations and physical contact. Reproduction is indirect; intromission occurs via a spermatophore. Courtship begins with a “dance” known as the promenade-à-deux, where the male grasps the female’s pedipalps with his own and leads her around while searching for a suitable substrate to deposit his spermatophore.

Once identified, he deposits the spermatophore, which attaches to the substrate with an adhesive “foot”, and guides the female over until it enters her genital aperture, catapulting the sperm mass into her gonopore when a lever or trigger is touched (a species-specific lock-and-key mechanism). Fertilisation is internal. Male and female separate after mating and the male retreats to avoid sexual cannibalism.

Like other scorpions, *M. caucasicus* is viviparous. Embryos develop in the female reproductive tract and receive nourishment from yolk. Reproductive rates are low in scorpions, litter size depending on the species and on environmental factors, with an average of eight offspring. The young, born singly, are large at birth, resemble their parents and cling to their mother until they have moulted at least once, before dispersing. They cannot survive without her before the first moult, as they depend on her for protection and to regulate their moisture levels. Growth is accomplished by periodic moulting of the exoskeleton (ecdysis). Time to sexual maturity, which varies from two to eight years depending on the species, requires between five and seven moults. Average longevity in scorpions is four to five years, but larger species live 25–30 years, making them among the most long-lived terrestrial arthropods. **AG**

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