Diel activity patterns and diet of the giant whipscorpion *Mastigoproctus giganteus* (Lucas) (Arachnida, Uropygi) in Big Bend National Park (Chihuahuan Desert)

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Summary

Studies were conducted on the diel periodicity and diet of adults of the giant whipscorpion *Mastigoproctus giganteus* (Lucas) in Big Bend National Park (Chihuahuan Desert). Males and females were strongly nocturnal with peak periods of activity occurring between 1900 to 0400 h Central Standard Time. Adults captured a wide variety of arthropod prey. The most common arthropod prey included insects such as orthopterans (22.9%), hemipterans (14.3%) and beetles (14.3%), and spiders (17.1%). No vertebrate prey were captured by whipscorpions at this study site.

Introduction

Although the giant whipscorpion *Mastigoproctus giganteus* (Lucas) represents a conspicuous component of the arachnid fauna of the Sonoran and Chihuahuan Deserts of the southwestern United States and Mexico, and can be locally abundant, there have been surprisingly few studies conducted on the natural history, ecology, and behaviour of this large and formidable arachnid. What information that is available has focused on its anatomy (Marx, 1886; Shultz, 1993), taxonomic status (Rowland & Cooke, 1973), water relations (Ahearn, 1970; Crawford & Cloudsley-Thompson, 1971), chemical defence (Eisner *et al*., 1961; Schmidt *et al*., 2000), reactions to light (Patten, 1917), and locomotor behaviour (Schultz, 1991, 1992). On the other hand, there is a paucity of data concerning its life history, longevity, dispersion patterns, diet, mating activities, and seasonal and diel periodicities. Marx (1891, 1893) provided a few general statements on the construction of a burrow, moulting, and the capture and ingestion of young cockroaches by a captive specimen.

In this paper, I report on the diel periodicity and diet of *M. giganteus* from Big Bend National Park. No previous data are available on populations from this location.

Description of study site

Studies were conducted on whipscorpions located within a 7 km radius of Burro Mesa (31°47′N, 103°18′W; elevation 870–917 m) in Big Bend National Park (BBNP), Brewster County, Texas. BBNP lies within the northern region of the Chihuahuan Desert in Trans Pecos Texas. For detailed discussions of the geology, topography, and vegetational zones of this area the reader is referred to Tinkam (1948), Medellin-Leal (1982), and Henrickson & Johnston (1983). The soils of this region are a mixture of sand, adobe and gravel and they support a predominantly sotol-lechuguilla shrub-desert community. The dominant vegetation includes lechuguilla (*Agave lechuguilla*), sotol (*Dasylirion leiophyllum*), creosote (*Larrea divaricata*), mesquite (*Prosopis glandulosa*), ocotillo (*Fourquieria splendens*), and scattered clumps of chino grass (*Bouteloua breviseta*). There are numerous rock-strewn hills, washes, arroyos and canyons throughout the area.

The adults of the giant whipscorpion (vinegaroon) *M. giganteus* occur throughout this area, where they are frequently found under rocks and surface vegetation, within rock crevices, and in abandoned rodent burrows.

Methods

Field studies were conducted from early May through August over a two-year period (1997, 1998). I used wooden stakes to mark fifteen square 0.25 ha plots chosen at random from a topographical grid map of the area (U.S. Geological Survey). I collected whipscorpions within each plot using pitfall traps (1.0 litre plastic cups) over a 24 h period on 20 days per month, at 3 h intervals beginning at 0400 Central Standard Time (CST). I used a cross-shaped grid as described by Bradley (1989) which consisted of 19 traps with the centre trap shared between the lines. Individual traps within the grid were separated by a distance of 0.5 m. Since over 90% of all animals collected were adults, only data on this developmental stage were used in this study.

Immediately after collection I recorded the following data for each adult whipscorpion: sex (based on the morphology of the genital sternite); time, date and location of capture; and ambient air temperature. Data on time of capture were used to determine diel patterns of locomotor activity for males ($n=135$) and females ($n=152$) over a 24 h period. Since no significant differences between the sexes were observed, the data were pooled and the results expressed as the percentage of animals active at the surface at various times of the day (3 h intervals; i.e. 0400–0659, etc.). Data were tested for significance using log frequency analysis as described by Sibley *et al*. (1990).

A total of 35 animals (12.2%) were observed carrying arthropod prey when they were collected. For dietary analysis each prey item was removed from the pedipalps and placed in alcohol for subsequent identification. Prey items in an advanced stage of digestion were listed as undetermined, since a more accurate identification was not possible.

Results

The giant whipscorpion was clearly nocturnal at this study site, and peak periods of surface activity occurred between 1900 and 0400 h (Table 1). Log frequency analysis (Sibley *et al*., 1990) showed that locomotor activity increased significantly during this time period ($F=13.7$, $p<0.01$). Most individuals walked over the surface at a steady rate, tapping the ground frequently with the first pair of legs which are modified as sensory structures. If the first pair of legs made contact with a

rock or other type of surface debris the animals would often stop abruptly, explore the surface of the object for several seconds, and then continue walking movements. If contact was made with a suitable type of prey, it was grasped immediately with the pedipalps.

Mastigoproctus giganteus captures a wide variety of arthropod prey (Table 2) and thus can be considered a generalist predator (Curio, 1976). No significant difference was found between the types of prey captured by adult males and females ($p>0.5$). Prey species consisted of insects and arachnids. The most common insects represented in the diet were orthopterans (grasshoppers and crickets), hemipterans and beetles (scarabaeids, carabids and tenebrionids). The most common spiders captured by *M. giganteus* consisted of lycosids and gnaphosids, spiders that hunt on the ground, are strongly nocturnal, and are therefore more likely to be encountered during foraging activity. None of the diurnal ground-hunting spiders such as lynx spiders (Oxyopidae) and wandering spiders (Ctenidae), which are common in this area, were captured by *M. giganteus* at Burro Mesa. Scorpions represented only 5.7% of the total arthropod prey, and no solifugids or small vertebrates were captured. Cannibalism was not observed at this site.

Prey taxon	Number of prey items	Percentage of total prey
Insecta		
Orthoptera	8	22.9
Coleoptera	5	14.3
Hemiptera	5	14.3
Dictyoptera	3	8.6
Arachnida		
Araneae	6	17.1
Scorpiones	2	5.7
Undetermined	6	17.1

Table 2: Arthropod prey items found in the pedipalps of 35 adults of the giant whipscorpion *Mastigoproctus giganteus* during field observations. The number of prey items ($n=35$) representing each prey taxon is listed as well as the percentage of total prey items.

Discussion

At Burro Mesa, *M. giganteus* was strongly nocturnal in its wandering and foraging activities. This is in general agreement with the nocturnal preferences exhibited by this species at other locations (Marx, 1893; Cloudsley-Thompson, 1958) as well as for other species of whipscorpions in general (Kraepelin, 1899; Roewer, 1934; Lawrence, 1949). This is not surprising, since nocturnal behaviour is common in desert arthropods and represents an adaptation to the harsh environmental conditions characteristic of deserts (Cloudsley-Thompson, 1975; Crawford, 1981; Main, 1982; Polis, 1990; Punzo, 1998a,b, 2000).

Mastigoproctus giganteus is a generalist predator that feeds on a wide variety of arthropods. Although this species has also been reported to feed on small vertebrates such as frogs and toads (Cloudsley-Thompson, 1958), no vertebrate prey were found in the pedipalps of whipscorpions captured in this study. In addition to arthropods, some tropical whipscorpions also feed on worms and slugs (Gravely, 1915). Flower (1901) reported that the whipscorpion *Thelyphonus schimkewitschi* readily consumed dead insects and pieces of over-ripe banana in captivity, as well as live caterpillars, moths, and dragonflies. In contrast, I have never seen *M. giganteus* accept dead prey, nor am I aware of any reports in the literature that this species is capable of scavenging. The evidence strongly suggests that the adults of *M. giganteus* are opportunistic predators that will consume any type of prey that they can subdue.

In captivity, the young of *M. giganteus* will feed on small crickets and katydid nymphs, as well as collembolans, apterous fruit flies, termites and small spiders (pers. obs.). However, small insects with harder cuticles such as early-instar mealworms and some adult beetles, are not attacked. Future studies should investigate what role (if any) cuticular hardness plays in the choice of prey by immature *M. giganteus*.

Finally, I should mention that at this study site I captured only three immature whipscorpions during the entire sampling period. Perhaps the preferred habitats and behaviour of younger instars preclude them from being collected in pitfall traps. It is important that we identify sampling techniques that will allow us to collect the immatures of this species so that we can begin to shed light on their preferred habitats, dispersion patterns and behaviour.

Time of day	Percent activity
0400–0659	2.7
0700–0959	0
1000–1259	0
1300–1559	0
1600–1859	1.1
1900–2159	14.3
2200–0059	57.2
0100–0359	24.7

Table 1: Diel pattern of locomotor activity for *Mastigoproctus giganteus*. Data pooled for adult males ($n=135$) and females ($n=152$). Activity expressed as the percentage of all adults ($n=287$) active on the surface of the ground at 3 h intervals (Central Standard Time).

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