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SHORT COMMUNICATION

Distribution of *Brachypelma vagans* (Theraphosidae) burrows and their characteristics in Belize over two years

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Abstract. To help to address the paucity of ecological knowledge available for *Brachypelma vagans* Ausserer 1875, a CITES protected species, we monitored a population in Western Belize for two years to provide data for distribution and dispersal. Despite previous over-collection for the pet trade, the species is locally highly abundant in some areas of Belize. We recorded the distribution, burrow and spider characteristics of *B. vagans* in 2007 and 2008 at Las Cuevas Research Station, Belize. Population dynamics were compared between years, as was individual location. Over 100 burrows were located in both years; however, previous assumptions that individuals do not move burrows regularly appear negated, since only 12 burrow locations matched between years, suggesting high intra-habitat dispersal. Despite this apparent high level of movement burrows were significantly clumped, to a similar degree, in both years. This movement could be due to disturbances throughout the year, including flooding during the rainy season. Burrow size correlated with individual body size, except in a few juveniles that appear to have opportunistically claimed an empty burrow, accounting for some small animals found in large burrows.

Keywords: Burrow, Belize, ecology, red-rump tarantula, population structure

Brachypelma vagans Ausserer 1875 is one of the most ubiquitous *Brachypelma* species of Neotropical lowland forest habitats. As these tarantulas are long lived, brightly coloured, and usually docile, they are popular pets and suffer from over-harvesting, now being listed as threatened CITIES Appendix II species (Peterson et al. 2006). Despite *B. vagans* having the widest distribution of *Brachypelma* species (being recorded from Mexico, Belize and other parts of Central America: Reichling 1999), there is limited information on its ecology and habitat preferences (e.g., Yañez & Floater 2000; Hénaut & Machkour-M'Rabet 2005; Machkour-M'Rabet et al. 2007; Dor et al. 2008), with most studies on *Brachypelma* tarantulas concerning their geographic distributions (Valerio 1980; Smith 1986; Edwards & Hibbard 1999; Locht et al. 1999), systematics (Coddington & Levi 1991; Perez-Miles et al. 1996) and genetics (Longhorn 2002; Longhorn et al. 2007; Machkour-M'Rabet et al. 2009). The rarity of some *Brachypelma* species (e.g., Yañez & Floater 2000), combined with habitat degradation and illegal capture and trade, suggests the need for captive breeding prior to reintroduction (Yañez et al. 1999). It is essential therefore, to obtain detailed knowledge of their habitat requirements and changes within populations to provide a greater understanding of the factors influencing their spatial distribution and population dynamics.

Brachypelma vagans construct burrows with single entrances where they spend the day, spinning silk around the entrance to transmit vibrations from prey movements (Yañez & Floater 2000). They are nocturnal predators feeding mainly on ground-dwelling arthropods and possibly small vertebrates (Marshall 1996). Machkour-M'Rabet et al. (2007) found densities of *B. vagans* to be higher in open rather than forest sites and with high densities of burrows characterised by deep clayish soils, which is unsurprising given that individuals, on the whole, dig their own burrows. Little is known about burrow fidelity and which factors cause burrow relocation, although some field observations suggest that females locate occupied burrows of conspecifics and attack and consume the residents (Hénaut & Machkour-M'Rabet, 2005). Lack of long-term distributional data for any *B. vagans* population poses difficulties in determining the level of intra-population movement, whether burrow swapping occurs, or the distances that individuals move to find, or dig, a new burrow. The current study examines the population dynamics and distribution of one *B. vagans* population for two consecutive years to elucidate patterns of movement and activity and provide an understanding of the habitat requirements and population pressures on the species.

The techniques used over the two years were identical. The study site at Las Cuevas Research Station, Chiquibul rain forest area, Cayo district, Belize (GPS location 88°59.188′W, 16°43.990′N, elev. 583 m) is classified as lowland tropical broad-leafed rain forest, which stretches from the Caribbean coast of Mexico, through Belize and into Honduras and the Peten region of Guatemala. The study population of *B. vagans* is in the clearing (150 × 121 m) surrounding research station buildings, which are mainly to the south side (the current research concentrated on the north side of the clearing: 98 × 121 m). Belt transects (1 m wide) were laid perpendicular to the back of the clearing (where it met forest undergrowth) and systematically searched for signs of burrows, which were labelled using a numbered flag to enable easy relocation at night, when individuals were extracted for measurement. The location of each burrow and its opening dimensions (using the widest width and longest length of the mouth) were recorded. The surveys took place in June and July in both 2007 and 2008.

Visiting burrows at night when individuals sat at the burrow mouth gave a clear indication of occupancy and helped to minimize stress when removing animals using a fishing technique (Reichling 2003) involving a blade of grass waved to mimic prey movements. Once the individual was removed, the entrance was blocked and the individual placed in a clear plastic bag to allow manipulation and measurement. When individuals were not seen, the burrow was monitored for signs of occupancy (e.g., silk and soil extracted from the burrow).

The minimum distance between burrows was calculated using trigonometry, and aggregation between burrows was assessed using nearest neighbour analysis (e.g., Wheater et al. 2011). The index of aggregation was calculated as the ratio between the mean and the expected distances between burrows (where the expected distance was estimated as: $1/[2\sqrt{\text{density}}]$). Independent samples *t*-tests were used to examine differences in nearest neighbor distances between years to determine whether clustering differs between years (see Krebs 1999 for a fuller explanation of nearest neighbor analysis). A Pearson's

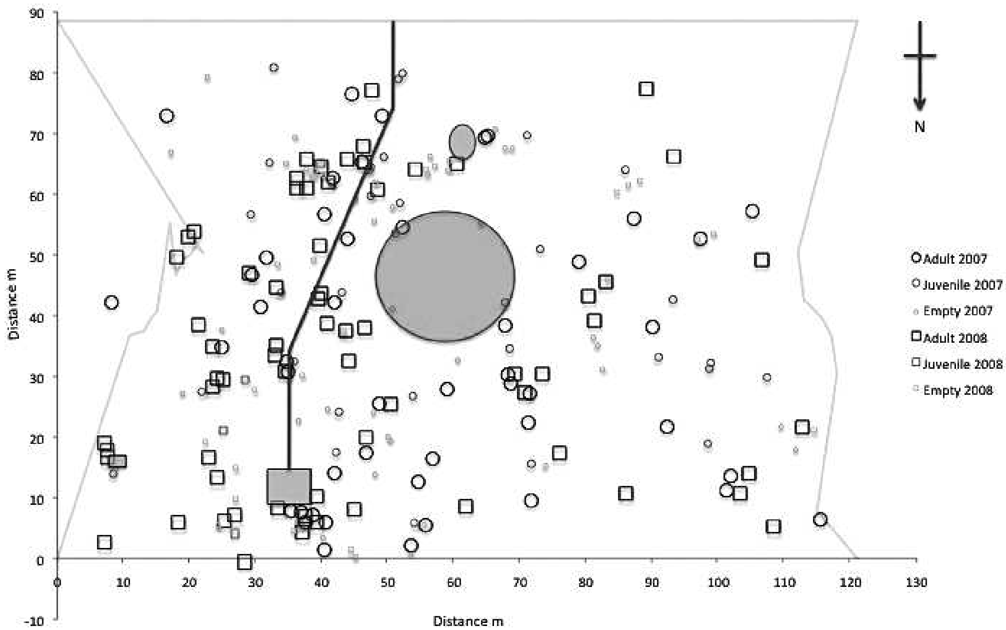

Figure 1.—Schematic representation of the location of all burrows located in 2007 and 2008 on the north side of the Las Cuevas Research Station clearing. The clearing boundaries, path and buildings and flood zone are all shown for reference (shaded areas).

product moment correlation coefficient was used to determine relationships between spider and burrow size, for all caught individuals, in each year.

Over 100 burrows were located (108 in 2007 and 107 in 2008), of which 80 were occupied in 2007, and 73 in 2008. More individuals were extracted in 2007 (48 compared to 26 in 2008), and there was a higher percentage of juveniles in 2007 (41%) than in 2008 (7%). Despite the similarity in burrow numbers found in both years, it is evident from Fig. 1 that their distribution is markedly different with only 12 present from 1 year to the next. Many burrows were located around buildings and on the edges of a concrete path. A large number of burrows were found in the west side of the clearing in 2007, whereas in 2008 the proportion present in this area was reduced. An area prone to flooding had few burrows present in either year (Fig. 1).

There was no significant difference between mean nearest neighbour distances between burrows in 2007 and 2008 (t = 1.658, df = 213, P = 0.099; 2007: mean = 3.88 (SE = 0.31) m; 2008: mean =3.16 (SE = 0.27) m). Burrows were significantly clumped in both 2007 (Z = 4.43, df = 107, $P < 0.0001$) and 2008 (Z = 7.23, df = 106, $P < 0.0001$), with similar indices of aggregation (2007: $I_A = 0.64$; 2008: $I_A = 0.60$). For occupied burrows, there was no significant difference between the nearest neighbour distances between years (t = 1.02, df = 152, P = 0.331; Table 1). In both years, occupied burrows were significantly clumped (2007: $I_A = 0.77$, Z = 4.43, df = 79, $P < 0.0001$; 2008: I_A = 0.70, Z = 5.41, df = 72, $P < 0.0001$). However, the spatial distribution of burrows differed between years (Fig. 1) with those containing adults being more clustered than those with juveniles, and areas where burrows were found in one year but not in the other.

For each year, the occupied burrow size was significantly positively correlated with spider body length (2007: r = 0.376, n = 48, P = 0.008; 2008: r = 0.424, n = 26, P = 0.031; Fig. 2), and in general larger spiders were found in larger burrows with some exceptions of small juveniles inhabiting what appeared to be abandoned adult burrows.

Despite similar numbers of burrows being found in both years, the locations were markedly different, suggesting that individuals move between pre-existing burrows or to new burrows. Examination of the clearing in 2008 revealed no visible signs of old burrows in areas where burrows had previously been present. This could be due to burrow structure as *B. vagans* can have up to four chambers off the main burrow (Machkour-M'Rabet et al. 2007) and be recorded at depths of 3–40cm (Machkour-M'Rabet et al. 2007) and up to 50 cm (Shaw pers. obs.). Rainfall can be high during the wet season, and the clearing is subject to seasonal flooding, which, coupled with the lack of deep roots, could lead to burrow collapse. Of those burrows matching between 2007 and 2008 some were protected from collapse, being underneath the edges of buildings, rocks and large roots. Burrow orientation can make them more susceptible to rain-carrying winds, helping to maintain high humidity (Machkour-M'Rabet et al. 2005), but leading to a trade-off between optimum humidity and having to move when flooded. Certainly areas that regularly flood have almost no burrows, and those at the edge of the flood zone can become waterlogged, resulting in tarantulas sitting huddled at the mouth of the burrow until the water subsides. Repeated flooding could result in abandonment, as observed in other burrowing spiders (Marshall 1995). Abandoned burrows would then be free for juveniles, possibly explaining the low correlation between spider stage and burrow size.

The nearest neighbour analysis showed similar mean distances between burrows in the North of Belize, as found by Reichling (1999: 3.4 m), and those at Las Cuevas (3.88 m, 2007; 3.16 m, 2008), suggesting that there may be an optimal distance driven by competitive repulsion (Reichling 1999). The level of between-year movement implied by this study may be due to relocation of juveniles prior to reaching maturity. Machkour-M'Rabet et al. (2005) found that adults and juveniles aggregated separately, although this is not evident in the study population. Reichling (1999) suggests that aggregative tendencies in theraphosids could reduce exposure to predators and increase reproductive success of nomadic males due to the shorter roaming distances required between fecund females. This can further be aided by the presence of detectable chemical cues (Yañez et al. 1999).

Dor et al. (2008) found females readily enter burrows of other females, sometimes resulting in the attack and death of one of them (Hénaut and Machkour-M'Rabet 2005). With high densities and clustered burrows, it is possible that there is frequent burrow takeover, particularly since chemical cues left by the silk at the burrow mouth can attract females to each other (Dor et al. 2008).

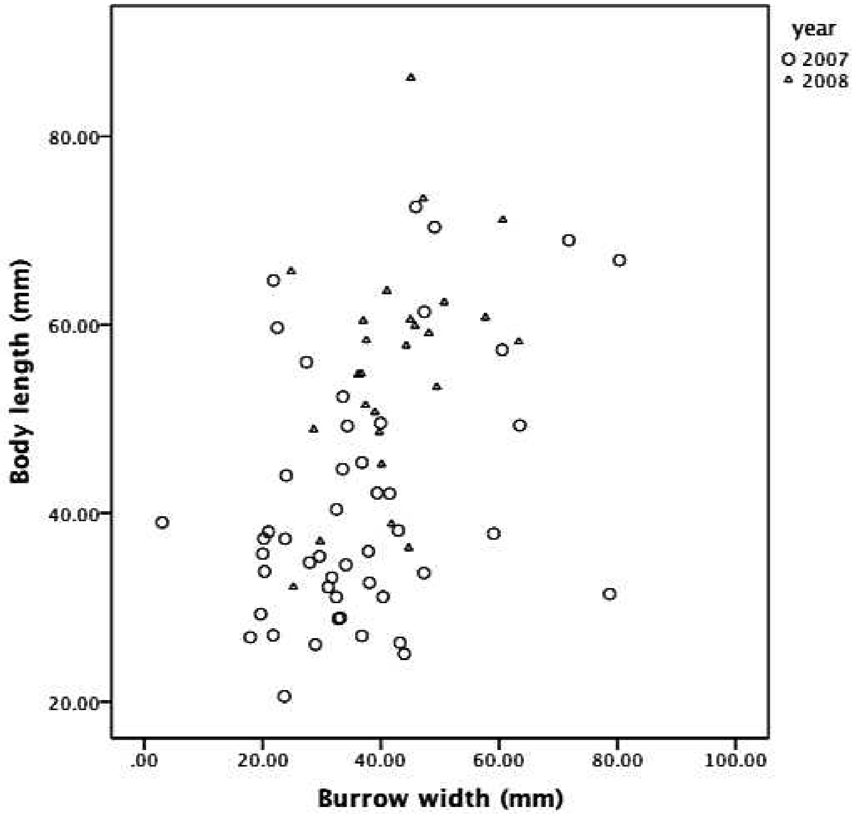

Figure 2.—Correlation between the body size of *B. vagans* tarantulas and the width of their burrows at Las Cuevas Research Station, Belize in 2007 and 2008.

In conclusion, this study highlights that the population of *B. vagans* at Las Cuevas Research Station is stable and highly mobile. In 2007 much of the captured population was composed of juveniles, whereas in 2008 more were adults, suggesting that the population is developing and indicating a potential population boom as the large number of adults produce juveniles. If this is the case, continued studies on this population should help elucidate some patterns of dispersal and distribution.

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