A not so natural history of the tarantula *Brachypelma vagans*: Interaction with human activity

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**Abstract**

We describe the structure of a population of *Brachypelma vagans* (Ausserer, 1875) in relation to the intensity of human activity and report characteristics of the burrows in Campeche, Mexico. During September and October 2003, we established sampling areas in five different classes of vegetation type/land use: mature forest (MF), secondary forest (SF), backyard (BY), and a football field divided into corner area (FC) and goal area (FG). The densities of spiders and the proportion of different age/gender classes of individuals on the sites were compared. Morphological data among adults and juveniles were contrasted, and differences in morphology between juveniles were tested according to land use class. We compared the nearest distances between neighbouring burrows and between burrows and trees. Also, we studied the orientation of the burrows, and compared the diameter of the burrow entrance. *Brachypelma vagans* was found exclusively in the open areas with densities that ranked from 0.02 to 0.1 individuals per square metre, being among the highest ever reported for Theraphosidae. However, there was a negative relationship between density and intensity of human activity. The population of this tarantula shows segregation in occupation of space. Females occupied exclusively the backyards, whereas juveniles occupied sites according to their stage of development. The youngest juveniles occupied the backyards, while the pre-adults occupied the football field. The distance between burrows was highly variable at all the sites. However it tended to be shorter in the backyards. The orientation of burrows was in all sites preferentially directed northwards. The diameter of the burrow entrances was a relatively good indicator of the sex and age of its occupier, and related almost directly to the dimension of the body. This study provides better knowledge of the structure of *B. vagans* populations in a human-modified environment and gives new information on the natural history of these spiders.

**Keywords:** Brachypelma vagans, habitat alteration, population structure, redrump tarantula

**Introduction**

Tarantula spiders from the genus *Brachypelma* are considered endangered because of trade and traffic, and as such are listed in appendix II of CITES (Locht et al. 1999). Species of
this genus are particularly attractive for people who rear these spiders as pets because they are colourful, large, and docile (Locht et al. 1999). Even if these tarantulas are officially protected, few efforts have been done to increase knowledge about their ecology (Yáñez and Floater 2000) and behaviour (Blein et al. 1996; Locht et al. 1999; Reichling 2000). In fact, most studies about Brachypelma tarantulas concern their geographic distribution (Valerio 1980; Smith 1986, 1994; Baxter 1993; Edwards and Hibbard 1999; Locht et al. 1999) and their systematics (Coddington and Levi 1991; Pérez-Miles 1992; Pérez-Miles et al. 1996).

Brachypelma vagans, commonly known as the Mexican Redrump Tarantula, is reported from Mexico, Belize, El Salvador, Guatemala, Honduras, and Costa Rica (Valerio 1980), but it has also been recorded in the wild in Florida (Edwards and Hibbard 1999), because its trade has promoted its dispersion beyond its natural range. The original distribution area has undergone one of the world’s highest deforestation rates during the past 20 years (Mittermeier et al. 1999). Changes in the landscape mosaic include an increase in secondary vegetation, agriculture, and urban or rural areas on one hand, and a decrease in natural vegetation on the other. Despite these land use changes, in southern Mexico the species is widely distributed and rather common (Locht et al. 1999). However, we did not find any study reporting on the impact of human activities on tarantulas.

As for most tarantulas, the biology and ecology of B. vagans are poorly known (Yáñez et al. 1999; but see Edwards and Hibbard 1999). However, the natural history of the genus Brachypelma was recently described by Locht et al. (1999). Brachypelma vagans, as most Brachypelma spiders, spend the day in burrows that have the entrance slightly wider than the spider body (Marshall 1996). They are nocturnal predators that feed on ground-dwelling arthropods, and possibly on small vertebrates (Marshall 1996). Brachypelma spiders grow slowly and are long lived (up to 25 years in the wild and more in captivity; Baxter 1993). According to Locht et al. (1999), males reach sexual maturity at 7–8 years and females at 9–10 years in the wild. Moore (1994) reports that B. vagans females make large silken egg sacs 4–5 cm in diameter containing around 300 young, and that spiderlings stay with the mother for several weeks before they disperse. During dispersal, spiderlings form a line, walking as ants in a column (Reichling 2000). Several authors have commented on the tendency of spiders of the family Theraphosidae to occur in local aggregation or colonies (Reichling 1999), while being absent in adjacent sites of similar habitat (Baerg 1958). However, only one quantitative study on spatial distribution patterns of theraphosid spiders has been realized in the field (Yáñez and Floater 2000).

In this paper we describe the structure of a population of B. vagans in different land use classes in relation to the intensity of human activity, and report on characteristics of the burrows.

Methods

Study site

The study took place in southern Mexico, in the area close to the Calakmul Biosphere Reserve (CBR), in the state of Campeche. Natural vegetation in the area is dominated by semi-humid tropical forest. Climate is warm with mean annual temperature around 25°C, and rainfall averaging 1300 mm annually. The rainy season starts in late May and finishes in October. The study was conducted at the village “11 de Mayo” (18°10’N, 89°45’W, altitude 270 m) on the edge of the CBR. This community is surrounded by small traditional
agrosystems interspersed with forest remnants. The centre of the village is the football field, around which are distributed the small traditional wood houses, each one with a backyard. This study was conducted in September and October 2003.

**Human activity and spiders**

We carried out all the observations in five different classes of vegetation type/land use. The first class is the natural mature forest with no noticeable human activity (MF); the forest ground is covered by a litter approximately 3 cm thick. The second class is a secondary growth 10 years old (SF), with a closed canopy and a mix of a thin litter (<2 cm) and bare ground. The other three classes differ from the latter by exhibiting a clear human influence and by having the ground covered with short grass. The backyard class (BY) is characterized by fruit trees that inhabitants have planted, and it features regular human activity that is linked to the use of the latrines. The following class is the corner of the football field (FC), which is treeless but experiences less human activity than the backyards. The last class is the goal area on the football field (FG), which is also treeless, but is widely used as shown by the aspect of the lawn (15–20 boys play every day for about 3 h). All classes were investigated in a single 400 m² area except for the backyard for which two areas were studied: one with less human activity (single old man; BY1), and the other with more human activity (family of six; BY2). We sampled each area during the day from 10:00 to 14:00 h, looking for silk on the entrance or food disposals that let us know that the burrow was inhabited (three burrows out of 110 were empty). We recorded the number of *Brachypelma vagans* spiders, which allowed us to estimate spider density for each class. We observed and measured spiders at night from 20:30 to 00:30 h using a small stick to take out the spiders and catch them carefully. We determined age, as adult or juvenile, and sex. For each individual, we measured the length and width of the prosoma (L_pro and W_pro, respectively), the length of patella I (P_I) and IV (P_IV), and tibia I (T_I) and IV (T_IV) (to the nearest 0.01 cm) as described by Chamberlin and Ivie (1938). We also weighed individuals (W) to the nearest 0.01 g, using a spring balance. Once all the data were recorded, we released each spider in front of its burrow entrance.

**Burrows description**

For all marked burrows, we measured the maximum diameter of each burrow entrance and noted if the occupier was a female, a male or a juvenile. For each sampling area, we determined the distance between a given burrow and its nearest neighbour. The distance from each burrow to the nearest tree was recorded in BY1 and BY2. The orientation of the burrows was determined using a stick placed along the axis of the entrance tunnel and a compass, and was classified as North, North-East, East, South-East, South, South-West, North-West, or West.

**Statistics**

The densities of spiders and the proportion of the different gender/age classes of individuals at the sites were compared with a maximum likelihood test. The morphological data among adults and juveniles were compared with a Kruskal–Wallis test followed by a Fisher least significant difference (LSD) test. Differences in morphology between juveniles according to land use class were tested with a Mann–Whitney *U* test. To compare the distances between
nearest neighbouring burrows, and distances between burrows and nearest neighbouring
trees, we used a Kruskal–Wallis test (plus a Fisher LSD test) and a Mann–Whitney \( U \) test,
respectively. The orientations of the burrows were contrasted to a regular distribution using
a frequency test. To compare the diameters of the burrow entrances, we performed a one-
way ANOVA (between vegetation/land use classes) or a Kruskal–Wallis test (among sex
and ages), followed by a Fisher LSD test. All analyses were performed with the software
Statistica version 6.1 (StatSoft Inc., 2003).

Results

Human activity and distribution of spiders

The density of tarantulas in each vegetation or land use class varied from zero in the forest
classes (MF and SF) to 0.1 spiders per m\(^2\) in FC (Figure 1). Within land use classes, the
density of tarantulas decreased with increasing human activity, from FC to FG (\( G=59.41, \)
df=3, \( P<0.0001 \)).

We analysed the distribution of females, males and juveniles for all land use classes. As
we detected no difference between the two backyards, on one hand, and the two football
sites, on the other, we pooled data into two broader categories: BY (BY1 and BY2) and FB
(FC and FG). Females were found exclusively in the backyards, and represented the
greatest proportion (50%) of individuals at these sites even if it was not significant
(\( G=4.19, \) df=2, \( P=0.12 \)). Males were found in equal abundance in both land use classes,
and represented a low proportion of the population (both BY and FB: 17%). Juveniles
represented 33% of the population in the backyards, but were significantly more numerous
than males on the football field (83%; \( G=5.82, \) df=1, \( P=0.02 \)).

For all morphological measures, females did not differ from males, but unsurprisingly
juveniles were significantly smaller than adults (\( H_{2,34}>15.2, \) all \( P<0.001 \); Table I). Juveniles
were slightly smaller in the backyards than on the football field, as indicated by
\( L_{\text{pro}} \) and \( P_{\text{IV}} \) measures (\( U_{1,17}<14.5, \) all \( P<0.05 \); Table I).

![Figure 1. Density of *Brachypelma vagans* in different vegetation/land use classes representing a gradient of human activity. F: mean of MF and SF. Site class codes are referred to in the Methods section.](image-url)
**Interaction of Brachypelma vagans and human activity**

### Table I. Morphological data of adults (females and males) and juveniles of *Brachypelma vagans*.

| Measures | Females (n=11) | Males (n=6) | Juveniles (n=17) | Juveniles BY (n=7) | Juveniles FB (n=10) | P² |
|----------|----------------|-------------|------------------|-------------------|---------------------|----|
| Lpro (cm)| 2.03±0.05a     | 2.05±0.07a  | 1.60±0.07b ***  | 1.44±0.13         | 1.74±0.07 *         | NS |
| Wpro (cm)| 1.87±0.06a     | 1.86±0.03a  | 1.43±0.06b ***  | 1.30±0.10         | 1.57±0.07 NS        | NS |
| P I (cm) | 0.95±0.03a     | 0.95±0.02a  | 0.74±0.03b ***  | 0.70±0.06         | 0.88±0.11 NS        | NS |
| T I (cm) | 1.16±0.02a     | 1.18±0.04a  | 0.90±0.03b ***  | 0.86±0.06         | 0.94±0.03 NS        | NS |
| P IV (cm)| 0.84±0.02a     | 0.86±0.01a  | 0.66±0.03b ***  | 0.60±0.04         | 0.73±0.03 *         | NS |
| T IV (cm)| 1.14±0.03a     | 1.21±0.04a  | 0.92±0.03b ***  | 0.85±0.06         | 0.99±0.03 NS        | NS |
| W (g)    | 12.92±1.21a    | 12.26±1.56a | 5.63±0.62b ***  | 4.56±1.03         | 6.71±0.67 NS        | NS |

The values presented are means followed by their standard errors. Letters following means represent intergroup differences (Fisher LSD test). Abbreviations can be found in the Methods. P¹, probability associated with Kruskal–Wallis test (***P<0.001); P², probability associated with Mann–Whitney test (*P<0.05; NS, not significant).

### Burrows description

The median distance to the nearest neighbouring burrow was highly variable within each site, but significantly different among sites ($H_{2,93}=19.88; P=0.0002; $Table II). However, the Fisher LSD test showed that only in FG were the distances between two nearest neighbouring burrows significantly longer than in the other sites. In the backyards, we found that the distance between burrows and nearest neighbouring trees was significantly longer than the distance separating two neighbouring burrows as shown by a Mann–Whitney test (BY1: $U_{1,42}=69, P=0.0001$; BY2: $U_{1,54}=124, P=0.0003$).

For all sites, burrows were preferentially orientated towards the North-East ($\chi^2=27.8, df=7, P=0.0002; $Figure 2A). Within each land use class (BY and FB) there was a significant difference among all directions (BY: $\chi^2=21.67, df=7, P=0.003$; FB: $\chi^2=15.84, df=7, P=0.03; $Figure 2B). For both BY and FB, the preferred directions were orientated towards North (North-East, North-West, and North). These three directions represented more than 50% of the burrow orientations, which was significant ($t=2.23, df=6, P=0.033$).

The mean diameter of the burrow entrances in the backyards was significantly wider than in the football field ($F_{1,110}=6.59, P=0.01; $Figure 3A). To get a better insight, we also compared the diameters of the burrows according to sex and age of individuals for all sites (Figure 3B). A Fisher LSD test showed that female burrow entrances were significantly

### Table II. Distances between nearest neighbouring burrows for the backyard and football field sites, and between burrows and nearest neighbouring tree for the backyard sites.

| Site class | n  | $D_{b/b}$ [range] (LSD) | $D_{b/t}$ [range] | P |
|------------|----|-------------------------|-------------------|----|
| BY1        | 21 | 190 [100–900] (a)       | 557 [100–980]     | ***|
| BY2        | 27 | 176 [65–510] (a)        | 383 [114–780]     | ***|
| FC         | 36 | 245 [140–390] (a)       | –                  | –  |
| FG         | 9  | 370 [250–1400] (b)      | –                  | –  |

Site class codes are referred to in the Methods section. n, number of burrows; $D_{b/b}$, median distance between two nearest neighbouring burrows (cm); $D_{b/t}$, median distance between burrow and nearest neighbouring tree (cm); LSD, interclass groups at the P=0.01 level; P, probability associated with Mann–Whitney test (***P<0.001).
wider than those of juveniles, while male burrow entrances were intermediate in size ($H_{2,34}=7.21; P=0.027$).

**Discussion**

In this study, we report for the first time the density of *B. vagans* in different types of vegetation or land use. Surprisingly, we found that this tarantula was absent both in mature and secondary forests, suggesting that in natural conditions this species probably uses clearings in the forest. The species actually is highly adaptable as demonstrated by its colonization of central Florida, an area with characteristics similar (soil type, vegetation type and climate) to the Yucatan Peninsula in Mexico (Edwards and Hibbard 1999). On the other hand, the density reached in the village (from 0.02 to 0.1 individuals per m$^2$) is among the highest ever reported for Theraphosidae. For instance, *Brachypelma klaasi*
Schmidt and Krause, 1994 reached a maximum density of 0.00006 individuals per m² on 214 m² areas in the Chamela-Cuixmala Biosphere Reserve on the Mexican Pacific Coast (Yáñez and Floater 2000). In Trinidad, *Avicularia avicularia* L. 1758, an arboreal tarantula, had densities varying between 0.0013 and 0.0031 individuals per m² on a 2.2 ha abandoned tonka bean plantation (Stradling 1994).

Although *B. vagans* lived exclusively in the disturbed area, there was a negative relationship between density and intensity of human activity. Therefore, the modification of the landscape, by human activity, created microhabitats favourable for the installation of the colonies of *B. vagans*, but only at moderate levels of disturbance. Additionally, there was a clear segregation in the occupation of space. Females occupied exclusively the backyards, whereas juveniles occupied sites according to their stage of development. The youngest juveniles occupied the backyards, while the pre-adults occupied the football field.

Figure 3. Mean diameters of the burrow entrances of *Brachypelma vagans*. (A) Between backyards (BY: BY1 and BY2) and football field (FB: FC and FG); (B) among individuals. ANOVA test: **P<0.01; Fisher LSD, interclass group at 1% level.
The segregation in spatial occupation of the juveniles may be the result of juvenile migration from the natal site, i.e. the backyards, to another nearby site where pre-adult development occurs, i.e. the football field. Foelix (1996) mentioned that dispersal in juvenile spiders is related to development stages, among other factors. For the arboreal tarantula *A. avicularia*, Stradling (1994) observed a segregation of space according to the age of spiders and related it to changes in prey demand. However, for *B. vagans* dispersal might also be triggered by females’ aggressive behaviour towards their spiderlings when they become bigger. Our further observations on high intraspecific aggression in this species support this hypothesis (unpublished data).

Post and Riechert (1977) wrote that selection of micro-habitat by individual spiders is probably related to specific biological needs or may reflect avoidance of some factor, such as encounters with other spiders. Following this assumption, juveniles occupy the site with the least complex structure, i.e. the football field, in order to avoid competition with adults. On the other hand, females may prefer backyards that have refuges (e.g. stones, tree roots), because it offers a more protective environment for eggsac and young. This age-related segregation of space is common in other organisms. For instance, in forest-dwelling birds, breeding adults occupy the best sites for nesting and feeding, whereas subadults are confined to least quality sites (Van Horne 1983).

The distance between burrows was highly variable at all the sites. However, it tended to be shorter in the backyards, which may be related to the avoidance of trees. In effect, the distance between burrows and the nearest neighbouring tree was significantly higher than the distance between nearest neighbouring burrows. Tree avoidance probably also explains why we did not find any tarantula burrow in the forest with closed canopy. The shallow soil in this karstic region favours superficial development of tree roots, which in turn is likely to be detrimental to *B. vagans*, by making burrow excavation more difficult.

Based on the findings of Yáñez and Floater (2000), we suggest that the preferential orientation of the nests is linked to the avoidance of high temperature and preservation of relative humidity. Conversely it makes burrows more exposed to major rain-carrying winds (Alizées and “Norths”), helping to keep humidity high within the burrow. In fact, we also observed another strategy used by burrowing tarantulas to limit water loss in the burrow, which consists of closing it with silk (Baerg 1958). Thus, this orientation seems favourable to maintain optimal body condition in the tarantulas, by limiting desiccation.

The diameter of the burrow entrances was a relatively good indicator of the sex and age of its occupier, and related almost directly to body dimension. An exception was female sizes that were similar to males, whereas female burrow entrances were larger. This was surprising because males are usually smaller than females (Smith 1994). We suggest that larger female dimensions are linked to mass and opisthosoma, since females eat more than males especially during the reproductive period (Smith 1994), and thus opisthosoma is larger. In other words, females reach largest dimensions during the reproductive season, which is logically reflected by the largest diameter of their burrow entrance. On the contrary, our measures were taken on body parts that are not influenced by the food ingested or the period of the year.

This study provides a better knowledge of how a tarantula population is structured in a human-modified environment, and gives new insight on the natural history of these spiders. According to our results, *B. vagans* seems to prefer human-made open areas, but reproductive adults avoid areas with much human activity. Our data suggest that tarantulas are territorial in an aggregative population structure. We propose further experiments to...
study agonistic behaviour of these spiders to understand intraspecific relationships between individuals of the same aggregative group.

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