Investigating the Potential for a New Methodology to Induce Hunting Behaviour for Observational Purposes in Neotropical Tarantulas

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Abstract

The Amazon rainforest is the most biodiverse region in the world and an alarmingly high proportion of its inhabitants are under severe threat from anthropomorphic activities. Understanding the ecological needs and life history of these organisms is a crucial step for implementing effective species-specific conservation, to ultimately preserve the health and ecological balance of the rainforest. Arachnids of the Theraphosidae family (more commonly referred to as tarantulas) make up an important part of this ecosystem as biological controllers and yet remain relatively understudied. Providing a suitable habitat for tarantulas in a laboratory environment has proven to be a challenge in previous research and may inflict welfare issues if undertaken inappropriately. Therefore, this study aims to investigate the potential for a new, non-invasive method that could be utilised in Theraphosidae research in the tropics. Such methodology involved the use of an insect bait derived from liquid fish remains and human urine combined in a ratio of 1:1 and has been previously used to attract an abundance of insect species across Finca Las Piedras. The bait was sprayed twice a day over a five day period at the entrance of five separate tarantula burrows, each inhabited by a single mature adult, in order to attract potential prey species and thereby induce tarantula hunting behaviour and emergence from the burrow. The results show an approximate success rate of 70% with a significantly greater number of responses occurring at night. There is also possible insight offered into additional factors influencing the success of this methodology, but further research would be required to provide sound confirmation of these perceptions.

Introduction

In the Peruvian Amazon, the Madre de Dios region is home to a vast abundance of animal species, including the Theraphosidae family (of the class Arachnida) which contains genera of the well-known tarantula spider. The vast majority of neotropical tarantula species occupy burrows on the forest floor that provide protection from predators and heat stress (Guerro, 2019) as well as providing a habitat suitable for their passive hunting method, informally referred to as the “sit and wait” technique (Pérez-Miles & Ferretti, 2014). These accomplished nocturnal predators have been recognised as important biological controllers (Reátegui-Suárez et al., 2014) through their consumption of various insects and small vertebrates. They also provide a valuable food source for many other occupants of the rainforest, particularly larger reptile and bird species (Wirth, 2006). Therefore their absence within the ecosystem would likely result in a cascade effect, following a reduction in the control of prey species populations.

Despite the establishment of their importance within tropical rainforests,

tarantulas still face many anthropomorphic threats including habitat degradation from both deforestation and fragmentation, as well as illegal trafficking due to their unique, attractive appearance and docile nature, making them a popular choice as exotic pets (Jiménez et al., 2004). Therefore, it is important that their species-specific conservation efforts are applied accordingly and effectively. In general, tarantulas are widely understudied and the lack of available information about their ecology may hinder conservationists' ability to protect the biodiversity of this famous carnivorous spider (Tellería, 2013). It has also been thought that studying animals in their natural habitat with minimal disturbance corresponds best when researching the ecology of the species (Pritchard et al., 2016). Therefore, this research aims to investigate the potential for a non-invasive method through the use of insect bait to induce predatory instincts in tarantulas, which could be useful in behavioural research and species identification.

Methods

Study Site

This investigation was undertaken at the Finca Las Piedras research station in Madre de Dios, Peru, which is under the ownership of the Alliance for a Sustainable Amazon NGO. The 54-ha property is predominantly made up of primary "terra-firme" forest, palm swamp (commonly referred to in Peru as "aguajal") and an area of partial deforestation.

Study Group

Knowledge regarding the activity budgets and occupancy of the family Theraphosidae relies largely on anecdotal field data and lacks formal research, most likely due to their limited mobility and typically nocturnal habits (Schwerdt et al., 2019). Their confirmed presence at Finca Las Piedras offers the opportunity to develop knowledge about their ecology, behavioural habits and what methods can be used to study these in the field, hence their selection as a study group. Furthermore, certain species of neotropical tarantulas have been recognised to be crepuscular (Cloudsley-Thompson & Constantinou, 1984), therefore this study additionally investigated tarantula activity and response at varying times of day to potentially allow further insight into their behavioural ecology and when field research can be most effectively carried out.

Data Collection

Five individual burrows each inhabited by mature adults were surveyed twice a day across a five day time period. Each burrow had a confirmed sighting of a resident adult tarantula within seven days prior to the first day of data collection to ensure all burrows surveyed were active. Surveys were split into two phases; "Light" (1.30-3pm) and "Dark" (7-8.30pm). The order in which the sites were surveyed was varied to reduce the potential influence of bias. The insect bait used in this study was comprised of human urine and liquid remains of local fish combined in a ratio of 1:1, an established method for attracting insects used regularly by the site's Lepidoptera research team, and was administered via a spray bottle. To keep the quantities of bait used consistent, five sprays were applied to each burrow at any one time. Following the application of the bait, a stopwatch was set and the time at which the tarantula emerged from the burrow to hunt any prey species present was recorded. If after 15 minutes there was no visible tarantula activity, the bait was regarded as ineffective for that data point. A "response" was defined as the full emergence of a tarantula from its burrow in order to demonstrate hunting behaviour

towards an organism that was attracted to the bait. Additional notes were also made regarding the type of prey species that were attracted to the bait and which of these were targeted by the tarantula. The effect of the bait on the presence of prey species was almost immediate, hence the stopwatch was consistently started as soon as the bait had been applied to the entrance of the burrow.

Data Analysis

Mean and standard deviation of response rates and response times for each phase were calculated and the distribution was checked. As this data was normally distributed (P>0.05), the Welch Two Sample t-test was utilised to identify statistical significance between the "Light" and "Dark" phases. All data analysis was undertaken using the statistical computing software R.

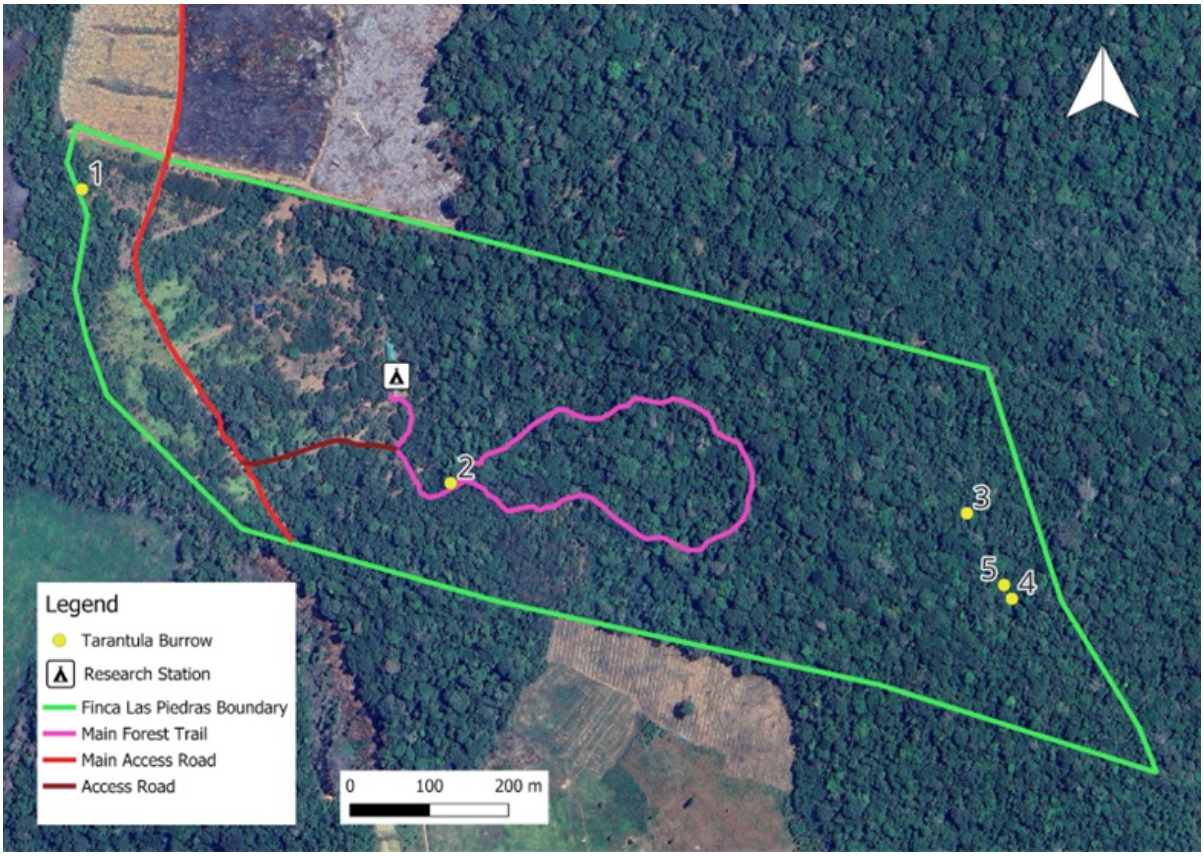

Figure 1: A Map of Finca Las Piedras indicating the main road, forest trail and the location of each surveyed tarantula burrow.

Burrow	No. Responses (Light)	No. Responses (Dark)	Mean Response Time in (Light)	Mean Response Time (Dark)
1	2	4	12:44	06:45
2	2	3	12:48	06:59
3	3	5	08:42	04:22
4	4	4	09:01	04:59
5	3	5	10:19	04:47

Table 1: A summary of the mean average response rate and time across both phases by tarantulas in Finca Las Piedras

Results

Response Rate

On average (across both phases) there was an approximate success rate of 70% whereby tarantulas responded to the use of the bait by exhibiting predatory behaviour, with a total of 35 out of a possible 50 successful responses recorded (see Table 1).

A total of 14 out of a potential 25 responses were recorded during the "Light" phase and 21 out of 25 responses were recorded during the "Dark" phase. There was a significant difference between the response rates of "Light" and "Dark" (P=0.02945) with an average mean response rate of 2.8 out of 5 and 4.2 out of 5 respectively.

Response Time

The overall mean average time to respond across all successful responses was 8 minutes and 12 seconds (08:12). Statistical significance was found in the response times between the two phases (P=0.001189) with a mean time of 10:50 for "Light" and 05:34 for "Dark". Burrows 1 and 2 exhibited the longest average response time to the bait by approximately 2 minutes for both phases. The mean average response time was shorter during the "Dark" phase for all 5 burrows.

Discussion

The results from this study highlight the potential usefulness of insect bait as a means of observing neotropical tarantulas in their natural habitat, which could provide a sound basis for further research on the ecological needs of this widely understudied predator. In comparison to other invertebrates, Theraphosids are relatively new to the laboratory environment and there are often misconceptions about their species-specific needs and how best to undertake effective husbandry (Lock et al., 2011). This, coupled with the concept that invertebrates are often subject to lower standards of welfare in a domestic environment, (Andrews, 2011) emphasises the importance of being able to study these spiders in a wild setting, utilising non-invasive methodology where possible, as presented in this research.

The 70% success rate of using insect bait as a means of surveying tarantulas is an appreciable statistic and would suggest the utilisation of an animals' natural instincts can potentially be useful in field research, even in arthropod species. It was found that the use of the insect bait was significantly more successful at night, but not completely ineffective during daylight hours. This aligns with current literature focusing on activity time budgets, whereby various species of Theraphosids have been found to hunt primarily at night or during the cooler

hours of the day (Ruhland et al., 2016; Punzo & Henderson, 1999). However, it is worth considering whether a similar response rate would occur in alternative biomes as tarantulas are widely distributed across the globe and it is currently unknown whether the resources used in this research would effectively attract the appropriate species in other habitats. The vast majority of organisms that were attracted to the bait consisted primarily of flies, cockroaches and an abundance of lepidoptera species. Typically, tarantulas would only prey on larger individuals, with moths and cockroaches being notable favourites. Therefore, it is worth considering whether this methodology would have the same effect in environments where the population density and diversity of these prey species is considerably lower than in the tropics.

The response time was significantly lower during the "Dark" Phase, which reflects the nocturnal hunting habits of tarantulas and indicates the most effective time to undertake observations for research. Additionally, there were notable differences in response times between the various burrows, with Burrows 1 and 2 taking longer to respond to the presence of prey when compared to the other three burrows. A potential explanation for this could be regarding the food availability in each location, as predation time has been found to decrease in tarantulas that have been deprived of regular food resources (Phillip & Shillington, 2010). Burrows 3, 4 and 5 are all within relatively close proximity of one another, whereas 1 and 2 are more isolated, possibly in areas with a lesser abundance of prey. Therefore, it could be argued the success of this methodology not only depends on time of day, but additionally the availability of prey species without the use of bait, outside of data collection hours.

While this study has potentially provided some insight into an affordable and accessible tool for studying tarantulas, there have been some identified limitations. The 5 day data collection period was notably short and would therefore not highlight the effects of long-term usage for this methodology. Due to further time constraints, individual surveys were limited to 15 minutes which may have resulted in missing potential data should any tarantula activity have occurred after this time frame.

Additionally, while tarantulas have notoriously poor vision, they are sensitive to light. A future recommendation for this methodology could be the use of red light (as opposed to bright white light) during nocturnal surveys as this has been thought to inflict less disturbance onto Theraphosids (Minch 1978).

Conclusion

There is currently very little information available regarding the conservation status of many Theraphosidae species, particularly concerning those individuals inhabiting areas that are vulnerable to human disturbance such as deforestation (Mendoza & Francke, 2017) as seen in some of the land surrounding Finca Las Piedras. Therefore, obtaining inventories and quality information regarding distribution, population size and trends will be key in assessing and implementing effective conservation efforts to preserve Theraphosids and their role within the rainforest. This study not only highlights a new potential method to aid obtaining this important information, but also relays the concept that data collection is not restricted to established survey methods and innovation can play a key role in the development of new, successful conservation research.

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