JOE HAMPSON

B.Sc. ZOOLOGY

VOCATIONAL SUPERVISOR: DR BENOIT GOOSSENS

ACADEMIC SUPERVISOR: DR CARSTEN MULLER

DANAU GIRANG FIELD CENTRE, BORNEO

Investigating activity patterns of the Common Brunei Arboreal Tarantula (*Phormingochilus everetti)* in the Lower Kinabatangan Wildlife Sanctuary, Sabah, Malaysia.

Word count: 3500

Formatted: Font: (Default) Arial, Bold

Formatted: Font: (Default) Arial, Bold

CONTENTS PAGE

Part A

Part B

Formatted: Justified, Line spacing: 1.5 lines, Tab stops: 13.52 cm, Left

Reflection on PTY

For my PTY I undertook my placement in Sabah, Malaysia at the Danau Girang Field Centre (DGFC) which is situated in lot 6 of the Lower Kinabatangan Wildlife Sanctuary. My placement was for 11 months and I was stationed at the centre from July 1st 2015 until the 20th of June 2016. The Danau Girang field centre was active the research of many animals throughout the year; and during my PTY I was able to assist in all ongoing projects and acquire an extensive multidisciplinary skill set.

Corridor monitoring with use of camera traps was a large part of my PTY which first enabled me to be able to effectively identify species. DGFC had multiple sites along the Kinabatangan river which were routinely checked in order to collect SD cards, assess the site and change batteries. The use of camera traps to monitor wildlife not only facilitated skills in species identification but also in the collection and handling of data. Analysing Camera trap data introduced me to extracting data using exiftool and inputting the raw data into excel. Use of excel was already familiar to me but inputting camera trap data allowed me to build competence and develop a higher level of understanding of inputting and organising large data sets.

Throughout the year DGFC enabled me to assist in all ongoing research at the centre.. Tracking both Slow Loris and Tarsier using radio telemetry gave me the initial skills in order to use more advanced tracking techniques throughout the year. Tracking in the jungle improved my ability to effectively navigate through the jungle and spot wildlife. DGFC enabled me to obtain extensive knowledge about tracking and using these skills I was able to effectively and efficiently track both nocturnal primates using radio telemetry as well as civets and crocodiles using satellite tracking.

Both trapping and sampling of wildlife was a critical skill to develop in order to further research animals in the future. Throughout the year I assisted both Meg Harris and Sergio Guerrero Sanchez in the trapping, sampling and collaring of civets and monitor lizards, respectively. The sampling included obtaining samples such as hair and blood for as well as making external observations and removing ectoparasites. Sampling such as this was already in my skill set due to previous work with the Cardiff University Otter Project; However, sampling at DG allowed me to gain hands on experience with live animals and build confidence in the understanding of the varying protocols required for different animals.

Working like this allowed me to build a better understanding of research in the field and in the lab as well as working in a team. Alongside the skills I developed for research throughout

the year I was able to grasp an understanding of the language which enabled me to form better working relationships with the staff and work more efficiently in the field. Furthermore, working at DGFC allowed me to explore a different side to science which is education. Throughout the year field courses of various sizes and ages visited the centre and accommodating them and leading them became a task which I became passionate in. Alongside this, giving presentations and contributing to the monthly newsletter improved my ability to present scientific research and communicate about science to the general public, a skill I feel highly transferable to work in science.

Abstract

The Common Brunei Arboreal Tarantula (Phormingochilus everetti) is a member of the mygalomorph infraorder and the family Theraphosidae. P. everetti found can be on the island of Borneo and has been described in areas of Sarawak, Brunei and other areas of Borneo. Arboreal tarantulas have previously been shown to be sit and wait predators having limited activity. This study aims to assess the activity patterns of the Common Brunei Arboreal Tarantula by way of camera trapping and direct observation by way of opportunistic sampling. Reconyx P-800 camera traps were set up to take an image every 5 minutes for 24 hours a day. Results show that *P.everetti* is a sit and wait predator that hunts exclusively at night preying on invertebrates. A single mating event was observed with >100 juveniles present for 1 month, after which a gradual dispersal occurred with one single juvenile would occupy the hole with its mother for a further 3-5 months. This study proves the effectiveness of camera trapping for use on invertebrates which has not previously been shown in literature.

Introduction

The Common Brunei Arboreal Tarantula (*Phormingochilus everetti)* (Pocock 1895) is a member of the mygalomorph infraorder and the family Theraphosidae. *P. everetti* can be found on the island of Borneo and has been described in areas of Sarawak, Brunei and other areas of Borneo (Smith 1994; Pocock 1895). Arboreal tarantulas have previously been shown to be 'sit and wait' predators having limited activity (Cloudsley-Thompson & Constantinou 1985; Dor & Henaut 2013; Shillinton and McEwan 2006)

Although not much is known about the habitat choice of *P. everetti* studies carried out on similar species (Stradling 1994; Shillinton and McEwan 2006; Dor & Henaut 2013) found that arboreal tarantulas occupy different habitats based on their instar, with immature individuals within their first eight instars found to be inhabiting the leaves of low growing plants. Beyond the 8th instar it has been documented that there is a general trend for retreats to be constructed in more elevated situations such as hollows in a tree or between the leaves of climbing plants (Stradling 1994; Shillinton and McEwan 2006).

Male tarantulas and indeed male individuals of all spider species have previously been documented to possess entirely different behaviour when it comes to habitat choice and activity patterns (Stradling 1994; Dor & Henaut 2013). Males have been found to frequent human dwellings (Stradling 1994) with the assumption that this roaming facilitates finding a mate. Females and larger immature individuals of both sexes however have been found in more permanent dwellings for prolonged periods, with the maximum period of residence in one hole being found at three years (Stradling 1994; Shillinton and McEwan 2006).

In light of the information provided by literature (Stradling 1994; Shillinton and McEwan 2006; Dor & Henaut 2013) - when studying the behaviour patterns of individual arboreal tarantulas, a bias towards females and larger immature individuals of both sexes will be hard to avoid due to their movements. This is

Commented [BG1]: You need to have a cover page with the logos of Cardiff University, DGFC, the title of your report, your name, student ID, type of degree, vocational supervisor's name (me); you need a page of content and you need to write a Part A which is an account of your PTY experience (1-2 pages), an abstract and then start your introduction

Commented [BG2]: Not in Sabah????

Commented [BG3]: Studies???? One reference only

Commented [BG4]: This is the only reference on the species???

Commented [BG5]: One reference!

perhaps why research into males of almost all spider species is so sparse and the same methodologies may not be appropriate for both sexes.

Furthermore it is not just research into males that is lacking within the literature, detailed research into Theraphosidae in general is limited and literature on *P. everetti* as a species is more limited still (Stradling 1994).

Due to the fact that arboreal tarantulas have such specialist habitat choice in the form of tree hollows and climbing plants such as vines, the overall condition and abundance of suitable dwellings must correlate to the abundance of arboreal species present in the area. (Tscharntke et al., 2008)

As both selective logging and other anthropogenic disturbances such as those facilitated by the oil palm industry carries on creating intense fragmentation within the forests of the Lower Kinabatangan Wildlife Sanctuary, Sabah, Malaysia, research into measuring change becomes increasingly more critical. The overall effect of human disturbances has been shown to drive a change in the composition of a community and alter how the forest will adapt and change to environmental change which ultimately provides the ecosystem with its habitat and community structure (Tscharntke et al 2008).

Commented [BG6]: You should mention where this is!

Use of invertebrates as potential bio-indicator species is well documented in the literature (Noss 1990, Soule 1988). This has been shown to be particularly true for the insects as they possess short generation times facilitating a fast response to changes in the environment and large sample sizes (Mattoni et al 2000, Fabricius et al 2003). Furthermore, research has shown that spiders also can be used as bio-indicators (Petillon, Canard and Ysne 2006). This research shows that spider communities can be used as indicators of environmental change. Using direct observation P.*everetti* occupies trees with tree hollows. If it is shown that *P.everetti* occupies a single species of tree based on its characteristics then this will highlight the importance of preserving a particular species of tree, for the conservation of the species.

Commented [BG7]: But what about spiders? Are they potential bio-indicators? And why? You should extrapolate here.

It is important to note that the length of the research project falls within an El Niño year (Kuo, Lee and Lu 2016) which is caused by the warming of waters in the eastern tropical Pacific Ocean, this in turn causes higher temperatures and lower rainfall which constitutes to an increased risk of drought. Due to this temperatures

collected during the experiment may not reflect the normal mean diurnal ranging from 22-32 ^{o}c

As tarantulas have been shown to employ a sit and wait strategy when hunting for food, using the sensitive hairs on its legs and body in order to detect vibrations, a redundancy has been shown, with most spiders in the development of the eye. Unlike hunting spiders, tarantulas do not possess a sensitive tepetum, In light of this redundancy the discovery of new individuals is difficult due to the fact that a head torch will not create eye shine in the tarantulas eye as the tepetum will not reflect the light. Furthermore a previous study has shown that tarantulas, although they do not have sensitive eyes are still highly sensitive to light, using white light on tarantulas have been shown to result in the tarantula retreating into hollow. The use of red lights however did not result in tarantulas retreating. Therefore when hunting for tarantulas a red light must be used in order to reduce the risk of a tarantula retreating before the individual is discovered. (Shillinton and McEwan 2006)

In addition to this the colouration of *P.everetti* is brown and indeed in all species within the genus, inconspicuous colourations are found based on their habitat choice, trees. Inconspicuousness is a technique used by prey in order to avoid predation by way of camouflage or blending into its chosen environment (Kane *et al* 2013; Kang *et al* 2012; Kang *et al 2013b)* Due to this evolutionary adaptation the discovery of new individuals may prove difficult and a bias towards individuals >5 may be found.

As shown by (Shillinton and McEwan 2006) tarantulas are very sensitive to disturbance due to the fact that they hunt by detecting vibrations emitted from the feet of the prey item nearby. In addition to this, tarantulas use this mechanism in order to avoid predation, when humans or other animals move within close proximity to the tarantulas hollow the tarantula will sense an overload in its sensory hairs due to the much larger vibrations emitted. The tarantula quickly enters its hole in order to avoid predation. In light of this, great care should be taken when direct observations are being recorded.

The main aim of the study is to assess the activity patterns of the Common Brunei Arboreal Tarantula. Previous studies of tarantulas have come from only direct observation of the individuals studied. Using direct observation is effective for

studying individuals in great detail for a short period of time (Shillinton and McEwan 2006). However for this experiment individuals will be studied 24 hours a day. In light of this; a combination of both direct observation and camera trapping will be utilised. The use of camera trapping to study tarantulas is an innovative technique and is effectively studying a micro animal as if it were a macro animal. Direct observation will be carried out by way of opportunistic sampling for males in order to assess habitat choice.

Methodologies

Study site and experimental procedure

The location chosen for the study was the Lower Kinabatangan Wildlife Sanctuary (LKWS), situated along the Kinabatangan River. More specifically research was carried out in Lot 6 of the sanctuary which consists entirely of secondary forest and oil palm (Davison, 2006). The Lower Kinabatangan Wildlife Sanctuary consists of Secondary forest which in part was selectively logged for its large dipterocarp species (Ancrenaz *et al*,. 2004). . Normal mean diurnal ranging from 22-32 ^{o}c

Individuals studied for this experiment were located during the night, which is when tarantulas are most active. Great care was taken when assessing each tree for the presence of a tarantula due to its inconspicuous body colouration and lack of eye shine from a head torch After a spider is found, the tree was then assessed to determine its species and if camera trapping in this location was possible. Tarantulas were sexed using direct observation; based on a criteria of both size and the presence of distinctive male pedipalps. Reconyx Camera traps were set up in front of the hole, and a secondary camera was set up if the spider did not reside near its hollow. Camera traps were set up on time lapse with use of a 5-second timer from 6 pm until 6 am.

Camera traps were checked each week to ensure they were operating, battery changes were made when required. SD cards were collected once a month and photos captured were analysed by eye and data collected by Reconyx camera traps was inputted into a spread sheet.

Commented [BG8]: What about the ecological characteristics of the site? Temperature, rainfall, humidity???? Kind of forest?

Commented [BG9]: First time you talk about camera trapping in your report… no mention of this innovative way of studying tarantulas in your introduction!

Commented [BG10]: Which ones? 800, 500?

Commented [BG11]: How regularly?

Commented [BG12]: Every???

When a potential male or juvenile is discovered its location and approximate size recorded in order to assess possible habitat choices for males of this species

Site 1: Site one was situated along a trail commonly used by researchers and in relatively close proximity to the research centre. The tree hollow was approximately 160cm from the ground and a depth of approximately 60cm. adjacent to bottom of the tree hollow possessed a second tree hollow, however, no attempts were taken to determine whether or not these hollows were connected.

Site 1 possessed a relatively high level of disturbance throughout the year due to human activities. Disturbance times were noted and the information used when analysing the photos. Alongside the analysis of camera trap data spider moults were also recovered from the site when discovered. Moults were stored and the age taken.

Two camera traps were set up at this site, with one camera directly facing the hollow and a secondary camera facing the spiders resting place (see Figure 1).

Figure 1: Picture showing camera trap set up of site 1 with one camera facing the hollow and the other the spiders resting place.

Site 2: Site two was situated approximately six metres from a main path with the hollow present in the tree residing approximately 200 cm from the ground. The depth of the tree hollow was unknown. The tree species was unknown

As this spider dwelled so close to a large amount of human activity, disturbance times were manually recorded by researchers as an approximate time and taken into consideration when reviewing the data. Disturbance was characterised by the spider entering its hole when exposed to human activity from vibrations or white light.

Commented [BG13]: How?

For this site only one camera was required in order to collect data and was tied to a post in order to capture data from the spider hollow.

Data analysis

Camera trapping data

For this experiment Reconyx camera traps were utilised. Reconyx camera model P-800 was chosen for use in the project because HC-500 was not able to run on timelapse. The cameras were all checked before being deployed in the field and supplied with charged alkaline or nimh batteries. SD cards used were programmed using the professional settings of reconyx to operate 24 hours a day and take photos in 5 minute intervals.

Regular checks were made to ensure the cameras were in operation and SD cards retrieved once batteries required changing.

The information collected by the Reconyx P-800 camera was extracted by software known as exif tool. The data was then inputted into Microsoft Excel and a number of variables isolated. Time, weather and moon phase being important variables extracted.

Following this data extraction, the photos were then analysed alongside the data retrieved from the camera trap itself. The spider's behaviour was determined based on its position on the tree and its activity was analysed in comparison to the temperature, moon phase and the time.

Results

A total of 4 females were located by researchers and their location assessed for the possibility of the deployment of a camera trap. Of those four, only 2 were deemed viable for use in the project due to the height in which the females resided.

P.everetti was only found reside in holes either naturally occurring in a tree or those created by a woodpecker and subsequently abandoned. 2 definite males were found during the study period and both males were discovered in or around human dwellings.

Although exact measurements were unable to be taken due to health and safety regulations in place, it was shown that the female individuals of this species were considerably larger than their male counterparts. The females possessed much larger abdomens, a reduced size in pedipalps and shorter, stockier legs. The males of this species in contrast were shown to be considerably smaller and with longer spindly legs and a smaller body size. In addition to this males were shown to have a larger more bulbous pedipalp.

P.everetti exited hole at times ranging from 6:00-6:20pm with an average time of 6:10pm. Individuals studied were recorded entering the hole at times ranging from 5:50-6:10am with an average time of 6:00am each morning.

During the full moon phase *P.everetti* was shown to have limited activity. Individuals studied were only noted to be actively hunting during 3 full moons with an average time of 9:00pm recorded.

P.everetti was shown to be a sit and wait predator who selected its hunting location on the tree on the same spot each night. Individuals were found to eat on average once every two weeks. However, following a large meal *P.everetti* was shown to retreat into its burrow earlier than usual and not hunt the following night. In addition to this, periods of fasting were observed in October, for one month. During this time *P.everetti* did not exit her hole at any time to hunt. *P.everetti* was found to eat invertebrates but identification to species level proved impossible due to the quality of the pictures taken and the positioning of the tarantula.

Following prey capture, *P.everetti* consumed its meal sat above its hole, an area *P.everetti only* used when feeding and grooming and no other times.

One mating event was observed in October with the discovery of juveniles being made in November. Although juveniles were difficult to count due to large numbers the approximate was >100.

During the course of November, juveniles were observed active outside of the tree hollow 24 hours a day. At the beginning of December a gradual dispersal was observed until only one juvenile remained, this juvenile remained present on the hollow of the tree for a further 3-5 months until it either dispersed or was eaten.

Discussion

The use of camera trapping proved to be an effective method of capturing the behaviour of large spiders like tarantulas who occupy one single dwelling. However, at periods during the year the predictability of the spiders hunting place reduced at times, this lead to pictures with an unknown location or behaviour of the spider, losing data. In light of this, Camera trapping of either male individuals, or individuals of a more active species would not be appropriate.

Picture quality proved to be quite restrictive when using the cameras at night. As the infrared pictures are greatly reduced in resolution. Moving the camera closer to the tree resulted in higher levels of picture resolution so prey identification could be carried out but photos during the day would be taken with the infrared flash on as the sensor would be too close to the tree resulting in unusable photos. So therefore camera trapping would only be appropriate for large species of invertebrates active during night but might be possible for smaller species during the day.

Using camera trap cameras that take pictures at regular intervals during the day everyday resulted in a greatly reduced battery output and even lead to cameras malfunctioning more quickly. For future experiments using the cameras professional features a more appropriate time schedule must be chosen to ensure the camera is not overworked which has led to the problems shown.

As shown in the literature (Cloudsley-Thompson & Constantinou 1985; Dor & Henaut 2013; Shillinton and McEwan 2006) most tarantulas are sit and wait predators and results from this study conform to this. Tarantulas are sit and wait predators due to their

evolutionary adaptations such as their heavy bodies and sensory hairs on their legs which detect movement. The tarantula is perfectly designed to opportunistically grab its prey.

Further evidence of this is shown by the sexual dimorphism found in spiders. Male spiders have been shown to have a much smaller body size in comparison to females and are much more mobile, often being found in and around out buildings and other human dwellings (Stradling 1994).

Commented [BG14]: This is the only reference on the species???

Although only one mating event was observed during the course of this experiment. The experiment duration did not last an entire calendar year, this led to the loss of data to conclude that only one mating event occurs each year and is proposed that a longer study would address this issue and allow future researchers to assess the number of mating events a year

Prior to this study there have been no behavioural studies on arboreal tarantulas in South East Asia meaning that this study was the first of its kind. The results from this study conform to (Stradling 1994 Cloudsley-Thompson & Constantinou 1985; Dor & Henaut 2013; Shillinton and McEwan 2006) when accounting the behaviour of tarantulas. In light of this, the behaviour of a tarantula is a very specialist one as it does not deviate across species or indeed across countries

Commented [BG15]: This is the only reference on the species???

Invertebrates were the only prey choice found in this experiment, however due to low resolution of photos it was not possible to determine the prey item on almost all occasions leading to limited data. Revisions of this experiment would be to include higher quality time lapse cameras such as DSLRs with an appropriate lighting set up and habituation period. This would lead to higher resolution photos and the correct identification of prey item down to the species level.

This experiment has proven the effectiveness of using camera traps to monitor the behaviour of micro species such as invertebrates which was not previously shown in literature, although there were some complications with the methodologies, revisions to this could lead to innovative research being carried out on the behaviour of invertebrates all over the world.

Acknowledgements

I would firstly like to thank Dr Benoit Goossens the director of Danau Girang Field centre, Miss Danica Stark and Mrs Meg Evans for allowing me to undertake scientific research at the centre. I would also like to thank PhD Dr Sergio Guerrero Sanchez,

Miss Valentine Thiry, Dr Luke Evans and Mr Richard Burger for their support throughout the year as both friends and academically. I would finally like to thank all the staff at DGFC for assisting me with scientific research in the field, the kitchen staff for feeding me every day and Miss Charlotte Cooper for her guidance as a friend and assisting with my project.

References

Ancrenaz, M., Goossens, B., Gimenez, O., Sawang, A. and Lackman-Ancrenaz, I. (2004). Determination of ape distribution and population size using ground and aerial surveys: a case study with orang-utans in lower Kinabatangan, Sabah, Malaysia. Animal Conservation 7: 375-385.

Azmi, R. (1998). Natural Vegetation of the Kinabatangan Floodplain. Part 1: An Introduction to the Natural Vegetation Including a Preliminary Checklist of the Region. WWF Malaysia, Kota Kinabalu, Sabah.

Bucherl, w. 1967. Escorpioes, aranhas e escolopendromorfos da Amazonia. Atas do Simposio sobre a Biota Amazonica 5(Zoologica): 111- 125

Cloudsleythompson, J. L. And Constantinou, C. (1985). Diurnal rhythm of activity in the arboreal tarantula *Avicularia avicularia* (l) (Mygalomorphae, Theraphosidae). Journal of Interdisciplinary Cycle Research 16:113-116.

Dor, A. and Henaut, Y. (2013). Importance of body size and hunting strategy during interactions between the Mexican red-rump tarantula (Brachypelma vagans) and the wolf spider Lycosa subfusca. Canadian Journal of Zoology-Revue Canadienne De Zoologie 91:545-553.

Fabricius C, Burger M & Hockey PAR (2003) Comparing biodiversity between protected areas and adjacent rangeland in xeric succulent thicket, South Africa: arthropods and reptiles. Journal of Applied Ecology 40: 392–403.

Kane, S. A. and Zamani, M. (2014). Falcons pursue prey using visual motion cues: new perspectives from animal-borne cameras. Journal of Experimental Biology 217:225-234.

Kang, C. K., Moon, J. Y., Lee, S. I. and Jablonski, P. G. (2012). Camouflage through an active choice of a resting spot and body orientation in moths. Journal of Evolutionary Biology 25:1695-1702.

Kang, C. K., Moon, J. Y., Lee, S. I. and Jablonski, P. G. (2013b). Moths on tree trunks seek out more cryptic positions when their current crypticity is low. Animal Behaviour 86:587-594.

Kuo, Y. C., Lee, M. A. and Lu, M. M. (2016). Association of Taiwan's October rainfall patterns with large-scale oceanic and atmospheric phenomena. Atmospheric Research 180:200-210.

Mattoni R, Longcore T & Novotny V (2000) Arthropod monitoring for fine-scale habitat analysis: a case study of the El Segundo sand dunes. Environmental Management 25: 445–452.

Noss, R.F. (1990) Indicators for monitoring biodiversity: a hierarchical approach. Conservation Biology 4, 355–364.

Petillon, J., Canard, A. and Ysnel, F. (2006). Spiders as indicators of microbabitat changes after a grass invasion in salt-marshes: synthetic results from a case study in the Mont-Saint-Michel Bay. Cahiers De Biologie Marine 47:11-18.

Shillington, C. and McEwen, B. (2006). Activity of juvenile tarantulas in and around the maternal burrow. Journal of Arachnology 34:261-265.

Soule D. F. (1998) Marine organisms as indicators: reality or wishful thinking? In: Marine Organisms as Indicators (Eds D. F. Soule & G. S. Keppel), pp. 1–11. Springer-Verlag, NY, USA.

Stradling, D. J. (1994). Distribution and behavioral ecology of an arboreal tarantula spider in Trinidad. Biotropica 26:84-97.

Tscharntke T, Sekercioglu CH, Dietsch TV, Sodhi NS, Hoehn P & Tylianakis JM (2008) Landscape constraints on functional diversity of birds and insects in tropical