A Comparison of Growth and Behavior in Group and Solitary Living *Monocentropus balfouri*

Nicolas Cazzaniga

Introduction:

Monocentropus balfouri was first described by Reginald Innes Pocock in 1897, on the Island of Socotra, off the coast of Yemen, part of the Yemen Republic(Pocock 1903). While it has since garnered minimal academic attention, the "Socotra island blue baboon" has been an object of increasing desire within the pet trade. It is not difficult to understand their popularity in terms of beauty, contrasting silvers and blues becoming very prominent in adult specimens. The species even won best in show at the 29th annual exhibition for the British tarantula society, and is called "fitam" which means Gemstone by the native people of the region.(Smith 2014), (Lister 2013) However, the source of their popularity further stems from a quality unique among Theraphosidae- communal tendencies.

First imported into Europe in the early 2000s, the species was originally exceedingly difficult to breed for even the most experienced keepers. Males and females would pair readily with minimal aggression, but egg sacks contained unexpectedly low numbers, with most nymphs not surviving once removed from the mother(Lister 2013). It was only after nymphs were left with the mother for the first several instars, that survival rates increased, though egg numbers never improved(Lister 2013). From here the species stabilized well and was brought over to the United States. It was only almost a decade later that the species was first documented to display communal tendencies. Because of the difficulty of separating dozens of offspring, breeders had begun to keep clutches together past the previously established period for mere survival, and were quickly surprised by the success of these newly founded colonies. Where other species had previously cannibalized, Monocentropus balfouri instead showed tolerance and complex behaviors, such as burrow sharing, prey sharing, and group foraging. These behaviors lend towards the prospect of true subsocial structure (Rayor 2013). This would add an additional unique route of evolution of social behavior among spiders, of which there have been only 18 recorded (Rayor 2013).

This all comes however, with many myths and assumptions perpetuated between hobbyists, with questionable support for these claims. One of the most significant in this case is that of higher rates of growth, and higher activity in solitary individuals. This capstone attempts to investigate this claim, alongside acting as a true scientific record of any communal behaviors, tolerance or otherwise, to be observed in group living individuals.

I hypothesize that while we may confirm many of these previously observed communal behaviors, it is unlikely that we will observe the perpetuated trends of

growth and behavior, given that we will be removing any limiting variables such as area, food, and water that may otherwise limit a communal living individual. In a captive setting such as this, with the usual limits on success of predation and resources (Rayor 1993)removed, pure instances of solitary vs communal existence should not greatly impact fitness of the individuals, in this case measured by growth and activity.

Materials and Methods:

Spiderling setup and care

Captive bred Spiderlings were sourced from a private breeder in order to ensure healthy specimens and species certainty. To ensure best sample size while taking account the factor of sex, individuals were broken up into 7 communal groups of 5, and 14 individuals. Individuals were housed in Tupperware of appropriate size determined by previous Theraphosid keeping experience, scaled up by volume between the solitary and communal groups. Soil volume was also standardized between the two treatments by number of individuals, ensuring enough soil for normal burrow development. Individuals were kept within the same incubator, maintained at 80* Fahrenheit. Individuals were fed once a week, and provided water at the same instances. Food was standardized per individual, and increased as growth dictated throughout the experience. Sex was determined using shed exuviae and a basic dissecting microscope, to ensure it had no significant effect on either growth and behavior.

Growth data collection

Growth was measured every 60 days and at the start of the experiment, over the course of 180 days. Growth was measured by diagonal leg span taken of the spiderlings themselves, measured from the tip of the front left leg, to the tip of the back right leg. DLS was chosen as a standard measurement for ease of measurement, alongside its ability to be taken regardless of stage within the molt cycle, in which weight and body length both fall short. DLS was taken at the fully outstretched position to ensure accuracy.

Behavior data collection

Behavior was recorded approximately every 3 days, at approximately 6:00pm in accordance with natural activity periods. Behavior was recorded generally, as any level of surface activity within the period of observation. Those periods in which behavior were not regularly recorded were due simply to unavoidable timing obstacles such as travel or illness. Communal specific behaviors were recorded throughout the experiment at any time they were observed, for the sake of general documentation.

Data Analysis

Numerical data was processed using Microsoft excel, and basic single way ANOVAs were run to determine statistical significance between solitary and communal groups as well as the significance of sex, using the excel data analysis toolpak. Figures were also generated using Microsoft excel.

Results:

Figure 1 displays the behavioral data in totality, averaging the communal groups against all of the solitary individuals. Very clearly the solitary individuals display higher levels of activity overall, as is supported by the values presented in figure 3, the single way ANOVA that was performed to identify statistical significance. This being said, this data does show quite a bit of variation between solitary individuals.

Figure 2 displays diagonal leg span over time, and while there is visible separation to the figure, the standard deviations show there is no significant difference in general DLS. Figure 4 consists of comparing change in DLS in an ANOVA, in which no statistical significance was observed as well. Change in DLS was used in the case of the ANOVA, as original DLS was not consistent individual to individual.

Figures 5 and 6 display the ANOVAs for significance of sex, in both cases showing no significance on either factor. In this case only solitary specimens had their sex determined. It would be beneficial in future studies to increase sample size given how close the P value is to significance.

Discussion:

Solitary groups showed a distinct higher level of activity compared to the communal group individuals, with some impressive variation between one another. I would most likely attribute this to some degree of seeking behavior, given some of the complex behaviors also observed that point towards true communal status. Individuals that were not exposed to others during this stage of life may be more likely to spend their time seeking out other individuals, which could explain the trends in activity that we observed.

This being said, even with this higher activity among solitary individuals, growth remained relatively similar in both parties. This follows the expected pattern in which when removing the regular limiting factors of growth such as temperature or food, communal living itself does not have a significant impact on growth rate. Having said this, it was observed in 3 communal groups that the runt of the group did perish as the experiment went on, despite having bountiful space and food. In at least one of these cases, a body was actually recovered, indicating that this was not necessarily due to cannibalistic tendencies of the other individuals. It is most likely that these runts were simply outcompeted. In a case such as this species in which social casts are not yet very clear, some level of self preservation likely remains despite evolving complex social behaviors. This would indicate some level of intergroup competition over resources even in the case of abundance, which could lead to the starvation of individuals that lag behind due to any other variables, as they are not able to compete with the larger individuals of the group.

In terms of Social behavior within the communal groups, several examples were observed and recorded. Once introduced into a new habitat, individuals sought out areas for and constructed independent “precursor” burrows, in order to have some degree of shelter in a new environment. However, by one week’s time into the experiment, all of these burrows had been abandoned in all communal groups.

Progressively as the week went by, individuals began to congregate together, eventually forming one cohesive network of burrows in a specific corner of the larger provided habitat. In this same vein, individuals were observed cooperating in burrow construction, as well as sharing burrows throughout the experiment. In many cases these individuals even congregated to the same area of the burrow, and were frequently observed in physical contact with one another.

In addition to these burrow tendencies, on multiple occasions, individuals were shown to display prey sharing behavior. Often when one individual would discover a prey item, others would quickly arrive to take part in the larger meal. In addition to this, individuals were shown to exhibit a type of following behavior in varying groups, in which one lead spider was followed directly by other individuals roaming about the greater habitat. This behavior was significantly different than the observed activity in solitary habitats, and occurred far less often. This is somewhat reminiscent of dispersal behavior recorded in several Central and South American Theraphosidae, but despite having the area to disperse, individuals always returned to the greater burrow complex. It would likely be beneficial to provide an even larger enclosure size in order to observe this behavior in greater depth, to ensure that the constraints of unknown terrain were not suppressing dispersal if this was in fact the same behavior being observed.

Finally, individuals generally displayed tolerance for one another that indicates some level of recognition. On multiple occasions during feeding and maintenance, spiderlings showed defensive displays and striking towards cleaning implements, as well as prey items they were startled by. When facing other individuals however, even in the unnatural situation of removal for data collection, no defensive behavior was observed between individuals, and individuals upon contact with others would often cluster together in holding containers prior to measurement.

Given all of these behaviors, some sociality within the species must be acknowledged. The degree to which and under what conditions this sociality does occur however, may be better explored in further studies. It can also be said with some certainty that the myth of increased growth and behavior by solitary culture, within the allotted timeframe, only proved true in terms of behavior. It should also be noted that the observed behavior could also be considered negative, given the potential implications of stress in seeking behavior, despite benefit of viewing for the keeper. To truly conclude an explanation for this increased behavior however, further studies are recommended.

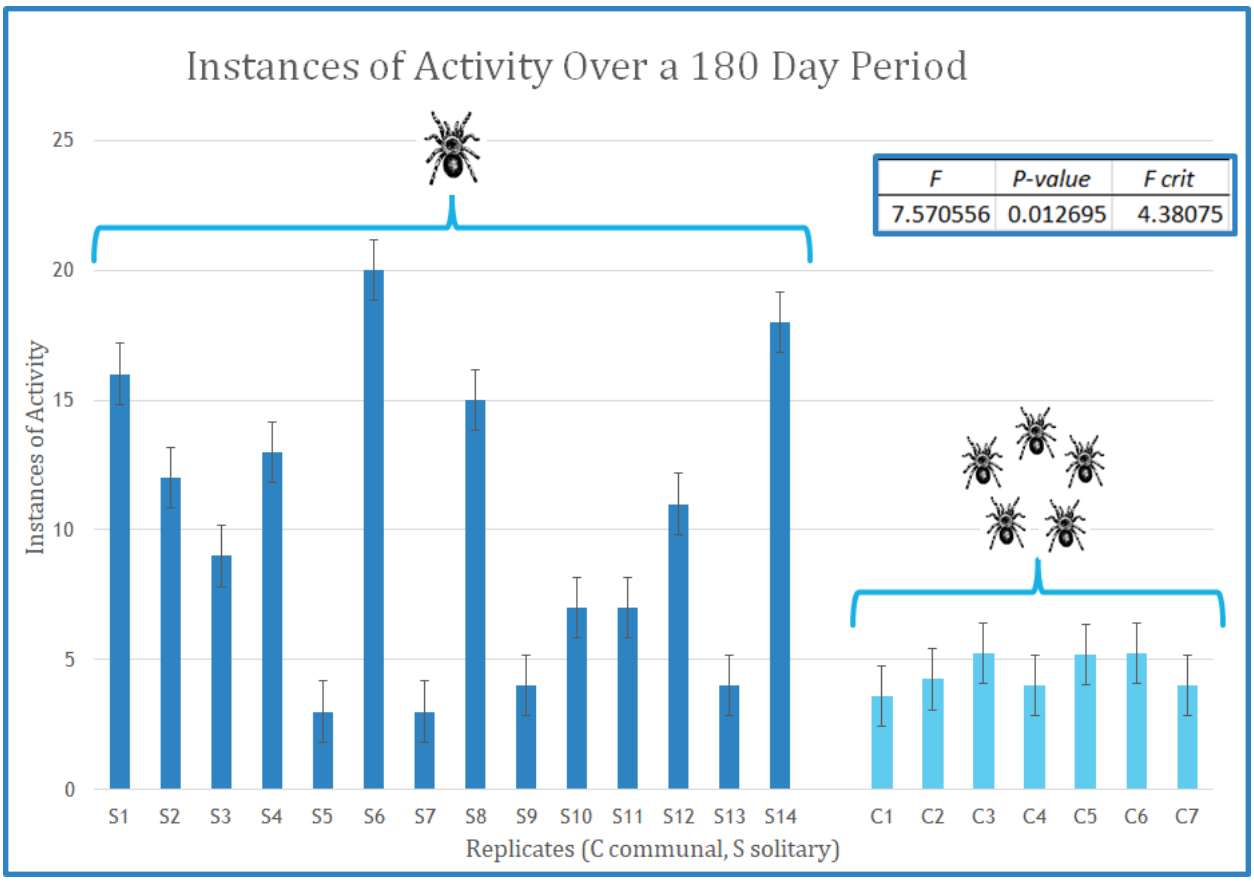

Figure 1. Spiderling activity over the course of the 180 day period, separated between communal and solitary living. Averages were taken for communal individuals as it was impossible to know which individuals were responsible for what activity.

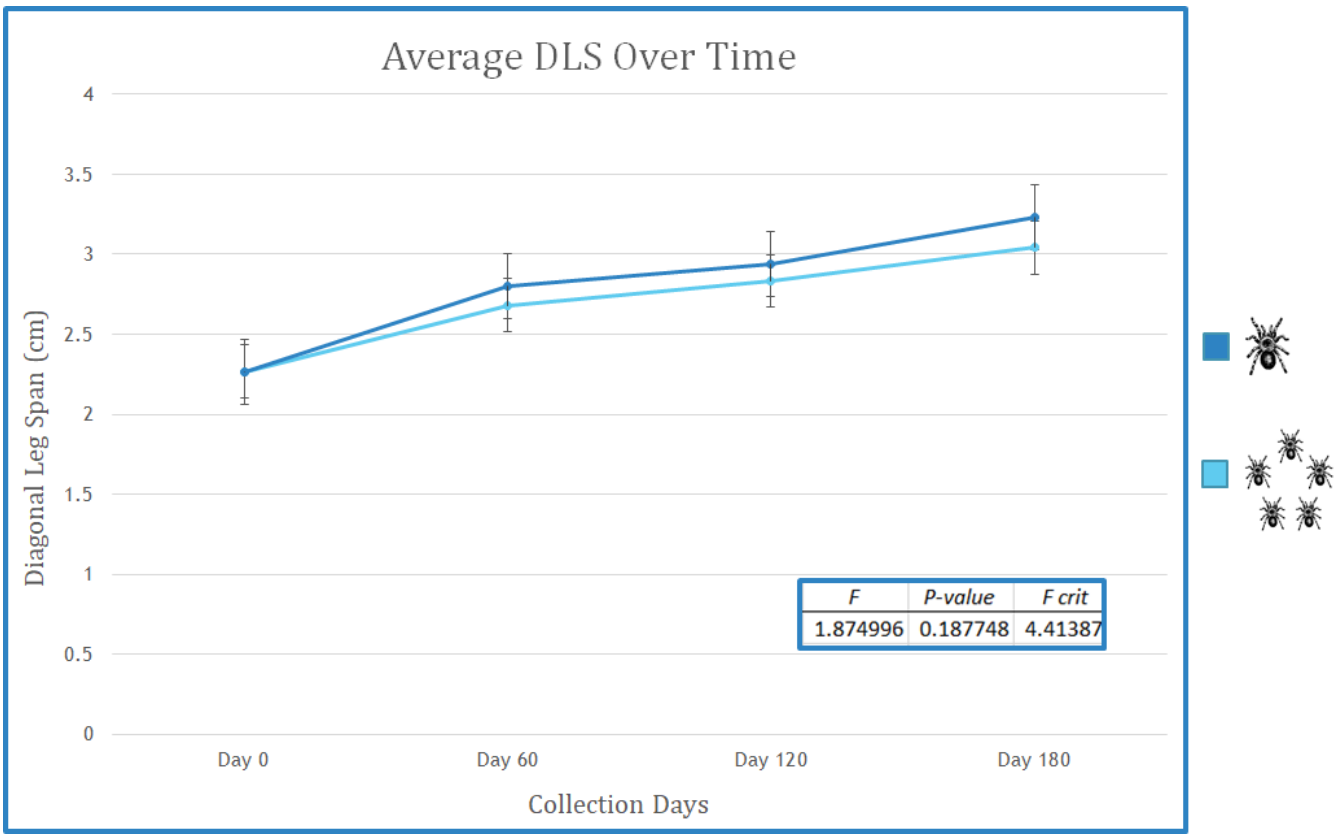

Figure 2. Average diagonal leg span among communal and solitary living *Monocentropus balfouri* over the course of a 180 day period.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	171.2152	1	171.2152	7.570556	0.012695	4.38075
Within Groups	429.7029	19	22.61594			
Total	600.9181	20				

Figure 3. One way ANOVA of behavior between solitary and communal living individuals.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.157672	1	0.157672	1.874996	0.187748	4.413873
Within Groups	1.513658	18	0.084092			
Total	1.67133	19				

Figure 4. One way ANOVA of growth between solitary and communal living individuals.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.364805	1	0.364805	4.942522	0.053287	5.117355
Within Groups	0.664286	9	0.07381			
Total	1.029091	10				

Figure 5. One way ANOVA of growth between males and females.

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	9.52381	1	9.52381	0.295058	0.596943	4.747225
Within Groups	387.3333	12	32.27778			
Total	396.8571	13				

Figure 6. One way ANOVA of behavior between solitary and communal living individuals.

References cited:

Pocock, R. I. 1903: On the geographical distribution of spiders of the order Mygalomorphae. Proc. zool. Soc. Lond. 1903

"Monocentropus Balfouri." ***Theraphosidae*****, 1 May 2019**, https://www.theraphosidae.be/en/monocentropus-balfouri/.

Smith, Roff. "World's Prettiest Tarantula Takes Best in Show 2014." *National Geographic*, 22 May 2014, https://www.nationalgeographic.com/news/2014/5/140521-tarantula-coventry-british-tarantula-society-theraphosidae-science-world/.

Rayor, L.S. & Uetz, G.W. Oecologia (1993) 95: 1. https://doi.org/10.1007/BF00649499

Rayor, L.S. & Uetz, G.W. Behav Ecol Sociobiol (1990) 27: 77. https://doi.org/10.1007/BF00168449

Yip, Eric C., and Linda S. Rayor. "Maternal Care and Subsocial Behaviour in Spiders." *Biological Reviews*, vol. 89, no. 2, 2013, pp. 427–449., doi:10.1111/brv.12060.

Smith, J.J.; Herzig, V.; Ikonomopoulou, M.P.; Dziemborowicz, S.; Bosmans, F.; Nicholson, G.M.; King, G.F. Insect-Active Toxins with Promiscuous Pharmacology from the African Theraphosid Spider *Monocentropus balfouri*. *Toxins* **2017**, *9*, 155.

Dor, Ariane & HÉNAUT, Yann. (2012). Silk use and spiderling behavior in the tarantula Brachypelma vagans (Araneae: Theraphosidae). Acta Zool. Mex. 28. 1-12. 10.21829/azm.2012.281812.