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Behavior of Marmosets (*Callithricidae*) in Non-Traditional Exhibits

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Behavior of marmosets (*Callithricidae*) in non-traditional exhibits

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Abstract

Marmosets and other members of the family Callitrichidae are very popular exhibits in zoos, mainly due to their attractive coats and entertaining social displays. Since they are highly social creatures, it is essential that they are kept in conditions that promote social stability. In many zoos, exhibits are designed in arrangements such as solitary or mixed-species enclosures that vary from traditional family groups. These alternative arrangements are solutions to financial constraints and a lack of spatial resources. This study sought to understand the effect of these arrangements on the behavior of callitrichids.

At the Perth Zoo, a mixed-species exhibit composed of a Common marmoset (*Callithrix jacchus*) and several Pygmy marmosets (*Callithrix pygmaea*), in addition to a solitary Emperor tamarin (*Saguinas imperator*), was compared to a breeding group of Pygmy marmosets using a behavioral ethogram. Furthermore, any attempts by zoo visitors to feed the monkeys were observed as this has become a problem at the zoo. Results show that the mixed-species exhibit is as stable as the breeding Pygmy marmoset group, and there were many displays of affiliative behavior between the two marmoset species. Some signs of stress were exhibited by the Emperor tamarin, which may necessitate his placement in a more preferable social arrangement at another zoo, if possible. Any feeding of the primates was minimal, but having more visible signs to educate visitors may discourage further feeding attempts.

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Introduction

Zoos are often faced with difficult decisions in arranging exhibits while trying to maintain animal wellbeing and promote visitor interest. When managing these constraints, animals are sometimes placed in conditions that are seen as not ideal due to a lack of resources. In these accommodations, it is important to monitor the animals in order to ensure they are settling in to the novel situations while also looking for any potential problems that may arise.

A common example of making the most of these constraints is by combining animals in a mixed-species exhibit, which showcase multiple species of animals in the same enclosure. Although most of the time these exhibits are set up because of spatial constraints, there are sometimes benefits of such arrangements. Mixed-species exhibits imitate natural overlap in sympatric species found in the wild. For example, increasing species diversity increases the social complexity of the exhibit, enhancing stimulation that may contribute to animal wellbeing (Buchanan-Smith 2011). However, there is always risk of aggression in an unconventional animal pairing, especially if they are known competitors in the wild. Especially in the arrangement of Neotropical monkeys in mixed-species arrangements, there is a history of unsuccessful mixed pairings (Buchanan-Smith 2012). These risks and potential benefits must be taken into consideration when proceeding with any mixed-species exhibit.

At the Perth Zoo, there is currently a mixed-species exhibit of three Pygmy marmosets (*Callithrix pygmaea*) and an adult Common marmoset (*Callithrix jacchus*). While these conditions seem to pose no problems, it is important to

examine if these conditions have any effects on the behavior of these animals. In past studies of mixed enclosures, there have been few successful attempts at mixing the Common marmoset with other primates (Buchanan-Smith 2012). Social ties are quite strong in marmosets, so being separated from conspecifics may increase aggression in captivity (Epple 1975). However, this combination of Pygmy marmosets and Common marmosets has not been recorded in the literature, so this novel arrangement may be non-violent.

Additionally, there is an adjacent exhibit featuring an Emperor tamarin (*Saguinus imperator*) that is in isolation. Although ideally he will be transferred to another zoo to be paired with a mate, his current conditions need to be examined.

These primates, in the family Callithricidae, are housed in arrangements outside of the ideal family group. Furthermore, there is a breeding group of Pygmy marmosets nearby that can serve as a comparison for these exhibits. This project investigates how these Neotropical primates are affected by social arrangements that are not single-species groups in exhibits.

Another addendum to this project will examine interactions between patrons of the zoo and the monkeys. Despite a number of signs around the exhibit pointing out the fatal consequences of feeding the monkeys, many visitors have been caught on camera offering food to the primates. An independent assessment of people feeding the primates was conducted to see if the animals actually take the food, and if they do, if this results in behavioral changes to actively search for it.

Background Information

The family Callithricidae is composed of both tamarins and marmosets, though the term “Marmoset” can refer to all members of this family. Some distinguishing features are that tamarins have longer lower canines than incisors, while the genus *Callithrix* has lower canines level with incisors, representing a difference in diet (Epple 1975). Although these can be used to differentiate the primates at the genus level, there are many more characteristics that group them together. Members of this family are small-bodied, arboreal, and diurnal, found mainly in forest and forest edges no higher than 20ft in the canopies of the Neotropics (Epple 1975). They consume tree or vine exudate, which is a key source of carbohydrates, as well as available fruit and insects (Soini 1988). Other shared characteristics include a lack of sexual dimorphism, a high occurrence of twins, and the tendency for older offspring to help care for newborns (Anzenberger & Falk 2012).

Affectional ties among kin are quite strong, but aggressive behavior may increase in captivity if there is insufficient space in an exhibit (Epple 1975). For this reason, members of this family are frequently housed in family unit structures or exhibits that mimic the social hierarchy in place. Overall these primates can be very aggressive, and severe fighting between adults has resulted in injury and death, especially for Pygmy and Common marmosets (Epple 1967, Christen 1968). To this end, it is essential for the wellbeing of the animals that they are housed in low-stress conditions that facilitate positive interactions between group members.

The natural range for the Pygmy marmoset is the western Amazon region in lowland evergreen forests in areas from 0.3-0.4 hectares (Soini 1988). For the Common marmoset, the home range is in the rainforests of Eastern Brazil. Though both Neotropical marmosets, there is no natural overlap in home range, and therefore no natural association in the wild. Whether this association can persist in captivity remains the focus of this study. Because of the territorial nature of marmosets, there may be some conflicts observed, with the larger Common marmoset displacing the smaller Pygmy marmoset. Informal interviews with zoo staff revealed that there is no history of violence, but further investigations will reveal the true nature of the relationships between the two species of marmosets. There may be subtle signs of tension in the exhibit that are shown at times when zoo-keeping staff are absent. Increases in locomotion, scent-marking, and self-scratching are seen as signs of stress for marmosets (Bassett et al. 2003). If these behaviors are observed at high rates in the mixed enclosure, it is possible that the Common marmoset may be under stress due to being housed with the Pygmy marmosets or vice versa. As compared to the breeding group of Pygmy marmosets, these signs of stress will be absent or at lower frequency in behavioral observations.

The lone Emperor tamarin may also exhibit signs of stress, since Callithricids are social creatures. Separation from social groups may cause severe stress (Anzenberger & Falk 2012). These signs of stress, like a reduction in resting as suggested by previous studies of stress in Emperor tamarins, may be more apparent when carefully observed (Pepper & Martin 2005). The aim of

this study is to evaluate the current state of each of these primate groups as a baseline for comparison with future assessments of animal wellbeing.

Methods

Study Species:

The individuals studied are a 13-year-old Common marmoset, nicknamed “Huey”, who is in a mixed-species exhibit with three 2-year-old female Pygmy marmosets; the breeding group of Pygmy marmosets composed of an 8-year-old male, 6-year old female, year-old daughter and juvenile; and the 5-year-old male Emperor tamarin who is in his own enclosure next to the mixed-species exhibit.

In the morning, each is fed Tamarin Cakes, with a mid-day snack of tamarin fruit and vegetable mix. The afternoon snack consists of egg, mealworms or crickets or roaches, tamarin cake, and chicken, while the Emperor tamarin is fed tamarin fruit and vegetable mix and moths or snails. One final late afternoon snack of Acacia gum is given from 3-5pm, and the Emperor tamarin receives hard gum logs twice per week (M. Tyler pers. comm.)

Experimental Design

Observations of behavior were conducted from 8:00AM-12PM over a 2-week period at the Perth Zoo. This timing was chosen in order to provide adequate observations around feeding time and when feeding by visitors were most likely. I used focal-animal sampling, which focused on recording all of the actions of focal animals (i.e. the Common marmoset) for a defined period of one minute and not recording the behavior of the other animals in the exhibit. This

observational method was best given the marmosets' small range of behaviors and the difficulty of observing the primates for long periods of time, as they move around very quickly and camouflage well in the exhibit. The behavior that made up the majority of the time sequence was documented. After a minute was over, the behavior of the next animal was recorded. Overall, behavior was observed for a minute every five minutes for a 10 minute sequence every hour. If an animal could not be followed for a whole minute, the recording period was terminated and I moved on to observing the next animal. Many feeding times were also observed, and the group of marmosets observed during feeding time was rotated every day.

The behavior of these species is poorly studied in the wild, but many studies are available on *Callithricidae* in captivity. Presence of key behaviors such as agonism due to unstable peer groups can be used as a measure of animal welfare (Duncan & Fraser, 1997). Other behaviors, such as increases in locomotion, scent-marking, and self-scratching can be indicators of stress in marmosets as well (Basset et al. 2003). These behaviors, in addition to the most common behavior of resting, were composed in an ethogram to observe the marmosets. See Table 1 below for behavioral categories and definitions. Behavioral categories were designed based on past studies of lesser primate behaviors in zoos and the most frequent observed behaviors found in preliminary studies of the marmosets (Stevenson & Poole 1976, Basset et al. 2003, Townsend 2001).

Locomotion: The individual moves between locations by walking, climbing, running or jumping (Stevenson & Poole 1976).

Resting: When a single individual remains alert, sitting or lying down in any part of the exhibit without engaging in other activity. This also includes hanging and swinging by the arms without moving in a particular direction

Self-Grooming: When a single individual uses hands, feet, or mouth to scratch, comb, or groom its head, limbs, or body.

Foraging: Activity related to acquiring or ingesting food

Affiliative Behavior: When two or more individuals are involved in activity with one another. This includes huddling/sleeping together, grooming each other, and playing with each other.

Out of site: The individual is out of the exhibit site and is unable to be seen.

Table 1. Behavioral categories and definitions used to categorize the behavior of the captive animals.

Data was normalized in order to account for variation in group size.

Because the Pygmy marmosets were almost always impossible to distinguish individually, each group of Pygmy marmosets were compared as a single individual. Additionally, sums of time observed doing each behavior were used instead of averages, as the standard error for each behavior was too large due to daily variations in behavior. Data was analyzed using Fischer's Exact Test in a 6x2 contingency table comparing the sums of behavioral data for each primate to the breeding group of *C. pygmaea* acting as the expected value, given that this exhibit has members in a healthy breeding group.

Results

Each individual was observed for a total of 102 minutes throughout the two-week observation period. When comparing the Pygmy marmoset breeding group to the group in the mixed-species exhibit, there were no significant differences in terms of behavior ($p=0.061$, $df=5$). There are certain discrepancies

between the two groups, such as higher resting time and less affiliative behavior in the mixed-species exhibit group (Fig. 1). However, this may be attributed to differences in age, sex, and natural variation in behavior between comparable groups.

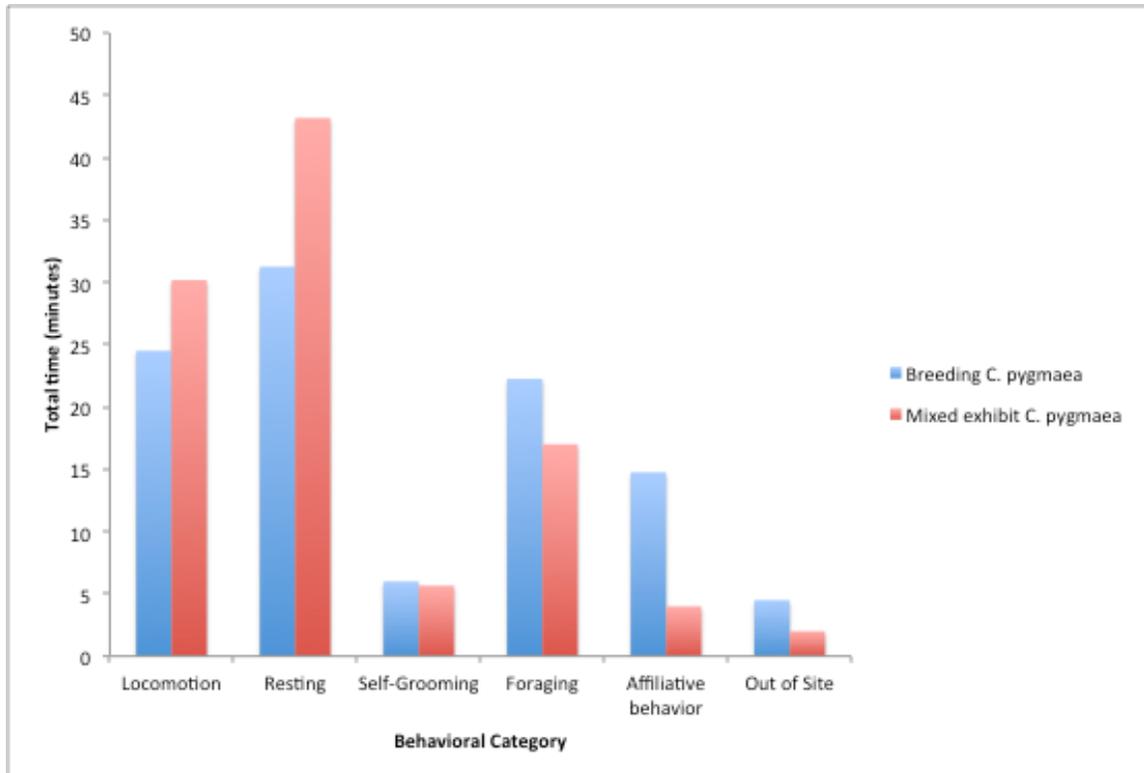


Figure 1. The behavior of *C. pygmaea* in a mixed-species exhibit compared to a breeding group at the Perth Zoo.

Though not perfect comparisons, other links can be drawn between the Common marmoset and Emperor tamarin and the breeding group of Pygmy marmosets. When comparing the Common marmoset to the congeneric breeding group of Pygmy marmosets, there are significant differences ($p=0.003$, $df=5$). This can be seen in the higher amounts of locomotive and resting activity exhibited by the Common marmoset and the lower amounts of affiliative behavior (Fig. 2). The Emperor tamarin's behavior differed significantly from the

confamilial breeding group of Pygmy marmosets ($p < 0.001$, $df = 5$). The Emperor tamarin exhibited far more locomotion and spent less time foraging and no time engaging in affiliative behavior, as he was alone in the exhibit (Fig. 3).

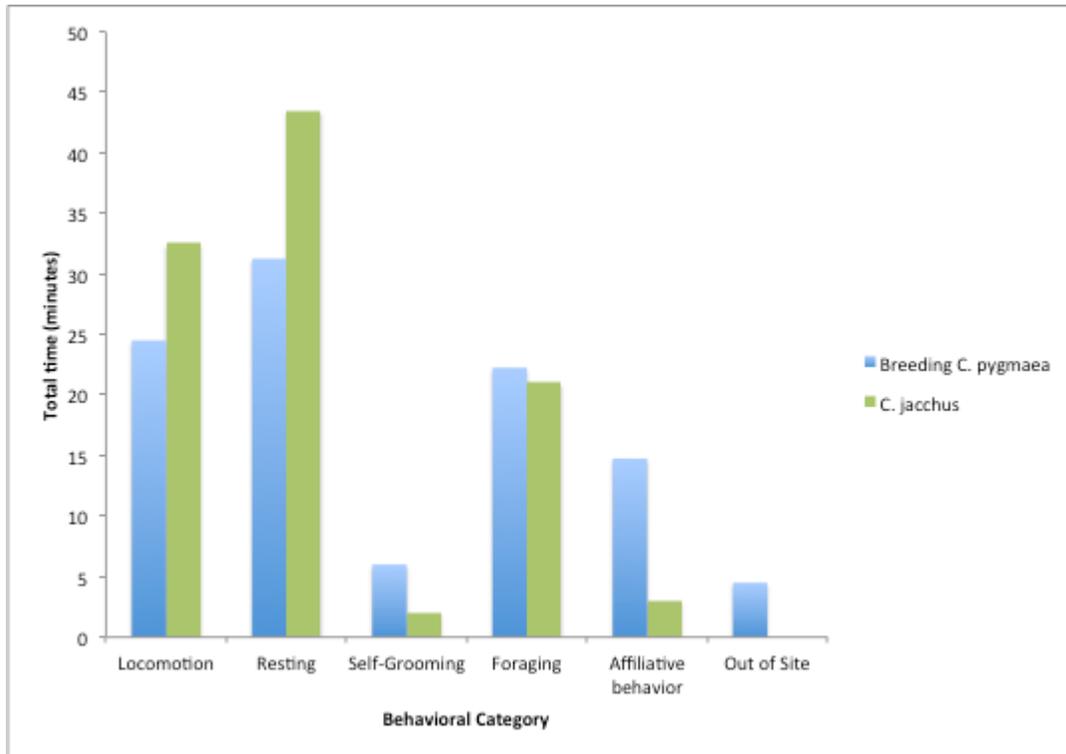


Figure 2. Behavior of *C. jacchus* compared to that of a congeneric breeding *C. pygmaea* group at the Perth Zoo.

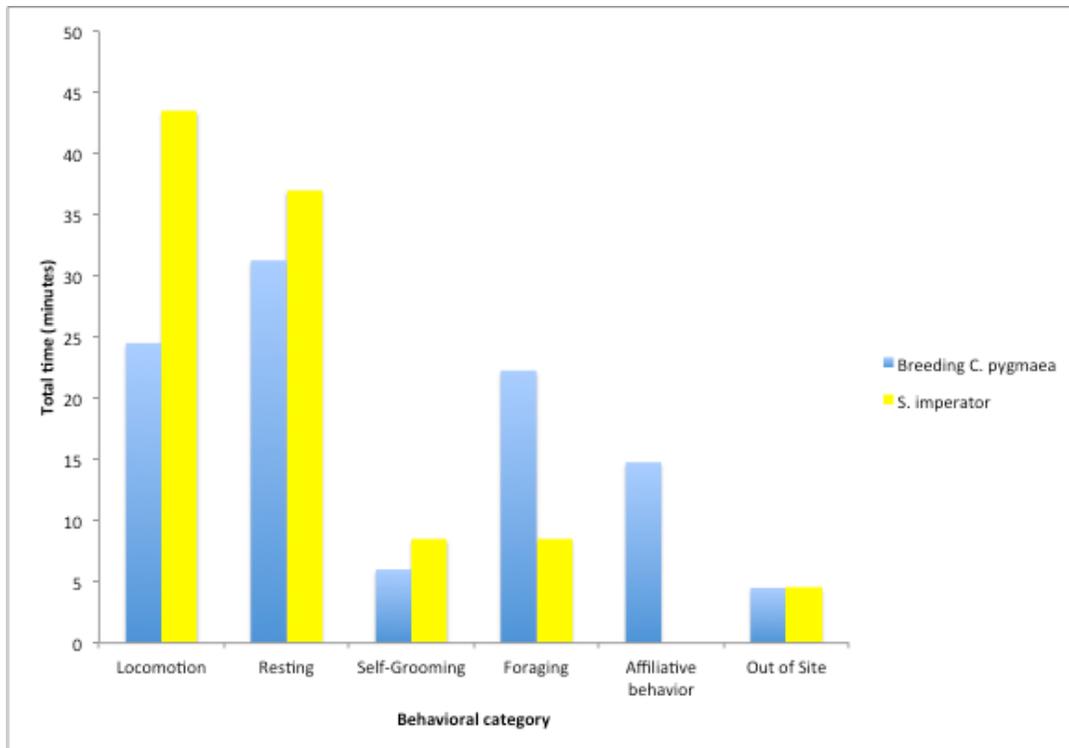


Figure 3. The behavior of *S. imperator* compared to a confamilial breeding group of *C. pygmaea* at the Perth Zoo.

Several attempts at feeding the Emperor tamarin were witnessed. A man and woman were eating a bag of Samboy chips when they noticed the tamarin in the exhibit. The man then held out the chip close to the cage for around a minute, with no response from the tamarin. Another boy eating a banana talked about feeding it to the marmosets, but they were not present and were not fed. Most of the time, lots of comments on the signs were overheard near the breeding Pygmy marmoset exhibit, with parents explaining to their children not to feed them and why it would be harmful for them.

Discussion

When analyzing the results it is critical to keep in mind that this is a baseline study for the behavior of the marmoset groups. This assessment of the

behavior of these groups of animals can be compared to later tests or analyzed for improvements. With that being said, there are certainly some deductions that can be made with respect to behavioral trends.

First off, the non-breeding group of Pygmy marmosets can be utilized as a control in this scenario. This family unit mirrors that of an ideal marmoset group, since family units are the most attractive groups for exhibits (Anzenberger & Falk 2012). The behavior of these groups can be compared to previous observations of Pygmy marmosets in captivity. About 32% of a Pygmy marmoset's time is spent consuming or looking for food (Ramirez et al. 1997). The breeding group of Pygmy marmosets is comparable, foraging for about 25% of the time (Fig. 1). Additionally, allogrooming or social grooming takes up 9% of the day, but can be up to 20% after an offspring is born (Soini 1988). The breeding Pygmy marmoset group matches up with this norm, with 15% of time spent engaging in affiliative behavior, which mostly consisted of social grooming (Fig. 1). Lots of movements of the tongue in-and-out were also seen, which is a sign of positive social interaction (Stevenson & Poole 1976). The breeding group of Pygmy marmosets is engaging in a healthy amount of social behavior and locomotion.

From this benchmark, comparisons between the other marmosets and the breeding pygmy group can be made. As the differences between the breeding Pygmy marmoset group and the group in the mixed-species exhibit are not significant ($p=0.065$), any variations from the Pygmy marmosets in the mixed-species exhibit can be attributed to normal variations in behavior. That being said, the lower amounts of affiliative behavior demonstrated by the Pygmy

marmosets in the mixed-species exhibit, in addition to the higher amounts of resting and locomotion, may be due to living arrangements that are outside a standard family structure. Housing in accommodations other than in the standard monogamous breeding pair with their offspring has been shown to be stable in same-sex sibling groups (Sodoro & Saunders 1999). Lower levels of affiliative behavior may simply be attributed to the fact that parents groom offspring more than any other members of a social group (Wamboldt et al. 1988). Family units are more likely to have a wider diversity of behaviors than other social arrangements for Callithricids (Anzenberger & Falk 2012). This explains the variations in the behavior of the Pygmy marmosets in the mixed-species group and is in no way indicative of an unstable group.

On the contrary, the Pygmy marmosets and the Common marmoset appear to be coexisting peacefully in a mixed-species exhibit. There is minimal difference in terms of displacement behavior, such as self-grooming or scratching, which is thought to be a sign of anxiety (Basset et al. 2003). There were also lots of tongue in-and-out movements observed between the Common marmosets and Pygmy marmosets, which is a sign of positive social interaction as stated earlier. The Common marmoset allocated its behavior in a similar fashion to the other marmosets in the exhibit, with higher amounts of locomotion and resting with less affiliative behavior than the breeding group of Pygmy marmosets (Fig. 2). Because these marmoset housing arrangements are not family unit structures, there is less affiliative behavior and more time spent resting and in locomotion.

However, there was some allogrooming witnessed between the two species. During social grooming between two Pygmy marmosets, the Common marmoset approached the two and began grooming one of them, while the other ran off. The grooming was then reciprocated by the Pygmy marmoset, who jumped on the Common marmoset's back. On multiple other occasions, they were seen grooming each other and the gesture was returned. A Pygmy marmoset was even seen approaching the Common marmoset for grooming, which was also reciprocated. Grooming is an important way of forming social ties in marmosets, in addition to the health benefit of minimizing parasite load (Ramirez et al. 1977). The presence of this behavior suggests that the Common marmoset and the Pygmy marmoset have positive social relations. Grooming between Pygmy marmosets did occur far more often, and the Common marmoset is most likely not spending as much time grooming as he would in a conspecific social arrangement. The common marmoset only spent 3% of his time allogrooming (Fig. 2), compared with other previous studies show adult Common marmosets spend 7% of their time allogrooming (Stevenson & Poole 1973).

There were also some displays of dominance. Typically in a mixed-species exhibit, the larger animal will be dominant to the smaller animal (Buchanan-Smith 2012). Several times, the Common marmoset was seen to assert dominance over a Pygmy marmoset at the feeding bowl or in passing. When the Common marmoset came across a Pygmy marmoset, most of the time the Pygmy marmoset avoided him and moved out of his path. They were very

wary of him most of the time and watched him carefully if he approached while they were foraging. Avoidance of the dominant animal by inferiors is an indication of rank in a group (Epple 1968) Multiple instances when the Pygmy marmosets did not mind him crossing overhead or feeding at the food bowl at the same time were also noted. One of the females even displayed at him during a hand-feeding, but he gave no response. Scent-marking on tree branches by the Pygmy marmosets was also occasionally observed. Displaying genitalia and scent-marking is often seen as a sign of aggressive threats by dominant females (Epple 1968). However, none of these behaviors elicited any noticeable responses from other members of the group. The Common marmoset was also seen scent-marking the bowl, which is seen as a sign of territoriality (Lazaro-Perea et al. 1999). He often approaches the bowl for food first or second during feeding times, while the other Pygmy marmosets got food regardless of his presence. Oftentimes, the Pygmy marmosets would consume their food away from the bowl if the Common marmoset approached for food. The Common marmoset most likely has assumed the dominant position in this exhibit, along with a female Pygmy marmoset that also displays dominant behavior.

Although the Emperor tamarin is not in the same genus as the marmosets, comparisons to confamilials can still be made with this in mind. The Emperor tamarin differed significantly from the other marmosets in terms of its behavior with higher locomotion, less foraging, and no affiliative behavior ($p < 0.001$, $df = 5$). Higher amounts of locomotion can be a signal of stress, and thus reduced welfare in Callithricids (Basset et al. 2003). The Emperor tamarin spent 44% of

his time in locomotion, nearly double that of the other marmosets (Fig. 3). The high amount of locomotive behavior could be a sign that he is under stress, perhaps from his present isolated conditions. Additionally, he was frequently observed self-grooming in shorter bouts throughout the observation time, so the data may not reflect his actual levels of self-grooming. Higher levels of self-grooming are also seen to be a sign of stress in marmosets (Basset et al. 2003). Although his levels of self-grooming do not appear to be much higher than those of the marmosets, qualitative observations showed that he engages in a high amount of self-scratching and self-grooming which may indicate stress due to isolation.

The Emperor tamarin was also observed to ritualistically run around the exhibit in a loop before going out of the site, then re-emerging into the exhibit to repeat the routine. He would then continue to repeat this behavior over half a dozen times before stopping. Most often this behavior was observed in the mornings before the first feeding, and it stopped when the keeper gave the Emperor tamarin food. The behavior was often triggered by the presence of a zookeeper walking nearby with jingling keys. The Emperor tamarin may be expressing some anxiety before feeding, as this behavior came about prior to feeding time, and he immediately approached his food bowl when it was given to him. Repetitive, persistent behavior with no obvious purpose is known as stereotypy, and it is associated with social isolation in monkeys and humans and can be an indication of poor wellbeing (Ridley & Baker 1982). Because primates generally live in social groups, individual housing and solitary confinement can

exacerbate stereotypy (Philbin 1998). The social isolation of the Emperor tamarin may be contributing to his stereotypic behavior, and his need for social interaction with other tamarins is apparent.

Furthermore, the Emperor tamarin was seen vocalizing many times. Oftentimes, the call was returned by a set of Common-top tamarins in an enclosure nearby. The call may be a contact call by an isolated individual (Epple 1968). His calling to the other tamarin group emphasizes his isolation, and this may also be contributing to an increased level of stress. Although there are financial and resource constraints, moving the Emperor tamarin to an exhibit with a female partner pair would improve his wellbeing and reduce stress, since most of the time introductions of unfamiliar heterosexual pairs do not result in complications (Anzenberger & Falk 2012). Other recommendations include introducing the Emperor tamarin into a fatherless group, with all female offspring (Anzenberg & Falk 2012). The reason for this is that juvenile males may conflict with the adult male, especially since this individual has a known history of aggression with other males, but there is less chance of conflict in an all-female group.

As for zoo patrons feeding the monkeys, the educational signs appear to be effective. Lots of discussions were overheard regarding the signs, and many visitors seemed to notice them. These conversations most often occurred near the breeding Pygmy marmoset exhibit, as the signs are more visible there. The sign near the mixed-species exhibit was not as noticeable, as it is surrounded by thick foliage and has a damaged post that causes it to lean back against the

cage. Few people were heard discussing the sign, and all of the attempts to feed the monkeys were seen near this exhibit. Although there were few feeding attempts witnessed, it is possible that there are higher amounts of feeding over the weekends when higher crowds come through to see the exhibits. If multiple people were willing to attempt feeding during the earlier mornings, it is likely that feeding the marmosets is a potential issue. If people were to successfully give salty, greasy food like chips to the marmosets, it could cause significant health problems for them.

However, there were many positive responses to the signs around the breeding Pygmy marmoset exhibit, suggesting that restoring the sign near the mixed-species exhibit may be effective in reducing the number of people attempting to feed the marmosets. Replacing the sign and putting it in a more visible location, such as in front of the thick foliage, would draw more attention to it and remind people to not feed the marmosets. If necessary, putting a sign on the cages may be effective as well, since then people would notice the sign when looking at the exhibit.

This study was conducted over a relatively short time period, consisting of just the mornings during the weekdays for two weeks. Far greater crowds of people come in over the weekends, and a larger diversity of people as well, since during the workweek most visitors are school groups or stay-at-home families with small children. This could mean that the scale at which people are feeding the marmosets is far greater than what was observed.

In addition to the short time span of the study, the observations were conducted only in the mornings when the marmosets were most active. It is possible that a larger range of behaviors is exhibited in the afternoons or that aggression could occur after the final feeding of the day.

There are also several limitations to the focal-animal and interval sampling that was used. Because the sampling method only allows for observations of one animal at a time, the behavior of other animals at that time was not being observed. Monkeys that may have been exhibiting noteworthy behavior may have gone unnoticed simply due to the timing of the sampling, as observations of individuals were only made for one minute every five minutes. Over the sampling period, observations of such behaviors should have evened out, but there may still be some fluctuations in behavior from what was observed to actual frequencies of each behavior.

The breeding Pygmy marmoset group was also not the ideal control group. Most of the time it was impossible to distinguish individuals unless they were right next to each other for size comparison. They were also very quick and difficult to spot when it was time to observe the next focal animal. Because of this, some individuals may have been sampled more in a given period than others, or potentially not at all. Over multiple observational periods, the animals which were observed may have evened out.

Conclusion

General observations of marmoset behavior at the Perth Zoo were observed in order to set a baseline for the present, potentially to be compared to future behavior to see if there are any improvements or if there is a decay of group stability.

The most relevant findings that came from this study included the observations of allogrooming between the Pygmy marmosets and Common marmoset, which is a definitive signal of group coexistence and bonding (Ramirez et al. 1977). A more important finding may be the behaviors that were not observed. The absence of aggressive behaviors from the Common marmoset despite being in a mixed species social group runs counter to past studies of separation involving the Common marmoset (Epple 1975). This successful exhibit differs from the previous trend of unsuccessful mixed-species exhibits involving the Common marmoset (Buchanan-Smith 2012). The marmosets in this exhibit did not display behaviors that suggest they were under stress, as the levels of locomotion, self-grooming were not significantly higher than the control group (Fig. 1, Fig. 2, Bassett et al. 2003). This exhibit can be considered stable with respect to behavioral interactions between the marmosets.

The Emperor tamarin, however, may be under significant stress, as suggested by the increased locomotion he exhibited (Fig. 3). As discussed earlier, the Emperor tamarin also showed stereotypic behavior in his frequent running loops around his exhibit, which is also a sign of stress (Ridley & Baker 1982). Efforts should be made to improve the welfare of the lone Emperor

tamarin, especially through extra stimulation through enrichment, since simulating responsive behaviors may aid in decreasing stereotypy (Ridley & Baker 1982). This can be implemented while trying to find a more appropriate situation for him elsewhere, such as with an unfamiliar female at another zoo.

There were fewer attempts to feed the monkeys than expected, but there was still several attempts witnessed. The primates did not seem to react to the feeding attempts, especially in comparison to their strong reactions to the keepers who feed them. The sign in front of the mixed-species exhibit should be fixed to ensure that zoo visitors are not tempted to feed the animals. A docent or other zoo volunteer may need to be positioned at the marmoset exhibits during busier times on the weekends in order to remind patrons who ignore or do not notice the signs not to feed the animals.

Further studies should repeat the methodology at a future time to assess if the exhibit condition has improved, declined, or remained the same to the present study. This is most important for the Emperor tamarin, which may be under the most stress of all the Callithricids observed. The breeding group of Pygmy marmosets does not necessarily need to be used as a control, as this study's observations of the mixed-species exhibit and the Emperor tamarin can serve as a basis of comparison.

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