UNIVERSITÀ DEGLI STUDI DI PADOVA
Dipartimento Biomedicina Comparata e Alimentazione
Department of Comparative Biomedicine and Food Science

Corso di Laurea /First Cycle Degree (B.Sc.)
in Animal Care

Arctictis binturong: behavioral observations of two captive specimens during an enrichment program

Relatore/Supervisor
Prof. Simona Rosaria Carla Normando

Laureanda/Submitted by
Barbara Pugliese
Matricola n./Student n.
1191222

ANNO ACCADEMICO/ACADEMIC YEAR 2021/2022

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SUMMARY

The *Arctictis binturong* is to this day a rather unknown animal. In fact, it is the only living species in the genus Arctictis, making a chance for comparison hard; furthermore, sightings in nature are fairly rare and inconsistent, and not many individuals are being kept in captivity, as per AZA (Association of Zoos and Aquaria) records.

This study aims to lay the foundation for studying and understanding the behavior of the Arctictis Binturong, through the observation of the range of actions expressed during the day at different times of two captive specimens. For this purpose, the dyad of the Cappeller Park in Veneto, Italy, was observed through the use of instantaneous scan sampling for one hour, twice a day, for 6 days.

Out of the total 12 hours of observation, 5 of them are centered around an enrichment program proposing sensory, cognitive, and environmental enrichment.

An ethogram is proposed by grouping all observed behaviors during the study time.

The results suggest that simple enrichments have a substantial impact on binturongs' activity levels, which are normally quite low in comparison to the time spent resting.

1. INTRODUCTION

1.1. *Arctictis binturong*

The binturong (Arctictis binturong), also known as bearcat, is a viverrid native to South and Southeast Asia (Lekagul and McNeely, 1977; Kanchanasakha, Simchareon and Than, 1998) (fig. 1). However, the exact range is likely to be slightly different, as poor survey efforts are being performed.

Binturong range

Fig. 1
By IUCN Red List of Threatened Species, species assessors and the authors of the spatial data., CC BY-SA 3.0

The Viverridae family includes 33 widely diverse species, among which the binturong represents the only living species in the genus Arctictis; some similarities can be found within the Paradoxurinae subfamily, composed of Asian, Golden, Brown, Masked, and Small-toothed palm civets, with

binturongs being the only civet with a semi-arboreal tail (Lekagul and McNeely 1977; Payne, Francis & Phillipps, 1985).

The binturong has been assessed as Vulnerable on the IUCN Red List, defined as a category containing species that are facing extinction due to rapid population declines of 30 to more than 50% in the previous 10 years (or three generations), a current population size of fewer than 1,000 individuals, or other factors.

This is not only due to their limited geographical range, but also because of residential and commercial development, agriculture and aquaculture, and the usage of local biological resources (Willcox, D.H.A., et al., 2016).

These animals are long and heavy, with short, stout legs. Their thick coat is distinguished by coarse, mainly black hair speckled with white. They have large white vibrissae, black ear tufts, and a large prehensile tail.

This species is arrhythmic and crepuscular (Grassman, L. 2004), weighing 9-20 kg (Cosson, L. 2007), taking into account a clear sexual dimorphism, with adult females being even twice the size of males.

Females are dominant, although this has probably less to do with their size and more with male's hormones: in fact, males show much higher concentrations of circulating estrogens, which could be linked to male deference, more so than androgen-mediated female aggression, in this species intersexual interactions (Greene, Lydia K et al 2016). Although they are believed to be mostly solitary in the wild, they are usually housed in opposite-sex dyads, which usually leads to females gaining dominance over space and resources.

Both males and females engage in glandular and urinary scent marking, with a higher incidence in males and mainly through metatarsus scuffing (Kleiman G., 1974).

Like many animals living in Bornean rainforests, their diet heavily relies on the fruits from the strangler fig (Nakabayashi M., 2016, 2018), making them the largest

endotherm with the ability to reduce their peripheral circulation so that the body becomes divided into a warm core and a cooler external surface, with a greater reduction in metabolism in lower temperatures (Lambert JE et al, 2014).

Captive specimens are also advantaged by large subcutaneous fat deposits, especially around the base of their prehensile tails; this energy storage is extremely precious, given that the lack of polysaccharide fermentation and short, carnivoran gut structure does not allow a great energy intake.

As they do not have relevant predators in the wild, they can inhabit small portions of land, either in open forest-grassland or closed forests, at different altitudes, although being mostly arboreal. Their activity patterns have been shown to depend predominantly on the abundance of the fruit of the strangler feed, forcing them to move somewhat disproportionately during the wet and dry seasons, with a mean daily distance of about 700 meters.

In the wild, they are accustomed to a mean temperature of 21°C, with extremes ranging from -3°C to 37°C; however, they are the most active with higher temperatures (Grassman, L. 2004).

2. ANIMALS, MATERIALS, AND METHODS

2.1. The animals

The two Binturongs (*Arctictis Binturong*) that were observed for this project at Parco Faunistico Cappeller in Veneto, Italy, are:

Charlie (fig. 2), a 15-year-old male born in Berlin in 2007 and arrived at the Park in 2008; and Moldava (fig. 3), a 10-year-old female born in Prague in 2012 and arrived at the Park in 2013.

The female is significantly bigger and often displays dominant behaviors over the male, being for instance the first one to eat and to choose where to lie down. She can also be recognized by bigger ear tufts.

The male has a smaller body structure and has fewer white patches on the fur.

Fig. 2 Charlie

Fig. 3 Moldava

Prior to this study, the animals were used to a set routine of eating a shared bowl of food around 8 a.m and then having their enclosure cleaned daily in the afternoon; occasional enrichments were administered but without a fixed schedule.

Throughout the year, their diet mainly consists of apple chunks and one source of protein each, mainly quails. When a greater variety of fruit becomes available during the warmer time of the year, they eat anything from watermelon to kiwis, bananas, pineapples, and so on. The protein source can vary between quail, chicks, and eggs.

During winter, they are mostly found in the indoor enclosure, resting next to the heating lamp, and become more active with warmer temperatures.

2.2. Enclosure

Fig. 5 Outdoor enclosure

The animals are housed together in an enclosure that includes an outdoor and an indoor section.

The outdoor enclosure (fig. 5) consists of a mainly naturalistic exhibit, with a wooden hut in the center connected to the indoor entrance and to the rest of the enclosure

through big trunks and branches; the angles of the branches range from horizontal to 45°, to vertical, allowing the animals to choose between walking and climbing, as it is important to allow the use of their prehensile tail to express many species-specific behaviors. The entire outdoor enclosure is surrounded and topped by wire-mesh fences (which the animals love to climb), is covered by grass, and furnished with shrubs. There is a single water fountain with a bowl that collects water, granting a fresh stream of water ad libitum.

Fig. 6 Indoor enclosure

Two guillotine doors separate the outdoor and the indoor enclosure, granting access to both the upper and the lower parts of the indoor space (fig. 6 and 7).

Fig. 7

This space is characterized by two wooden shelves where the animals can rest, spacious enough to host both of them simultaneously, of which one is higher up and closer to the heating lamp used during the colder months. Big, long branches connect all the available places, and two large windows allow a view of the

outdoor enclosure and of the rest of the zoo. Fresh straw bedding is provided daily, alongside the food bowl.

A big sliding door separates the space into a small room where the keepers can enter and both lock the door to the public and prevent the escape of the animals when working inside the enclosure. Usually, the animals are able to move freely in their outdoor and indoor space, even with the zoo staff inside.

Both the indoor and the outdoor exhibits are viewable to the public every day from 9 a.m. to 19 p.m.

2.3. Environmental conditions

The observations for this study were carried out between April and May 2021, with temperatures ranging from 6°C to 22°C. As previously mentioned, in their natural habitat they are accustomed to extremes from -3°C to 37°C, with a mean of 21°C, but are more active in a warmer climate.

In fact, when the observations began, they were just starting to go outside, far from the heated indoor enclosure.

It might also be important to note that, due to COVID-19 restrictions, the public was not allowed in the zoo until the last days of the observations.

2.4. Enrichment and general observations

For the entire duration of the observation period, an enrichment program was established. From April to June, the animals were exposed to a variety of stimuli twice a week, comprising sensory, environmental, and cognitive enrichments.

The enrichments ultimately included in the observations are: spices rubbed against the branches of the outdoor enclosure, scatter feeding of a variety of food items at different times of the day, and cut-up quail hid in straw inside of a sack.

2.4.1. Sensory enrichments: defined as any activity that engages the animals' sense of taste, smell, hearing, or sight.

- Mirrors

A small mirror was tied to the branch directly in front of the hut where the animals usually spent their time outdoors and rested. It is important to note that, at the time of this study, information about Viverridae's self-awareness obtained through the mirror test does not seem to be available. Due to this lack of knowledge, the expected response ranged anywhere from indifference to curiosity about the new object itself, to possible aggressive display due to the sight of an unknown conspecific in the enclosure.

While the female only took a few glances and went back to rest, the male instantly focused on the new object, smelling it thoroughly and going back and forth on the branch.

- Bedding from other enclosures

A big sack containing straw bedding from the Lar gibbons' (*Hylobates lar*) enclosure was placed in the binturongs' outdoor area. For this occasion, the feces of both of the hosted primates have been tested for the presence of any parasite. The aim of this activity was to provide a new stimulus through the possibility of gathering all the new information about a likely unknown scent. The white-handed gibbon was chosen due to the closeness of the two species in nature, as they share not only the same

geographical range but also the same habits, both being arboreal and predominantly frugivorous; in fact, their encounters in nature have been previously monitored and studied (Nettelbeck AR, 1998).

Both animals did not show particular interest in the new object, which only received a very brief olfactory inspection by the male.

- Digging boxes

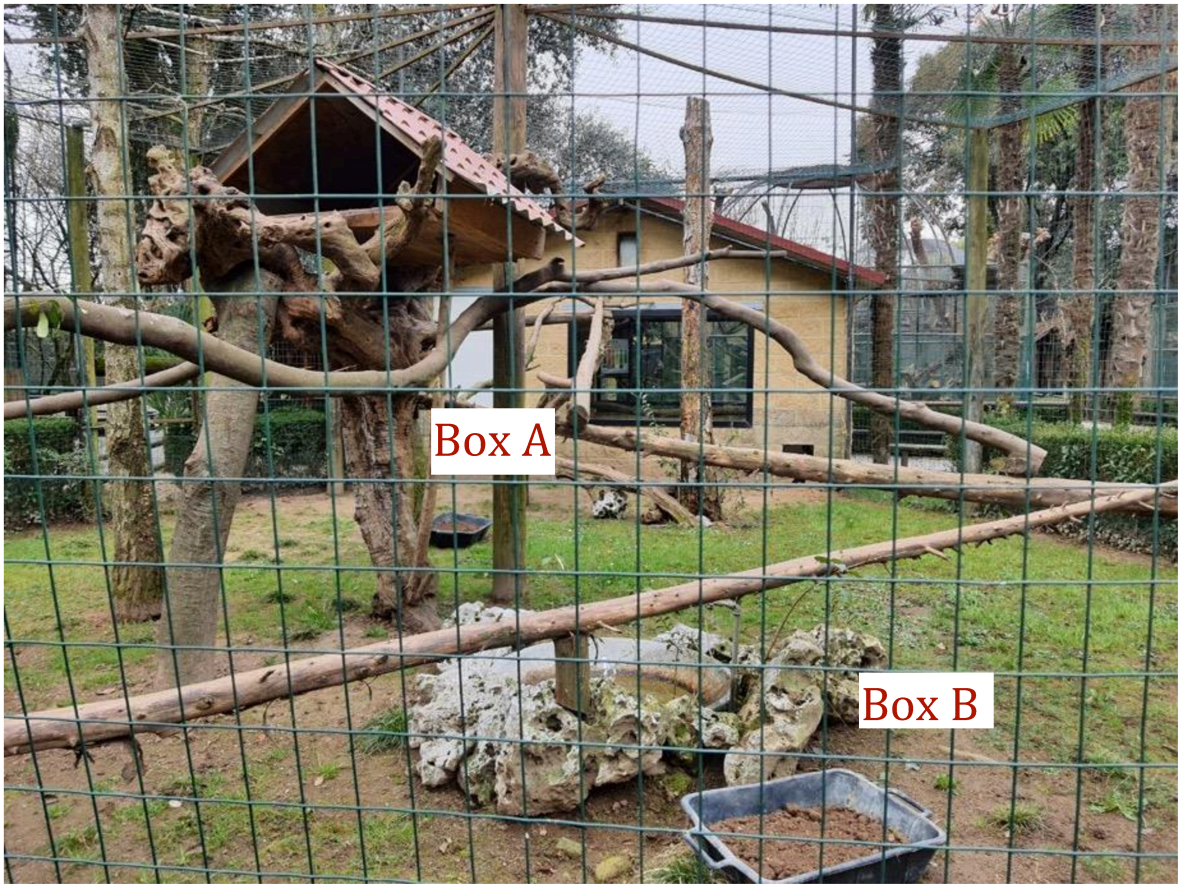

Fig. 8.

The animals were presented with two plastic basins measuring 66x44x16 cm (fig. 8). The containers were half-filled with soil, and 2 bananas each were hidden inside, still protected by the peel; the fruit was cut up in half, for a total of 4 pieces of banana in each basin, placed at different depths. The reason behind this placement was to get a

basic idea of the functioning of the two binturongs' sense of smell and their capability to dig, other than providing a new stimulating way of getting a snack.

The containers were left overnight, as the animals were not particularly active during the day; one (Box A) was positioned in a random place in the outdoor enclosure, and the other (Box B) was placed next to the water fountain.

The next morning, 3 out of 4 pieces were eaten from Box A, including the one buried the deepest, and 2 out of 4 from Box B.

The possibility of the fruit being eaten by any kind of pest that can be commonly found in zoos, such as rats or mice, has been ruled out due to the pieces appearing smashed, with the pulp squeezed out of the peel, compatible with the eating style of binturongs (fig. 9).

This concludes that at least one of the animals was able to accurately locate the buried fruit and subsequently dig it out from about 15 cm of soil.

Fig. 9

- Spices

Spices and other kinds of olfactory enrichment have been widely and successfully used to stimulate zoo animals, reduce their stress and stress-related behaviors, and much more (e.g. Vaglio et al, 2021 and Skibiel et al, 2007).

The spices used for this study were dried basil, thyme, rosemary, and cinnamon and were randomly distributed exclusively outdoors on branches, trunks, grass, and bushes.

At the time of the enrichment's administration (1 p.m. 3/05/21), both animals were resting inside; despite having acknowledged the keeper who brought and scattered the spices (even in front of the door linking the outside and inside spaces), the animals did not go outside to inspect until 2 hours later.

At 3 p.m. the male finally went outside and, after an olfactory exploration, started snarling loudly and pacing while visibly alert. When the female came out as well, the male intensified his agonistic behavior, directing it toward her with snarls and growls.

- Basin filled with blankets

A single plastic basin measuring 66x44x16 cm containing a soft blanket was placed on the grass, between the lower entrance and the water fountain in the morning.

The aim was to allow the exploration of an unknown texture, maybe even providing a comfortable, alternative resting spot. However, except for a brief olfactory inspection performed by the male, the object was completely ignored for the entire day. It was then removed at night for safety reasons.

2.4.2. Environmental enrichments: defined as changing a captive animal s environment in a way that improves the animal s quality of life (UFAW[1]).

- Hammock

A hammock was created using a reinforced waterproof polyethylene tarp (fig. 10) tied to the branches in front of the treehouse with four ropes. This enrichment was structured considering two main factors:

1. The comfort and safety of the animal, thanks to the addition of another spot to rest wide and sturdy enough to potentially hold both of the animals at the same time; the new texture and the necessity to find balance with the branches and the ropes were also introduced to favor the expression of species-specific behaviors.

Fig.10

2. Giving the public the possibility to observe the animals up close, thanks to the eye-level placement of the hammock in contrast to the higher-lever treehouse and inside racks.

The final product was very stable and close to higher branches, allowing the animals to use their prehensile tail for a greater sense of security.

[1] https://www.ufaw.org.uk/why-ufaws-work-is-important/environmental-enrichment-3

Both the male and the female appeared interested at first: they were approaching the new object and putting their front paws on it. Unfortunately, after a few trials, they both stopped getting near the hammock.

- Rope

Ropes are an easy yet precious enrichment, as they are simple to set up, add variety, and create a three-dimensional environment that encourages exploration.

A big rope was tied to two branches, resulting in a new slightly inclined pathway for the animals to explore their outdoor space.

Binturongs appear to be a generally sedentary species, as pointed out for instance by Grassman L. (2004), who observed many wild specimens in Phu Khieo Wildlife Sanctuary in Thailand over the span of 12-23 months; during this time, the animals were only active for about 47% of the observations, and their mean daily distance was about 688 meters.

The specimens observed for this study do not seem to differ, as they were active for about 45% of the observations and were mainly found in their fixed resting points; for this reason, this enrichment appeared to be a great way to encourage the animals to move inside their space in a new, stimulating way.

Over time, the placement can be easily switched up to allow further and maybe more challenging exploration by changing the rope's tension and incline.

Once placed horizontally on two branches of the outdoor space, the new pathway was promptly accepted and used.

- Suspended bucket

A plastic bucket big enough to fit both of the animals was tied up with two ropes, secured to a branch and a trunk (fig. 11). The placement of the ropes was chosen considering the binturongs' need to use their prehensile tails to find more stability, while simultaneously remaining challenging for their balance. Two bananas cut in half were placed inside the bucket, so that the animals were obliged to stand fully on one of the ropes to get to their favorite snack.

Fig. 11

While none of them got fully inside the bucket, they both reached far enough to get their piece of fruit.

2.4.3. Cognitive enrichments: defined as any provided activity that engages cognitive skills by providing opportunities to solve problems and control some aspect of the environment (Clark F., 2011).

- <u>Bottles with holes and food inside</u>

Two apples cut into chunks were placed inside a see-through perforated 5-liter plastic bottle. This enrichment aimed to encourage foraging behaviors and object manipulation, as the bottle would have to be rolled and moved in order to get the fruit.

Once placed on the ground, the animals quickly went to inspect. They both started to move around the object with their snout and paws from opposite directions, stopping to eat whenever a piece of fruit was released. This process was repeated until the bottle was empty, without any sign of aggression or dominance.

- Sack containing straw and quail

Two quails were cut in half and hidden amidst some straw in a 25-liter sack. The aim was to provide the animals with the opportunity to forage their own food in a new and interesting way, comprising smell, digging, and object manipulation.

In normal circumstances the dyad has an established feeding routine: a single bowl containing fruit on the bottom and protein on top is shared between the animals. Naturally, the dominant female is the first to access the feed, with the male only getting a chance to eat while the female is busy chewing. In this routine, there is no time to waste: if the male were to move away from the bowl or take longer eating, he might not find the desired food anymore. That morning, however, their food bowl only contained apple chunks, so that the protein could be used for the enrichment program; the animals appeared satisfied with their food, even going to rest with a few apples to spare.

Interestingly, this enrichment allowed us to witness a previously unseen behavior. When the sack was introduced inside the enclosure, both the male and the female approached it to smell it. Charlie was the first to get to the opening of the sack to directly smell the straw and immediately started digging with his paws and snout until he reached a quail half. At this point, both of them started moving the sack around to get the straw out, until they both managed to get at least a piece of quail. However, instead of eating it, the male took it into his mouth and carried it to the treehouse, something he was never previously seen doing.

- Rope braids

A simple braid was obtained from a piece of rope, and was then filled with fruit and hung on a branch. The enrichment was easy to reach if climbing from above and quite raised from the ground. Nevertheless, while the male approached it from above, balancing on the branch with the help of his tail, the female chose to interact with the item from below, by standing with the sole use of her rear legs. The enrichment was instantly met with enthusiasm, and all the fruit was retrieved and eaten in the span of 10 minutes from the installation of the rope.

- Scatter feeding

Scattering food around the enclosure instead of always placing it in the same spot is a great, easy tool to avoid boredom and stimulate the natural instincts of foragers like binturongs. In fact, this simple act creates the necessity of refining the individual's sense of smell and sight, as well as encouraging movement and changing control dynamics regarding food, especially useful in the case of established hierarchies. This grants a more balanced control over the environment, as each individual now gets to choose what and where to eat.

An additional variable also proposed in this study would be to vary the time of the day in which the feed is administered, in order to mimic a natural setting even more, especially for arrhythmic species such as the binturong.

This enrichment was extremely successful, leading to a significant increase in activity and a complete absence of dominant behavior surrounding food.

2.5. Data collection

2.5.1. Instantaneous scan sampling

Scan sampling is a sampling rule that involves the observation of the whole group in a quick sequence. This appeared to be the best way to gain a basic sense of the differences and similarities between the two animals in relation to common parameters, such as time of the day and presence of enrichment.

Additionally, instantaneous sampling is a form of time sampling in which the observation session is divided into short sample intervals. On the instant of each sample point, a record is made of whether or not a given behavior pattern is occurring (Bateson, M., & Martin, P., 2021).

The data in this study was acquired through the use of instantaneous scan sampling, with one-hour sessions sampled at intervals of 30 seconds; the observations were carried out twice a day, for a total of 6 days.

Out of the total 12 hours of observation, 5 included interactions with an enrichment from the enrichment program.

2.5.2. Working Ethogram

The data in this ethogram were gathered during the whole observation period, from 04/03/21 to 30/04/21.

Tabella 1-1

Behavior	Modifiers	Description	State or Event
Aggression		Attacking (inter- and intra- specific)	Event
Alert		Tensing of the body	
Adjusting		A slight alteration of the animal's current posture.	
Allogrooming		The animals licks a conspecific	State
Body shake		Rapid side-to-side movement of the body while remaining in the same spot	Event
Climbing		The animal uses its paws and claws to move vertically (or at steep angles). When descending, the prehensile tail is often used to grasp a steady item (e.g. a branch or a trunk)	State
Coughing		The animal abruptly releases air while making a grasping sound with its throat.	Event
Digging		Using a front paw to excavate something from the ground	Event
Drinking		Consuming water	State
Ear twitch		Quick movement of one or both ears	Event

Tabella 1-1

Behavior	Modifiers	Description	State or Event
Eating		The animal places food in its mouth either directly or collecting it with its paws. It then uses vertical movements of the jaw until able to swallow it. Sometimes the head us thrown back to aid with chewing and swallowing	State
Gaping and moving whiskers		The animal lifts its head, opens its mouth and moves the whiskers back and forth. This can last for several minutes and be directed at anything, even a wall	State
Grooming		Licking paws, tail, genitals; scratching with front paws over head, or scratching the back of the head with a rear paw	State
Growling		Agonistic behavior consisting of a long, low, guttural sound, usually while showing teeth and/or grimacing.	Event
Hissing		Quick release of air, presumably from the nose	Event
Interaction with enrichment		Walking on an enrichment item, touching it with paws/head etc.	State or event

Tabella 1-1

Behavior	Modifiers	Description	State or Event
Lip licking		Passing the tongue on the lips	
Locomotion	Pacing	Moving towards a given direction at any pace	State
Mating		The male mounts the female with reproductive aims	State
Observing		Staying still and carefully looking at/watching something	State
Olfactory exploration	Air, other animal, structures, objects, enrichment, undefined	Sniffing air, each other, an object or the ground. Usually with eyes closed, lofting the head and slowly moving it to the direction of the smell	Event
Paw twitching		Sudden rapid shaking of the paw, seen while sleeping	Event
Resting	Together Alone	The animal lays still, usually curled up with head resting on the tail. Eyes can be closed or open	State
Scent marking		The animal grabs a branch with his front limbs to slightly lift the rear limbs; he then proceeds to drag the rear paws on the selected branch	Event
Sitting		Resting on the rear part of the body	State

Tabella 1-1

Behavior	Modifiers	Description	State or Event
Snarling		Agonistic behavior consisting of a slow start with a long, low, guttural sound, then escalating to a higher pitch and volume and to the animal showing their teeth.	
Snoring		Sounds made while sleeping	Event
Stretching		The animal extends front and/or rear limbs	Event
Threat		Growling or hissing while in a tense stance, directed at a conspecific or another animal or person	Event
Turning		The animal turns around on the same spot. Usually once before laying down to rest. Sometimes around the bowl of food while eating.	Event
Urinating/Defecating		Expelling fecal matter or urine	Event
Vocalization		Any sound made by the animal	Event
Whisker twitch			Event
Yawn		Intake and release of hair with mouth wide open	Event
Other		All behaviors not described above	
Not visible		The animal cannot be observed	

2.6. Statistical analysis

As there were only two animals, the analyses were done using single observations as entries (as for Grisa et al., 2013). For each behavior and for each animal, the percentage of scans in which the animal was recorded showing that behavior on the total of the scans in that observation was calculated.

For the behaviors whose distribution allowed for it (i.e., resting, adjusting, grooming, observing, olfactory exploration), generalized estimated equations were done on the resulting data, with part of the day (two levels: morning vs afternoon), presence of enrichment (two levels: presence vs absence), the animal (two levels, female vs male) and the interactions part of the day * animal included and enrichment * animal in the model as predictors. Bonferroni corrected pairwise comparisons were made for the statistically significant factors.

3. RESULTS AND DISCUSSION

3.1. Time budget and behavioral pattern

For this study, a total of 12 hours of observations were analyzed, amounting to 2904 total behavioral scans. The chart below (fig. 12) displays the time budget obtained from these data showing that, on average, the binturongs spent the majority of their time resting, as it was recorded 1,586 times, making up about 55% of the total observation time. The other recorded behaviors were grouped into two main categories: “Active”, which encompasses any behavior resulting in voluntary movement not performed with the aim of increasing comfort or hygiene. This includes the times the animals were seen alert, carrying food, climbing, gaping and moving whiskers, with their head up and eyes closed, in locomotion, observing, performing olfactory exploration, standing, scent marking, and engaging in agonistic behaviors; and “Maintenance”, which includes any voluntary or involuntary behaviors ultimately resulting in an improvement of comfort and/or hygiene: those are the time spent adjusting, body shaking, coughing, grooming, moving the head, licking and moving their snout, panting, sitting, snoring, yawning, eating, and experiencing a whisker or ear twitch.

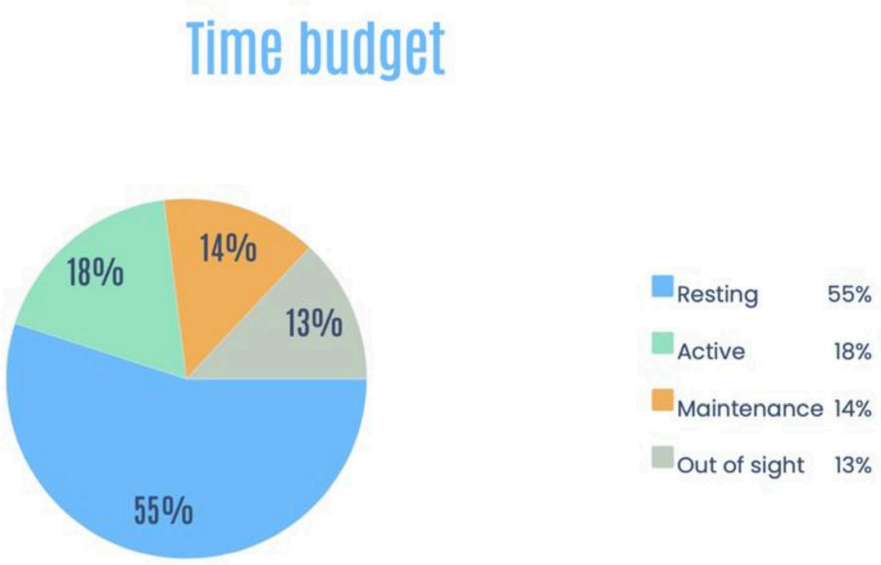

Fig. 12

Active behaviors were seen 531 times 18%, whereas maintenance behaviors were performed 398 times 14%; the animals were out of sight for a total of 386 times, 13%.

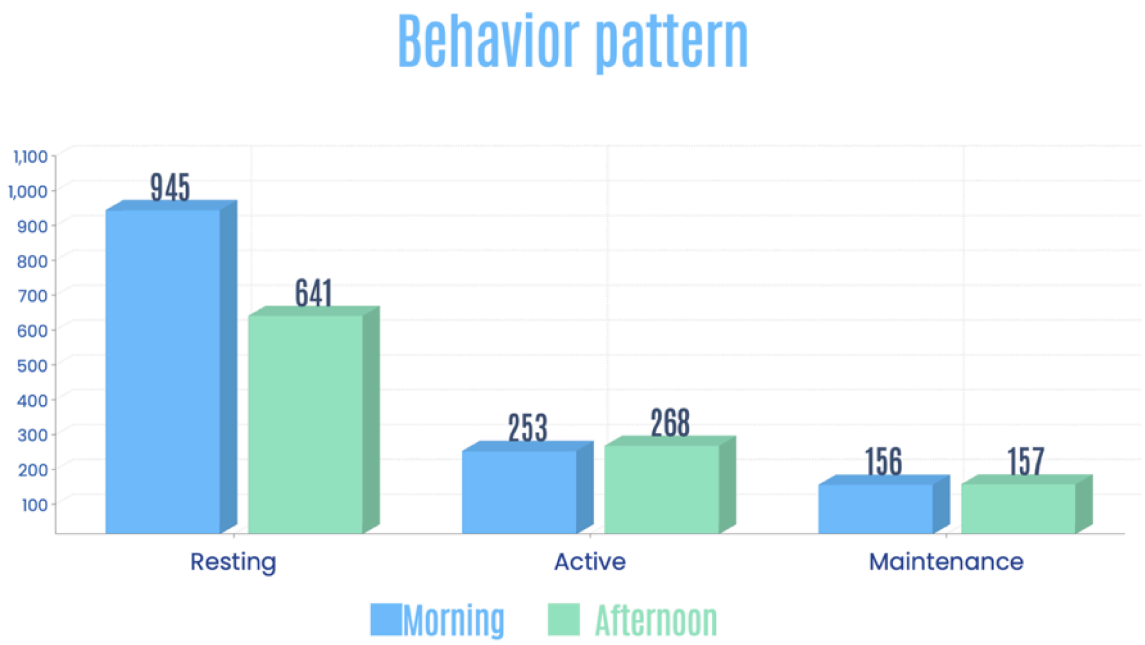

Fig. 13

Furthermore, we can notice (fig. 13) that overall, the animals rested more in the morning than in the afternoon, while active and maintenance behaviors do not appear to differ significantly in relation to the time of the day.

3.2. Enrichment program

The following image (fig. 14) represents the number of times that an active behavior was recorded, with the numbers circled in green being the result of the days in which enrichment was presented.

Fig. 14

More in detail (fig. 15), it seems that the enrichment program was met with gradually increasing interest; the activities observed are, in ascending order, a sack containing

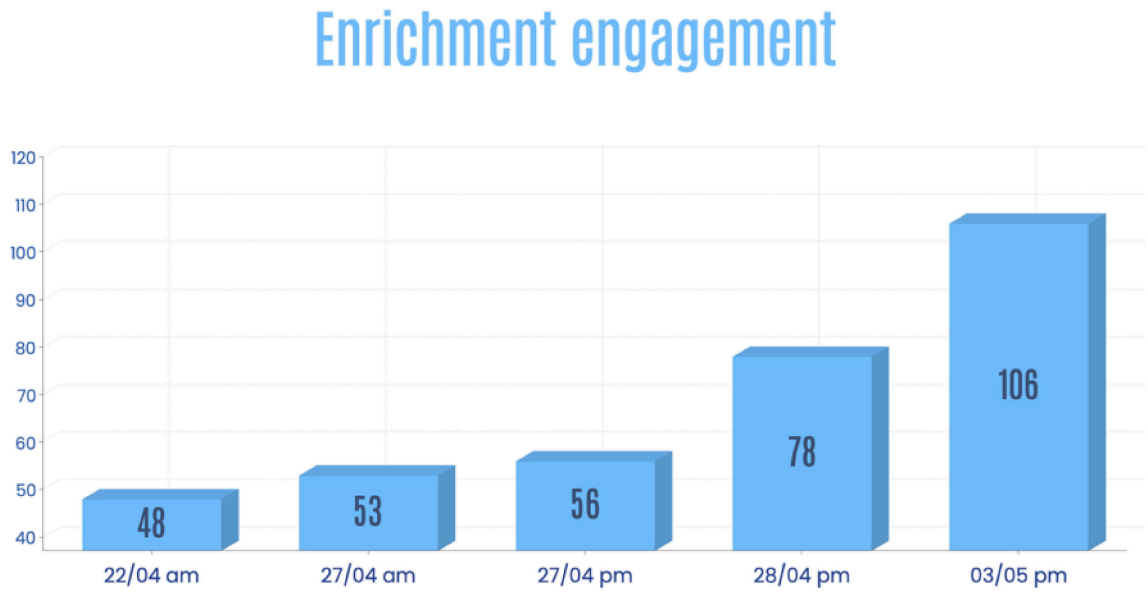

Fig. 15

quails and straw (22/04 am), scatter feeding (27/04 am), scatter feeding proposed at an unusual time of the day (28/04 pm), and spices (03/05 pm).

The results of the generalized estimating equations are shown below.

Behavior		Intercept (df=1)	Daypart (df=1)	Enrichment (df=1)	Animal (df=1)	Daypart * Animal (df=1)	Enrichment * Animal (df=1)
Resting	p	<0.001	0.008	0.003	<0.001	ns	0.007
	≠		M>A	E>NoE	Fe>Ma	-	NoE_Fe>NoE_Ma; NoE_Ma<E_Ma
Adjusting	p	<0.001	ns	ns	ns	ns	ns
Grooming	p	<0.001	ns	ns	ns	ns	ns
Observing	p	<0.001	0.005	0.04	<0.001	Ns	ns
	≠		M>A	NoE>E	Ma>Fe		
Olfactory	p	<0.001	0.004	ns	<0.001	0.002	ns
	≠		A>M	-	Ma>Fe		

3.3. Conclusions

The binturongs observed in this thesis, in coherence with other previously cited studies, have proven to be sedentary creatures who are wary of especially challenging situations. Nevertheless, they successfully engaged in many of the proposed enrichments, eventually leading to an overall increase in activity.

While environmental factors such as a progressively warmer climate might have played a role in this increase, the significance of the enrichment program is evident, considering for instance the expression of previously unseen behaviors and the presence of peaks of activity significantly higher than average.

Captive specimens could therefore benefit especially from simple measures, such as scattering their feed or varying the time of the day in which they are fed. Ultimately, this is not only beneficial for the individual's welfare, given the possibility to reduce stress and express species-specific behavior, but also for the public; in fact, it is likely that public interest increases by being able to observe a wider range of behaviors (e.g. Altman, J. D 1998 and Salas, M. 2021), facilitating visitor learning and thus raising awareness more efficiently about conservation efforts.

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ACKNOWLEDGEMENTS

I would like to thank everyone who has been part of this incredible journey. Thank you to my professors and friends in the Animal Care course, for making this possible and for every experience we shared. Thank you to my family for the support and to my roommate; if it weren't for you, I don't know where I would be. Thank you to my partner, I cannot begin to express how grateful I am for you. And lastly, I would like to thank myself, for everything it took to reach this milestone.