UNIVERSITÀ DEGLI STUDI DI PADOVA
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Effects of Environmental Enrichment in 3 Species of Parrots at Cappeller Zoo: *Ara ararauna*, *Trichoglossus haematodus* and *Amazona leucocephala*

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To my granny Tina
and to Prof T. Alessio;
sources of wise and open-minded teachings,
who always protect us from above.

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"The greatness of a nation and its moral progress can be judged by the way its animals are treated."

M. Gandhi

Summary

This experimental thesis aims to analyse the effects of some categories of environmental enrichments on 3 species of psittacine at Cappeller Zoo: *Ara ararauna* (blue-and-yellow macaw), *Trichoglossus haematodus* (rainbow lorikeet) and *Amazona leucocephala* (Cuban Amazon).

The first part of the thesis is dedicated to the materials and methods reviewed for the experiment; regarding the methods: the location (the zoo and the exhibits), the species selected, and the enrichments chosen. The methodologies section is focused on the schedule of the enrichment presentation and observations, the identification and the type of sampling used.

The experimental observations took place during this candidate's traineeship at Cappeller Zoo (Cartigliano, VI) from August 16 to October 8, 2021.

The observed subjects were: 2 blue-and-yellow macaws (a male and a female), 9 rainbow lorikeets (4 males and 5 females), and 2 Cuban amazons (a male and a female).

The materials chosen and used for the enrichment were:

- Sisal rope of different dimensions according to the species, positioned to be "stimulating" for the animals, like in areas in which most of the activity occurs;
- Water bowls, made of stainless steel and of different dimensions. Water was changed every day and offered more interaction through playing, bathing and drinking. These were presented together with ropes;
- Small coffee spoons made of stainless steel (2 tied together) positioned, hanging on branches of trees in the enclosures, to simulate the jingling sound of bells through interaction with the parrots. They were presented together with food bowls;
- Fruit and vegetable bowls made of stainless steel, of different dimensions, and the contents changed every day. Food was cut in very small pieces, as parrots are wasteful, and may take just a few bites and then throw food to the ground,

(which in the wild feeds other organisms) and was separated in small groups to allow parrots to decide which food to pick (Personal communication, Walsh E.A., 2021).

Behavioural observation took place from Monday to Thursday from 8:30 to 10:30 and from 16:00 to 18:00, and on Friday from 8:30 to 10:30 and from 13:30 to 15:30, for a total period of 7 weeks.

The first week was dedicated to preliminary observations and to the identification of individuals, while the following two weeks were dedicated to the habituation of the parrots to the various enrichments. From the fourth week the effective experimental period started, in which ropes and water bowls were presented alternatively in week one, and spoons and food bowls in week two. During the subsequent weeks the enrichment types were alternated in the same way.

In the second part an analysis of data was carried out to determine the results, with the aim of identifying the effect of the environmental enrichment on the three observed species, if any.

Introduction

The three observed species, *Ara ararauna*, *Trichoglossus haematodus* and *Amazona leucocephala*, all belong to the order of Psittaciformes (https://it.wikipedia.org/wiki/Psittaciformes).

The observed species are raised and maintained in captivity at Cappeller Zoo.
According to a dictionary, a definition of "captivity" is "a situation in which wild animals are kept in a place such as a park or zoo instead of living in their natural environment" (https://www.macmillandictionary.com/dictionary/british/instead).

The term "zoo" is an abbreviation of "zoological garden", and it was used for the first time probably in 1847 (Rees, 2011). According to the legal definition of the European Union, a zoo means "all permanent establishments where animals of wild species are kept for exhibition to the public for 7 or more days a year..." (Council directive 1999/22/EC (zoos directive), article 2).
Therefore the term "zoo" includes safari parks, aquariums and others, while it does not include, for example, pet shops, circuses and laboratories (Rees, 2011).
"Since the 1960s, zoos have considered the conservation of endangered and threatened species as one of their most important functions" (Mench and Kreger, 1996) as environment and loss of biodiversity issues increased, together with attention to animal welfare (Rees, 2011).
For example, Chester Zoo's Mission developed in 2004, with the aim of being "a major force in conserving biodiversity worldwide", thus mainly focusing on "conservation through the protection of natural environment" (Rees, 2011).
As a matter of fact, welfare should not be a purpose, rather a duty, while conservation should be the aim (Rees, 2011).

However, captivity in zoos "is often associated with frequent exposure to stressors, which may be the source of persistent negative affective states" (Lecorps et al., 2021).
"The stress of captivity dramatically increases susceptibility to disease and has an overall negative effect on welfare" (Clubb et al., 2003; Cubas, 1996; Hoppes, 2010), therefore "whether wild-caught or captive-bred, undomesticated animals are vulnerable to suffering

associated with unnatural conditions of captivity" (Mason, 1991; Morgan et al., 2007). They are unnatural because they "deviate hugely in terms of foraging, food, sociality, ambiance, sound, smell, and habitat". In particular, "a bird's ability to successfully adapt to various captive situations depends on his or her basic genetic and psychobiological makeup and developmental experience" (Bradshaw et al., 2013).

For animals living in captivity, positive animal welfare, intended by the World Organisation for Animal Health, as a positive "physical and mental state of an animal in relation to the conditions in which it lives and dies" (https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare/#ui-id-1), should be essential and always respected. This can be achieved by respecting the "5 Freedoms", developed in 1965 and "describing society's expectations for the conditions animals should experience when under human control", as well as informing the World Organisation for Animal Health's work on the welfare of terrestrial animals.

The "5 Freedoms" are (https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare/#ui-id-1):

1. Freedom from hunger, malnutrition, and thirst
2. Freedom from fear and distress
3. Freedom from heat stress or physical discomfort
4. Freedom from pain, injury, and disease
5. Freedom to express normal patterns of behaviour

However, the "5 Freedoms" have been expanded, built on and developed into the "5 Domains" that, in the most updated Model, are (Mellor et al., 2020):

1. Nutrition
2. Physical Environment
3. Health
4. Behavioural Interactions
5. Mental State

"The focus for welfare enhancement is on animals' use of opportunities to experience positive affective engagement" (Mellor et al., 2020).

These opportunities could be offered to the animals in captivity through Environmental Enrichment, which is defined as "an improvement of the environment of captive animals, which increases the behavioural opportunities of the animal and leads to improvements of the biological function" (Riber et al., 2018).
The introduction of enrichments inside animal exhibits is generally aimed at stimulating and maintaining the species-specific characteristics of animals, promoting both psychological and physical welfare, and consequently alleviating situations likely to cause negative welfare, which can be reflected in behaviours associated with "distress" (negative stress condition); but they are also "possible measures to increase the expression of normal behaviours" (Griffin et al. 2000, Reading et al. 2013).
"Biologically relevant environmental enrichment can significantly improve the welfare of captive animals by facilitating adaptive behaviour" (Newberry, 1995), but "little is known about the elements necessary for effective environmental enrichment for avian species in general, and particularly parrots" (e.g. Birchall, 1990; Shepherdson, 1992; King, 1993). However, "environmental modifications that facilitate use of behavioural skills are likely to be more effective in improving welfare than a random assortment of objects" (Mench, 1998), therefore their design requires knowledge of the animals' biology and ecology (Meehan et al., 2002).

Enrichment could be a useful mean to prevent and avoid any stereotypy, defined as "a behaviour that is repetitive, invariant, and has no apparent purpose or meaning" (Meehan et al., 2004).

This is why, during the experimental period of observations of parrots, environmental enrichments were introduced.

Understanding whenever a behaviour is normal or stereotyped could be an issue. "An animal's behaviour consists of a stream of movements and events" (Martin & Bateson, 2007), that must be organized in specific categories through an ethogram.

An ethogram is “a behavioural inventory of a detailed descriptive list, of all behaviours known to occur, in any given context, in a species, and guidelines for defining and discriminating among these behaviours” (Personal communication, Walsh E.A., 2021).

“Each of these behaviours must be distinct and independent from one another in order collect data accurately” (https://experiment.com/u/IEAVwA).

Through the ethogram, the collection of data, their analysis and thus the evaluation of welfare is possible.

Part I

Materials and Methods

1. MATERIALS

1.1 The location of the experiment

a. Cappeller Zoo

The wildlife Zoo Park Cappeller is located in Cartigliano (VI) near Bassano del Grappa (coordinates: 45.719099; 11.699670), a historically relevant town of the Veneto region. It opened to the public in 1998, but it was founded many years before as a private park of Cappeller family as a consequence of their passion for animals.

It is 40.000 square meters, in which hundreds of wild and farm species of animals are hosted, together with more than 500 species of plants and vegetation, such as aquatic plants, fern, conifers, palms etc.

The main Mission of the zoo, together with all the other parks and aquariums of the AZAs groups, is to safeguard the species subject to extinction. To reach this goal, these structures work synergistically in plans of Conservation, in which environmental education is of fundamental importance (https://parcocappeller.it/parco-faunistico-cappeller/mission/conservazione-ex-situ/).
The zoo is part of the UIZA (https://uiza.org) and AIGZOO (https://www.aigzoo.it) associations and it collaborates in both in-situ and ex-situ projects, for example Waldrappteam for hermit ibis (http://waldrapp.eu/index.php/it/progetto/informazioni-del-progetto), Silent Forest (https://www.silentforest.eu) and others.

From 2009 a museum was opened inside the park, which is dedicated to Evolution and its main scholar Charles Darwin. It is developed in two floors with a total area of 2400 square meters. The visit starts from Prehistory with many sculptures and reproductions of archaeological findings; it continues with the exposition of 1:50 sculptures of invertebrates and with the exposition of more than 4000 specimens of invertebrates and vertebrates. The museum has many educational signs and some didactic areas for school groups.

The park currently manages two main sections: the zoo itself and the museum. It has an overall number of 11 employees, and it is structured as follows (Fig. 1): at the entrance, on the right, there is a small shop and café, together with the toilet services. On the left there is an area dedicated to dinosaurs and nearby there is the entrance to the museum; the pathway proceeds with the various animal enclosures, interspersed with picnic and children's areas, which are a total of 6. There are also many green areas with vegetation and small lakes, with some species of fish too.

There are about 139 species of animals hosted. Their enclosures are structured according to the kind of species and their needs, and they are located according to their native Continent and area of origin (for example the "African aviary"), or according to their taxonomical classification: for example, some parrot species' aviaries are placed in the same area of the zoo, as well as some eagles which are adjacent to each other.

There are some mixed-exhibits similar to the African aviary, the main lake in the zoo and an enclosure which hosts Tibetan goats, dwarf Vietnamese piglets and sheep.
At the very top of the park, there is the main café and refreshment area, a shop and other toilet services, as well as a didactic area, dedicated to educational purposes for both children and keepers.

There is an indoor working area, composed of a kitchen, a room dedicated to bowl washing, a fridge and freezer, a workshop, a hospitalization area, a vet laboratory, a nursery, and a changing room for workers. This area is reserved for workers at the zoo, and it is not open to the public.

Figure 1. Map of the zoo illustrating both enclosures and services areas, as well as a suggested pathway to follow during the visit.

1. Studied *Ara ararauna's* enclosure
2. *Trichoglossus haematodus'* enclosure
3. *Amazona leucocephala's* enclosure

b. The areas of observations: external and internal exhibit

The experimental observations took place in three specific enclosures, each related to a parrot species, *Ara ararauna*, *Trichoglossus haematodus* and *Amazona leucocephala*.

Regarding the enclosure of the Ara, it was located nearby the cafè and refreshment area, towards the end of the park.
The lorikeets' enclosure is also next to the café, more or less in front of the Ara's enclosure.
The Amazon' enclosure is located in a different area, not very distant from the Ara and lorikeets, more precisely in the "avian area", in front of the ostrich and next to *Amazona ochrocephala* (yellow- and blue-crowned Amazon).

The **macaws' enclosure** (Fig. 2) is located inside an area surrounded by a low wooden fence, with which parrots do not interact. This fence is aimed at keeping visitors quite distant from the parrots' cage itself. The fence borders with the refreshment area from two sides and with the park pathway from the other two sides. On the inside of the fence there is a grass area with a flowerbed on the side of the refreshment area
The cage itself is quite circular in shape, though it has about 15 sides and thus angles; it measures about 5 metres in diameter x 2.6 – 3.4 metres in height. It is a wire kind of fence, with small spaces between each wire.

Figure 2. *Ara ararauna'* enclosure (view from the main zoo pathway)

Looking at the exhibit from the main zoo pathway, on the right side there is a quite small entrance gate for the keepers to enter the cage, which is kept locked. This is used mainly for cleaning and managing enrichments, since food is given from outside the cage, with a particular system which rotates from inside to outside the cage, permitting the keeper to extract the food bowl with food already eaten and to put the bowl with "new" and fresh food inside (Fig. 3).

Regarding the inside of the enclosure, the feed mechanism is located next to the small entrance gate; next to it, in front of the visitor, there is a cement water bowl (Fig. 4), where a tap drops water. This bowl is used by the Ara to both drink and bathe. The female usually drinks at the base of it, while the male prefers to drink perched on the tap and bending to reach the drops of water (Fig. 5). Regarding bathing, they usually do it perching on the edge of the tank (Fig. 6), or alternatively next to or inside of it, dipping their head under the water drops and spreading them over their body with head movements.
On the right side of the bowl, at the highest position, a wooden house is located, which has space both inside and on top of it (Fig. 7).
At the centre of the enclosure, there is a little tree with some thick branches, where birds may perch, to play and explore (Fig. 8).

Figure 3. *Ara*' food bowl (feed mechanism)

Figure 4. *Ara*' cement water bowl

Figure 5. Male macaw (MA) drinking from the water tap

Figure 6. Male macaw (MA) bathing on the water bowl

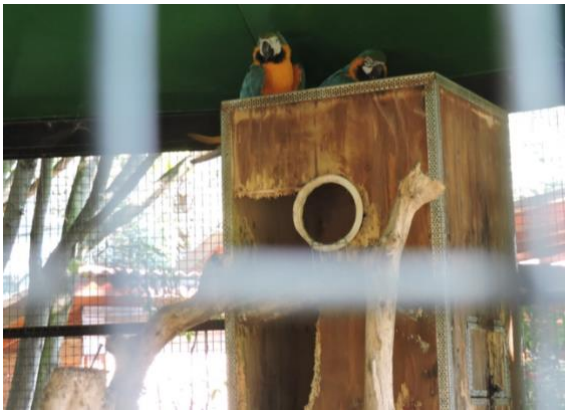


Figure 7. *Ara'* woodhouse

Figure 8. The branches inside *Ara'* enclosure

Figure 9. Closer look at the macaws perching on the branches

The **enclosure of the rainbow lorikeets** (Fig. 10) is located in front of the Ara enclosure, next to the café. The external enclosure area is confined by a wooden fence, as in the macaws', within which there is a grass area. The cage is surrounded by hedge and plants, and it is hexagonal in shape. The measurements are 6.5 m diameter x 3.5 m high, and it is made of wire.

Figure 10. *Trichoglossus haematodus'* enclosure

To enter the external enclosure, the keepers use a little wooden gate that can be locked to prevent access to the area. The working area of the café is next to the gate and in front of the cage. On this side, an iron gate door permits access to the inside of the cage, which only keepers can enter.

The inside of the cage is structured as follows: a large selection of tree branches (Fig. 11; Fig. 15) is positioned in the centre of the cage as well as in most of the cage area, permitting the lorikeets to perch, play, perform locomotory behaviour and explore. There are three scattered wooden square bowls hanging on the thicker branches with string, in which food bowls are put and changed daily (Fig. 12; Fig. 15; Fig. 16).

Figure 11. Tree branches inside lorikeets' enclosure

Figure 12. One of three food bowls

From the same viewpoint (with the café to the rear) on the upper right side of the cage, there are six wooden houses (Fig. 13), allowing birds to find refuge for resting or protection from climatic conditions. Each house has a hole permitting birds to enter inside, but the lorikeets often use the top of the house too, as the macaws do.

On the furthest side of the cage, towards the zoo pathway, there is a cement pond (Fig. 14), which is bigger than that of the macaws' and is made up of two parts: a larger pond at ground level, not too deep to prevent birds from drowning, and an upper part made of rock. Here the water falls from a tap to the lower part in small drops, simulating a small waterfall. This pond is used by both lorikeets, the Eurasian oystercatcher *(Haematopus ostralegus)* and the ruff *(Calidris pugnax)* to bath and drink as it is quite big.

Figure 13. Woodhouses in lorikeets' enclosure

Figure 14. Cement water pond in lorikeets' enclosure

Figure 15. The lorikeets exploring the tree and feeding from the food bowl

Figure 16. A pair of lorikeets feeding from the food bowl

The Cuban Amazon' enclosure *(Amazona leucocephala*) (Fig. 17) is located not very far from the other parrot species', in front of the ostrich (*Struthio camelus*) and next to the yellow- and blue-crowned Amazon *(Amazona ochrocephala).*

Looking at the enclosure from the front, on the zoo pathway and with the ostrich behind, the exhibit is bordered by the yellow- and blue-crowned Amazon' enclosure on the left, a little bush area behind connected to a picnic area, a grass area on the right connected to the cockatoos' enclosure and the pathway at the front.

The external exhibit is surrounded by a wooden fence with a small, chained entrance with a sign to restrict access. This fence surrounds the other Amazon species and the cockatoos too. Inside this area, there is a grass area with some small trees and bushes, as well as the

cage itself. The exhibit door is on the left side, as well as the rotating bowl mechanism (Fig. 18) that was present also in the macaw' exhibit. This mechanism allows keepers to feed parrots without entering the enclosure, by taking out the food bowl of the previous day and exchanging it with the "new" one with fresh food.

The enclosure is square in shape, it is made of wire, and it measures 3.3 m x 3.3 m x 3.5 m in height. At the centre, left and right sides of the enclosure there are about five trees with branches, that allow birds to perch. At the upper right side, there are two wooden houses attached to the wire, with an entrance in the middle, to allow parrots to enter.

Figure 17. *Amazona leucocephala'* enclosure (view from the zoo pathway)

Figure 18. Food bowls of the Cubans

Figure 19. Woodhouses of the Cubans

1.2 Animals involved in the study

The individuals observed belong to three species of Psittaccine: *Ara ararauna* (blue-and-yellow macaw), *Trichoglossus haematodus* (rainbow lorikeet) and *Amazona leucocephala* (Cuban Amazon).
I observed two macaws, a male and a female, nine lorikeets (four males and five females) and two Cuban amazons, a male and a female.

The two macaws (Fig. 20) are a pair and they are quite old, especially the female, who was old when she arrived at the Cappeller Zoo in 1996, according to the records of the zookeeper. She is characterized and distinguishable by less black stripes on the side of the face (respect to the male) and by the rather bald head, since she is missing some feathers on the head and on the tail. It is not clear the reason for her balding, whether it is cause by old age or by feather plucking. The male does not present balding instead, and he looks like having more vivid feather colours, as well as more black stripes on the side of the face. Therefore this was helpful for their identification during the observations.
Both are characterized by a yellow and blue plumage with a spot of green on top of the head.

Figure 20. The two observed macaws: the male (on the left) and the female (on the right).

Regarding the **lorikeets** (Fig. 21), there are nine birds, four males and five females. According to the zoo records, three lorikeets arrived at the zoo in 2008 and one in 2010, while four of them were born at the park, respectively in 2009, 2010, 2013 and 2016.

Apart from one female (Fig. 22), who was raised by humans, the other lorikeets usually maintain proximity to each other in fixed pairs. Of these pairs, one is composed of two females and one of two males.
The fifth female is not included in any couple or group, as she was hand-reared by her previous family; she is therefore more habituated to and attracted to humans than to her species members, as she seeks interaction with keepers, trainees, and other people.

Figure 21. A pair of the observed lorikeets, perching together on a branch

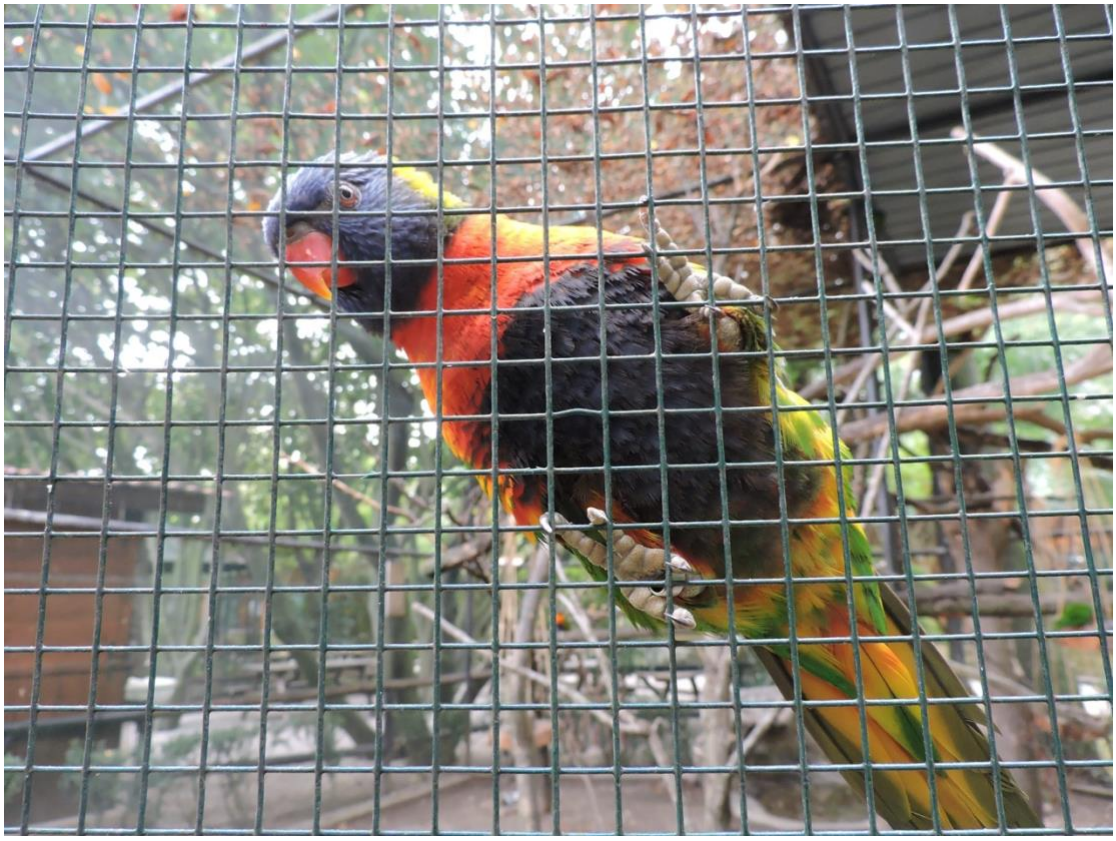


Figure 22. The female hand-reared lorikeet

The recognition of the individuals was accomplished by distinguishing the pairs first; then, within the pairs, each individual has specific and peculiar spots on the head and body surface, as well as different personalities or habits. For example, some couples were more active during the afternoon and attended some places like the wooden houses or branches more than others, and this was helpful to recognize them.

This enclosure is quite recent; according to the zoo records, in March 2021 all the lorikeets were introduced together for the first time in that exhibit, which was new for them, thus encountering other unknown conspecifics. In the lorikeets' enclosure, two other species of birds were already and still present before their introduction, sharing their space but living on the ground: the Eurasian oystercatcher *(Haematopus ostralegus)* (Fig. 23) and the ruff *(Calidris pugnax)* (https://en.wikipedia.org/wiki/Ruff_(bird)) (Fig. 24). These species were chosen for management and space reasons, but considering the species characteristics, they live well together sharing spaces, without difficulty. The oystercatcher and the ruff usually

live on the ground, in contrast to the lorikeets that usually prefer to live higher up in trees. This allows a balanced sharing of the space inside the enclosure.

These two other species were not observed for my thesis, although they were taken into consideration as regards influence on the lorikeets living in the same enclosure.

Figure 23. The Eurasian oystercatcher (on the upper left) and the ruff (on the lower right)

Figure 24. The ruff *(Calidris pugnax)*

There are two Cuban amazons, a male and a female forming a pair (Fig. 25; Fig. 26). According to the zoo records, they were both born in 2014 and arrived at the zoo in the same year.

What distinguishes them is a small irregular smear of red spot on the neck of one, but that unfortunately did not allow me to understand whether it was the female or the male.

Another feature that distinguishes them is the location in which they prefer to perch and stay, and their usual behaviours. For example, the one with the irregular smear exhibits locomotory behaviour or plays more on the left side of the wire, while the other one prefers to perch and rest or vocalize on the branch in the middle of the cage.

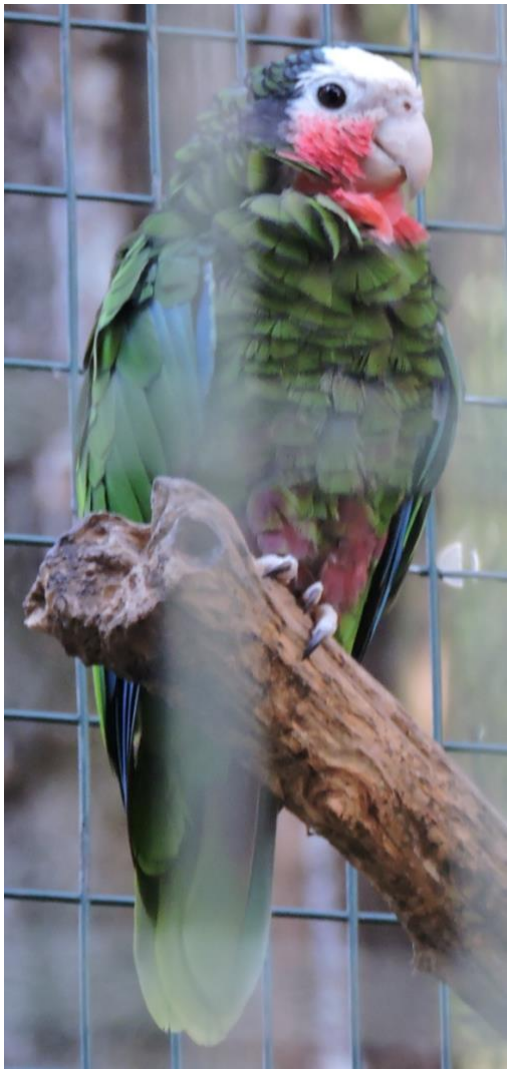


Figure 25. The Cuban parrot *J*

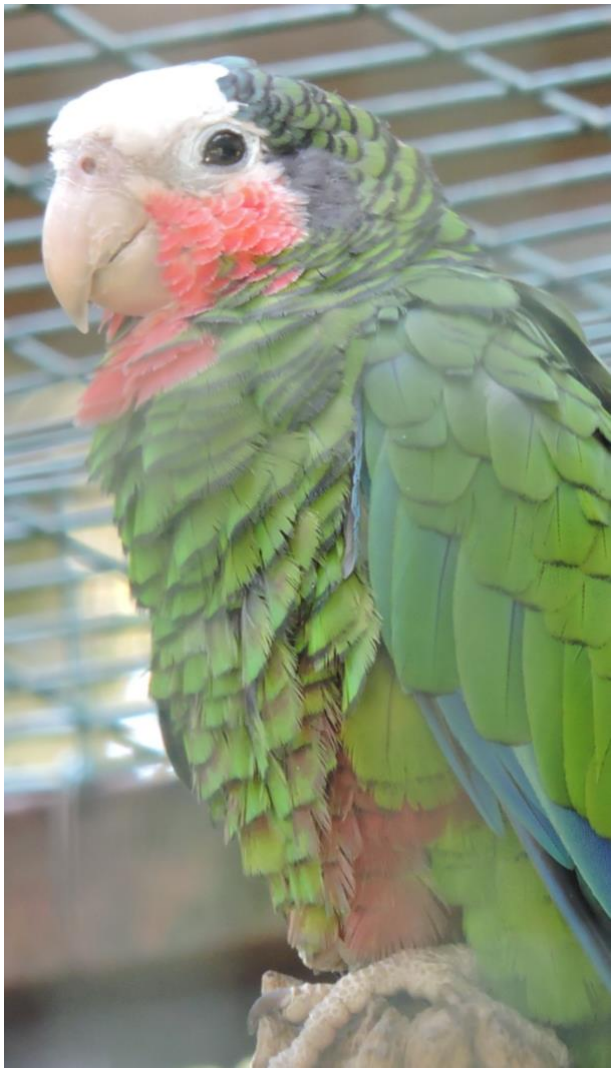


Figure 26. The Cuban parrot *K*

a. Management of the observed species

Regarding management and routine, the keepers usually feed the three species at about the same time as the other parrot species.

The "food distribution" starts in the morning at about 7:30-8:00 am and concludes when food is distributed to all the animals of the zoo.

In the afternoon, after 1:00 pm to about 4 pm, the cages are cleaned.

Feeding and cleaning are the main management routines for these three species.

1.3 Enrichments used and why

The enrichments used were discussed and chosen with the guidance and advice through the help of E.A. Walsh MSc., and Dr. Normando, considering the species being observed. All the enrichments were put inside the cage with the help of the zookeepers, since entering in some enclosures is restricted to zookeepers for safety reasons.

The enrichment items chosen were: sisal rope in combination with extra water bowls for bathing, and stainless steel spoons strung together to emit a jangling noise when played with, combined with extra food bowls.
These enrichment items were chosen as to be the least intrusive and the most easily adapted to and accepted by all the parrot species observed.
In particular, food bowls were chosen since in the wild parrots have a vast and varied diet dependent on season. Their diet is extremely important and it is a source of reward, interest and excitement to them. (Personal communication, Walsh E., 2021). As a matter of fact they spend a conspicuous amount of time foraging, although they "can obtain a higher foraging yield by optimizing energy expenditure or minimizing time costs" (Sotillo A. et al., 2019).
Water is essential and parrots have a requirement to bathe to maintain feather condition and overall health. Water sources offering areas large enough to bathe in are important to allow the birds to bathe, in addition to drinking, as self-maintenance behaviours are an indication of positive welfare (Personal communication, Walsh E.A., 2021).
Ropes provide an alternative climbing and perching structure, which moves, in a realistic way, and is of a different texture (Personal communication, Walsh E.A., 2021).

All parrots love jingling bell sounds and playing. The Stainless steel spoons tied together resembled the sound of bells and they are durable and safe for parrots (Personal communication, Walsh E.A., 2021).

Describing the enrichment items more in details, **sisal rope** was of different specific thickness, according to the species. It was presented in combination with extra water bowls, as I will describe later.
Introducing ropes, the aim was to stimulate birds to interact and play with it, for example hanging on it, perching and climbing.

The preferred material for ropes was sisal fiber, as non-toxic for birds, free of irritants and oils. Twine was not used as it poses a risk of entanglement with the birds' nails and entrapment (Personal communication, Walsh E.A., 2021).
The ropes were positioned in different locations according to the species and to their enclosure; at different heights and areas of the cage (not overhanging food or water bowls, to avoid soiling). The location provided a new route through or around the enclosure, or an area to play/interact on.

The sisal ropes used for the macaws were the thickest, at 24 mm in diameter (Fig. 27; Fig. 32). The quantity of rope was chosen taking the cage measurements into consideration, which was 5 metres in diameter and 2.6 – 3.4 metres in height. Three ropes were introduced, and these were strung across the cage at different heights.
Looking at the exhibit from the zoo pathway, one rope was positioned at 2 metres height, passing from the left side to the right side of the cage and in front of the wooden house, which is the place in which the macaws spend much of their time. This rope passed through the tree which is in front and about one metre from the house.
The other two ropes were positioned 2 metres high, crossing each other the first one, positioned from the left to the right side of the cage.

There were four ropes used for the lorikeets, and their diameter was less than those of the macaws', at 10 mm (Fig. 28; Fig. 29; Fig. 33).
The cage measurements were (6.5 m diameter x 3.5 m height), the first two ropes were positioned at 2 m height, across the cage (from the angle near the café to the opposite side next to the zoo pathway) and one was positioned at 2.5 m height. They were positioned in opposite directions, crossing over.
The third and fourth ropes were positioned crossways in the two "busiest" corners, in which birds interacted most, one at 2.5 m and one at 3 m height.

In the Cuban amazons' enclosure, the rope used was 10 mm in diameter (Fig. 34).
The enclosure measured 3.3 m x 3.3 m x 3.5 m high, and three ropes were used in this enclosure. The first one was positioned at 1.5 m height, across the centre of the enclosure, while the two other ropes were positioned about 1 m apart from each other, at 2 m height and perpendicular to the first rope.

Figure 27. Sisal rope for the macaws (24 mm diameter)

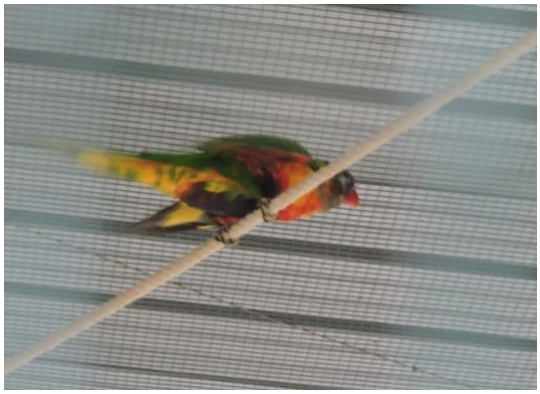


Figure 28. The lorikeet *B* perching on the enrichment sisal rope (10 mm diameter)

Figure 29. Rainbow lorikeets interacting with the enrichment ropes

Together with sisal rope, extra **bowls of water** (Fig. 30) were added as enrichment, to allow birds to more opportunities for bathing and drinking, as well as playing. Bowls were made of stainless steel (as many metals are toxic to parrots) and they had different dimensions according to the species. Water was changed daily so that they could have clean and fresh water every day.

For the macaws we provided 2 bowls filled with water up to a height of about 8 cm from the bottom (Fig. 32). The bowls measured 29 cm in diameter x 12 cm in depth, and they were placed in different and quite distant positions, which were maintained throughout the study.

A big smooth stone was added inside the bowls, after being washed, to maintain balance in the bowl on the ground. Also, as a stone was required in the bowls of other parrots for safety reasons, it avoided introducing a variable (Personal communication, Walsh E.A., 2021).
Large chunks of timber were placed around each bowl, to prevent them from moving and to give them stability. These also allowed the birds to easily reach the bowls and provided a place to stand on while they were eating from the bowl, avoiding it tipping over.

The water bowls used for the lorikeets were lower and larger (Fig. 31; Fig. 33), thus less deep, since the lorikeets are quite small and therefore it was important to protect them from drowning. There was a total of 2 steel bowls (sourced at the zoo), and the measurements were: 32.5 cm in diameter x 9 cm in depth. The quantity of water was less than that of the macaws, as it reached about 3.5 cm in height from the bottom of the bowl.
Some smooth washed stones were put inside each bowl as for the Ara. There were stones of varying size, positioned on one side of the bowl, to allow the birds to climb out of the water and out of the bowl after, for example, bathing. This protected parrots from drowning and gave stability to the bowls.
Bowls were positioned quite distant to each other, in approximately the same place each time, and they were stabilized also by chunks of timber.

The Cuban amazons had 2 bowls of water: one measured 28 cm in diameter x 8 cm in depth, while the other one measured 28 x 9 cm (Fig. 34). They were filled up with fresh water to a depth of 3.5 cm, as for the lorikeets.
Some smooth stones were added in this case too; they were of varying dimensions, and they were placed in the same way as those for the lorikeets, since they had the same purpose. Wood chunks again stabilized the bowls; the location of the bowls was not too distant from each other, and it was maintained approximately throughout the study.

Figure 30. Enrichment water bowls

Figure 31. A lorikeet interacting with an enrichment water bowl

Figure 32. Enrichment ropes and water bowls positioned inside the macaws' enclosure

Figure 33. Enrichment ropes and water bowls positioned inside the lorikeets' enclosure

Figure 34. Enrichment ropes and water bowls positioned inside the Cubans' enclosure

In combination with extra food bowls, coffee **spoons** (Fig 35; Fig 36) were used as a type of interactive enrichment. They were a total of 30 spoons, 11 cm long, made of stainless steel and they were presented in the following way: two spoons tied together with sisal rope 100 cm long (with some extra rope at the end where the spoons were, to be available as a preening item and to attract birds) and about 0.5 cm thick.
These were hung from some tree branches allowing birds to access them, not in front of houses or bowls to avoid the possibility of causing any unexpected adverse reaction.

As we could not purchase suitable bells for logistical reasons, mainly connected to Brexit, spoons constructed in a way in which they jingled, were thought to be a reasonable substitute. Being tied together, spoons could create a jangle similar to bells, through the movement and interaction of the parrots.
This jingling sound is usually appreciated by parrot species and therefore stimulates interaction with them, specifically play, interacting with the object with their beak, body, feet, and claws, sometimes moving the object, sometimes hanging from it, or beating it with their beak, to create that sound (Personal communication, Walsh E.A., 2021).

In the macaws' exhibit there were four sets of spoons presented (four of sets of two spoons each), in approximately the same position each week, always hanging from the branches and separate from each other (Fig. 41).

In the lorikeets' cage there were 8 sets of spoons, hung not close to each other from branches (Fig. 42). Some of them were placed on a branch which was over another, as to permit the parrots to reach the spoons from the branch below.

In the Cuban amazons' enclosure, three sets of spoons were hung, not close together (Fig. 43).

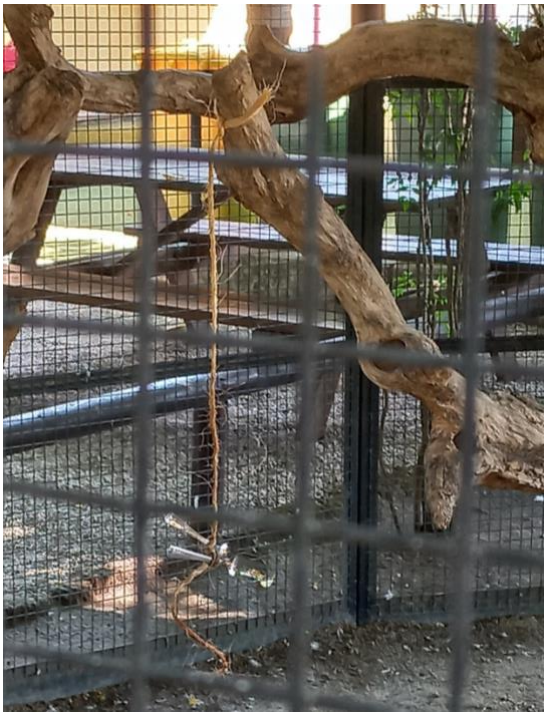


Figure 35. Enrichment spoons tied together and hung from the branches, in macaws' enclosure

Figure 36. A lorikeet interacting with the enrichment spoons (pecking its rope)

Extra **food bowls** (Fig. 37) were put in addition to the usual feed bowls, and they were filled up with fresh fruit and vegetables that was changed every day to keep them fresh, palatable, and inviting for the parrots.

The kind of fruit and vegetables changed each day, also according to availability at the zoo, and in general they were: apple, pomegranate, orange, grapes, papaya, banana, peas in the pod, green beans, carrot, celery, fresh corn, courgette, but also chili pepper, cantaloupe, pineapple and other kinds. Berries and very small-diced fruit were also chosen for the lorikeets, as well as additional nutrient powder preparation with nectar, since they have special dietary requirements for nectar and a specialized tongue to eat it (https://www.psittacology.com/lorikeet-tongue-diet/).

The food was also cut in very small pieces and separated in small groups. The former is because parrots are wasteful and may take just a few bites and then throw food to the ground (which in the wild feeds other organisms); the latter was to allow parrots to decide which food to pick (Personal communication, Walsh E.A., 2021).

Bowls were stabilized by wood chunks as for the water bowls and positioned in different and areas of the enclosure, that were maintained approximately during the study.

For the macaws 3 steel bowls (sourced at the zoo) were used (Fig. 40; Fig. 41), each measuring 27.5 cm in diameter x 14 cm in depth. The type of fruit/vegetables were 2-3 for each additional bowl, with a total of 6 or more additional types of fruit and vegetables as enrichment.

There were four lorikeets' food bowls made of stainless steel with a grip at the bottom, and they measured 14 cm diameter x 6 cm depth (Fig. 38; Fig. 39; Fig 42).
There were two types of fruit/vegetables for each bowl, and a special nutrient powder feed which contains nectar specific for the lorikeets, that was added on top of the food.

The Cuban amazons were given 2 additional bowls with 3 different food types each, thus a total of 6 different types of food, and the bowls were the same as those used for the lorikeets (Fig. 43).

For each week in which a form of enrichment was presented, the enrichment was put inside the cages on Monday morning before observations and taken out on Friday afternoon after observations.

Figure 37. Prepared enrichment food bowls, for all the observed species

Figure 38. Enrichment food bowls for the lorikeets positioned inside the enclosure

Figure 39. A lorikeet feeding from an enrichment food bowl

Figure 40. The female macaw feeding from an enrichment food bowl

Figure 41. Enrichment spoons and food bowls in the macaws' enclosure

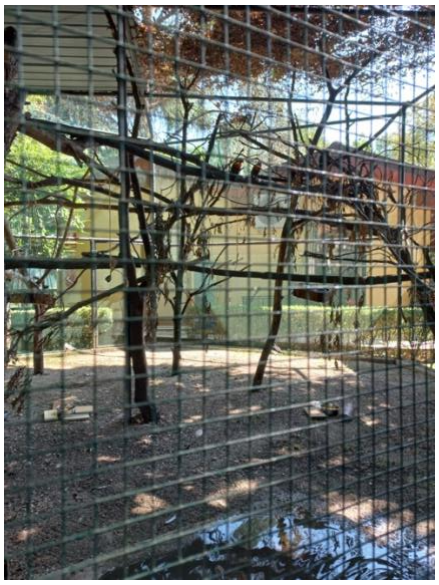


Figure 42. Enrichment spoons and food bowls in the lorikeets' enclosure

Figure 43. Enrichment spoons and food bowls inside the Cubans' enclosure

2. METHODOLOGIES

2.1 Enrichment schedule: dates, timing and ethogram

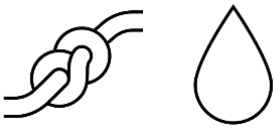
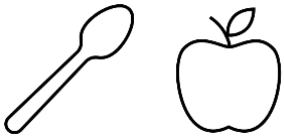
The first trial observations started from August 16, in which I generally observed the parrot species to get to know them well, to refine the working ethogram's draft and to get the animals used to my presence as observer. Afterwards, the actual observation period started from August 23 until October 8, for a total period of 7 weeks, from Monday to Friday with a specific schedule, from Monday to Thursday from 08:30 am to 10:30 and from 16:00 to 18:00. On Friday, the observation schedule was: 08:30-10:30 and 13:30-15:30.

The described timeline was designed and managed according to the parrots' habits, since they are usually more active at early morning and late in the evening (Personal communication, Walsh E.A., 2021). However, it was managed also according to the keepers' availability, since I needed their help to put the enrichments inside the cages, thus considering time spent placing the different objects and preparing food.

Preliminary observations were done from August 23 to August 27. They included identification of the individuals, training, and trials, also to see how the parrots would react to the enrichment types.
Starting from August 30 to September 3, habituation to enrichment was scheduled, as well as trial observations. The enrichment presented were sisal ropes combined with water bowls.
From September 6 to September 10, habituation to the other types of enrichment and trial observations were scheduled, specifically regarding jingling spoons and food bowls.
Starting from the fourth week, from September 13 to 17, the first experimental period began, to observe the effect of ropes and water bowls as enrichment, gathering data through behavioural observations.
The week after, from September 20 to 24, the second experimental period with spoons and food bowls was examined, following a third experimental period in the week between September 27 and October 1 with ropes and water bowls, and concluding with a final fourth experimental period from October 4 to 8, observing parrots' interaction with spoons and food bowls.

Therefore the enrichments were divided in sets (ropes and water bowls, and spoons and food bowls) and alternated through the experimental weeks (Table 1).

As already mentioned, enrichments were put in cages on Monday morning before observations and taken out on Friday afternoon after observations.

Working week	Activity
23/08 to 27/08	Preliminary observations, identification of individuals, training, trials, etc. 
30/08 to 3/09	Habituation to enrichment 1+2 + trial observations. 
6/09 to 10/09	Habituation to enrichment 3+4 + trial observations. 
13/09 to 17/09	First experimental period: effect of enrichment 1+2. Behavioural observations to gather data. 
20/09 to 24/09	Second experimental period: effect of enrichment 3+4. Behavioural observations to gather data. 
27/09 to 1/10	Third experimental period: effect of enrichment 1+2. Behavioural observations to gather data.

	
4/10 to 8/10	Fourth experimental period: effect of enrichment 3+4. Behavioural observations to gather data. 

Table 1. Graphic explanation of the enrichment schedule

The working ethogram used for the present study is detailed in the table below (Table 2). It was designed by E.Walsh MSc. starting from her experience and from the relevant academic literature on psittacine species (as for Marcuk et al, 2020; Assis, 2016) and refined during the preliminary observations (as for Personal communication, Walsh E.A., 2022; Lopes et al., 2018; https://what-when-how.com/birds/rainbow-lorikeet-birds/; http://www.mickaboo.org/resources/reading-bird-body-language; https://languages.oup.com/google-dictionary-en/).

The ethogram and thus scientific literature were fundamental to interpret many behaviours.

Working Ethogram

Self-maintenance

- Preening – tidying and cleaning feathers with beak
- Bathing
- Foot cleaning
- Beak cleaning – by rubbing the beak along a hard surface such as a perch or tree
- Vigorous head and body scratching
- Excreting
- Shaking body parts (like wings and tail) or entire body off

Social affiliative behaviours

- Allopreening – Two birds together, one who grooms the other, usually if a pair, in turn
- Allofeeding – associated with copulation in birds, the male feeding the female who solicits feeding by crouching, head lowering, fluffing feathers and vocalizing
- Mating and courtship behaviour – wing-fluttering, swinging upside down, head-bobbing, tail-fanning and bill-fencing
- Head bobbing – neck wagging side to side
- Crouching – head lowered, wings close to body
- Pecking each other's beak

Vocalizations

- Natural vocalizations – vocalizations which appear natural to the parrot and not imitative of human or sounds within the captive environment
- Human/acquired vocalizations – Imitation of human speech or sounds from within the captive environment

Feeding

- Feeding alone – taking food from the feeder (through beak or claw), holding it in beak, ingesting it and chewing
- Feeding at enrichment devices
- Feeding with another parrot
- Drinking – taking water into the beak and swallowing it. Neck could be tilted back

Resting/inactivity

- Resting:
    a. Feathers may be fluffed, on one foot, eyes closed or half closed
    b. Feathers may be fluffed, on two feet, eyes closed, head tucked back underneath a wing
    c. Feathers may be neither fluffed nor sleek, on one foot, eyes relaxed
    d. Parrot is tucking itself down low on its legs/crouching low
- Perching – parrot is standing or resting on something like a branch, the woodhouse, or a rope
- Yawning – the reflex action of opening the mouth wide and inhaling deeply due to contentment/tiredness or other reasons
- Positioning on a branch/rope – the parrot is adjusting its position with feet/wings
- Beak grinding – the bird is scraping the lower mandible against the upper mandible. It is usually a sign of a bird feeling secure and content

Locomotion

- Walking
- Fluttering or flying to a specific place
- Hopping
- Turning around

Exploration

- Pecking with beak on surfaces or items (sometimes accompanied by following chewing)
- Hanging on the mesh (sometimes also upside down), usually walking, or doing other behaviours (looking around, pecking, vocalizing...)

Fear

- Alert, feathers sleek, smooth to the body, neck stretched, eyes may be pinned
- Alarm, rises flapping and vocalising spontaneously if in a confined space, if in a larger space will also try to flee
- Fear, feathers sleek, smooth to the body, leaning back or sidewards away from object or person if there is no other exit available

Antagonistic behaviours

- Body head, neck and wing feathers are raised
- Bilateral wing-unfolding either partly or fully with an open beak
- (Macaws) A slow lifting of one leg, pointing the front toe at the opponent
- An open beak, threatening bite (will be contiguous with other body signalling)
- Lunging with an open beak, and threat of bite display
- Attempting to bite any part of an opponent's body
- Redirected behaviours – Redirection of mild to high intensity aggression from dominant partner to subordinate mate, when the potential intruder is out of reach
- Approach between an aggressor and another, may be by walking/running/flight

Ambiguous behaviour

- Eye pinning – Eyes can be contracted or dilated which is termed "pinning". This can occur with positive and with negative emotions (interpretation is dependent on context)
- Head held to one side – may sometimes be to increase visual field

- Approach towards a human, by flying, walking, stepping – May be friendly or antagonistic, dependent on entire body signal
- Other behaviours like looking at the observer, opening wings, moving head, opening beak, poking tongue out and licking, flapping wings, sneezing, and wagging tail

Repetitive behaviours
• Route tracing – Walking the same route repeatedly without variation • Feather picking – Removing feathers from itself or from another bird when preening

Table 2. Working Ethogram listing the behavioural categories used

2.2 Methods of sampling

a. Identification

Training for correct identification of the animals was carried out during preliminary observations.

The macaws and the Cubans appeared to be much easier to recognize than the lorikeets, because of their low number in the enclosure and their physical characteristics.
The **macaws** (Fig. 44) had some peculiarities allowing to easy distinguish them. As suggested by the zookeeper, the female macaw, who is the older one, shows some baldness at the top of the head, and she lacks some feathers on the tail too. The male macaw' feathers appear more vivid in colour, he has more black stripes on the sides of the face and he is not bald or lacking any feathers instead.
In the data collection and analysis, I differentiate them with the name *Female (FE)* and *Male (MA)*.

Figure 44. The macaws observed: the male macaw (on the left) and the female macaw (on the right). Physical peculiarities are visible

The **Cuban amazons** are a male and a female, as the macaws (Fig. 45). They are very similar in appearance to each other, and therefore some behaviours helped me distinguishing them. Some red spots at the neck level are a bit different: one is more jagged in shape than the other one, although it was not possible to identify who is the male and who is the female, since the Cubans, as the other observed parrot species, do not possess much sexual dimorphism (https://animaldiversity.org/accounts/Amazona_leucocephala/; https://en.wikipedia.org/wiki/Rainbow_lorikeet; https://en.lepal.com/animals-show/animals/blue-and-yellow-macaw), thus male and female look the same on physical appearance.

Regarding their behaviours, the individual with the more jagged spot on the neck tended to spend more time perching on the branch in the middle-right of the enclosure, preening or relaxing, and I identified it with the code name letter *K*; the other individual used to spend much time climbing the mesh instead, usually on the front and left side of the cage (looking at it from the viewpoint of the zoo pathway), and climbing up branches on the left, thus

tending to be more active and playful than the first individual. I identified it with the letter *J*.

Figure 45. The observed Cuban parrots: Cuban *J* (on the left) and Cuban *K* (on the right)

Recognizing the **lorikeets** was more challenging that the other two species, as the enclosure is larger and thus they were more distant from me as observer, because of their quite small size in respect to the other species. Moreover, there were more of them, and some of them are quite identical to each other.

Therefore, the observations started with the identification of the different pairs, since at Cappeller Zoo they tend to spend most of their time in pairs, and then looking at their usual behaviours and preferred or most often occupied area.

In the enclosure the individuals are 5 females and 4 males. As told by the zookeeper, the pairs are constituted as follows: two male-female couples, a female-female couple, a male-male couple, and a female alone.

The female not belonging to any couple is a hand-reared parrot (Fig. 46), meaning that she was previously owned and reared by a human family, thus she is adapted to captivity and often seeking contact with humans, such as keepers, trainees, and other workers, instead of contact with conspecifics. This is why she is not included in a specific pair or group, in fact she tends to stay alone and separated from others.
These behavioural characteristics make her almost always distinguishable, in addition to the fact that we know her sex. As already mentioned, the lorikeets, as for the Cubans and other species, do not possess sexual dimorphism, meaning that we cannot recognize them from physical appearance and looking at them, because males and females look the same. To be able to recognize them, surgical sexing by a veterinarian or DNA test is necessary, removing a feather sample and sending it to a specialized laboratory (https://en.wikipedia.org/wiki/Rainbow_lorikeet).

Apart from the behaviour, the hand-reared female has very vivid colours of plumage and very clear and definite spots. For the collection of data, I chose to name her with letter *A*.

Figure 46. The female hand-reared lorikeet

The first couple that I am going to describe now (Fig. 47) is one of the first couples I was able to recognize, since the physical characteristics and behaviours of the male were quite peculiar and evident.

As a matter of fact, the male individual, recognized with the letter *B* (Fig. 48), is characterized by some grey jagged spots all around his eyes and head, thus he was easily recognizable, from a distance too. Regarding behaviour, he used to perform a courtship dance to a female in particular, the one he spends most of the time with. As a consequence, he performed mating behaviour too, and this confirmed the hypothesis claiming he is a male.

What I also noticed in this male individual is that his behaviour was quite active, vigorous, energetic, and very noisy, as a matter of fact he spent much time performing locomotory behaviour, exploring and jumping onto the ropes, and using enrichment in general, but also performing many sounds towards other individuals and going to eat from bowls in which some other birds were already eating.

The female was named *C*, and she was calmer and quieter than the male. She was not very distinguishable for the appearance, since her plumage colours are quite vivid and there is no peculiar sign, as for other individuals. Her pairing with *B* is what distinguishes her from others, in fact she follows him most of the time to explore, perform locomotory behaviour, eat and other activities.

They used to take shelter inside the first woodhouse on the left, in fact most of the pairs tended to have a specific woodhouse to take shelter in.

Figure 47. The lorikeets *B* (on the left, doing courtship behaviour) and *C* (on the right)

Figure 48. The lorikeet *B*

The second pair was constituted by *D* and *E*, whose sex is unfortunately unknown (Fig. 49).

The former has a quite big and relevant jagged grey spot on the neck region, while the latter is distinguished by few small grey spots next to its eyes, on a side of the head.

Figure 49. The lorikeets *D* and *E*

The third pair I recognized was constituted by *F* and *G* (Fig. 50).

It is still not clear whether they are of different of same sex, since there was not any behaviour to verify it.

F is characterized by a sharp quite vertical grey sign under the chin, that looked like a small scar, while *G* has very vivid colours in the plumage (similarly to *C*).

Figure 50. The lorikeets *F* and *G*

H and *I* formed another pair, whose sex is still unclear (Fig. 51).

The former is characterized by big areas of grey indentations on the plumage, specifically around the head and eyes and on the dorsal part of the wings and body.

I has very vivid colours of plumage instead, and no particular signs like *G* and *C*, but differently from them it is not so small in size, and it looked almost larger than its partner *H*. Also, she was used to spend much time inside the woodhouse, in particular the sixth one from the left.

Figure 51. The lorikeets *H* (on the left) and *I* (on the right)

The identification of the individual lorikeets was quite challenging: it started with the pairs' identification, going towards the identification of the single individuals. It lasted all the first week, but it was necessarily done each time I was going to observe the species, since it was fundamental to take notes on what was the behaviour and who did it. Thus, it took quite an amount of time, before the observation time, to distinguish them.
The large enclosure was another contributing factor too, since the lorikeets resulted to be quite small and not always visible or clearly recognizable, and this was an issue.

b. Instantaneous focal sampling

After the preliminary observations, the animals' behaviour was recorded using an instantaneous (every 20 seconds) focal animal rule for 7 minutes per individual per observation (total 22 sample points per animal per observation).

In the morning, the order of observation was: first the Cubans, then the macaws and the lorikeets. The order for the two former species was alternated each other day.
In the afternoon the order was: the lorikeets, the Cubans, and the macaws (these two latter alternated each other day as in the morning).

This order was chosen because the macaws and the Cubans showed more activity in the early morning and in the late evening, as the experiments' results demonstrate.

c. Statistical analysis

For the macaws and the Cuban parrots, as there were only two animals, the analyses were done at the individual level (as for Grisa et al., 2013) using the single observations as entries. For each behaviour and for each animal, the percentage of scans in which the animal was recorded showing that behaviour on the total of the scans the animal was visible (and his/her behaviour identifiable) was calculated.
Generalized estimated equations were done on the resulting data, with part of the day (two levels: morning vs afternoon), type of enrichment (two levels: Ropes and Water bowl vs Spoons and Food bowls), the cycle (two levels, first vs second) and the interaction part of the day * type of enrichment included in the model as predictors. Bonferroni corrected pair-wise comparisons were made for the statistically significant factors. The choice to exclude the two habituation periods was made due to the fact that the animals seldom interreacted with the enrichment for the whole length of the study.

For the lorikeets, data pertaining to recognisable individuals (n=9) were used and the analysis was done at a group level, with individual as random factor. Generalized estimated equations were done on the resulting data, with part of the day (two levels: morning vs afternoon), type of enrichment (two levels: Ropes and Water bowl vs Spoons and Food bowls), the cycle (three levels, habituation, first, second) and the interactions part of the day * type of enrichment and cycle*type of enrichment included in the model as predictors. The habituation period was included because the animals began interacting with the enrichment already during the first week it was presented (i.e., during habituation). However, as during several observations in the habituation periods some animals were always out of sight, we decided to include “visibility” as a target variable, and to analyse the raw data, i.e., the number of sample point in which a behaviour was shown by that individual in that observation (total sample points 22 for observation), without dividing for the number of times the animal was visible. Bonferroni corrected pair-wise comparisons were made for the statistically significant factors.
Further analyses are in progress.

Part II:

Results and Discussion

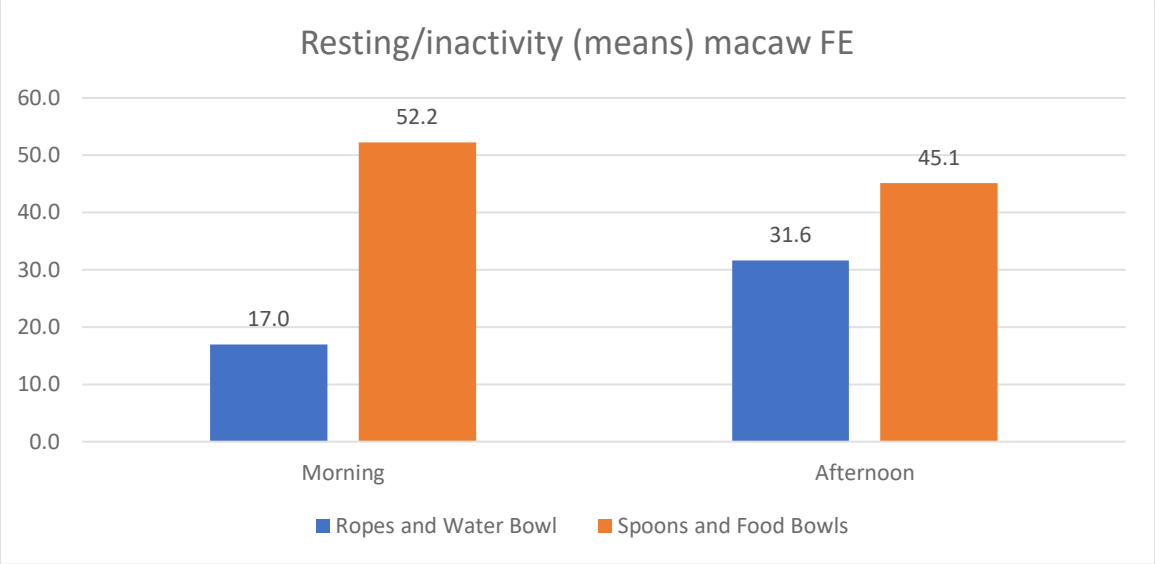
3. RESULTS: ANALYSIS OF DATA

3.1 *Ara ararauna*

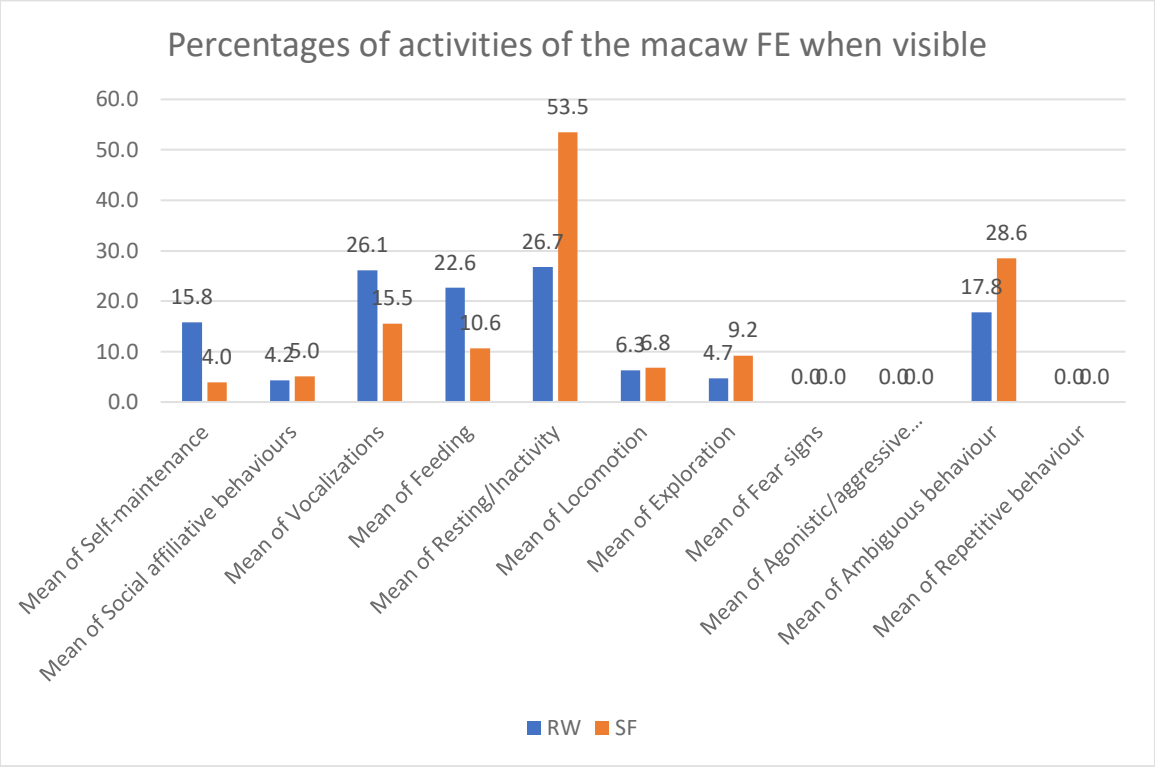
a. Macaw FE

Behaviour	Part of the day (df=1)	Enrichment type (df=1)	Cycle (df=1)	Enrichment type* Part of the day (df=1)	Intercept (df=1)	Significant Effects
Self-maintenance	0.81 (ns)	3.06 (ns)	0.04 (ns)	0.39 (ns)	8.51 (p=0.004)	
Social affiliative	1.31 (ns)	0.09 (ns)	3.10 (ns)	1.39 (ns)	12.37 (<0.001)	
Vocalizations	0.06 (ns)	1.61 (ns)	1.04 (ns)	<0.001 (ns)	24.96 (<0.001)	
Feeding	4.32 (0.038)	2.06 (ns)	4.33 (0.04)	1.18 (ns)	15.87 (<0.001)	Morning >afternoon; 1>2
Resting / inactivity	0.16 (ns)	5.28 (0.022)	5.36 (0.021)	1.40 (ns)	47.40 (<0.001)	SF>RW; 2>1
Locomotion	0.01 (ns)	0.02 (ns)	2.12 (ns)	0.001 (ns)	22.08 (<0.001)	
Exploration	1.29 (ns)	1.09 (ns)	0.16 (ns)	0.16 (ns)	9.96 (p=0.002)	

Table 3: Results for the macaw FE (Wald Chi-Square (p)). RW stands for Ropes and Water bowls, SF for Spoons and Food bowls.



Graphic 1. Significant effect of Resting/inactivity behaviour in the macaw FE

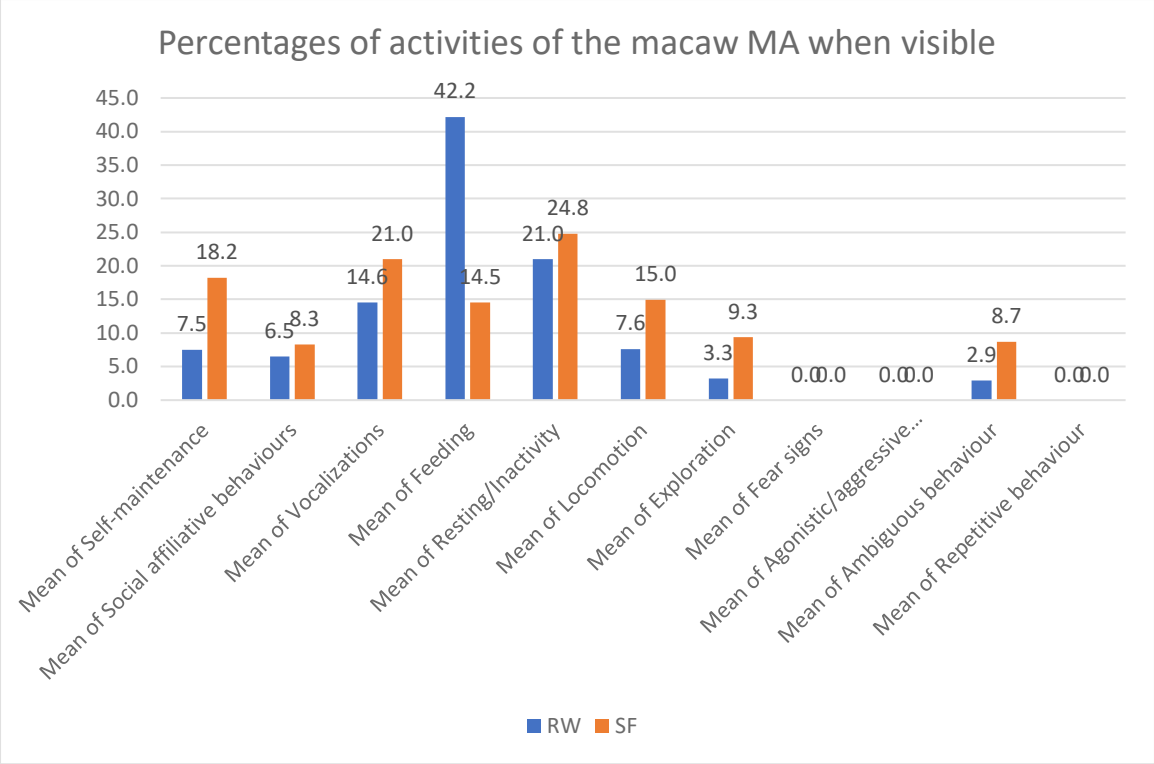


Graphic 2. General graphic of all the behaviours observed in the macaw FE

b. Macaw MA

Behaviour	Part of the day (df=1)	Enrichment type (df=1)	Cycle (df=1)	Enrichment type* Part of the day (df=1)	Intercept (df=1)	Significant Effects
Self-maintenance	1.49 (ns)	2.31 (ns)	7.02 (0.008)	0.61 (ns)	13.41 (<0.001)	2>1
Social affiliative	0.003 (ns)	0.13 (ns)	0.19 (ns)	2.06 (ns)	9.27 (p=0.002)	
Vocalizations	0.13 (ns)	0.94 (ns)	0.005 (ns)	0.01 (ns)	28.90 (<0.001)	
Feeding	0.001 (ns)	5.57 (ns)	0.85 (ns)	0.50 (ns)	23.47 (<0.001)	
Resting/inactivity	0.80 (ns)	0.13 (ns)	0.61 (ns)	0.07 (ns)	19.44 (<0.001)	
Locomotion	0.02 (ns)	2.61 (ns)	0.91 (ns)	0.02 (ns)	24.63 (<0.001)	
Exploration	0.01 (ns)	2.33 (ns)	0.82 (ns)	0.04 (ns)	9.98 (p=0.002)	

Table 4: Results for the macaw MA (Wald Chi-Square (p)). RW stands for Ropes and Water bowls, SF for Spoons and Food bowls.



Graphic 3. General graphic of all the behaviours observed in the macaw MA

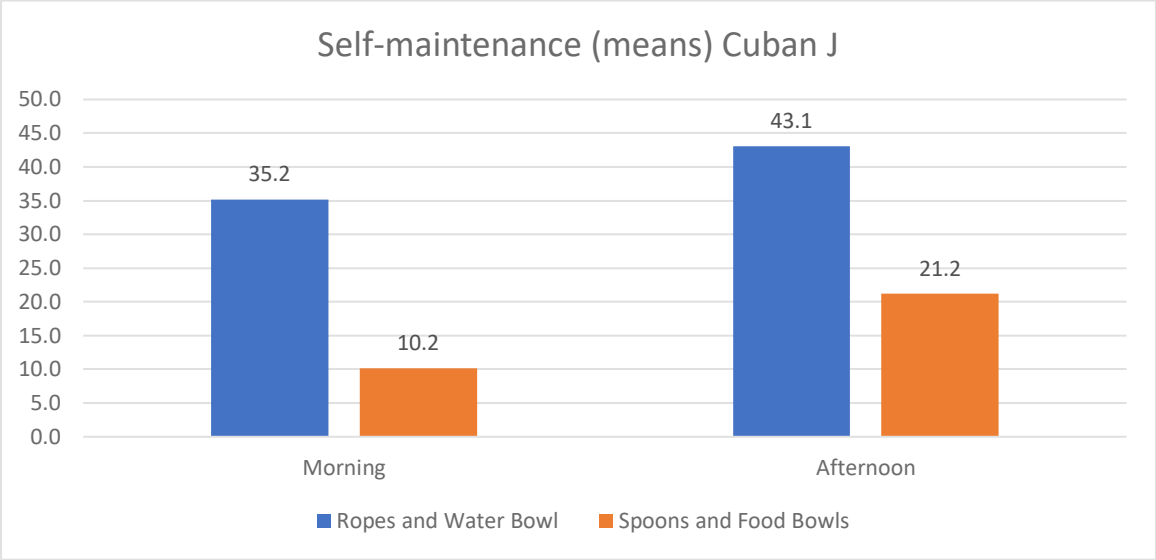
3.2 *Amazona leucocephala*

a. Cuban parrot J

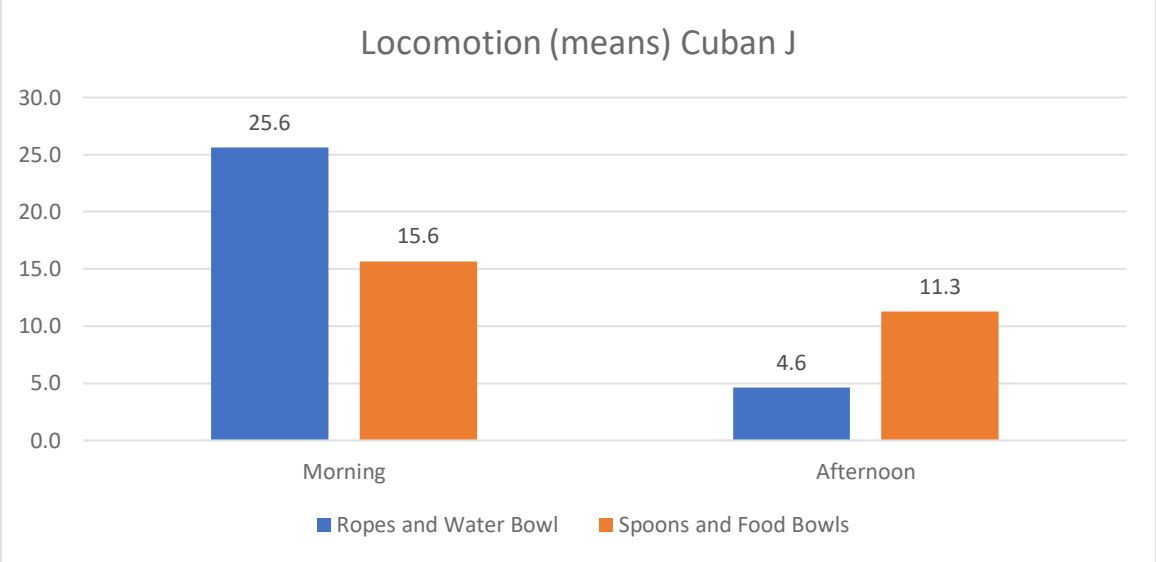
Behaviour	Part of the day (df=1)	Enrichment type (df=1)	Cycle (df=1)	Enrichment type* Part of the day (df=1)	Intercept (df=1)	Significant Effects
Self-maintenance	1.26 (ns)	6.80 (0.009)	0.005 (ns)	0.03 (ns)	37.15 (<0.001)	RW>SF
Vocalizations	0.51 (ns)	1.06 (ns)	3.30 (ns)	0.48 (ns)	20.25 (<0.001)	
Feeding	1.82 (ns)	3.59 (ns)	0.72 (ns)	0.59 (ns)	9.44 (p=0.002)	

Resting/inactivity	1.56 (ns)	0.38 (ns)	1.19 (ns)	0.23 (ns)	43.80 (<0.001)	
Locomotion	12.47 (<0.001)	0.12 (ns)	0.74 (ns)	5.35 (0.021)	36.32 (<0.001)	morning >afternoon
Exploration	0.96 (ns)	0.18 (ns)	2.70 (ns)	0.83 (ns)	24.13 (ns)	

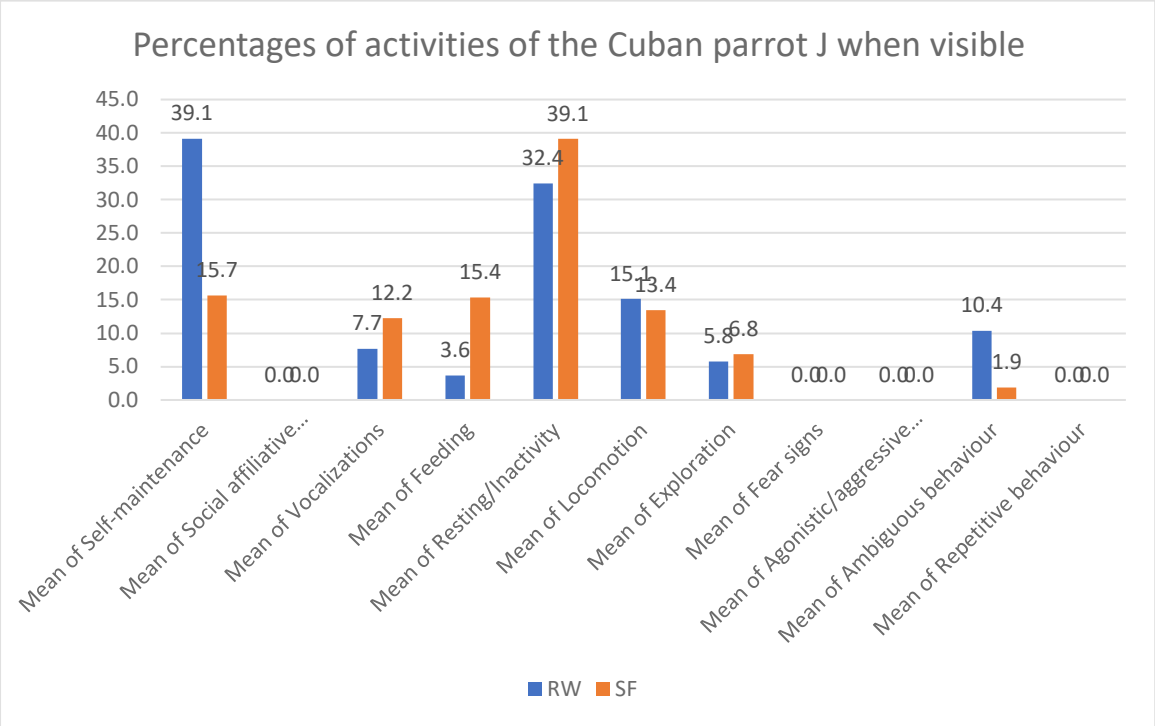
Table 5. Results for the Cuban parrot J (Wald Chi-Square (p)). RW stands for Ropes and Water bowls, SF for Spoons and Food bowls.



Graphic 4. Significant effect of Self-maintenance behaviour in the Cuban parrot J



Graphic 5. Significant effect of Locomotion behaviour in the Cuban parrot J



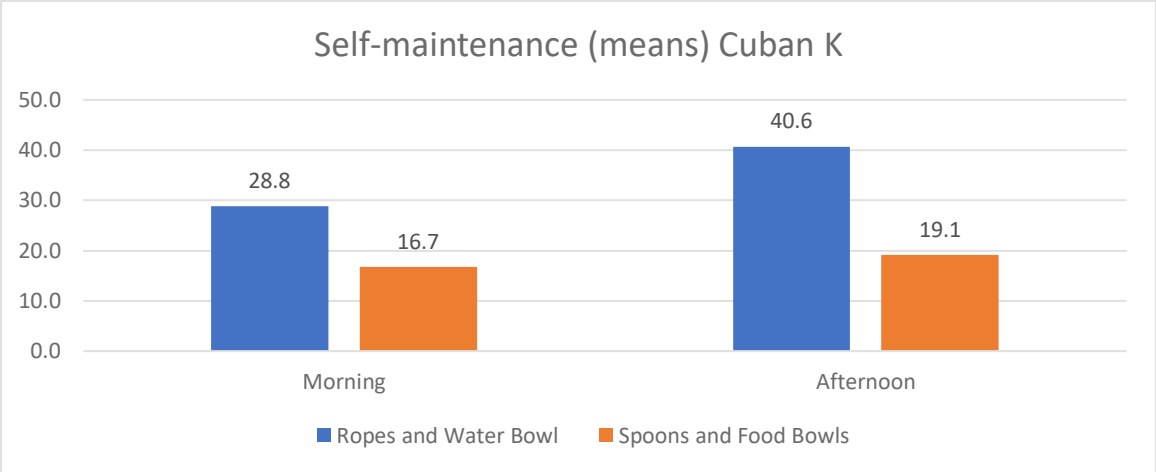
Graphic 6. General graphic of all the behaviours observed in the Cuban parrot J

b. Cuban parrot K

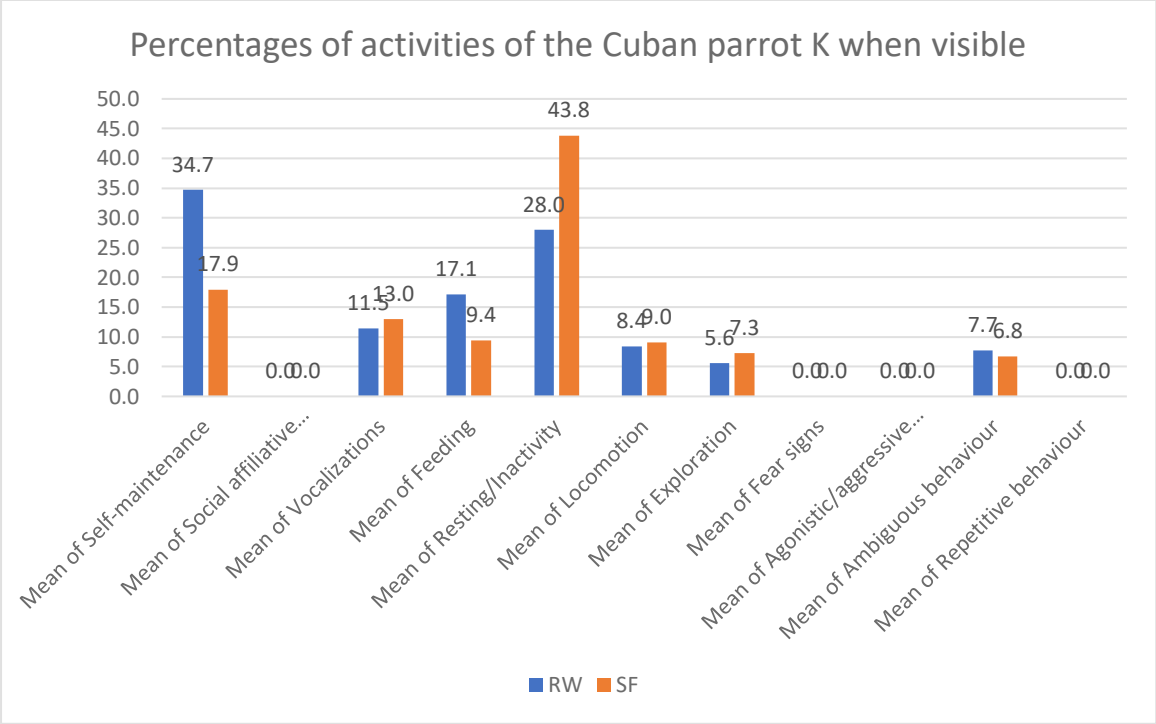
Behaviour	Part of the day (df=1)	Enrichment type (df=1)	Cycle (df=1)	Enrichment type* Part of the day (df=1)	Intercept (df=1)	Significant Effects
Self-maintenance	0.41 (ns)	3.92 (0.048)	1.62 (ns)	0.18 (ns)	38.50 (<0.001)	RW>SF
Vocalizations	1.87 (ns)	0.09 (ns)	0.37 (ns)	0.50 (ns)	23.24 (<0.001)	
Feeding	0.03 (ns)	0.94 (ns)	0.006 (ns)	0.73 (ns)	11.22 (0.001)	
Resting/inactivity	1.35 (ns)	2.50 (ns)	1.18 (ns)	0.37 (ns)	51.67 (<0.001)	

Locomotion	2.87 (ns)	0.04 (ns)	0.44 (ns)	2.06 (ns)	34.76 (<0.001)	
Exploration	2.56 (ns)	0.16 (ns)	0.36 (ns)	0.84 (ns)	9.31 (p=0.002)	

Table 6. Results for the Cuban parrot K (Wald Chi-Square (p)). RW stands for Ropes and Water bowls, SF for Spoons and Food bowls.



Graphic 7. Significant effect of Self-maintenance behaviour in the Cuban parrot K



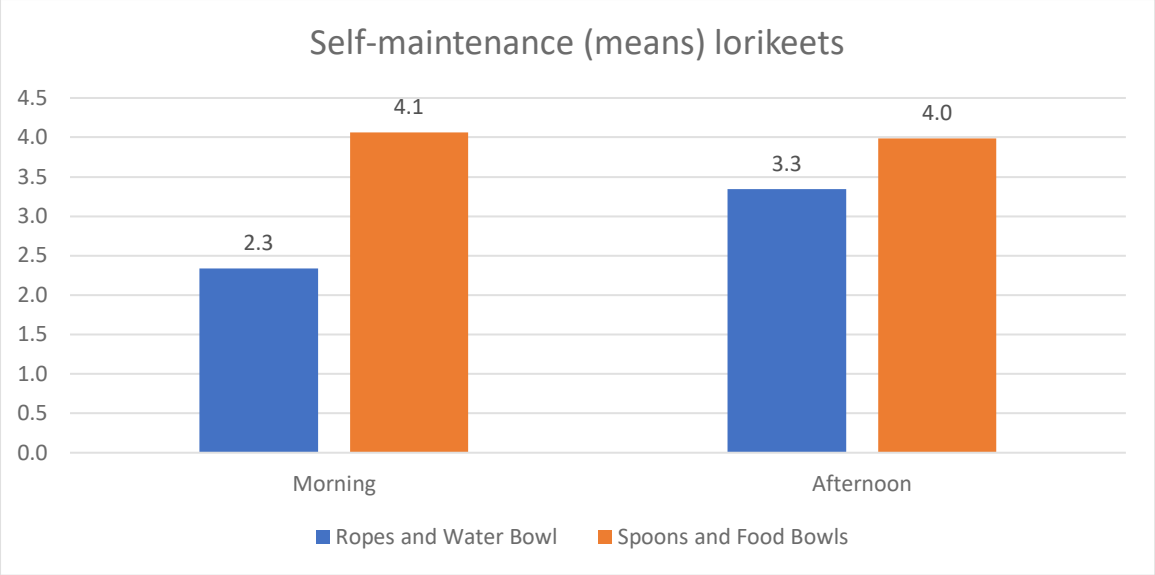
Graphic 8. General graphic of all the behaviours observed in the Cuban parrot K

3.3 *Trichoglossus haematodus*

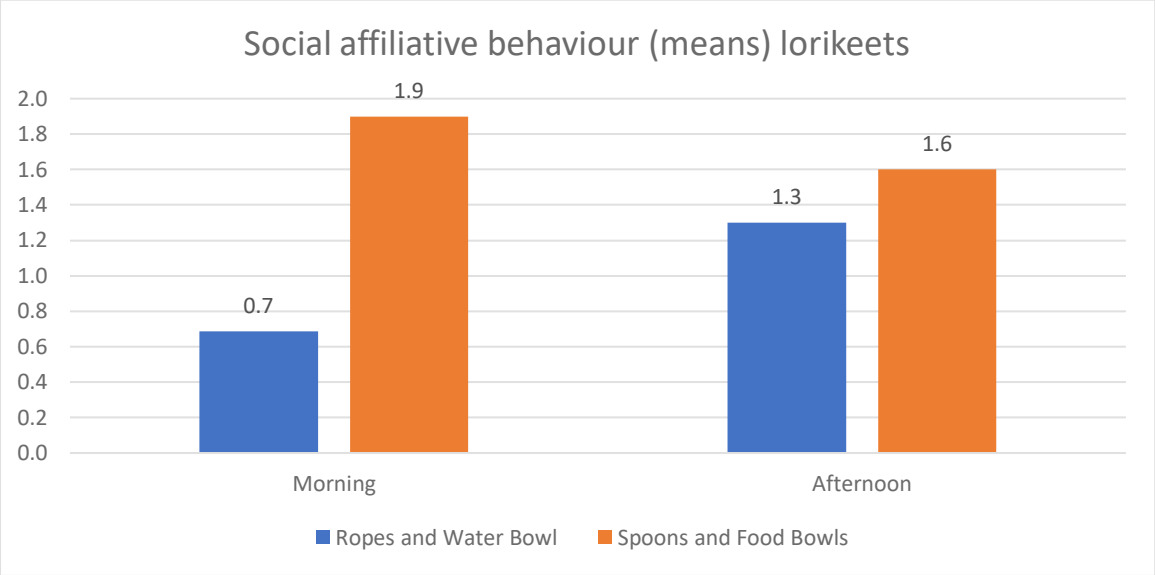
Behaviour	Part of the day (df=1)	Enrichment type (df=1)	Cycle (df=2)	Enrichment type* Part of the day (df=1)	Enrichment type*Cycle	Intercept (df=1)	Significant Effects
Self-mainteinance	2.01 (ns)	12.6 (p=0.000)	25.38 (p=0.000)	1.46 (ns)	5.29 (ns)	139.6 (<0.001)	SF>RW; H<1; H<2
Social affiliative	0.32 (ns)	5.14 (p=0.023)	9.27 (p=0.010)	7.9 (p=0.005)	5.33 (ns)	22.95 (<0.001)	SF>RW; H<1; RW-morning <SF-morning
Vocalizations	0.97 (ns)	3.11 (ns)	10.89 (p=0.004)	0.31 (ns)	1.27 (ns)	24.19 (<0.001)	1 tends to be >2
Feeding	1.60 (ns)	3.55 (ns)	45.19 (p=0,000)	0.45 (ns)	16.05 (p=0.000)	164.16 (<0.001)	H<1; H<2; 1<2; RWH<RW2; RW1<RW2; RW1<SF1
Resting/inactivity	2.04 (ns)	4.27 (p=0.04)	4.41 (ns)	1.24 (ns)	1.53 (ns)	149.4 (<0.001)	RW<SF

Locomotion	6.25 (p=0.012)	0.45 (ns)	4.75 (ns)	1.61 (ns)	0.13 (ns)	46.26 (<0.001)	Morning <afternoon
Exploration	3.6 (ns)	3.51 (ns)	7.32 (p=0.026)	4.06 (p=0.044)	1.56 (ns)	190.04 (<0.001)	H<2; RW-morning >SF-morning
Interaction with enrichment	0.17 (ns)	6.68 (p=0.01)	2.01 (ns)	12.08 (p=0.001)	7.14 (p=0.028)	76.77 (<0.001)	RW>SF; RW-morn morning RWH>SF SFH<SF2
Visibility	3.85 (ns)	6.44 (p=0.011)	88.75 (p=0.000)	3.37 (ns)	22.67 (p=0.000)	1900.03 (<0.001)	SF>RW; H<1;H<2;1<2; RW-H<RW-1;RW-H<RW-2; RW-1<RW-2; RW-1<SF-1

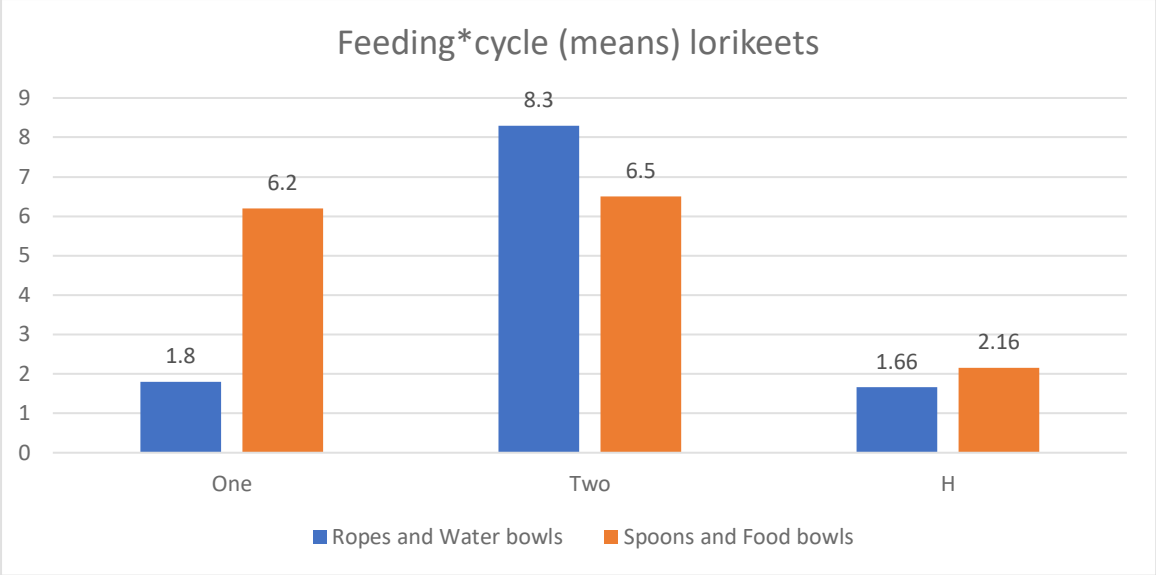
Table 7. Results for the lorikeets (Wald Chi-Square (p)). RW stands for Ropes and Water bowls, SF for Spoons and Food bowls.



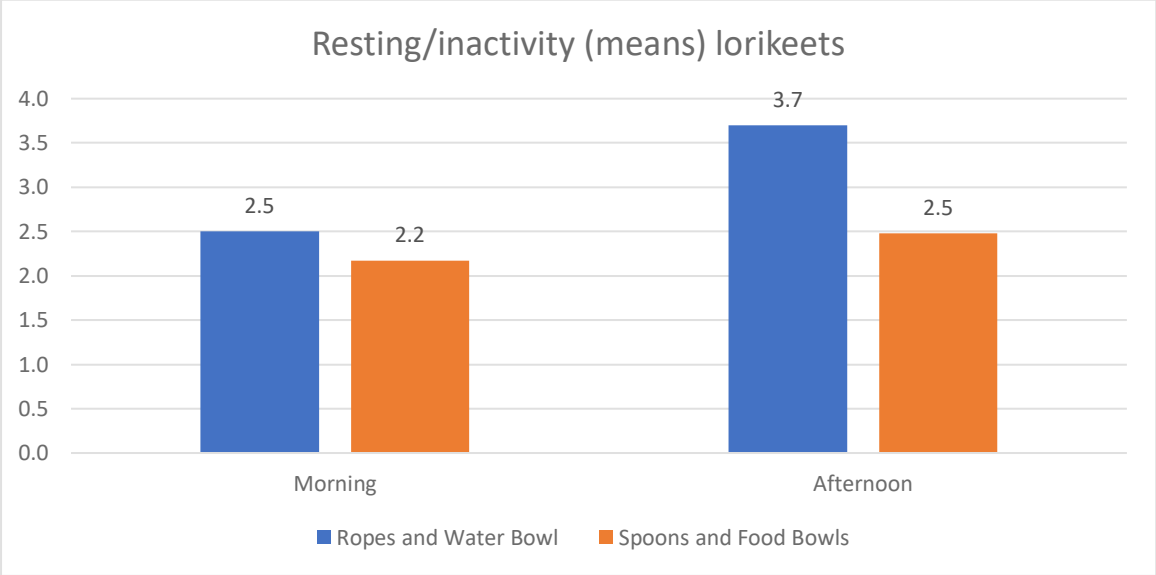
Graphic 9. Significant effect of Self-maintenance behaviour in the lorikeets



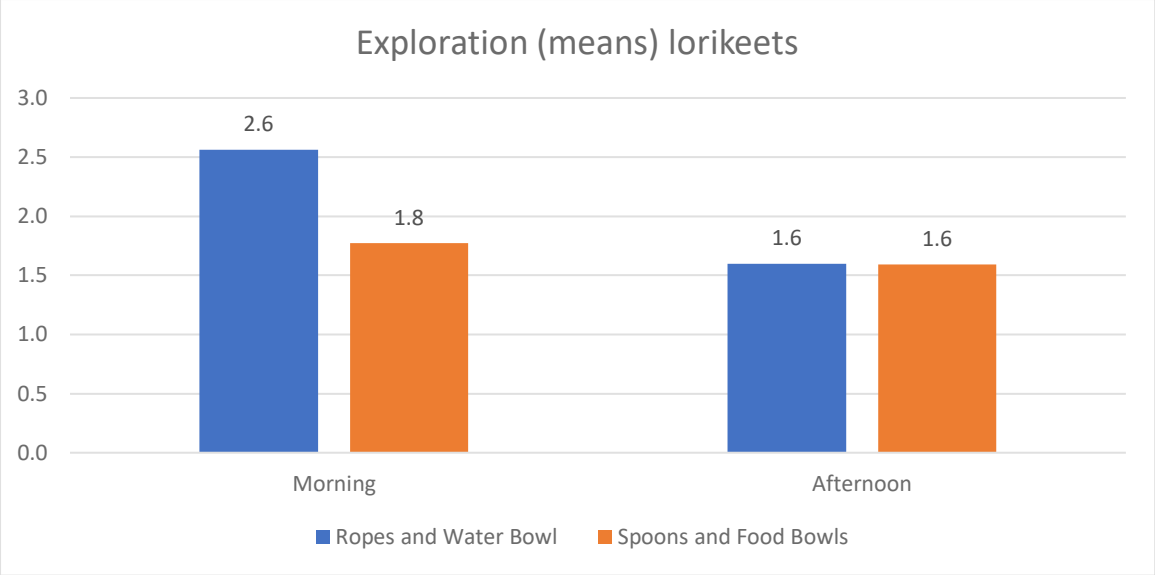
Graphic 10. Significant effect of Social affiliative behaviour in the lorikeets



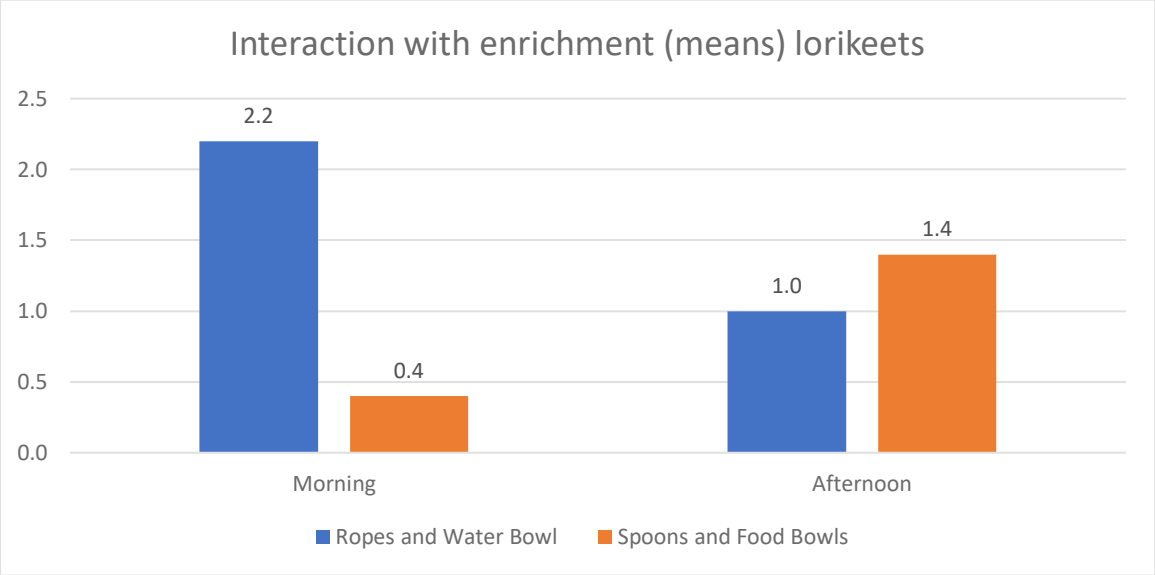
Graphic 11. Significant effect of Feeding behaviour*cycle in the lorikeets



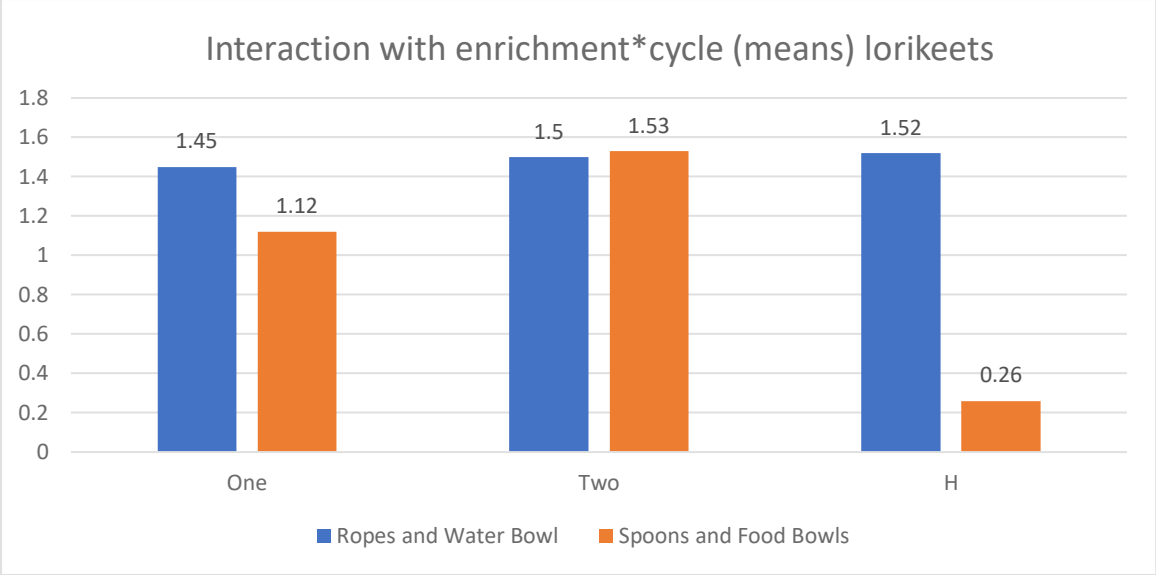
Graphic 12. Significant effect of Resting/inactivity behaviour in the lorikeets



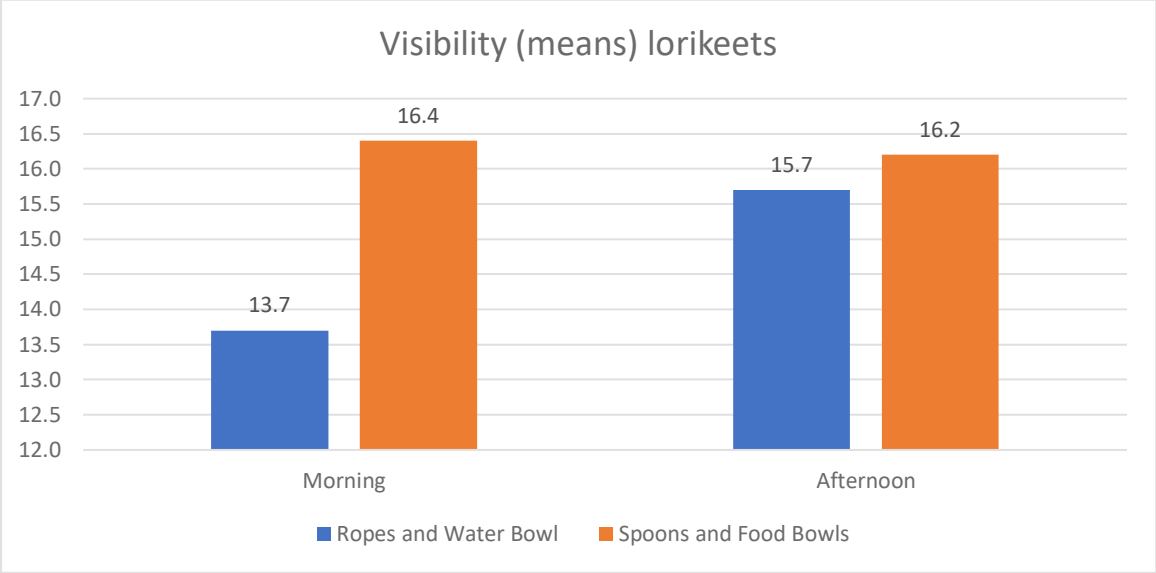
Graphic 13. Significant effect of Exploration behaviour in the lorikeets



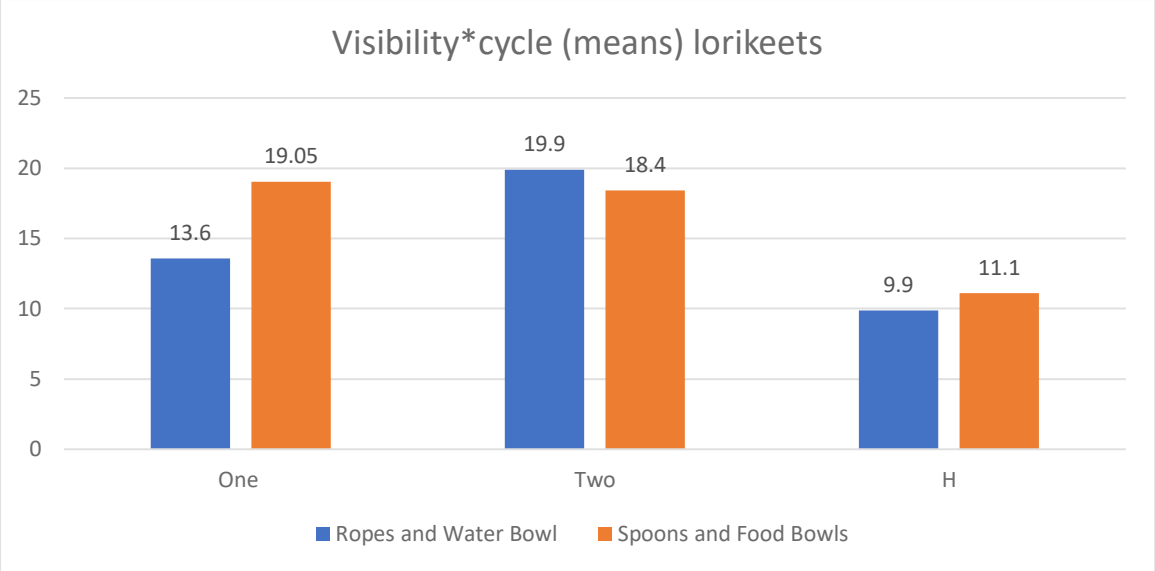
Graphic 14. Significant effect of Interaction with enrichment in the lorikeets



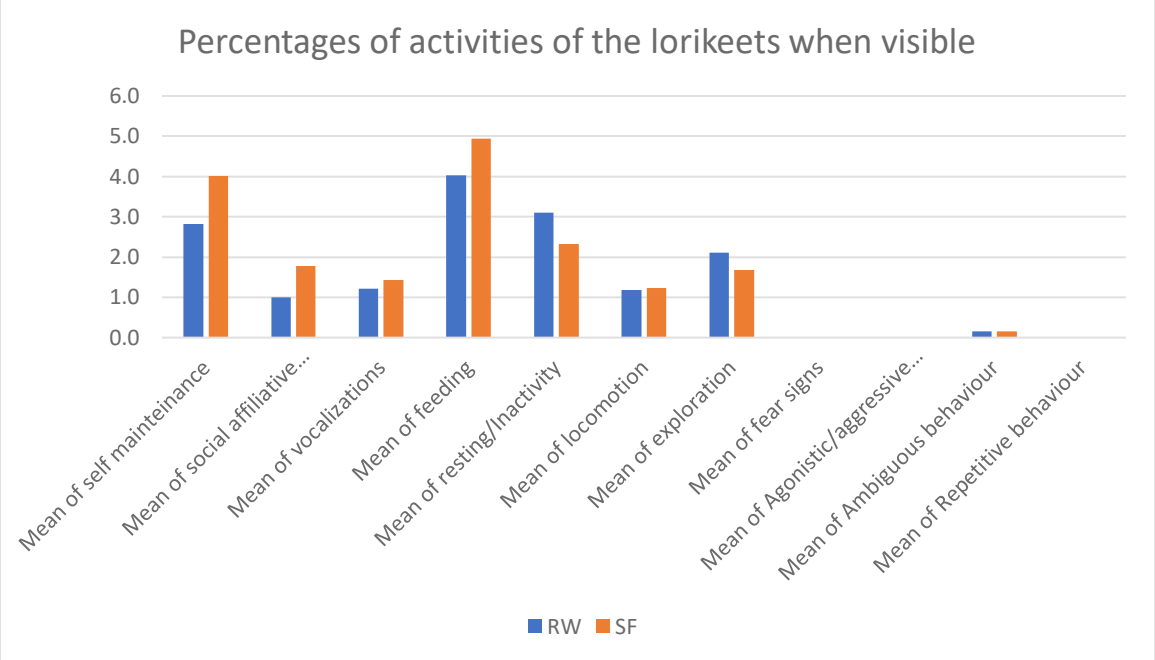
Graphic 15. Significant effect of Interaction with enrichment*cycle in the lorikeets



Graphic 16. Significant effect of Visibility in the lorikeets



Graphic 17. Significant effect of Visibility*cycle in the lorikeets



Graphic 18. General graphic of all the behaviours observed in the lorikeets

4. DISCUSSION

Analysing data, the results showed some significant effects concerning specific behaviours performed by parrots or a specific time of the day.

Specifically, the **female macaw (FE)**, as shown in the Graphic 1, showed a significant effect of Resting/inactivity behaviour.
This behaviour was observed in the morning, when spoons and food bowls (SF) were present as enrichment, with a higher percentage (52.2%) respect to the afternoon (45.1%). However, with ropes and water bowls (RW) as enrichment, the situation changed: in the morning the frequency of behaviour was only 17%, while during the afternoon it was 31.6%.
The highest percentage in the morning could be a suggestion that she preferred or used to rest during the morning, although a conspicuous part of Resting behaviour was seen during the afternoon too.

Graphic 2 shows the general percentages of all the behaviours observed in the macaw FE, in which Resting/inactivity results to be the most frequent behaviour during the observation times with spoons and food bowls (SF), with a total percentage of 53.5%, followed by Ambiguous behaviour during SF (28.6%), Resting/inactivity during RW (26.7%) and by Vocalizations with RW (26.1%).
The percentage of Vocalizations suggest the great amount of time spent vocalizing, especially with the male.

Fear signs, Agonistic/aggressive and Repetitive behaviours were not seen at all (0%), but apart from that the least frequent behaviour resulted to be Self-maintenance during SF, with a percentage of 4%, that was 15.8% during RW instead.

Regarding the **male macaw (MA)**, no significant effects resulted from the analysis of data. However, differently from the female, the highest percentage of activity observed was in Feeding behaviour when ropes and water bowls (RW) were present, specifically 42.2%. While during SF it was only 14.5% (Graphic 3).

The second highest frequency was for Resting/inactivity behaviour: 24.8% when SF and 21% when RW, suggesting the conspicuous amount of time spent resting as for the female, almost independently from the enrichment present.
Vocalizations were 21% too when SF, while 14.6% when RW, quite less than the female's percentage.

As for the female macaw, Fear, Aggressive and Repetitive behaviours were not seen during the observations, while Ambiguous behaviour when RW resulted the least frequent behaviour, with a frequency of 2.9% (that grew to 8.7% when SF).
The frequency of Exploration was the second lowest (3.3% when RW), growing to 9.3% when SF.

The female macaw was seen interacting with food bowls (eating from them, even if not frequently), while the male macaw did not show any interaction with enrichments.
However, the absence of an effect of the feeding bowls used as feeding enrichment in the present study seems to disagree with the increase in foraging found by Miglioli and Vasconcellos (2021), but the feeding enrichment used in their study consisted of paper rolls covered with grains/seeds, pinecones stuffed with fruits, green coconuts stuffed with food, corn cobs, whereas in the present study simple bowls with food were used. The same can be said regarding the difference with the results of de Almeida et al. (2018).

Talking about the **Cuban Amazon J**, Graphic 4 and 5 show significant effects for the behaviours, respectively, Self-maintenance and Locomotion.

In particular, Self-maintenance resulted to be in higher frequencies whenever ropes and water bowls (RW) were present: 35.2% in the morning and 43.1% in the afternoon.
When spoons and food bowls were present, instead, lower percentages were seen: 10.2% in the morning and 21.2% in the afternoon.
However, no interaction with enrichments was seen at all during observations to the Cubans, therefore an eventual influence caused by the enrichment types is maybe to exclude. Preening behaviour, foot and beak cleaning were very frequent, but not related to any enrichment.

However generally, as shown by Graphic 6, Self-maintenance was one of the most frequent behaviours observed, with a total percentage of 39.1% with RW and a lower of 15.7% when SF.
Locomotion frequency resulted higher in the morning, instead, both when RW and SF were present: 25.6% when RW and 15.6% when SF.
In the afternoon, 4.6% of Locomotion was seen when RW, while 11.3% when SF.
These percentages suggest the influence that the time of the day had on the kind of the behaviour, as the Cuban J was used to doing Locomotion more during the morning respect to the afternoon, independently from the type of enrichment.

Generally, Locomotion was not one of the highest frequencies observed during the observation times (Graphic 6), with a total percentage of 15.1% when RW and 13.4% when SF.
As already mentioned, Self-maintenance was the highest frequency of behaviour observed when RW (39.1%), together with Resting/inactivity (39.1% when SF and 32.4% when SF).
Thus overall, the highest percentage of behaviour observed was that of Resting/inactivity, in both enrichments' period, suggesting the great amount of time spent by the Cuban J resting/perching but also preening.
Feeding when SF was almost high as Self-maintenance when SF, with a percentage of 15.4%.

As for macaws, Fear, Agonistic and Repetitive behaviours were not seen, as well as Social affiliative behaviour, but apart from them, the least frequent behaviour was Ambiguous behaviour (1.9% when SF, but 10.4% when RW).

The **Cuban Amazon K** showed a significant effect regarding Self-maintenance (Graphic 7): higher frequency when ropes and water bowls were present (28.8% in the morning and 40.6%, the highest, in the afternoon), and lower when spoons and food was presented (16.7% in the morning and 19.1% in the afternoon).
Self-maintenance was thus more frequent in the afternoon and when RW but, similarly to the Cuban J, no interaction with enrichments was seen during the observations, supposing that enrichment was not a contributory factor to this as well as all the other behaviours.
Much preening, foot and beak cleaning was observed, not related to any enrichment.

Generally, the most frequent behaviour was Resting/inactivity during SF period (43.8%), while during RW period it was 28%, lower but still higher than other behaviours (specifically the third highest). The second highest behaviour was Self-maintenance when RW (34.7%), while when SF the percentage was quite lower (17.9%).
Therefore, Resting and Self-maintenance was highly frequent in both Cuban parrots.
Fear signs, Agonistic, Repetitive and Social affiliative behaviours were not seen, as for the Cuban J and the macaws. The lowest frequent behaviour was Exploration when RW (5.6%), that was 7.3% when SF, more or less equal to the one showed by the Cuban J (5.8% when RW and 6.8% when SF).

Regarding the **lorikeets**, analyses show significant effects for the following behaviours: Self-maintenance, Social affiliative, Feeding (respect to the cycle), Resting/inactivity, Exploration, Interaction with Enrichment and Visibility (these two also respect to the cycle).

Self-maintenance (Graphic 9) resulted to be most frequent during the morning, when spoons and food bowls (SF) were present, with a 4.1%, although in the afternoon, with the same enrichments, the percentage was almost equal (4.0%). Considering both enrichment types, the afternoon is the time of the day in which Self-maintenance was more frequent, since the percentage when ropes and water bowls (RW) were present was 3.3% (respect to 2.3% in the morning).
Social affiliative behaviour (Graphic 10) had the highest percentage during the morning when SF (1.9%), followed by 1.6% in the afternoon when SF. The lowest frequency was during the morning when RW (0.7%).
Feeding behaviour (Graphic 11) had a significant effect respect to the cycle in which it was examined. The highest percentage was in cycle Two when RW (8.3%), followed by 6.5% when SF in the same cycle. The lowest was 1.66% in cycle H (Habituation), when RW.
Resting/inactivity (Graphic 12) was the highest generally in the afternoon, specifically when RW (3.7%). When SF the percentage was 2.5%. The lowest frequency was during the morning when SF (2.2%). This could be due to the heat of the morning; the evening time, as it is less hot, stimulates parrot to become active again (Personal communication, Walsh E.A., 2022).

Exploration (Exploration 13) was generally more frequent in the morning, especially when RW (2.6%), followed by 1.8% when SF. In the morning the percentages were both 1.6% when RW and SF.

The highest percentages in the morning for Exploration and in the afternoon for Resting/inactivity suggest that the lorikeets were generally more active during the morning.

Regarding Interaction with enrichments (Graphic 14), the highest frequency was seen during the morning when ropes and water bowls were present (2.2%), suggesting that ropes and water (but mainly ropes as I observed) were preferred and most used by the lorikeets respect to the other types. This was probably influenced by the fact the lorikeets were more active during the morning.

The second highest percentage was 1.4% for spoons and food bowls in the afternoon, while it was only 0.4% (the lowest) in the morning when SF.

Considering the Interaction with enrichment respect to the cycle (Graphic 15), the highest frequency was 1.53%, in cycle Two when spoons and food bowls were present, followed by a 1.52% in cycle H when ropes and water was present. Overall, the highest percentage was during cycle Two, since also the frequency of RW was high (1.5%).

The frequency of Visibility (Graphic 16) was the highest when SF, specifically in the morning when SF (16.4%), followed by 16.2% in the afternoon. The lowest frequency was in the morning when RW (13.7%).

Considering the Visibility respect to the cycle (Graphic 17), overall, the highest frequency was in cycle Two, as for Interaction with enrichment, probably because in the last period the observer was more used and practical in doing observations and a quick and easy identification of the individuals was possible.

Specifically, in cycle Two the highest value is 19.9% when RW, and 18.4% when SF. The second highest frequency, however, was when SF in cycle One (19.05%). The lowest was when RW in cycle H (9.9%).

As Graphic 18 shows, overall, the most frequent behaviour of the lorikeets when visible was Feeding, regardless the type of enrichment, with percentages of 4.9% when SF and 4.0% when RW. This demonstrates that the enrichment food bowls influenced and enhanced that behaviour.

The second highest percentage was during Self-maintenance when RW (4.0%), while when SF it was lower (2.8%).

Resting/inactivity was also mediumly high: 3.1% when RW and 2.3% when SF.

Fear signs, Aggressive and Repetitive behaviours, as for the other species, were not present at all, while Ambiguous behaviours is the one having the lowest frequencies (0.2% both when RW and SF).

Another behaviour which was very infrequent was Locomotion: 1.2% of frequency both when RW and SF.

Conclusions

Having observed the species involved and having examined the data obtained through the observations, as a conclusion it is possible to assert that the **macaws** spend a great time resting or perching, especially the female, and specifically on the top of their woodhouse. It is not clear whether this inactivity is due to the old age or to small space and boredom. However, on the top of the woodhouse they are also used to do preening and interact or explore with the house itself, pecking on it, although exploration is one of the less frequent behaviours, both in the female and in the male, while self-maintenance is quite more frequent.

Feeding is the most frequent activity in the male, differently from the female (who spends most of her time resting or perching), and it usually occurs at the edge of the food bowl, although some episodes of feeding and pecking on the ground, as well on the top of the woodhouse, were seen.

Feeding was seen in the female too, and sometimes also from the enrichment food bowls, specifically toward apple and grape, to which she had a preference. The fruits were usually not completely eaten, however; for example, sometimes grape was eaten just in the internal part, or there were some leftovers, as it is usual for parrots to eat just part of fruit and being wasteful in captivity (Personal communication, Walsh E.A., 2022). This is why the enrichment food was cut in small pieces and divided into small groups, as the parrot could choose which food to eat, avoiding wastes. The male Ara was not seen interacting with enrichments at all, as well as the female concerning the other kinds of enrichment.

Vocalizations are also mediumly frequent, especially when a keeper approaches with food, and sometimes they join in with the Ara species, *Ara chloropterus,* who are nearby.

Regarding Locomotion, it was quite infrequent (but higher in the male). However, they move a lot hanging on the mesh, to reach places like the food bowl, the water tank and the ground.

They are sometimes, but rarely, seen perching on branches, the size of which was various, but mainly thick, respect to the other species' branches, although not much long (about 2 metres long). The fact they were not seen much on these branches could be a clue that they were not much motivated to perch, but the observation times could be a limit for this, as they could have perched more during later or earlier times.

Regarding the **Cubans**, they spend a great amount of time resting and perching, as well as preening and doing self-maintenance. Resting/inactivity and Self-maintenance appear to be the most frequent behaviours in the Cubans J and K, especially when spoons and food bowls are present (for Resting) and ropes and water bowls are present (for Self-maintenance).
However, as already mentioned, no interaction with enrichments was seen in the Cubans, therefore a correlation between behavioural type and enrichment type is probably to exclude, although the observation times could be a limit for this, as the interaction could have happened during another time of the day.
Feeding, vocalizations and locomotory behaviour are also mediumly frequent in this species. They show a great variety of vocalizations, also when it is feeding time and together with other species like *Amazona ochrocephala*, *Cacatua moluccensis*, *Aratinga solstitialis* and others, who share the same zoo area.
The Cuban J exhibits more locomotory and exploration behaviour than the Cuban K, usually on the left side of the mesh and looking at *Amazona ochrocephala,* while the Cuban K is used to rest, perch and vocalize more, on the branch in the middle of the cage.

As regards the **lorikeets'** routine, they are usually very active, especially in the morning and in late afternoon. As data show, in fact, they tend to rest more in the early afternoon, while explore more in the morning, and this behaviour is mediumly frequent overall. They vocalize a lot, also when food is arriving, but they exhibit also much locomotion, foraging and eating (which is overall the most frequent behaviour), exploration, playing hanging on the roof of the enclosure or branches as well as bathing and self-maintenance in general (which resulted to be the second most frequent behaviour overall). Some courtship attempts and mating were also seen. When they are not active, they spend much time preening and resting in couples, in specific places which are often the same, for example perching on a branch or on top or inside a woodhouse.

Regarding enrichments, all of them were used by the lorikeets, in particular food bowls and ropes with a higher frequency, while water bowls and spoons were less frequently interacted with. Data show that the highest frequency of Exploration was when ropes and water bowls were present, during the morning, suggesting that ropes enhanced this behaviour. Feeding was also frequent when food bowls and spoons were present.

Regarding spoons, some of them were placed hanging from a branch, while others on a branch which was over another, as to permit the parrots to reach the spoons from the branch below. These spoons, located in this way, were used more by the lorikeets, hypothetically due to their location, as they were easier to reach, than the ones hung without any branch below.

Parrots *A* and *B* showed particular interest and interaction with the enrichments, often perching, performing locomotory behaviour and vocalizations on the ropes, eating from food bowls, pecking on spoons or on the rope to which spoons were tied and hung, and exploring/bathing on water bowls (although with much less frequency).
Parrot *A* (who is a female hand-reared by humans) was very keen on using enrichments, as she started using them from the first day in which they were put inside the cages without hesitation nor fear, and this could be a sign of the trust she has on humans.
Also, she was used to approach the observer walking on the mesh or flying, and this may also be a way to solicit attention from the observer.

Generally, results showed that they are very active as they spent much time Feeding. Self-maintenance was also much frequent, followed by Resting/inactivity and then by Exploration.
The Interaction with enrichment was most frequent with ropes and water bowls, and generally in cycle Two for both RW and SF. This suggests that, although food bowls have influenced the frequency of Feeding behaviour (as it was the most frequent), ropes were preferred and much used by the lorikeets, especially in the last cycle, since they were probably more habituated to the enrichments, and more precise observations were possible.

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First and foremost, I would like to thank the Supervisor and Co-supervisor of my thesis: Professor Simona Normando and MSc CABC Elizabeth Walsh, for giving me the opportunity to be part of this research project and guiding me through my experimental thesis. Thanks to them, I have discovered a bit of the world behind Ethology and some animals I did not know and I fell in love with: the parrots.

Thank you to all the personnel at Cappeller Zoo: the keepers, the owners and all the workers that guided and helped me during my traineeship. I am very grateful for having had the chance to do my traineeship there.

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Thank you to Emanuele; for the continuous and precious help, support, and patience, for always staying close when I need it most.

Thank you to those who have shared this journey at University with me, in joys and pain: my classmates.

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Bibliography of pictures

- Figure 1: Map of the Cappeller Zoo, in https://parcocappeller.it/parco-faunistico-cappeller/mappa-parco-cappelle/

All the other pictures are property of the author (Ilaria Marian).
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