PhD THESIS

Normal and pathological behavior of primates in captivity

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INTRODUCTION

The behavioral development is supported by the development of the nervous system and by the placement or patterns of the neural circuits. The primates are sociable creatures capable of complex cognitive reasoning. They are gregarious and interactive within their own group, aspects revealed by their complex and specific behaviors so as to ensure the survival of the group. Life in captivity involves types of environment, climates and life-styles or habits that are different from those in the wild, as they are controlled by the humans. Thus, the individual animal find itself within an externally, human-imposed group of primates, in an environment oftentimes characterized by weak environmental stimuli. These alterations, when compared to the species' natural habitat, can have repercussions on the physiological and physical well-being of the animal. To diminish the negative effects of this issue, more and more zoological parks use an ethological approach towards primates. The attitudes specific to the primates' well-being in the wild are compared to their attitudes in captivity in order to identify possible behavioral problems.

The zoological parks have the obligation of promoting the health and well-being of the captive animals. They must try to secure living conditions very similar to the ones in the wild so as to ensure their species' particular behaviors (GUSSET ET DICK, 2011; PEREZ-GALICIA ET COLLAB., 2017). Recently, the number of studies dealing with abnormal behaviors of primates in captivity in zoos throughout the world has significantly increased (HOSEY, 2005). The well-being of non-human primates in zoos can be influenced by two specific factors. Whereas the first one refers to the confinement specific stressors represented by visitors and different enclosure particularities, the second one comprises environmental elements such as artificial light or inadequate control of the temperature (HOSEY, 2005; SMITH, 2014; MORGAN ET TROMBORG, 2007). With the populations of captive primates, the most important factor of stress might be the presence of unknown human visitors (PEREZ-GALICIA ET COLLAB., 2017). Moreover, the study of the interactions between the humans and the captive monkeys, also known as ethnoprimatology represents one of the main debate issues of the 21st century, as it may result in multiple solutions to the already existing problems related to animal grouping within zoological parks (FUENTES ET HOCKINS, 2010). All these factors may induce transformations at a behavioral level, ending with the manifestation of stereotypes such as the following: turning in circles, left-right head movements or self-mutilation (WOLFENSOHN ET COLLAB., 2018). However, there are not many known aspects related to the influence of the environment on the behavior of primates in captivity in the case of zoological parks in Romania nowadays, and, even more, not to

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the interactions between visitors and primates in zoos either, as this is a subject that is not made evident for the time being

THE MAIN RESEARCH OBJECTIVE AND SPECIFIC AIMS

The main aim of this research paper is to evaluate, supervise and analyze the normal and pathological behaviors in the case of captive monkeys. For the beginning, we will present the natural living conditions of primates in the wild. At the same time, we intend to design a structured from related to behavior assessment in order to establish the elements that ensure the species well-being and that offer a diagnose for certain behavioral disorders. The second part of this paper will deal with explaining different methods of observing primates in captivity. Eventually, we will suggest methods for improving the living conditions of primates in captivity so as to secure their well-being.

In setting the objectives of the current research paper on the behavior of monkeys in captivity, we took into consideration four main aspects: inquiring the mechanisms triggering the respective behavior; analyzing the stimuli, the social and living environment conditions and the neurophysiological and endocrinological mechanisms that control the respective behavior; gathering information about the evolution of the respective behavior be means of ontogeny, which involves analyzing growth processes and learning about and understanding the adaptive function of the respective behavior, as well as its relation to the living conditions of the individual, in other words, determining the manner in which the respective behavior contributes to the individual's survival.

This study was elaborated as to allow the following approaches:
- comparing the results of the structured forms with those observations noted down by a professional in the field of primates' behavior, a biologist in this case;
- comparing the before-after stages of the targeted behavior, in the wild and in captivity, recognized and adapted according to the set aim;
- researching the well-being factors in the case of the studied monkeys;
- establishing various correlations between general results and each of the behavioral criteria;
- comparing the observations conducted by two or more observers, the observations being then shared among themselves.

THE STRUCTURE OF THE THESIS

The PhD thesis called *"The Normal and Pathological Behavior of Primates in Captivity"* has been conducted according to the legal rules and regulations and is structured in two parts: one part deals with the specialized literature and the other part comprises the individual research with a rich and impressive graphical material made of 9 tables and 79 figures.

Part I - Theoretical Background - this part has 27 pages that cover 4 main chapters targeting the updated data presentation of: the current classification and morphology of primates (**Chapter 1**), the behavioral repertoire and the living traits of primates (**Chapter 2**), the well-being of animals in zoos (**Chapter 3**) and specific stereotypes (**Chapter 4**).

Part II - Individual Research Study - this part has 84 pages and it is structured in 5 chapters, each of them containing an introductory part, methods and materials, results and discussions, partial conclusions, general conclusions, recommendations and a reference list of 185 entries.

The 5ᵗʰ chapter of the second part comprises the experimental aspects of the current study, the main objective and aims of the research and specific materials and methodology.

The targeted animals, in the case of this research, are female and male primates form the zoological parks of de Târgu Mureş, Oradea and Cluj. A total of 77 primates were evaluated, out of 57 were from Târgu Mureş, 14, from Oradea and 6 from Cluj. Eleven (11) primate species were studies in the case of the Zoological Park of Târgu Mureş: *Macaca fascicularis* (n=6); *Eulemur macaco* (n=2); *Lemur Catta* (n=10); *Cercocebus chrysogaster* (n=2); *Erythrocebus patas* (n=2); *Cercopithecus albogularis kolbi* (n=3); *Sapajus apella* (n=2); *Macaca fuscata* (n=6); *Papio hamadryas* (n=8); *Macaca sylvanus* (n=8); *Mandrillus sphinx* (n=8). Four (4) species of primates were under study in the case of the Zoological Park of Oradea: *Papio hamadryas* (n=5); *Macaca fuscata* (n=2); *Cebus paella* (n=4); *Saguinus midas* (n=3), whereas in the case of the Zoological Park of Cluj, there was only one species under study: *Macaca mulatta* (n=6), namely an isolated female primate. The results are presented according to each species and target the living and care conditions, as well as social, eating and sexual habits or behaviors for each of the three zoological parks under discussion.

Chapter 6 focuses on study I, namely „**The Behavior of Primates at the Târgu-Mureş Zoo**". The biological material consisted of 59 primates from 11 different species living at the zoo in Târgu-Mureş (Verii Street, no 57, Târgu Mureş, Romania). In

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order to identify the behavioral problems of primates, an ethological questionnaire has been used. The study of animal behavior was conducted between 10-16 November 2017, and the corresponding observation was done daily, for three hours, the observation interval being different for each of the 7 days mentioned above.

Chapter 7 comprises study II, namely „**The Non-invasive Evaluation of Cortisol and of the Gastrointestinal Parasitism in the Case of Primates in Captivity in Romania".** The study took place between March and May 2022 in tree zoos in Romania: Oradea, Cluj and Târgu-Mureș, and it targeted 77 primates, females and males, used to visitors throughout the years. The age of the primates varied between 1 and 29 years, out of which 9 primates were of very young ages (11,2%), 24 were young primates (31,2%), 27, adults (35,1%) and 17 were older (22,1%). They belong to the following species: *Macaca fascicularis* (n=6), *Macaca fuscata* (n=8), *Macaca luisa* (n=6), *Macaca sylvanus* (n=8), *Mandrillus sphynx* (n=9), *Papio hamadryas* (n=13), *Sanguinus midas* (n=3), *Sapajus apella* (n=2), *Cebus apella* (n=4), *Cercocebus chysogaster* (n=2), *Cercopithecus albogularis kolbi* (n=3), *Erythrocebus patas* (n=2), *Eulemur macaco* (n=3), *Lemur catta* (n=10). The participants to this study were regrouped in groups of 2 to 29 individuals, according to the species. The building did not have artificial light and the primates had free access to the food stand.

The main research aim was to establish if there is a direct relation between cortisol rates, the gastrointestinal parasitism and the living conditions. The cortisol was determined from fecal samples. All the efforts have been made to avoid collecting fecal samples that might have been contaminated by contact with soil or water. There was no trace of blood or mucus observed in the collected samples. The consistency and the colour of all sampled stools were very similar. The day of sample collecting was also the day of their secured transportation, in a refrigerating container, directly to the lab. The part of the sample meant for cortisol analysis was placed in a refrigerator until its proper analysis. The stools collected for parasite analysis were kept in the fridge over one night. The cortisol was extracted by using an adapted version of the method designed by WASSER ET COLLAB., (1993). Every fecal matter sample was analyzed by applying the method of flotation, using a saturated sodium chloride solution (specific gravity 1,28) and the method of sedimentation. Cysts, ovocytes and eggs were identified by using morphological criteria with the help of the Japanese microscope Olympus BX61 with lenses of x10, x20 et x40 (KASSAI, 1999; MIRCEAN ET COLLAB., 2011).

Chapter 8 tackled study III, which a case study – „**The Behavior of a Solitary Primate in Captivity in one of the Romanian Zoos**". The female primate aged 17, Luisa, of unknown origin, was brought to the zoo called "The Windmill Recreational Park, Sălicea", Cluj, Romania in 2008. Before that, it was a pet in two different families. Luisa was the only primate of the zoo during the research period corresponding to this

PhD paper, living all alone after being brought at this zoo. A comprehensible ethogram was designed with the compliance of the caretakers of the primate. The categories include daily behaviors such as: food, social aspects, signs of aggression, grooming and stereotypical movements. The data were collected over a period of 4 months, between the beginning of October 2017 and the end of February 2018. The validity of the experiment was confirmed by a biologist specialized in behavior who obtained viable information. The behavioral data were collected by using the focal sampling method, with an interval of 15 seconds during one hour observation periods, resulting in 240 data points for one hour of observation. The date were collected by using direct observation, during 3 hours per day over a period of 4 months. There were 86.400 observations collected over 360 hours of observation of the animal behavior. The number of observations for each behavior was noted in each specific table. The enclosure of the primate was also studied using the same data collection method. This space was divided into different areas for research purposes.

Chapter 9 comprises the research conclusions and recommendations and **Chapter 10** presents the elements of original research and the innovative contributions of the current PhD thesis.

THE RESULTS OF INDIVIDUAL RESEARCH

In **Chapter 6**, the registered results revealed the fact that, sometimes, normal and abnormal behaviors were both observed in the case of the primates in captivity at the zoo in Târgu-Mureş. The analysis showed that the insertion of a natural environment meant to improve the well-being of the animals at this zoo led to the absence of stereotypical behaviors. On the other hand, the presence of certain factors such as the visitors or the living conditions may cause the manifestation of stereotypical behaviors. Therefore, identifying the different factors associated with a possible behavioral therapy is mandatory for improving both the visiting experience of the visitors and the well-being of the animals. In further studies, we shall focus on studying the behavior of the primates at the zoo in Târgu-Mureş by using more variables over a longer period of time, thus including a long-term daily observation period.

Chapter 7 - The frequency, the prevalence, with a 95% general confidence margin for each species and the infections caused by several endoparasites were assessed in the case of all primates under study, of all ages, sexes and from all the zoos taken into consideration in the present research. The statistical "chi-square" test was used to compare the prevalent values. The arithmetic mean and the mean standard errors were calculated for the cortisol dosage in the fecal samples, for different

categories: the total, according to age, sex, zoo and type of endoparasitic infection. Overall, *Trichuris spp., Capillaria spp*. and *Strongyloides spp*. were the most frequent endoparasites (x^2 = 27.293, df = 6, P = 0.0001). The *Trichuris spp*. endoparasites were the most frequent in the case of very young individuals (X^2 = 13.5, df = 6, P = 0.04), followed by the older individuals (x^2 = 6.375, df = 6, P = 0.383). *Strongyloides spp.* (x^2 = 24.769, df = 6, P = 0.0004) and *Capillaria spp.* (x^2 = 15.839, df = 6, P = 0.02) were the most frequently met endoparasites in the case of young and adult primates. The age has been identified as a risk factor in the case of *Strongyloides spp.*, through univariable analyses, the young primates being more predisposed to infections (x^2 = 8.68, df = 3, P = 0.04). The highest cortisol concentration values were revealed in the case of the primates that had no gastrointestinal parasite (after specific investigations), which shows that the stress is mainly caused by living environment and social factors rather than by parasitism. Different parasitic infections were observed in the case of the examined animals. The identified parasitic infections may be considered a threat for the health of the visitors and of the workers that come into contact with the respective animals or with their stools. Consequently, efficient prevention strategies should be put into practice in order to determine the risk factors, the parasite cross-contamination mechanisms, the importance of hygiene practices and the adapted implementation of deworming programs for the animals, the zoo workers and the visitors.

In **Chapter 8**, the main research idea was to assess the daily activities of an isolated primate in captivity at the Windmill Zoo in Sălicea, Cluj. As a follow-up, we analyzed the behaviors manifested by the animal for each behavioral sequence or pattern. First of all, our data highlight that the search for food is the most important activity performed by the primate. Considering our results, we could conclude that the organization of the enclosed living space and the visitors' attitude had significant effects on the behavior of the primate, under the current research conditions. Searching for food was a time-consuming activity, covering 40% of the daily activities. The second most important observed activity took place inside the building in which the primate lived; thus, one may assume that the primate rested, away from the visitors' eyes, but it also meant that it could not be observed by the researcher. The social activity roughly represents 2%, which means that during the respective part of the day the primate had social interactions only with the visitors or the caretakers. These positive relations mainly manifested when the visitors gave it food or when it rested against the cage bars so that the visitors could "pet" it. Nevertheless, 0,89% of its time was characterized by non-positive reactions to people, which might be qualified as stress-generated aggression. This percentage is not alarming, but the causes should be studied so as to avoid the negative behavior. Around 4% of the time was used for grooming activities, including scraping and and delousing. Most of the time, the primate was inside its

enclosure or inside its hut. The area the least used by the primate was the one around the entrance door. Regarding the exterior space, most of the time, the primate was in the inferior area, more exactly, on the left. The upper part of the exterior enclosure was the least used by the primate. In order to ensure the well-being of the isolated primate in captivity, it would be recommended to focus on a larger population of isolated primates so as to deeply analyze and improve the well-being of these animals.

GENERAL CONCLUSIONS

Chapter 9 of the current thesis is dedicated to the general conclusions resulted from the collected data.

1. Organizing the living conditions of the monkeys in captivity as similarly as possible to the natural conditions represents one of the easiest and most efficient solutions meant to prevent and treat pathological behaviors.
2. The good organization of the living conditions and feeding sessions in optimal quantities only rarely lead to aggressive behavior.
3. It was noticed that pathological manifestations such as stereotypical behaviors and the pica syndrome are mainly generated by the location of the cages, these being the first in contact with visitors. This has caused a permanent stress in the case of monkeys and changing the location of the cages has lead to the disappearance of these pathological manifestations.
4. As observed in the case of the first study, there was no direct causal connection between the level of cortisol and the gastrointestinal parasitism, only between cortisol levels and social and living environment factors.
5. Efficient prevention strategies should be put into practice in order to identify the risk factors, the parasite cross-contamination mechanisms, the importance of hygiene practices and the adapted implementation of deworming programs for the animals, the zoo workers and the visitors.
6. Considering our results, we could conclude that the organization of the enclosed living space and the visitors' attitude had significant effects on the behavior of the primate, under the current research conditions. In order to ensure the well-being of the isolated primate in captivity, it would be recommended to focus on a larger population of isolated primates so as to deeply analyze and improve the well-being of these animals.

RECOMMANDATIONS

To conclude with, the fact that different parasitic infections were observed in the case of the assessed monkeys could be considered a threat for the visitors and the caretakers that have a direct contact with them.

In order to diminish or even completely eliminate the stereotypical behaviors observed in the case of the monkeys in captivity under study, as well as their prostration states, several recommendations should be taken into consideration: placing the cages at a greater distance from the visitors, inserting cognitive stimulation elements into their living conditions and adapting the number of group members according to the existing living space.

Another recommendation would be to provide specific instructions for the visitors related to proper behavior when meeting the monkeys in captivity.

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