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THE USE OF ENVIRONMENTAL ENRICHMENTS ON THE MEERKATS' RUN (*SURICATA SURICATA*) IN ZOO CONDITIONS TO ELIMINATE AGGRESSIVE BEHAVIORS

ZASTOSOWANIE WZBOGACEŃ ŚRODOWISKOWYCH NA WYBIEGU SURYKATEK (*SURICATA SURICATA*) W WARUNKACH ZOO W CELU ELIMINACJI ZACHOWAŃ AGRESYWNYCH

ABSTRACT

Animals in zoos should be provided with proper environmental conditions, similar to their natural environment, and should be free of stress stimuli. In meerkats (*Suricata suricatta*) kept in zoo conditions, aggressive behavior occurs most often at the feeding time, which is the main behavioral problem to solve. One of the possibilities used to improve the well-being of animals kept in zoos are environmental enrichments.

The aim of the study was to use selected environmental enrichments in a meerkat's run to eliminate aggressive behaviors between individuals at the feeding time. Two types of environmental enrichments were provided: related and non-related to feeding (6 enrichments in total). The observed animals were interested especially in enrichments related to feeding (hidden insect larvae), which is consistent with the natural behaviors of meerkats, as they actively search for food in soil, grass, and under rocks. A noticeable effect was also the calmer behavior of the animals in the second part of the day. Active search for food is a very good way to produce mental fatigue in animals; it provides not only food but also many other stimuli. This type of enrichment should be included in the typical conditions for maintaining this species in the zoo.

KEY WORDS: environmental enrichments, meerkats, behavior, *Suricata*, zoo.

STRESZCZENIE

Zwierzęta w ogrodach zoologicznych powinny mieć zapewnione odpowiednie warunki środowiskowe, zbliżone do ich naturalnego środowiska, oraz powinny być pozbawione bodźców stresowych. U surykatek (*Suricata suricatta*) utrzymywanych w warunkach ogrodu zoologicznego, zachowania agresywne występują najczęściej w porze karmienia, co stanowi główny problem behawioralny do rozwiązania. Jedną z możliwości poprawy dobrostanu zwierząt utrzymywanych w ogrodach zoologicznych są urozmaicenia środowiskowe.

Celem pracy było zastosowanie wybranych urozmaiceń środowiskowych na wybiegu dla surykatek w celu wyeliminowania zachowań agresywnych pomiędzy osobnikami w porze karmienia. Zastosowano dwa rodzaje urozmaiceń środowiskowych: związane i niezwiązane z karmieniem (łącznie 6 urozmaiceń). Obserwowane zwierzęta szczególnie interesowały się urozmaiceniami związanymi z karmieniem (ukryte larwy owadów), co jest zgodne z na-

turalnymi zachowaniami tych zwierząt, które aktywnie poszukują pokarmu w glebie, trawie i pod kamieniami. Zauważalnym efektem było również spokojniejsze zachowanie zwierząt w drugiej części dnia. Aktywne poszukiwanie pożywienia jest bardzo dobrym sposobem na wywołanie zmęczenia psychicznego u zwierząt; dostarcza nie tylko pożywienia, ale również wielu innych bodźców. Ten rodzaj urozmaicenia powinien być włączony do typowych warunków utrzymania tego gatunku w zoo.

SŁOWA KLUCZOWE: wzbogacenia środowiskowe, surykatki, behawior, *Suricata*, ogród zoologiczny.

INTRODUCTION

The principal role of a modern zoo is to protect endangered species and to ensure conditions similar as much as possible to their natural environment or at least free from unnecessary stress factors. Many years ago, the zoo was seen only as a place of entertainment; nowadays however, when the public awareness of problems related to the conservation of wild species is greater, these zoological parks have an educational function as well (Hill and Broom, 2009). Animals in the zoo should be appropriately maintained in good physical and mental condition. They should be free of pain and suffering, with elimination of stressors, and all basic needs such as food, clean water, and clean soil should be met, according to the five freedoms of welfare (Webster, 2008; Botreau et al., 2007; Morgan and Tromborg, 2007; Mellor, 2016). Unfortunately, creation of artificial environmental conditions that will be as close as possible to the natural habitat is not a simple task, although the needs of wild animals are well understood. Species of exotic animals imported from zoos across the world face many challenges related to the need for quick adaptation to completely alien conditions, in addition to the new and often small run or enclosure. One of the possibilities used to improve the well-being of animals kept in zoo are environmental enrichments. Scientific research shows a clear increase in researchers' interest in topics related to environmental enrichments (Alligood and Leighty, 2015). Research on the development of this field focuses primarily on enrichments for primates, felids, bears, canids, reptiles and amphibians, birds, ungulates, large mammals (e.g. elephants), and small mammals (meerkats, wombats, ant-eat-

ers) (Alligood and Leighty, 2015).

One of the first definitions of environmental enrichment developed by Viktor and Annie Reinhardt (1998) defined them as "providing stimuli that promote the expression of behaviors and mental actions appropriate for a given species in an environment that is understood as the environment". The more extensive definition proposed by Shepherdson (2003) says that enriching the environment is a process of improvement of the environment and care of the animals in the zoo in the context of their behavioral biology and the development history of the species. It is a dynamic process in which changes in the structures and practices of breeding are introduced in order to increase the behavioral choices available to animals and to determine their respective behaviors and abilities, thus improving their well-being. Because the term means enrichment, it typically includes identification and subsequent addition to the zoo environment of a specific stimulus or characteristic that the user (animal) needs but which was previously not present. Today's definition of "enrichment" includes all changes in the environment of an animal (not only wild but also domestic, companion, terraristic, etc.), thanks to which natural behavior is stimulated, which has a positive effect on its psyche, but also reduces abnormal behaviors (e.g. stereotypes). However, the effects of all environmental enrichments are changes in behavior referred to as "behavioral enrichment". Currently, there are several types of enrichments used in zoological gardens; they are presented in Table 1.

Every change that is planned to be made in the animal run should be carefully thought over and implemented gradually, and its effect on the animal should be constantly monitored. Is it re-

Table 1. Types of environmental enrichments used in zoos (Young, 2007).

Social	Occupational	Physical	Sensorical	Nutritional
Contact with other animals	Solving tasks through manipulation	Changing the size of the enclosure	The use of visual, fragrance, or sound stimuli to produce instinctive behavior in an animal	Feed changing
Animal – human interaction	Searching for feed	Creation of natural hiding places		Changing the method of serving meals
	Introducing new objects or unknown toys that stimulate the curiosity of the animal	Better managed run		Enriching the diet

ally a change for the better or will it only disturb the animal or caregivers? The purpose of introduction of any changes should be considered as well. Do we want to strengthen some specific behavior or, on the contrary, reduce the incidence of adverse reactions? What kind of enrichment will be used and what is its effectiveness? First of all, it should be borne in mind that these enrichments are aimed at improving the well-being and quality of the life of animals living in captivity. Mellen and MacPhee (2001) developed a six-stage framework for effective enrichment programs, i.e. the “SPIDER” Setting Goals, Planning, Implementing, Documenting, Evaluating, and Readjusting program. The components of this program are widely recognized as critical for the development and maintenance of state-of-the-art enrichment programs in animal husbandry in the world. It is included even in the Association of Zoos and Aquariums accreditation standards (Association of Zoos and Aquariums, 2015).

The aim of the work is to use environmental enrichments in the run for meerkats (*Suricata suricatta*) kept in the Silesian Zoo to eliminate aggressive behaviors between individuals at the feeding time.

MATERIAL AND METHODS

The research involved a herd of meerkats kept in the Silesian Zoological Garden in Chorzów, Poland. The herd consisted of 12 adults, including 8 females and 4 males. The individuals in the herd were from 4 to 10 years old. The animals had 2 runs at their disposal: an internal area of 36

square meters and an external area of 55 square meters. The internal run is used all year round; it comprises sand used as a substrate, branches and artificial rocks where animals can climb, two caves serving meerkats as a place to rest and sunbathe, and two heaters mounted in their ceiling. In addition, animals have a large dome-shaped hiding place at their disposal, which serves as a burrow where the whole family sleeps. On the outer run, there are two narrow tunnels terminated with a window opened only in the summer period when the air temperature does not drop below 10°C even at night. There, meerkats can use deep sand, which they dig in their natural way, and have access to sunlight. In the middle of the run, huge tree roots have been placed, which serve primarily as the highest observation point, but at the same time as an additional element to chase around and to look for delicacies hidden therein by caregivers. Feeding the entire herd takes place once a day around 10:00 in the winter and twice a day at 10:00 and 17:00 in the summer. The feed is given in one place in a portion corresponding to the needs of all individuals, which results in fighting for food.

In order to increase the emotional effort of meerkats at the zoo, new environmental enrichments were used. The purpose of these enrichments was to limit aggressive behaviors between animals in the herd during feeding.

In the summer period, six environmental enrichments were used to determine the possibility of changing the aggressive behaviors occurring in the examined herd of meerkats. In order to determine the suitability of the different en-

richments for meerkats, two types of enrichments were used: (1) enrichment associated with fun, i.e. a new object in the environment and (2) enrichments related to food intake. The observation was made for six hours after placing the specific type of enrichment.

Enrichment associated with fun, i.e. a new object in the environment

Enrichment 1 - Balloons

The first enrichment was colored longitudinal balloons placed on a long bamboo stick and hooked in the room with meerkats so that they could only reach the objects with their paws but could not bite them (Figure 1).

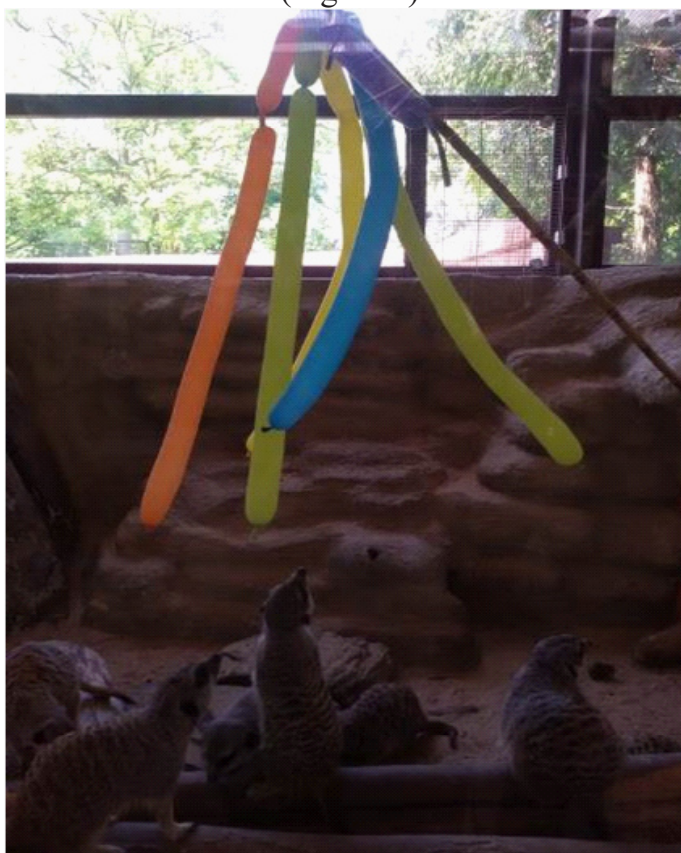


Figure 1. Enrichment 1 – Balloons.

The second enrichment was a 0.5 x 1.5 m mirror placed on the outer run (Figure 2). It was placed low enough at the back wall of the run so that the meerkats could see not only their own reflection, but also that of the other members of the herd. However, the animals were unable to check what was behind the mirror.

ENRICHMENTS RELATED TO FOOD INTAKE

Enrichment 3 – Pool with balls and insect larvae

Enrichment 3 consisted in placing insects such as mealworm larvae, zoophobas larvae, and



Figure 2. Enrichment 2 – Mirror.

crickets into a basin. Then, the whole pool was filled with light plastic balls so that the animals had to crawl between them to find food (Figure 3). The reaction of the animals to the introduction of the new objects on the run was observed.

Enrichment 4 – Container with food insects covered with sand

The next enrichment (Figure 4) consisted in filling a rectangular transparent plastic container with a mixture of food insects covered with a thick layer of sand. Several insects were placed on the surface so that the meerkats could associate that there might be more of them underneath. Additionally, a bowl of beef and egg yolk (a food that the meerkats get twice a week and know it well) was placed near the container prepared in this way.



Figure 3. Enrichments related to food intake: Pool with balls and insect larvae (EN-3), Plastic balls with larvae inside placed on the ground (EN-5), Plastic balls with insects inside hanging from a tall branch (EN-6).



Figure 4. Enrichment 4 – Container with food insects covered with sand.

Enrichment 5 – Plastic balls with larvae in the middle placed on the ground

Colored plastic balls were attached with a string to a branch and then filled with larvae of mealworms and zoophobas (Figure 3). The toy was placed on the meerkats' outer run. Due to the very intensive reaction of the animals to the enrichment used and the use of insects placed therein, the method was improved.

Enrichment 6 – Plastic balls with insects inside hanging from a tall branch

The same balls with insects inside that were used in Enrichment No. 5 were hung much higher so that the meerkats had limited access and had to use more energy to get the food out (Figure 3). The animals were still highly interested; this time, they had to learn to hit the balls properly with their paws so that the insects would drop through the holes in the balls.

RESULTS

The analysis of the time of the contact of the meerkats with a given environmental enrichment revealed that enrichment No. 4, i.e. the

container with food insects covered with sand arouse the greatest interest in these animals (210 minutes). In the case of the two enrichments that were not related to feeding, the meerkats spent the longest time with enrichment No. 2 (mirror) – 120 minutes. Noteworthy is the fact that their interest in enrichment No. 5 after refinement increased fivefold (enrichment No. 6) – 30 minutes and 150 minutes, respectively. Overall, the mirror and insects hidden under the sand as well as other food-related enrichment were the used most frequently.

Enrichment 1

The meerkats were interested in the new object only for several minutes. At the beginning, some of them began to compete for the new item. The insufficient surface of access to the enrichment produced an opposite effect to the expected one, i.e., the meerkats began to compete with each other for access to the colored object instead of becoming interested in this object itself. The herd, however, quickly realized that tapping the paws on the high suspended balloons produced no effect. Over the next few minutes, only 4 meerkats were curious about the toy, but after thirty minutes they all lost interest. This enrichment was considered unnecessary for the meerkats. Additionally, it had no effect on decreasing inter-individual aggression during feeding.

Enrichment 2

The mirror was attached to one of the outer-edge walls. The animals showed great interest in the new facility in their surroundings. At first, the herd kept a distance from the mirror and only watched it with interest. All of them - without exception - immediately set their tails up, which is a signal for meerkats to take special caution (Manser et al., 2002). They only looked from behind the branches with curiosity, but did not approach at a distance of less than 3 meters. After about two minutes, one of the meerkats very calmly and slowly approached its reflection in the mirror (still with the tail raised high). This enrichment did not reduce aggression during feeding, but it did increase interaction time between individuals. Suricates are extremely social animals, thus the appearance of “new individuals” in the mir-

ror reflection resulted in increased social activity among the observed animals.

Enrichment 3-4

Many of the meerkats showed interest in the pool with colored balls placed on the inner run. The mealworm and zoophobas larvae added inside made the enrichment more attractive to the animals. The meerkats were eagerly occupied with diving between the balls and searching for insects. Getting the “delicacies” out of the pool took the meerkats no more than one hour; however, sometimes they went into the pool a few more times and were simply sitting therein. Enrichment 3 turned out to be appropriate, as it aroused moderate interest and the meerkats had enough space to dig for the larvae and did not have to chase each other. Fun and energy utilization for food search are important in captive animals. Research shows, however, that fun has no significant impact on inter-individual relationships and hierarchy, especially in mammals that form large herds, such as meerkats (Sharpe and Cherry, 2003; Sharpe, 2005a; 2005b). In the case of enrichment 4, the reaction of the meerkats was almost immediate. They missed the already known bowl with easily available food and began to dig in the container, where larvae buried under the sand with a depth of about 10 cm were visible in the side walls. This challenge took most meerkats about three and a half hours. The very possibility of digging in deep sand in search of food was not only fun for them, but also the possibility of expressing natural behaviors for the species. This enrichment engaged the meerkats for such a long time that they did not attack each other while eating. A noticeable effect was also the calmer behavior of the animals in the second part of the day.

Enrichment 5-6

The entire herd immediately took off the balls and began to look for larvae (enrichment 5). Unfortunately, the balls placed so low were too easily accessible that the meerkats quickly used their sharp teeth and claws to get all larvae out of the balls and devastated the entire structure in just a few minutes. This enrichment was very curious for the animals, but improvement was needed

because it ceased to serve its purpose too quickly. Therefore, this idea for enriching the environment was improved in accordance with the previously described program "SPIDER" (Mellen and MacPhee 2001) and used in the next attempt as enrichment 6. This time, the enrichment was placed at a greater height, and the animals did not have direct contact with the suspended balls of food. The meerkats played with the balls hanging on the tall branch for over an hour; for another hour and a half, they were running up and trying to get out the insect larvae from inside. Because the enrichment was much harder for meerkats to dismantle, the whole process (before all the larvae dropped out of the balls) took about two and a half hours, because the animals were still coming back and checking if there was nothing in the balls. Enrichment 6 proved to be a great solution for boredom for meerkats on the outer run and a good way to extend the feeding time of small predators. This enrichment significantly reduced the incidence of aggressive behavior at feeding time. It should be noted here that this species is typically terrestrial (as well as subterranean), so prolonged use of enrichments that are high above the substrate (and thus difficult to access) can have a negative effect on the animals and their daily schedule.

DISCUSSION

Active search for food is a very good way to produce mental fatigue in animals - it provides not only food but also many other stimuli (Wells, 2009). Observations made in this study are consistent with the natural behaviors of meerkats, who actively search for food in soil, grass, under rocks, etc. (Clutton-Brock et al., 2001; Erdoğan et al., 2016). As reported by Doolan and McDonald (1996), meerkats spend most time searching for food during breeding and rearing; then, invertebrates constitute up to 78.1% of their diet, even those possibly dangerous (spiders, scorpions, centipedes) (Thornton and McAuliffe, 2007). Therefore, the use of enrichment 4 becomes more reasonable for use in the rearing of these animals in the zoo. Research conducted by Sharpe et al. (2002) showed that meerkats that had a diet supplemented with natural food to be searched spent more time playing, compared to traditionally feed

groups. The results of the observations presented in this paper confirm that a properly enriched environment, especially with new feeding methods, means that animals do not waste their energy on competition for food to a large extent. The enrichment used during the experiments provided adequate psychic and physical stimulation of the meerkats. Moreover, it had a positive effect in the reduction of aggressive behaviors within the herd. The environmental enrichment related to the way the food was provided (insect larvae covered with sand) aroused the greatest interest in the meerkats. This type of enrichment should be included in the typical conditions for maintaining this species in the zoo.

CONCLUSIONS

The results of the observations presented in this paper confirm that a properly enriched environment, especially with new feeding methods, means that animals do not waste their energy on competition for food to a large extent. The enrichment used during the experiments provided adequate psychic and physical stimulation of the meerkats. The use of environmental enrichments for the meerkats had a positive effect in the reduction of aggressive behaviors within the herd. The environmental enrichment related to the way the food was provided (insect larvae covered with sand) aroused the greatest interest in the meerkats. This type of enrichment should be included in the typical conditions for maintaining this species in the zoo.

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