



Abnormal Behaviours in Adult Female Captive Brown Bears *Ursus arctos* Linnaeus, 1758 (Carinivora: Ursidae), with an Emphasis on Non-nutritive Suckling

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Abstract: Bears are among the most popular animals in zoos. Unfortunately, in many institutions, the care conditions are far from optimal and this often leads to a performance of abnormal behaviour. Understanding the reasons for such behaviour can help to reduce its occurrence in zoos. In this regard, the abnormal behaviours displayed by two adult female captive brown bears (*Ursus arctos*) in one of the Bulgarian zoos were studied. One rarely observed behaviour in bears, i.e. the non-nutritive suckling, as well as other abnormal behaviours like walking in a figure-of-eight, circling and head tossing were observed. Ethogram of these abnormal behaviours was done. The sequence and duration of the separate parts of the behavioural model of the non-nutritive suckling behaviour were described in details. A seasonal difference in the occurrence of the abnormal behaviours was found – they were observed in August and September but not in October. The non-nutritive suckling behaviour stopped being observed as soon as the bears had the opportunity to separate. We believe that the reasons for the occurrence of these abnormal behaviours are the improper zoo conditions and husbandry procedures for the bears. The positive message is that the non-nutritive suckling is reversible when proper housing following the social structure of the species is provided.

Key words: stereotypic behaviour, social interaction, Ursidae, zoo animals

Introduction

The brown bear (*Ursus arctos* Linnaeus, 1758) is a species traditionally reared in captivity. From the visitor's point of view, bears are among the most popular animals in zoos. They are active, big, impressive and well known for their presence in the folklore of many countries. Unfortunately, in many institutions, the care conditions are far from optimal. In this regard, the performance of abnormal behaviour in animals in zoos (and especially in bears) appears to be one of the major problems for keeping these animals in captivity. It is assumed that the manifestations of abnormal behaviour are

directly associated with specific rearing conditions and are considered indicators of poor animal welfare in zoological institutions (VUČINIČ & LAZIČ 2008, SORIANO et al. 2017). Abnormal behaviours are not observed in the typical behaviour patterns of wild or free-roaming animals (CRISWELL & GALBREATH 2005).

There are different categories of abnormal behaviour observed in mammals. These include abnormal escape reactions, refusal of food, excessive aggression, stereotypic motor reactions (head-toss, pacing or straight-line, figure-of-eight, circular and oval circuits), self-mutilation, abnormal sexual behaviour (substitute sexual objects), apathy, oral

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stereotypies (biting, coprophagy, regurgitation and re-ingestion, licking), abnormal mother-infant relationships and prolonged infantile behaviour (FOX 1968, SORIANO et al. 2017, BERNSTEIN-KURTYCZ ET AL. 2022). One type of abnormal behaviour observed in zoological institutions is the stereotypic behaviour, which is characterised by morphologically identical movements repeated regularly without any apparent function (MASON 1991 a, b, LAWRENCE & RUSHEN 1993, MASON & RUSHEN 2006).

Due to their complex biological needs, the members of the family Ursidae usually exhibit abnormal behaviour in zoological institutions. That is particularly related to seasonal variations in activity, feeding (omnivorous), the extensive territories in nature, which are difficult to be provided in zoos (VICKERY & MASON 2003, WARD & KYNASTON 2003). Zoo exhibits for bears are usually small and often poorly furnished. Bears kept in such barren environments, particularly from an early age, tend to perform stereotypies (FORTHMAN et al. 1992).

Bears also exhibit oral stereotypies, although they are more common in ungulates such as giraffes, okapi, horses, cows and others (VICKERY & MASON 2004, SORIANO et al. 2017). The non-nutritive sucking as a form of oral stereotypy can be classified as behaviour directed to the inanimate surrounding or towards other members of their species (FRASER & BROOM 1997). The non-nutritive sucking is registered, albeit rarely, with bears. It could be accompanied by a characteristic sound made by the cubs of the family Ursidae from a very early age, called “humming” (FAUST & FAUST 1959, PETERS et al. 2007). Cubs may also produce this sound for extended periods in various behavioural situations like sucking on some part of their own body, that of their human keeper or a companion animal, an object, or just lying or sleeping relaxed without sucking (LINKE 1991, SERGIEL et al. 2014, KILHAM & GRAY 2002). It is considered that this acoustical signal has a relaxing effect on the nursing female and thus strengthens the mother-cub bond. In captive adult bears, humming usually occurs while the animals suck on parts of their own body or of that of another co-habiting bear, a behaviour not known to occur in wild bears (PETERS et al. 2007, SERGIEL et al. 2014). For instance, non-nutritive suckling, accompanied by humming sounds, was described in an adult male bear in captivity in Croatia, while performing felatio on another male bear.

Despite the development of zoos in Bulgaria, many captive bears still live in concrete pit-type enclosures, which do not provide enough space, with a small or no pool at all and poor enrichment.

As of January 2020, in Bulgaria, nearly 50 brown bears are living in captivity and many of them perform stereotypic behaviour. In this regard, the aim of this work is to study the abnormal behaviours displayed by two adult female captive brown bears in one of the Bulgarian zoos (Aytos Zoo) and to attempt to find the reasons for their manifestation. We suggest that the display of abnormal behaviours could be connected to the rearing conditions. Understanding the reasons of abnormal behaviours can result in recommendations for a better management in zoos.

Materials and Methods

Animals and housing

We studied two of the three bears living in 2020 in Aytos Zoo, Bulgaria, which were a mother and a daughter. The mother (Elena) was born in 1998 in the Kormisosh Game Breeding Station (near the town of Laki, Plovdiv Province, Rhodope Mountains) and arrived at the zoo in 2004. In the Aytos Zoo, she was impregnated in 2007 by a male brown bear, which brought on a breeding loan and did not live at the zoo longer. Elena gave birth to her daughter (Mia) in 2008. Since then, the two females have been living together in the same enclosure. The information for the individuals is presented in Table 1. Both bears lived in a “concrete pit” enclosure, which is divided into two parts, with a total area of 250 m². Each part measures 10 to 11 m with a concrete base, without any vegetation inside. In one of the enclosure parts, there is a pool measuring 2 × 3 m. The back wall is an “artificial rocks” type, in which there is a den, where the bears hibernated together until the winter of 2020. At that time, they had no indoor premises and insulators. The bears have no view outside of the enclosure and visitors watch them from above, often throwing food inside (Fig. 1).

Until the end of September 2020, there was a third female bear in the enclosure. She was over the age of 20 and lived in the other part of the enclosure. The mother and daughter did not allow her to enter their part of the enclosure. Thereafter, this bear died and since then, the bears Mia and Elena have access to the other part of the enclosure (both parts are connected by a passage, which is open all the time and the zoo staff closes it only for cleaning). After the death of the third bear, Mia and her mother separated themselves each in a different part of the enclosure. During visits to the zoo in August and September, the mother and daughter inhabited together the one part of the enclosure. In October 2020, the daugh-

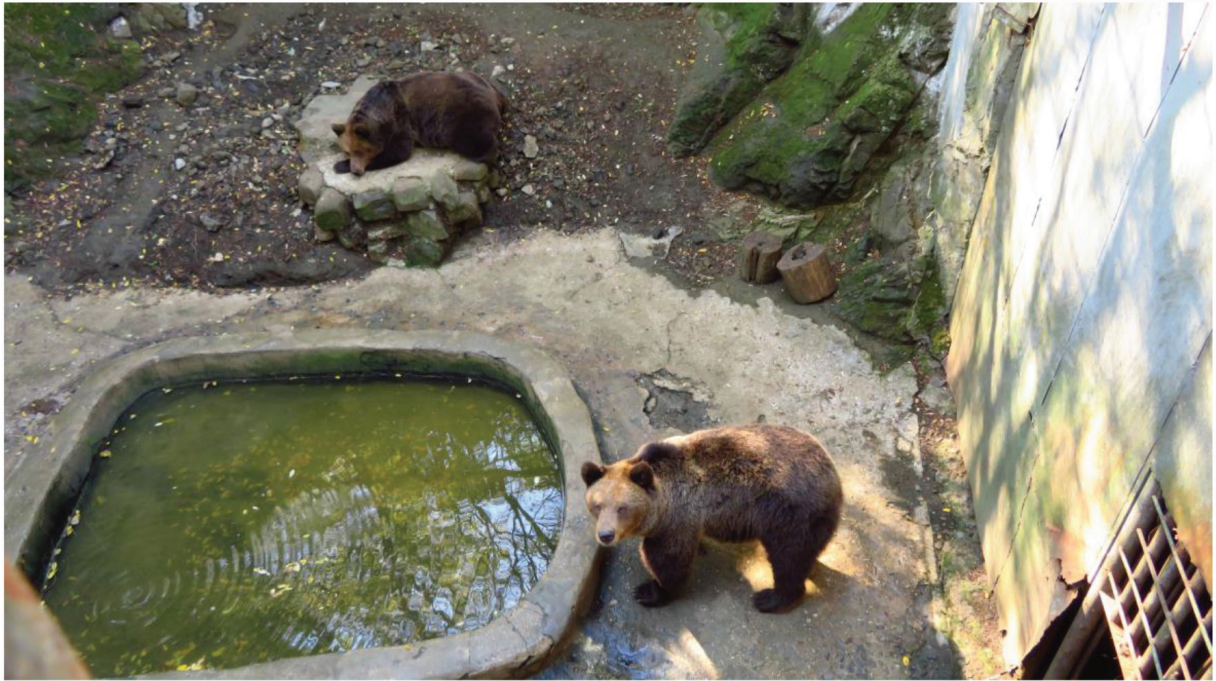


Fig. 1. Bear enclosure in Aytos Zoo.

Table 1. Demographic information of the bears

Abbreviated name	Name	Birth date and location	Parentage and rearing	Arrival date at the zoo
MF	Elena	1998 Lucky (Kormisosh)	Unknown	2004
DF	Mia	2008 Aytos Zoo	Parent (MF x male)	2008

ter moved herself to the other part of the enclosure, available after the death of the third bear.

The number of visitors varied between 30 and 53/hour in August and 45–100/hour in September. In October, their number was 5 – 10 people/hour. The temperatures during our visits in August and September varied between 23°C and 28°C and in October – between 12°C and 22°C.

Husbandry procedures

The cleaning of the bear facility was once a week. The bears were fed twice a day – at 10 a.m. and 4 p.m., and the food was usually thrown by the keepers from above. There was no fresh water in a separate drinking bowl and the bears used the water in the pools. The bears received weekly portions of powdered milk dissolved in water with the other food. The mother and daughter were fed together and, until the death of the third bear, were not separated during feeding.

Data collection and analysis

Aytos Zoo was visited in August, September and October 2020 for three days and the bears were observed for 6 hours between 10 a.m. and 4 p.m. each

day. The total amount of observation time was 18 hours. For the detailed description of the abnormal behaviours, they were recorded by video camera ACME VR06–4K Ultra HD and photographed with a photo camera Canon SX730HS. The analysis of stereotypical behaviours in August and September was based on 65 min. of video recording each month in a period when both bears performed stereotypical behaviour, usually from 11 a.m. to 2 p.m. The same person, positioned at the visitors' site, performed all observations. The sequence of the behavioural model and the duration of each separate part of the non-nutritive suckling behaviour were described. The frequency and the duration of all stereotypic behaviours were compared by One-sample χ^2 test for statistically significant differences. In addition, the mean duration of stereotypic behaviours performed by Elena and Mia were compared between the months of observation using the Student's t-test. Variables were tested for normal distribution by Kolmogorov–Smirnov test. Data were analysed using Statistica (Version 7.0) statistical software (StatSoft Inc. 2004). In all tests, a significant statistical difference was assumed when $p < 0.05$.

Ethical considerations

The study met all humane standards as no manipulations were necessary, and only non-invasive observations were carried out on the animals.

Results

During observations in August and September 2020, bears were resting beside the pool, entering the pool and staying in the water, drinking water from the pool, eating food, moving in another part of the enclosure and scratching at surrounding objects. Some types of stereotypic behaviour also were observed such as circling, walking in a figure-of-eight and head tossing. The observed abnormal behaviours in the two bears (MF and DF) are presented in Table 2.

The young female Mia displayed the stereotypic behaviour of walking in a figure-of-eight around the pool, while her mother demonstrated only circling and head tossing. Between 52 and 105 walking in figure-of-eight per hour were registered, the duration of each being 5-16 s (Table 3).

A statistically significant difference was found as between the total duration of all walking in figure-of-eight registered in August and September

($\chi^2 = 255.09$, $p < 0.001$, $df = 1$, One sample χ^2 test), as well as between the mean duration of the separate figures-of-eight ($t = 5.46$; $df = 143$; $p < 0.001$), (Table. 3). In addition, the frequency of walking in figure-of-eight was almost twice as high in August than in September ($\chi^2 = 13.97$, $p < 0.001$) (Fig. 2). One part of the figure-of-eight was the circumference of the pool, and the other part was smaller. The movement was always clockwise. Unlike Mia, the older bear Elena demonstrated circling 15-27 times per hour, with the duration of each being 12-17 s. Performing circling, Elena often showed head tossing (25-42 times per hour, Table 3).

A statistically significant difference was found in the duration of all circlings and all head tossings registered in August and September (Fig. 2). In August, the total duration of all circlings was significantly higher than in September ($\chi^2 = 25.38$, $p < 0.001$, One sample χ^2 test). The total duration of all the head tossings was also significantly higher in August than in September ($\chi^2 = 4.91$, $p < 0.05$, One sample χ^2 test) (Fig. 2). However, no statistically significant difference was found between the mean duration of the separate circling and head tossing events, Table 3. There was no statistically

Table 2. Ethogram of abnormal behaviours in the brown bears.

Abnormal behaviours	Definition
Walking in the figure-of-eight	Moving around the enclosure, always following the same path (MONTAUDOUIN & LE PAPE 2005), in this case in the figure of eight
Circling	Moving in a circular direction constantly (VEERASELVAM et al. 2013)
Head tossing	An individual throws the head back and turns it with accompanying elevation of the front parts of the body upright, sometimes with sitting, usually while pacing at the extreme edges of the path (MAŚLAK et al. 2016)
Non-nutritive suckling	In the present study - false suckling of DF of MF. More details in the text

Table 3. Mean \pm standard error (SE) of the duration of observed separate stereotypic events „walking in the figure-of-eight“, „circling“ and „head tossing“ in the two female bears in August and September. The statistically significant difference between the two months revealed by the Student's t test is given in bold.

Observation	Mean \pm SE	Min	Max
DF – Mia	<i>Walking in the figure-of-eight</i>		
August, n = 95	12.53 \pm 0.16	9.00	16.00
September, n = 50	10.76 \pm 0.32	5.00	15.00
Student's t test	Significant, t = 5.46, p < 0.001		
MF – Elena	<i>Circling</i>		
August, n=17	15.05 \pm 0.39	12.00	17.00
September, n=10	15.40 \pm 0.47	13.00	17.00
Student's t test	Not significant, t = 0.54, p = 0.59		
	<i>Head tossing</i>		
August, n=19	2.21 \pm 0.12	1.00	3.00
September, n=12	2.00 \pm 0.17	1.00	3.00
Student's t test	Not significant, t = 1.02, p = 0.32		

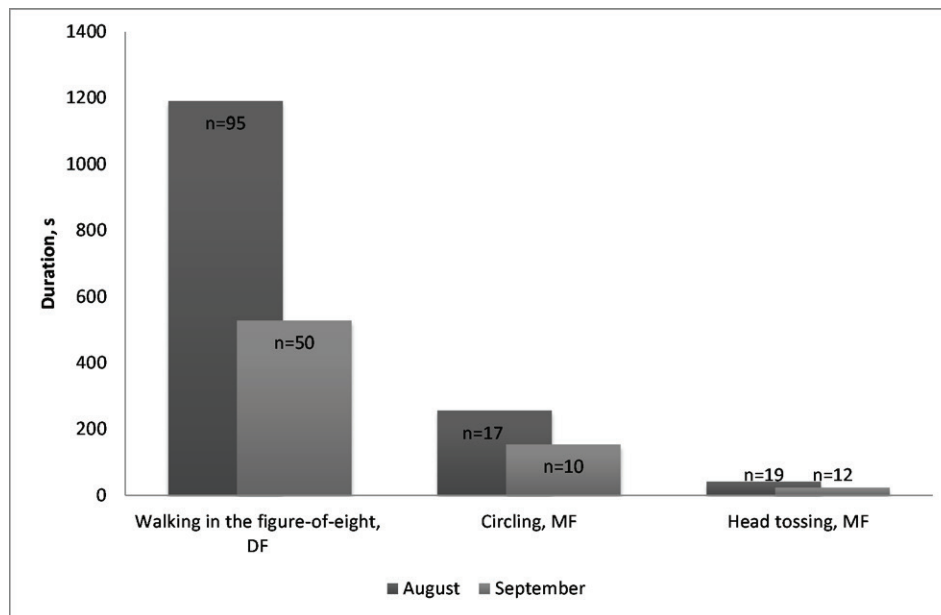


Fig. 2. Total duration (s) and frequency of the stereotypical behaviours walking in the figure-of-eight, circling and head tossing in August and September.



Fig. 3. Non-nutritive suckling behaviour in the social interactions of two captive female brown bears.

significant difference in the frequency of these two stereotypes in August and September ($\chi^2 = 1.81$, $p > 0.05$ for circling; $\chi^2 = 1.12$, $p > 0.05$ for head tossing, respectively).

In August, we had the opportunity to observe and record the non-nutritive suckling behaviour in the interactions between the two bears with a total duration of 310 s (Fig. 3).

The model of this behaviour is presented in Fig. 5. It proceeded as follows. The daughter Mia

began pushing with her snout in the upper part of the body under the front limbs at the mammary glands of the mother who was sitting calmly. The daughter bit the fur in the area of the nipple with her lips and began to make suckling movements with her mouth, making the characteristic sound of suckling, which bear cubs produce (humming) and resting (putting) her paws on her mother's belly. There were no signs of lactation and functional suckling. During this time, the adult bear was sitting patiently, showing no



Fig. 4. Mutual grooming between the two female brown bears.

signs of pain or anxiety. After the end of the “suckling”, the two bears did self-grooming and after that moved on to mutual grooming (Fig. 4).

We registered the non-nutritive suckling behaviour only once but, according to the zoo staff, it always occurred in this sequence and the daughter was always the initiator. Zookeepers also shared that she initiated the non-nutritive suckling more persistently before the age of 5 years but this behaviour continued periodically until the present when Mia was 12.8 years old.

The bears did not perform any stereotypical behaviour during the observation period in October. Then, the two bears had divided the territory and the daughter was already living in a separate part of the enclosure. The temperatures were lower and the bears were lethargic. According to zoo staff after the death of the third bear, Mia started to enter the emptied part of the enclosure more and more often and, at the beginning of October 2020, she was already settled permanently in it. The passage between the two enclosures remained open. In October 2020, we observed how the daughter tried to enter and approach the mother 3 times. That was met by the older bear with anxiety and threatening behaviour expressed through threatening vocalization and paw swing. The vocalization included three types of signals: growl, mouth clapping and a repeating guttural sound. This response of the mother forced the daughter to return to “her” part of the enclosure.

According to information from Aytos Zoo staff in mid-November 2020, the mother entered the den

in the old part of the enclosure, where she prepared for hibernation. The daughter continued to try using the old part of the enclosure and entered her mother’s lair but was chased away by a growl. Thus, from the first days of December, Mia entered the den in her part of the enclosure, where she spent most of the time.

Discussion

The obtained results confirmed some tendencies about demonstrations of stereotypic behaviour. Circling and walking in figure-of-eight are among commonly observed stereotypies in bears (MONTAUDOUIN & LE PAPE 2005). Like other authors such as LAWRENCE & RUSHEN (1993) and FERNANDEZ (2010), we also found that long time spent in captivity (for the daughter her entire life), lack of individual space, as well as isolation or poor environment, lead to the manifestation of abnormal behaviour.

Circling around the pool in the cage was observed in both animals. However, with the daughter there is a deviation for one more round (so the figure-of-eight is completed), and with the mother, at a certain place during the round, the tossing of the head is observed. During our observations, most of the time both bears stereotyped simultaneously. We assume that they have evolved the different forms of abnormal behaviours because of the small area they have in which to diverge. Another possible explanation could be that this difference might be due to their personality. As well as FAGEN & FAGEN (1996)

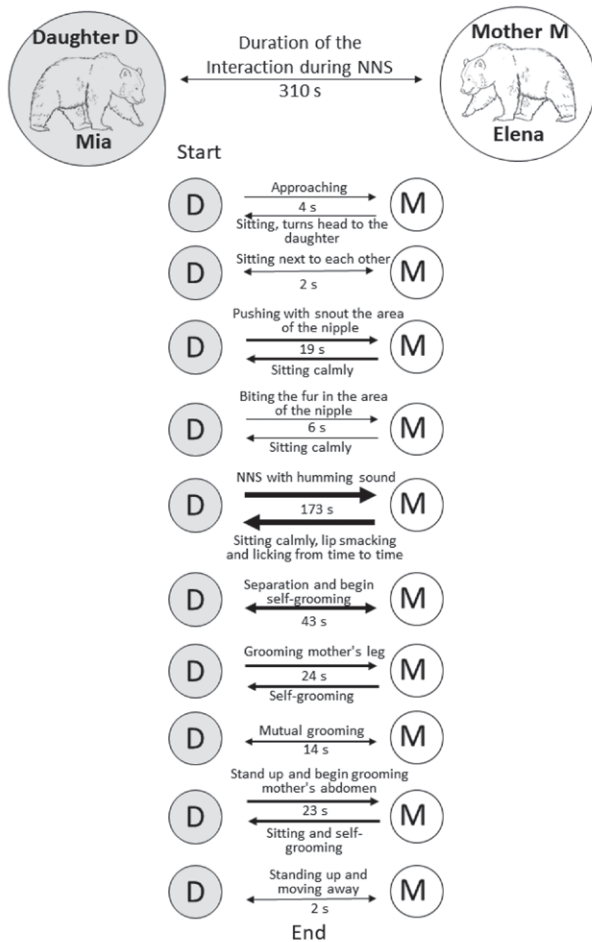


Fig. 5. Behavioural events sequence of the observed non-nutritive suckling (NNS) behaviour of the two bears Mia (daughter D) and Elena (mother M). The thickness of the arrows is proportional to their duration.

and QUINTAVALLE et al. (2017) pointed out, bears are animals with distinctive personality.

It could be suggested that the lack of a program for environmental enrichment in Aytos Zoo could be a prerequisite for the development of various forms of stereotypies. As mentioned by WEMELSFELDER (1993), lack of stimuli often leads to boredom in animals. Boredom can be reduced by environmental enrichment (MEAGHER & MASON 2012, SORIANO et al. 2019). Therefore, we assume that this could be also a reason for the manifestation of non-nutritive sucking behaviour.

The results showed that the younger bear Mia was the initiator of the oral stereotypic behaviour of non-nutritive suckling. Hence, it could be suggested that young animals are more likely to develop abnormal behaviour in captivity. RIDLEY & BAKER (1982) mentioned that the effect of captivity seems to be more profound for a young bear than for mature animals in terms of the expression and persistence

of abnormal behaviours. One of the causes for the abnormal non-nutritive suckling behaviour might be the circumstance that the two females have been living together for 12.8 years – since the birth of the daughter, which would not have been possible under natural conditions. According to DAHLE & SWENSON (2003) and MCLELLAN (1994), in brown bears (*U. arctos*), offspring separate from their mothers at age of 1–3 (occasionally 4) years. At the latitude of Bulgaria, it happens even earlier, around the end of the second year. Besides, the lack of a male brown bear at Aytos Zoo and the lack of any contact with a male could also be considered a cause of abnormal behaviour. This is in agreement with the observations by DAHLE & SWENSON (2003) that that family breakup in *U. arctos* is initiated by females entering estrus in the presence of an adult male, suggesting that termination of maternal care has not been initiated by offspring.

The presence of dairy products in the diet of bears (in particular, powdered milk) also could provoke non-nutritive suckling. Thus, the taste of milk could stimulate non-nutritive suckling in calves (RUSHEN & DE PASSILLÉ 1995). Registration of humming sound vocalization in a 12.8-year-old brown bear during suckling complemented the short list of cases in adult bears. According to PETERS et al. (2007), the humming sound vocalization is typical for bears in captivity. This gives us reason to assume that the humming sound has a calming effect for the mother and strengthens the relationship with the daughter. In our observations, the animals were in almost continuous tactile contact, sitting side by side. Moreover, after the cessation of suckling, they performed mutual grooming. In many mammalian species, grooming is a major social activity and a means by which animals that live nearby may bond and reinforce family links and build companionships (HENAZI & BARRETT 1999). Assuming that the non-nutritive suckling is a type of infantile behaviour, it could be a strategy to suppress potential aggression by the older bear. In spite of that, the daughter's attempts to approach the mother in her part of the enclosure in October, which were met with growls and hostility and the mother did not let her nearby. Therefore, providing rearing conditions that meet the requirements of the specific biological species limit or even cease the manifestations of the stereotypic behaviour non-nutritive suckling. In our opinion, this proved that so far there had been no suitable conditions for the normal process of family breakup. That happened when the first opportunity for the two bears to separate themselves in their own space appeared.

The environmental factors, such as the ambient temperature could have significant effects on stereotypic behaviours causing the expression of various stereotypies. Higher environmental temperature reduced the duration of pacing but increased the frequency of pacing and the duration of head-toss in giant pandas (LIU et al. 2017). It is possible that the higher temperatures during our observations in August and September account for the higher levels of stereotypy in the two bears (compared to October).

In brown bears, as in other species in captivity, the presence of visitors could be associated with greater levels of stereotypies, locomotion, vigilance and increased use of the back part of the enclosure (WELLS 2005, SORIANO et al. 2013, SHERWEN & HEMSWORTH 2019, GUPTA et al. 2022). In the present study, the influence of the zoo visitors (their number and behaviour) also could be the reason for the differences in the duration and the frequency of the manifestation of stereotypical behaviour of the two bears in August and September. Although the number of visitors in August and September was almost 10 times higher than in October, it seems that rearing conditions are of paramount importance.

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