

Ethogram of young European bison (*Bison bonasus*) maintained in the conditions of a zoological garden

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Summary

The study aimed to develop a proposal for an ethogram of young European bison maintained in the conditions of a zoological garden based on direct observations and audiovisual material. Observations were conducted at the Warsaw Zoo from March to September 2023. The subjects of the study were two young individuals: a 3-year-old heifer and a 2-year-old bull. The total duration of the recordings amounted to 74 hours, 22 minutes, and 10 seconds. The developed ethogram consists of 19 behavior categories. It includes not only behaviors typical of the species, but also stereotypic behavior, interactions with tourists, and ambiguous behaviors that can be assigned to multiple behavior categories. The proposed ethogram may be used in future studies concerning the behavior and welfare of young European bison in captive conditions.

Keywords: European bison, zoological gardens, ethogram

Zoological gardens and other ex-situ facilities housing European bison continue to play a crucial role in the conservation of this species. European bison kept in zoological gardens are included in the European Endangered Species Programme, which oversees the use of individuals for reintroduction, exchange between institutions, and reinforcement of wild populations (36, 43). Scientific research and educational programs focused on this species are carried out in facilities that house European bison, helping to raise public awareness and support for existing wild populations and future reintroduction initiatives (21, 36, 37). In reintroduction process and individual exchange aimed at „genetic refreshment”, young individuals are particularly important, as they offer a greater potential for gene transmission due to their longer lifespan in a new environment. Young animals also exhibit greater behavioral plasticity and adaptability to new surroundings, which enhances their survival probability and successful integration into existing populations (36, 50). Moreover, incorporating young individuals into wild populations can effectively reduce the risk of inbreeding depression, thereby supporting the species' genetic diversity (35, 39).

Maintaining a high level of welfare is crucial for the success of these conservation efforts, yet this can be challenging in captivity due to human-induced stress factors. Prolonged exposure to stressors may lead to

chronic stress, resulting in weakened immune function, increased susceptibility to diseases, and reduced reproductive success, potentially excluding certain individuals from planned reintroductions (17). Given the serious consequences of compromised welfare, regular welfare assessment should be a fundamental aspect of animal care in zoological gardens (16). Various criteria are used for this purpose: behavioral, physiological, and health-related (46, 51).

An ethogram is a useful tool for assessing animal welfare. This tool serves as a catalog of behaviors characteristic of a given species (6, 31). To date, only one ethogram of the European bison kept in a zoological garden has been developed, published in Czech with a summary available in English (53). Other scientific studies on European bison behavior in captivity primarily describe basic behavioral categories, such as standing, walking, running, lying, foraging, and ruminating (4, 34). Some studies focus exclusively on reproductive behaviors (10, 11) or selected social behaviors (25). A more comprehensive description of European bison behavior was presented in a study comparing the behavior of European bison and Heck cattle; however, it does not include submissive or reproductive behaviors (38).

The aim of this study is to propose an ethogram for young European bison kept in a zoological garden, based on direct observations and audiovisual record-



Fig. 1. POLATKA (Photo by M. Wilk)

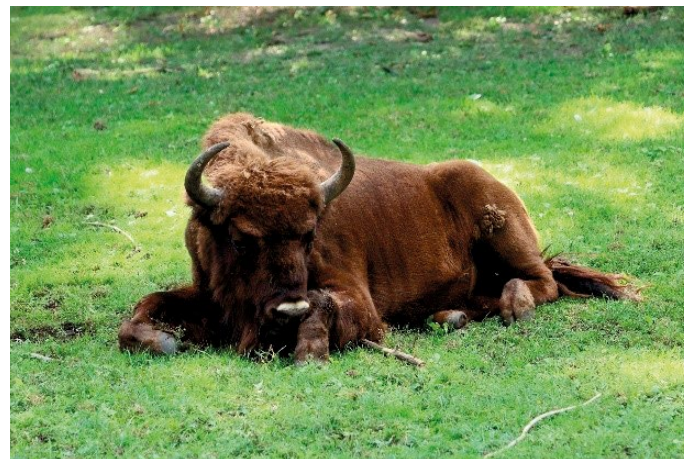


Fig. 2. POLON II (Photo by M. Wilk)

ings. The resulting ethogram may be used to assess the welfare of European bison in captive conditions, including zoological gardens, display enclosures, and breeding facilities.

Material and methods

Direct observations of European bison behavior were conducted at the Warsaw Zoo from March to September 2023. The study focused on two young individuals born at the Warsaw Zoo: a three-year-old heifer, POLATKA (Fig. 1), and a two-year-old bull, POLON II (Fig. 2). In addition to these individuals, the herd consisted of two 12-year-old cows – POGÓDKA (mother of POLON II) and POCIEMNA (mother of POLATKA and POGRALKA) – as well as a two-year-old heifer, POGRALKA. During the observations, both POLATKA and POLON II were separated from the herd at different times.

During the study period, the European bison were kept in two adjacent enclosures measuring 2,900 m² and 3,800 m², respectively (Fig. 3). The animals in the enclosures could see each other but had no physical contact due to a separating pathway. On the first day of observations, the herd was housed in the larger enclosure, while POLATKA remained in the smaller one. After the two cows and POGRALKA joined POLATKA in April, POLON II stayed alone in the larger enclosure until the end of the observation period.

Every day at approximately 7:30 AM, the animals were provided with concentrate feed supplemented with veg-

etables and fruits (carrots, beets, apples), followed by green forage between 9:00 and 10:00 AM. Throughout the day, additional leaf fodder and acorns were supplied. The animals had *ad libitum* access to hay and a salt lick. A mineral-vitamin supplement was also provided. One observational session spanned three days: Friday, Saturday, and Sunday. The observational sessions were conducted regularly every two weeks, except for June, when one session was omitted, and September, when the interval between two observational sessions was three weeks. Observations took place during the zoo's opening hours at three time points: 9:30 AM, 12:30 PM, and 3:30 PM. Two 20-minute recordings were made for each time. One individual was recorded first, followed by another after a five-minute break. Observations were conducted from behind the enclosure fence on the eastern side, providing a clear view of the animals. During each observation, all behaviors exhibited by the studied individuals were recorded. If an individual was out of sight (e.g., inside a shelter or obscured by enclosure elements to the extent that behavior interpretation was impossible), the recording was paused and resumed once the individual was visible again. The recording was completed once a full 20 minutes of observation per individual had been captured. A rule was established that if the recorded animal remained out of sight for 20 minutes or longer, the recording was not continued. Similarly, if the animal was out of sight in the enclosure for 20 minutes (or longer) from the scheduled start of the observation, it was not recorded. Recording was

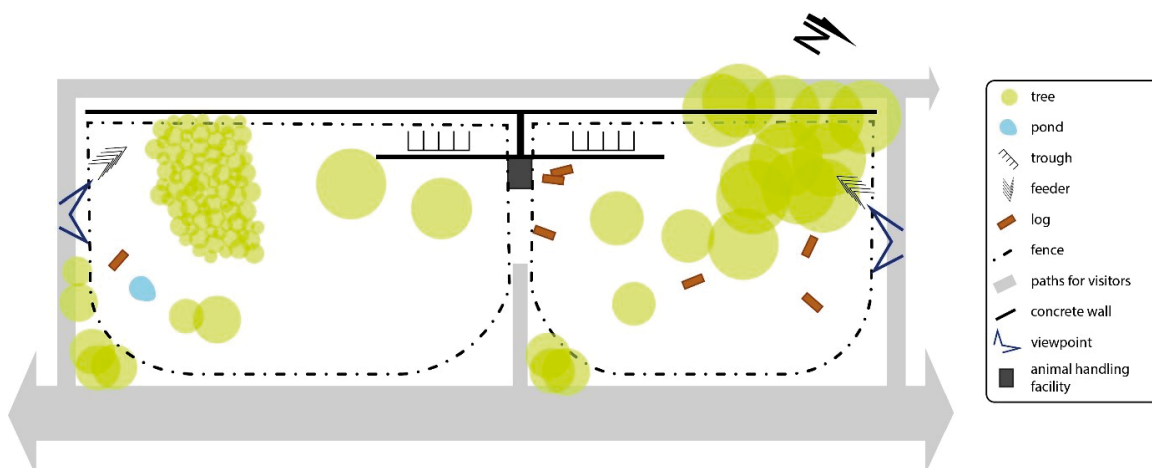


Fig. 3. Larger enclosure (left), smaller enclosure (right)

also paused when staff were present at the enclosure (e.g., during water replacement or enclosure cleaning) if their activities influenced the animals' behavior. Recordings lasting 10 minutes or less were excluded from further analysis. Observations were conducted over 39 days, with a total recording

time (excluding recordings shorter than 10 minutes) of 74 hours, 22 minutes, and 10 seconds. The observed behaviors were categorized into specific behavioral categories, forming an ethogram. The development of the ethogram for this study was preceded by the compilation of a hypothetical list of behaviors based on literature concerning the behavior of the European bison and the American bison in both captive and free-ranging herds (4, 7-12, 15, 22, 23, 25, 26, 28-30, 32, 34, 38, 42, 44, 48, 53). The ethogram consists of „state” behaviors (states), which persist over an extended duration, and „event” behaviors (events), which are short-term occurrences (1).

Results and discussion

Based on direct observations of POLON II and POŁATKA, 19 behavioral categories were identified, including seven „state” behavior categories (foraging, ruminating, lying, standing, locomotion, grooming, long submissive behavior) and twelve „event” behavior categories (short submissive behaviors, dominant behaviors, reproductive behaviors, play behaviors, interactions with tourists (negative), interactions with tourists (positive), orienting response, vocalization, defecation, urination, ambiguous behaviors, and stereotypic behavior) (Tab. 1).

Foraging and ruminating. During the direct observations of POLON II and POŁATKA, two behavioral categories were recorded – foraging and ruminating – which dominate the daily activity of wild-living European bison during the vegetative season (8). The individuals consumed not only the feed provided by the zoo staff but also exhibited a natural form of foraging – grazing. However, browsing and bark-stripping, which are also part of the European bison’s feeding behavior (8, 13), were not observed. This was due to the lack of available shrubs and trees with bark in the enclosure. Ruminating in both POLON II and POŁATKA most frequently occurred while lying in a sternal recumbency position with the forelimbs bent. On a few occasions, ruminating was also observed while lying on the side of the body or in a standing position. These body positions have also been documented in wild European bison herds (7, 8).

Lying. During lying, the animals would position themselves either on their sternum or side. On several occasions, lying was observed with eyes closed or partially closed, and in the case of the male, sleeping was recorded twice. In the wild, European bison may also sleep during the day; however, this occurs infrequently (7).

Standing. In some studies, standing is classified as a form of rest (7, 8, 38), but it was not assigned such role in the present study. Standing still and periodically observing the surroundings was noted in both individuals. While standing, the animals observed the pathways used by visitors and the adjacent street. During the separation period, the European bison frequently stood near the fence dividing the two enclosures and observed the other individuals.

Locomotion. Locomotion was most frequently observed when the European bison transitioned from foraging to resting or when moving to their indoor stalls. The locomotor activity of the animals in the zoological garden, due to constant access to food and limited living space, is significantly reduced compared to the locomotion of European bison in the wild, which must move to search for food (8).

Grooming. Various forms of grooming were observed in both individuals, including wallowing on sand, which are behaviors also noted in wild-living European bison (7, 8).

Long and short submissive behaviors. Submissive behaviors were most frequently recorded during hay and green forage consumption. When attempting to approach the feed, the observed individuals were driven away by older cows. In response, they would retreat or move back a few steps and then observe the remaining foraging individuals for several minutes before making another attempt to approach and consume the feed. This behavior was classified under the category of long submissive behavior. The ethogram also included a category of short submissive behaviors, which were either abrupt (e.g., jumping sideways) or more subtle (e.g., turning the head away from the dominant individual). This category also encompassed situations in which an individual left its resting spot upon the approach of a dominant individual. In such situations, the dominant cow most often lay down in the exact location previously occupied by the subordinate animal. Observations of European bison kept in the Prague Zoo similarly indicated that agonistic behaviors occurred in the context of food intake and the selection of resting places (53). In free-ranging herds, agonistic interactions have also been observed during foraging at winter feeding sites. The highest cows in the hierarchy and adult bulls were the first to access food, while subordinate individuals were driven away from the feeding area (7).

Dominant behaviors. Dominant behaviors were observed exclusively in POŁATKA. These behaviors were most frequently recorded during the consumption of green forage. POŁATKA would drive POGRALKA away from the feed by swinging her horns toward the heifer or striking her on the head, flank, or rump with her horns. On several occasions, POŁATKA was also observed nudging the lying POGRALKA with her horns and subsequently taking over her resting spot. Dominant behaviors are a component of agonistic interactions, which are part of the behavioral repertoire of both European bison and American bison (7, 30, 32, 42, 48, 53).

Reproductive behaviors. During his time in the herd, POLON II exhibited reproductive behaviors toward both POGÓDKA and POGRALKA. On several occasions, the bull was observed sniffing and licking the anogenital regions of the cow and heifer. These behaviors were not followed by the flehmen response, which is commonly observed in bulls in both natural set-

tings and enclosures (7, 25). Additionally, the male was recorded sniffing and licking the flank, neck, and rump of POGRAŁKA. POLON II was also seen resting his chin on the rump of POGÓDKA, occasionally followed by attempts to mount her. Several instances of mounting behavior were observed; however, POGÓDKA immedi-

ately walked away each time. In one case, the male was observed sniffing and licking urine from POGÓDKA, followed by a flehmen response. On multiple occasions, POLON II also tended POGÓDKA and POGRAŁKA, which involved following closely alongside the female and moving with her throughout the enclosure.

Tab. 1. Ethogram based on observations of young European bison (*Bison bonasus*) in the Warsaw Zoo

Behavioral categories	Forms of behavior
Foraging (S)	<ul style="list-style-type: none"> - grazing – grasping grass with the tongue followed by tearing it off with a head movement. During grazing, the European bison moves slowly and may occasionally raise its head briefly while continuing to chew the grass. - ground sniffing in search of food - licking branches lying on the ground** - consuming hay - consuming green forage - drinking water*
Ruminating (S)	<ul style="list-style-type: none"> - regurgitating food boluses and performing rotary jaw movements (in a standing or lying position)
Lying (S)	<ul style="list-style-type: none"> - sternal lying with the forelimbs bent (one or both) - lateral lying on the right/left side of the body with limbs extended - during lying, the head may be elevated, resting on the ground, or supported by a forelimb or hindlimb; the eyes may be open, half-closed, or fully closed
Standing (S)	<ul style="list-style-type: none"> - standing in place (occasionally accompanied by observing the surroundings)
Locomotion ¹ (S)	<ul style="list-style-type: none"> - walking around the enclosure
Grooming (S)	<ul style="list-style-type: none"> - rubbing the head, chin, neck, flank, back, or rump against elements of the enclosure – such as a concrete wall, wooden fence, metal barrier, fallen log, or tree - rubbing the chin, neck, or head against the ground or against a forelimb/hindlimb while lying - licking one's own fur - wallowing on sand - scratching using a hind limb or a horn - scratching the head by rubbing it against a branch lying on the ground
Long submissive behavior (S)	<ul style="list-style-type: none"> - waiting to access feed (hay/green forage) while it is being consumed by higher-ranking individuals
Short submissive behaviors (E)	<p>Responses to dominance behaviors of older cows:</p> <ul style="list-style-type: none"> - jumping sideways - withdrawing - turning the entire body 90°–180° away from the dominant individual - walking or running a few steps away - taking a lateral step - (during the above behaviors, the head may be raised/lowered and/or turned away from the dominant individual) - turning the head away from the dominant individual (head may be raised or lowered) - leaving a resting spot
Dominant behaviors (E)	<ul style="list-style-type: none"> - striking another individual with the horns on the head, flank, or rump** - driving another individual away from the feed by lowering the head and swinging the horns toward it** - nudging a lying individual with the horns and taking over its resting spot**

Behavioral categories	Forms of behavior
Reproductive behaviors (E)	<ul style="list-style-type: none"> - sniffing and licking the neck, flank, rump, and anogenital regions of the female* - resting chin on the female's rump (mounting intention movements (28)), either followed or not followed by an attempt to mount the female* - mounting the female* - tending behavior (accompanying female in a parallel position relative to her body)* - sniffing and licking the female's urine followed by a flehmen response (lifting the upper lip, parting the mouth, and extending the neck upward)*
Play behaviors (E)	<ul style="list-style-type: none"> - mock battles – horn pushing with another individual with the neck lowered and tail down - lifting and lowering a branch using the horns** - resting the chin on the rump of a heifer** - attempting to mount a heifer**
Interactions with tourists (positive) ² (E)	<ul style="list-style-type: none"> - approaching tourists in search of food - consuming food offered by tourists
Interactions with tourists (negative) ² (E)	<ul style="list-style-type: none"> - attempting to deter tourists by abruptly raising and lowering the head in their direction - rapidly approaching tourists
Orienting response (18) (E)	<ul style="list-style-type: none"> - sudden interruption of an ongoing activity, focusing attention on the source of the stimulus, and turning the head toward it (18) - abruptly rising from a resting position and turning the head toward the stimulus
Vocalization (E)	<ul style="list-style-type: none"> - soft or loud grunting
Defecation (E)	<ul style="list-style-type: none"> - the individual raises its tail and squats on the hind limbs
Urination ³ (E)	<ul style="list-style-type: none"> - the female raises her tail and squats on the hind limbs - the male raises his tail without squatting on the hind limbs
Ambiguous behaviors (E)	<ul style="list-style-type: none"> - sudden dashing a few steps away with the tail slightly raised - trotting with the tail slightly or vertically raised (sometimes accompanied by head shaking or hopping) - galloping with the tail held vertically** - butting plants in the enclosure with the horns, with the tail lowered or held upright* - kicking with the hind limbs* - pawing at the sand with the forehooves while urinating, followed by vigorous wallowing in the sand at the site of urination*
Stereotypic behavior (E)	<ul style="list-style-type: none"> - licking the metal fence**

Explanations: S – state, E – event; Behaviors observed exclusively in the male are marked with the symbol “*”, and those observed exclusively in the female are marked with “**”. ¹The locomotion category did not include situations in which the individual took several steps, e.g., while grazing. ²The end of an interaction with tourists was defined as the moment the European bison returned to the previously interrupted activity, most often foraging; simply turning the head toward tourists for observation was not considered an interaction. ³If the male urinated while foraging, the behavior was classified solely under the category of urination.

However, this behavior lasted only a few minutes. In contrast, in the wild, tending cows may persist from several minutes to up to two days (11). The reproductive behaviors exhibited by POLON II have been previously observed in European bison bulls living under both captive and free-ranging conditions (7, 8, 10, 11, 15, 25, 53). In the literature concerning American bison behavior, chin-resting on another individual's rump and mounting attempts have also been interpreted as play behaviors or expressions of dominance (29, 32, 48). In the case of POLON II, however, these behaviors were not accompanied by other elements of play or dominance and were therefore classified under the category of reproductive behaviors.

The reproductive behaviors of POLON II were observed in March and April. In free-ranging herds, the rutting season typically occurs from August to October (24); however, in captive conditions, it may extend from July through March (23). Reproductive behaviors can also occur outside the typical breeding season (10). It has been observed that European bison bulls kept under captive conditions in the Bavarian Forest National Park exhibited both tending behavior and inspection of cows' anogenital regions not only during August and September but also in March and April (25).

Play behaviors. During the period of group housing, the play behaviors exhibited by the individuals involved horn pushing with POGRALKA. This form of play has also been observed among European bison in the wild (7, 8) as well as in enclosures (53). POŁATKA also demonstrated solitary play behavior, consisting of lifting and lowering a broken branch using her horns. A similar behavior was observed in two European bison at the Prague Zoo (53).

During one observation day (April 30), following a horn-pushing interaction with POGRALKA, POŁATKA rested her chin on the rump of the heifer, which immediately moved a few steps away. A few minutes later, POŁATKA approached the foraging POGRALKA and attempted to mount her, but the attempt was unsuccessful as the younger heifer walked away at once. Shortly afterward, POŁATKA approached POGRALKA again and once more rested her chin on the heifer's rump. Subsequently, at POGRALKA's initiative, the cows resumed horn-pushing. The co-occurrence of mock battles and mounting has also been observed among young American bison. The authors classified these behaviors under the category of "play" (32, 48). Chin-resting on another individual's rump and mounting have also been interpreted in the literature on American bison behavior as expressions of dominance (29, 32). However, POŁATKA's behavior was classified as play behavior, as it alternated with horn-pushing, which is a recognized element of playful interaction.

Interactions with tourists. Interactions between the observed individuals and tourists occurred near the feeder, which is located directly adjacent to the fence in both the larger and smaller enclosures. The observed

interactions were categorized as either negative or positive. Negative interactions included attempts to deter tourists through abrupt head-raising and lowering motions directed at them, or by rapidly approaching them. Similar behaviors were displayed toward humans by European bison kept in enclosure in Germany (38). Both behaviors are components of agonistic behavior and have also been recorded in the American bison (28, 44). POLON II and POŁATKA exhibited these behaviors in direct response to specific behaviors by tourists, such as touching or attempting to touch the animals, and climbing onto the fence near the feeder. Animals ignored other behaviors from tourists, such as shouting, clapping, or hitting the fence with their hands. Since the European bison did not exhibit any behavioral changes in response to the mentioned tourist behaviors, it can be concluded that they had no impact. On the other hand, positive interactions included approaching tourists in search of food and/or consuming food offered by them. The European bison would abandon hay or green forage and approach tourists even when no food was offered.

Constant contact with tourists is an inherent part of the zoological garden conditions and may exert a positive or negative influence on animals, but in some cases changes in behavior are not observed (47). A review of 104 publications from 1992-2022, containing 304 interpretations of tourist impact on animals, revealed that 53% of the interpretations indicated a neutral effect, 21% a negative effect, and only 4% a positive effect (55). Studies conducted in Poland demonstrated that the presence of tourists in the Warsaw Zoo did not lead to elevated stress levels in European bison. Moreover, researchers noted that the placement of feeders near visitor's path at the Forest Culture Center in Gołuchów might have contributed to reducing aggressive behaviors within the herd (20). In the case of young individuals at the Warsaw Zoo, contact with tourists was not a stimulus they avoided; on the contrary, the animals initiated interactions with tourists themselves and responded with aggression only to specific, infrequent tourist behaviors. However, the absence of behavioral stress responses in the observed individuals is insufficient to conclude that contact with tourists does not induce stress. It would be necessary to supplement the behavioral analysis with physiological parameter measurements (33).

Orienting response. The orienting response involves the abrupt interruption of an ongoing activity, focusing attention on the stimulus, and turning the head toward it (18). This category also included sudden rising from a resting position accompanied by head orientation toward the stimulus. In nearly all recorded cases, the orienting response resulted in the interruption of foraging. Only once, in the case of POŁATKA, did it interrupt urination, and in the case of the bull, it interrupted lying. During observations of POŁATKA during the separation period, the direct cause of the orienting response was identified twice. In both cases, it was triggered by

sudden, loud music from a car passing along the western side of the enclosure. In the case of the bull, one direct cause of the orienting response was recorded – a loud sound caused by the fall of a heavy object. Following the response to the stimulus, the European bison quickly resumed the previously interrupted activity. Orienting responses were recorded infrequently. If their frequency were high, it could indicate that the animals are alarmed, for example, by the presence of tourists or auditory stimuli. However, this is not always the case. In studies examining the responses of 12 species of ruminants to tourists in a zoological garden, no increase in the frequency of such behaviors was found (52). The lack of response to tourists may result from habituation to their presence (47).

Vocalization. Vocalization, referred to as grunting, was recorded infrequently. It occurred significantly more often when the individuals were separated than when they were housed in the herd. In the case of POLON II, grunting was most pronounced during the observation conducted the day after his separation (April 28, 2023). During the separation period, both animals most frequently vocalized while standing near the fence and observing the individuals in the adjacent enclosure, indicating attempts to establish contact. An increase in vocalization associated with separation has also been documented in other social species, such as horses (19, 41), goats (49), and cattle (3). In free-ranging European bison herds, vocalization is relatively rare and serves primarily for communication between cows and calves, as well as a threatening signal by bulls during the rutting season (8). Observations of European bison at the Prague Zoo also confirmed the rarity of vocalizations. Grunting was a reaction to unusual or unexpected behavior by one of the individuals or in response to a familiar person (53).

Ambiguous behaviors. This category includes behaviors that could not be clearly interpreted and may potentially be assigned to several different behavioral categories. In the case of POLON II, such behaviors included: trotting with the tail slightly or vertically raised (sometimes accompanied by lateral head shaking and hopping); kicking with the hind limbs and butting plants with the horns (with the tail either lowered or held upright); pawing at the sand with the forehooves while urinating, followed by vigorous wallowing at the site of urination; and sudden dashing a few steps away with the tail slightly raised (including two instances that occurred when another individual suddenly ran off with its tail raised). None of the observations identified a direct cause that could have triggered these behaviors. Sudden movements exhibited by the male may have been triggered by insect activity. Behaviors such as butting plants with the horns, kicking with the hind limbs, and running with the tail raised can be classified as play behaviors (22, 32). A similar form of play, involving hitting young trees with the horns, has been observed in American bison (32). Running with the

tail raised and kicking with the hind limbs may also be interpreted as stress-related behaviors (9, 26). During the period when the male was separated, the stress may have been caused by the inability to integrate with the herd in a situation perceived by the animal as threatening. Conversely, butting plants with the horns, pawing at the ground while urinating, followed by wallowing, are behaviors observed in European bison and American bison bulls during the rutting season (12, 15, 22, 23, 25, 28, 32, 48). European bison bulls also demonstrate their strength by breaking and uprooting young trees using their horns (22).

Ambiguous behaviors were also recorded in POŁATKA. During one observation conducted in the separation period, the heifer was seen trotting along the fence dividing the enclosures, with her tail slightly raised, occasionally circling, hopping, and vigorously shaking her head. At the same time, three other individuals – POGÓDKA, POLON II, and POGRALKA – were running in the adjacent enclosure. The heifer was likely attempting to establish contact with the other individuals, as indicated by additional behaviors, such as frequently watching the European bison in the neighboring enclosure while standing by the fence and twice climbing onto a fallen log when they moved away from her. Her behaviors may have been intended to draw the attention of the herd members. Behaviors such as vigorous head shaking and trotting with the tail slightly raised may also be interpreted as signs of stress (9, 26), which, in the case of POŁATKA, could have been caused by the separation. During the separation from the herd, POŁATKA also exhibited the following behaviors: sudden dashing with the tail slightly raised, trotting with the tail slightly or vertically raised, and galloping with the tail held vertically. In none of these cases was a direct cause identified for the observed behaviors. Each instance was brief, and the heifer quickly returned to the activity that had been interrupted, most often foraging. As in the case of the male, these behaviors may have represented attempts to escape from insects or may have been stress-related responses.

Stereotypic behavior. POŁATKA was observed licking the metal fence on several occasions. This behavior represents a form of oral stereotypy, which is frequently observed in ruminants kept under captive conditions (2, 27, 40, 54). According to the definition, stereotypic behaviors are purposeless and repetitive actions that may be triggered by animal frustration. They are considered indicators of poor welfare (5). In the case of POŁATKA, the observed behavior may have resulted from frustration caused by separation from the herd, as it was recorded only during the period of isolation. However, confirming the repetitive nature of the fence-licking behavior is difficult, as it was noted during only three observation days. Additional full-day observations of the POŁATKA would be necessary to determine whether the observed behavior was repetitive and whether it disrupted other activities.

The proposed ethogram may be applied in future studies concerning the behavior and welfare of young European bison under captive conditions. One indicator of high welfare observed during the study conducted at the Warsaw Zoo was the occurrence of play behaviors (14), whereas an indicator of low welfare was the oral stereotypy observed in the heifer. This ethogram can also be used to develop time budgets; that is, graphical and numerical representations of the percentage of time allocated to specific behaviors or behavioral categories in relation to the total activity time of the individuals (45). Moreover, the proposed ethogram may serve as a useful tool for comparing the behaviors of young European bison from different breeding centers and zoological gardens, as well as for supporting ex-situ population management.

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