

Specific Aspects of Nutrition of European bison in Prioksko-Terrasnyi Biosphere Reserve

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Abstract: The aim of present paper is to investigate specific aspects of nutrition of fenced European bison, especially how the herd uses the forest habitat. The analysis is based on the archives, reports, and nature records from Prioksko-Terrasnyi Reserve, as well as scientific papers on European bison and personal observations over years 1988–2013. It was found that captive breeding in large enclosures does not affect the major behavioural patterns of E. bison. As European bison move among various parts of the forest, the forage reserves are used optimally. In summer the major portion of biomass come from forest pastures. Parts of woody plants are among the main nutritional components of E. bison diet throughout a year.

Key words: European bison, nutrition, habitat use

Introduction

It is known that all morphological trait of the *Bison* species are under profound influence of environment what could be a specific aspect of habitat use. Initially, whole *Bison* species inhabited forest, woodland grasses interspersed with meadows and riverside scrubs. The European bison existence started at and has always belonged to forest (Flyorov 1932). The whole of its inhabited range belongs to forest, with a low snow level on a forest bed and a reasonably mild climate.

Unlike American bison, the European bison does not increase body weight during autumn, making itself dependent on availability of woody forage in forest during winter (Zablotsky 1960).

The European bison is a herbivore with plasticity regarding the food, what is confirmed by the long list of plant species in its natural diet. Grass and herbs constitute the major part of its forage, but woody forage is very crucial and in winter it may reach as high as 70 to 90% of daily food intake. An usual daily diet of a mature European bison in natural conditions consists of about 60 to 100 kg of grasses, 2 to 3 kg of twigs, and about 20 litres of water. European bison inhabiting various geographical areas (Białowieża Forest, Northern Caucasus, Moscow region) have mostly similar diet, and their both used and preferred plant species are similar (Zablotskaya 1957; Korochkina 1972; Treboganova 2014). During the vegetative season their diet mostly consists grasses (67%), whereas trees and shrubs account

for 3 per cent (Borowski, Kossak 1972). The major factor influencing the European bison's roaming through forest complexes is high nutritional requirements. Preferred forest ecosystems change seasonally with a phenological phase of plants and their availability in different types of forests (Kraśńska 1978; Korochkina 1972).

In classification based on comparative analysis of digestive tract morphology, Hofmann (1978) classified the European bison together with the American bison, water buffalo (*Bubalus bubalus*), and beef cattle into a specific grass eater group that feed on grasses and fibrous food, which they consume in abundance without obvious preference. This is confirmed by the level of nutritional adaptation of the European bison (Borowski, Kossak 1972; Korochkina 1972).

There is an earlier research on the European bison populations in Prioksko-Terrasnyi Biosphere Reserve that cover the feeding and specifics of natural forage of the European bison (Zablotskaya 1957). Korochkina (1972) during 4 years conducted similar research on feeding and daily activities of the European bison in Białowieża Forest.

Research Goals and Tasks

The aim of present paper is to investigate specific aspects of nutrition of fenced European bison.

The following matters were addressed:

1. Specific features of European bison nutrition.
2. How the herd of the European bison uses the forest habitat in Prioksko-Terrasnyi Reserve (analysis of seasonal changes in their usage of the forest complex, analysis of correlation between the number of encounters with the herd and the composition (forest types) of encounter site areas).

Materials and Methods

The present paper is based on the archives, reports, and nature records from FBGU "Prioksko-Terrasnyi Biosphere Reserve" (the "PTBR"), scientific papers on European bison restitution challenges, and personal observations over 1988–2013 at Prioksko-Terrasnyi Biosphere Reserve and the European Bison Breeding Centre (the "EBBC").

The investigated territory comprised the following forest types: mixed coniferous forest, mixed deciduous forest, moist deciduous forest, swampy coniferous forest. Dominating tree species in deciduous forest are: aspen, birch, linden and oak. A coniferous forest is dominated by pine and fir tree. Data were collected through direct observation of herd in PTBR, collecting freshly foraged pieces at pastures, tracking the herd over the 200 ha territory, and tracking the herd of youngsters (1988–1992). The herd was represented by about 50 animals, and within the large enclosure there was a group of 12 to 15 individuals. Each observation was docu-

mented to determine the location, age class, and forest type. Presence of an observer rarely had any effect on behaviour and activities of animals (except for an encounter itself as it is a challenge to approach the animals unobserved in a forest). Identified tracks of *E. bison* were mapped. The available facilities were also included on the map: trails, wallows, scratching posts, preferred pastures and resting places, etc. Eventually, there were 55 trails tracked to the total length of about 90 km and 40 most intensively grazed pastures were cut at different vegetation stages.

Results

Supplementary feeding of European bison

Scientific data on European bison being released into the wild shows that after six of twelve months after release, animals from breeding centres become wild, i.e. they avoid people and live by themselves, though come to supplementary feeding sites when strictly necessary.

Dispersion of the European bison highly depends on sites of intensive supplementary feeding. In the breeding centre *E. bison* are fed two times a day: at 8 a.m. and at 4 p.m.

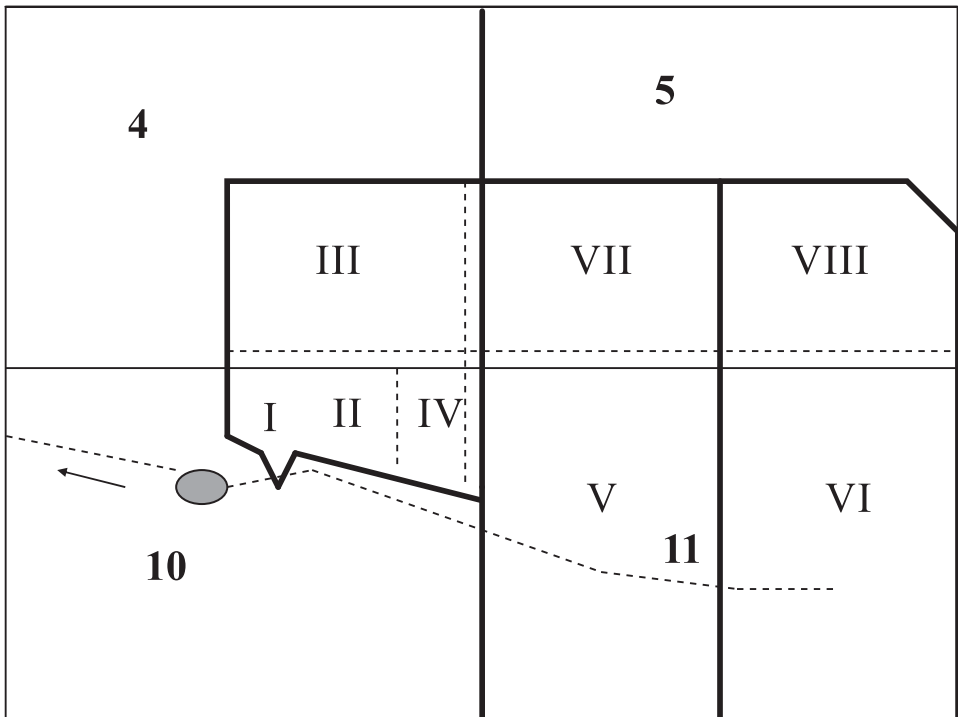


Fig. 1. The Scheme of pens in the Breeding Centre.
(10 – forest area number; I – pen number)

Daily dose of fodder per animal:

Hay: 10–15 kg daily (in winter).

Green grass: in summer, supplementary feeding depends on standing crop of grass within a pen and daily intake calculated for a mature bull is at least 100 kg and for a cow for at least 60 kg of green grass;

Concentrated food (formula feed): 4–7 kg per bull, 3–4 kg per cow, 1–3 kg per calf (depending on age).

Root vegetables: 4–6 kg of fodder beet, turnip, 2–4 kg of carrot, 6–8 kg of cabbage, 3–5 kg of apple (apples must be cut into four pieces).

Salt brick: about 50 g/animal. In pens, salt bricks are provided in wooden troughs or are fixed to tree stubs. The salt brick used as supplementary feeding is KNZ (made in Holland) containing additional minerals. The European bison readily make use of the salt bricks, especially during summer, when calving cows are at deficit of minerals and vitamins, or during the breeding season in autumn. At the breeding centre, most bison cows have calves every year, whereas free-ranging bison cows breed every two or three years.

At the breeding centre, we supplement the forage with the woody plants the European bison prefer (aspen, willow, oak).

Specific features of European bison nutrition***Feeding Behaviour***

The feeding behaviour of ungulates depends on the specifics of their mouth apparatus: the structure of their lips and arrangement of their teeth. The European bison bites off grass at the height of 1.5–2.5 cm. Foraging bouts of the European bison last for 40 minutes at a time. If grass is higher and sparser, the animal eats less. At natural pastures that can offer more attractive fodder the grazing time varies from 7 to 14 hours a day. Periods spent on rumination of consumed forage regulate the daily activity rhythm.

As the European bison move among parts of the forest, the forage reserves are used optimally. Thus, the reserves are not overly exploited and the herb layer can recover. The European bison never eats all available plants to the ground. They forage mostly in habitats with herb layers at the peak of their vegetation. Animals would return to formerly used place in a couple of days (6–12). July has the shortest return periods of 6–8 days. This might be due to relatively short vegetative phase of plants in that period, and probably confirms regarding good memory of the European bison regarding the state of their habitats. After coming back to the same area, e.g. a clearing in the woods, the European bison would graze near the site where they had been grazing previously, rather than at the patch where they had already grazed the herb layer. This might be due to the fact that the previously grazed herb layer could not yet reach the height sufficient to efficient grazing (i.e. not reaching the peak of vegetation).

Preferred habitats

Data on the composition of consumed forage was collected in the form of visual observations and records of foraged plants. The same plants species can be consumed to different levels depending on the composition of the plant community, soil and climate conditions, seasonal fluctuations, age and growth phase of plants and grazing pressure etc.

The home range of the European bison at PTBR is composed mostly of forest habitats. During the observation period, the European bison was rarely seen in a fresh coniferous forest or swampy coniferous forest. The ungulates only used these habitats when translocating to most used by them deciduous and mixed coniferous forests (Tabl. 1).

Effective foraging of the European bison involves movements of the group, where the direction of translocation and its speed depend on the nutritional demand of the animals. Habitat preference directly depends upon their available forage resources. The extent to which many plants are consumed mainly correlates with their growth conditions. Plants growing on open sites with enough light are consumed to a much greater extent than plants growing on a forest bed. In June, the European bison prefer mixed forests and deciduous forests but latter to a lesser degree. In July and August deciduous forests are used the most often (Tabl. 1). In June, the most preferred plants are: meadow fescue (*Festuca pratensis*), orchard grass (*Dactylis glomerata*), bluegrass (*Poa* sp.), clover (*Trifolium* sp.), 'lady's mantle' (*Alchemilla* sp.), woodreed (*Calamagrostis* sp.), and wood vetch (*Vicia sylvatica*).

In case of shortage or decreased quality of forage due to, e.g., grass ageing or poor growth in a dry period, the movements of the European bison change altering the size and location of inhabited sites and eventually modifying the nutritional activity of animals. Our observations involved a group youngsters as well as family groups with mature European bison. The youngster herd included only individuals not older than 3 years, i.e., without experience of habitat usage. Those young animals had to survey the territory by themselves. They were however successful and used the same trails, pastures and resting sites as the mature individuals that

Table 1. Intensity of use of forest habitats by European bison at PTBR(%).

Month	May	June	July	August
Number of observations	20.0	22.0	19.0	23.0
Conifer	1.8	2.2	3.6	2.1
Deciduous	28.3	22.7	47.4	56.5
Moist deciduous	4.2	6.8	12.2	3.4
Mixed deciduous	32.0	41.0	26.3	21.8
Swampy conifer	–	–	–	3.2
Mixed conifer	33.7	27.3	10.5	13.0

inhabited the pen previously. The similarity in the pattern of habitat use without the opportunity to learn from older individuals proves that the European bison has a perfect sense for orientation (the ability to re-track trails formerly used by the herd responding to biological signals).

Food selectivity

As the majority of large ungulates, the European bison is not particularly selective in its foraging. The species selects sites with abundant preferred herbs rather than search for individual preferred plants. Thus, they may satisfy their requirements for energy intake rather quickly. The European bison is highly adaptive regarding its diet, which is possible due to variety of available forage. In the Belarusian part of Białowieża Forest, the diet of European bison includes 376 plant species (Korochkina 1972). Earlier study on the European bison diet at PTBR showed that they consumed 140 grass species and 36 tree and shrub species, with the total amount of forage plants in the Reserve amounting to over 200 species (Zablotskaya 1957). In Caucasus region, over 110 grass species and over 30 tree and shrub species are recorded to be consumed by European bison (Krajnova 1951). Our observations show that the European bison diet at PTBR during the vegetative season included 106 plant species. There is a reduction in plant species for European bison forage within the breeding centre territory as forage reserves of pens there are exhausted, overexploited, and already occurring the extinction of some plant species.

Among the wide range of grassy species that the European bison may forage upon, the major portion of their diet includes species belonging to families of Fabaceae, Poaceae, Compositae, and Apiaceae. They are mostly widespread to the south of Moscow region, so the European bison, not being that selective, have to forage these plants, which grow in abundance, with high density of sward, and sufficiently available for their normal life activity.

Poaceae are mostly grazed in spring when they contain considerable amounts of sugars. Before the flowering period, fibre contents in Poaceae is minimal; the European bison eat then the whole plant. Later on, they only graze on leaves of rosettes above central taproots and vegetative shoots, whereas stems are not used at all. Throughout summer and autumn, the European bison graze at grasses growing within mowed sites or earlier grazed sites. In spring, while the grassy layer is sparse and forage is scarce, the herd disperses rather far and graze on the move. In this season, considerable movements from site to site are a usual matter. In mid-summer, the European bison settle on most forage-rich sites and stay there for long periods.

By the end of summer, the diet of the European bison is considerably enriched with increasingly larger contribution of the following species: *Galium*, *Veronica chamaedrys*, *Stellaria holostea*. Poaceae are of lesser significance then. The average height

of grasses at intensively grazed sites is 35 ± 8.4 cm with density of sward of 80%. The European bison mainly then graze leaves and upper parts of stems, actually choosing the most rich forage: they graze fresher parts of plants and move to a new location where vegetative season is delayed to choose plants in various layers of grasses and trees. When the the grass layer is on a decline, grazing mainly includes current twigs of woody plants.

Nutritional significance of trees at PTBR

The diet of European bison differs depending on the season. In summer, they mainly forage on grasses, whereas in winter, on bark and shoots of trees and shrubs. Parts of woody species (bark, vegetative ends of twigs, leaves, fruit) are among the main nutritional components of the diet throughout a year, however, their proportion differs from season to season. European bison browse the bark, leaves, and shoots, i.e. parts with highest nutritional value of almost all species of trees and shrubs. Mostly preferred are bark and shoots of willow, aspen, maple, and linden, whereas alder, bird cherry, rowan, birch, pine belong to least preferred. Also, the European bison browse dry twigs. Fallen leaves are consumed only in autumn and early winter. Regardless of a forest type, the European bison may debark trees older than 20 years of age with a trunk of 10–20 cm in diameter. It should be noted that pens in the breeding centre lack underbush and underwood of deciduous trees, which results from long term presence there (over 60 years) of animals with no replacements and with the population over the nutritional capacity of pens.

In spring, leaves and shoots have an equal share in the diet of the European bison; their nutritional value is roughly the same at this time of year. In summer, shoots turn rough with fibre proportion becoming two times higher than in leaves, whereas ash and protein contents become 1.5 times lower (Malinovskaya 1973). Leaves of any trees and shrubs have then higher nutritional value than grassy species. The proportion of twigs in the diet increases in early summer when their nutritional value is the highest. The above patterns explain changes in nutritional behaviour of the European bison during summer. Debarking is a seasonal issue. In spring, debarking occupies most of feeding time, when sap starts to flow, and there are not yet neither fresh shoots nor grass. During this period, the European bison mainly browse on trunks and branches of aspen, willow, alder and linden. Leaves on fresh shoots of linden are the favourite then for European bison, which prefer a lime forest with looser canopy. The preference for linden leaves by the European bison is the highest among other ungulate species. Therefore the European bison may be a regulation factor for this species especially at sites where linden is spontaneously rejuvenating within underwood. The most willingly browsed are shoots of any deciduous trees that grow somewhat apart. European bison regularly return to certain foraging patches not only within one year but in the course of a few years.

Frequently also observed is browsing on bark and branches of fallen trees, especially aspen. Pens in PTBR offer an abundance of such trees. Additionally the Centre personnel often cuts down aspen trees that are rotten inside to ensure that European bison would not browse on healthy trees. In table 2 is shown the patterns of use of tree and shrub species determined by direct observations of the European bison at PTBR.

Significance of certain species in the diet of the European bison depends on availability of the forage and accessibility of edible parts of trees and shrubs. At PTBR, the majority of the diet compose willow, aspen, linden (widespread in under bush and underwood), then in descending order of nutritional value: spindle tree, oak, alder, birch, maple, and other species (the comparison is based not only on the density of foraged pieces (number per area unit) but on the volume of foraged pieces as well). The European bison gladly forage upon hazel, raspberry, honey-suckle, currant, spindle tree, shoots of oak. In the summer diet, at least 40% of the whole amount of consumed food includes leaves, shoots, twigs, and bark of trees and shrubs, which are as valuable as grassy plants. By the late summer, with drying out and degradation of the grass, debarking becomes increasingly significant.

Table 2. A comparison of use of various woody species by E. bison at PTBR.

No	Species	% of consumption	Consumed parts	Availability	Importance
1	Willow	80–85	B, T, L.	wide enough	+ + +
2	Aspen	70–80	B, T, L.	wide	+ + +
3	Linden (mainly underbush)	45–55	B, T, L.	wide	+ + +
4	Spindle tree	45–50	B, S, L.	wide	+ +
5	Alder	40–45	L., T.	sparse	+
6	Oak (shoots)	35–40	L., T, B.	sparse	+ +
7	Rowan	35–50	B, T, L.	wide	+ +
8	<i>Vaccinium vitis-idaea</i>	15–20	S, L., F	wide	+
9	<i>Vaccinium myrtillus</i>	15–20	S, L., F	In excess	+
10	Maple	15–20	T, B, L.	sparse	+
11	Birch	10–35	L., T.	wide	+
12	Poplar	10–35	T, L., B.	wide	+ +
13	Fir	5–10	B.	wide	Sgl
14	Pine	5–10	B.	wide	Sgl

Legend for the table:

L. leaves, T. current growth of twigs, B. bark, S. tops of shrubs, F. fruit

Forage significance:

+ + + major, + + supplementary, + minor, Sgl occasional

Discussion

System of pens established at the PTBR influences the patterns of area use by European bison since their movements are artificially limited. Forage quality and availability determine how often and how long animals visit particular parts of their pens (beside feeders where they spend most of the day, in wallows, at scratching posts, on lying sites). According to Zablotsky (1957) the standard pasture area per mature European bison in a breeding centre (i.e. with mandatory twice-a-day feeding) must be at least 5 ha. These standards were not observed at PTBR, thus leading to a considerable overexploitation of land, degradation of under bush and underwood, changed soil composition, especially at feeding sites, changed composition of plant species in favour of Cyperaceae, ferns, and other plants that are scarcely components of the European bison diet. Until early 1990s, there were few measures taken to improve the quality of vegetation cover within pens at PRBR.

Conclusions

1. Captive breeding in large enclosures does not affect the major behavioural patterns of *E. bison* (how the territory is used, how sites are rotated, how animals behave as a herd, etc.) but facilitates their settling in new habitats and adapting to new conditions. This ensures successful adaptation of *E. bison* resettled to natural ecosystems.
2. The diet of the European bison involves shoots and bark of trees and shrubs, and ground flora of forests. The European bison mainly graze upon the most rich patches: they graze fresher parts of plants and choose plants in different layers of grasses and woody plants. The European bison tend to remain for long periods of time within the most forage-rich sites.
3. As European bison move among various parts of the forest, the forage reserves are used optimally. Animals only come back to the same grazed site every few days.
4. In summer, the main foraging grounds for the European bison are deciduous forests, wide-leaved grass pine forest, forest edges, forest openings and meadows. Most preferred are plants belonging to families: *Poaceae*, *Fabaceae* and *Compositae*, which constitute the major portion of biomass at forest pastures and have relatively high nutritional value.
5. Parts of woody plants (bark, vegetative ends of twigs, leaves, fruit) are among the main nutritional components of *E. bison* diet throughout a year. Significance of certain plant species in the diet of the European bison depends on availability of the forage, abundance of certain species and accessibility of edible parts of plants.

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Specyficzne aspekty żywienia żubrów bytujących w Prioksko-terrasnym rezerwacie

Streszczenie: Celem pracy było zbadanie aspektów żywienia żubrów w zagrodach rezerwatu, ze szczególnym uwzględnieniem wykorzystania przez stado siedlisk na terenie zagród. Prezentowana analiza bazowała na danych archiwalnych, raportach i sprawozdaniach z rezerwatu, jak również na literaturze naukowej i własnych obserwacjach z lat 1988–2013. Stwierdzono, że hodowla w dużych zagrodach nie wpływa na zmianę podstawowego behawioru żubra. Żubry przemieszczają się swobodnie na terenie rezerwatu pomiędzy różnymi środowiskami, przy czym optymalnie wykorzystują zasoby pokarmowe. Większa część pobieranej latem biomasy pochodzi z pastwisk śródleśnych. Żer pędowy jest bardzo ważnym składnikiem diety żubrów w okresie całego roku.
