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EFFECT OF CATTLE GRAZING ON HABITATS FOR THE STEPPE MARMOT (*MARMOTA BOBAK*) IN NORTH-EASTERN UKRAINE

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Effect of Cattle Grazing on Habitats for the Steppe Marmot (*Marmota bobak*) in North-Eastern Ukraine. Ronkin V. I., Savchenko G. A. — Qualitative and quantitative composition of vegetation cover, foraging and diet of the steppe marmot (*Marmota bobak* Müll.) were studied in 1990–1997 at a stationary site in north-east of Kharkov region. The green food intake rate was chosen as a criterion for the foraging quality evaluation of different steppe marmot habitats. Cattle grazing leads to diminishing of the vegetation cover diversity and to disappearing of those patches where the green food intake rate by the steppe marmot is the least one. Accordingly the values of the food intake rate, the high proportion of dead plants together with species rejected or eaten in low quantities (for similar mass of forage plants) relative to total aboveground plant mass diminishes the accessibility to forage and worsens foraging conditions for marmots.

Key words: steppe marmot, grazing, food intake rate.

Влияние выпаса на местообитания степного сурка (*Marmota bobak*) на северо-востоке Украины. Ронкин В. И., Савченко Г. А. — В 1990–1997 гг. на участке постоянных исследований на северо-востоке Украины изучали качественный и количественный состав растительности, питание и состав рациона степного сурка (*Marmota bobak* Müll.). В качестве критерия пригодности различных местообитаний для степного сурка была выбрана скорость потребления зеленого корма. Установлено, что выпас крупных копытных приводит к уменьшению разнообразия растительного покрова и выпадению тех микрогруппировок растительности, в которых зарегистрирована наименьшая скорость потребления. По данным скорости потребления (при одинаковой массе кормовых растений) высокая доля некормовых видов и ветоши снижает доступность поедаемых растений и ухудшает условия питания сурков.

Ключевые слова: степной сурок, выпас, скорость потребления корма.

Introdacshion

The investigations carried out by many authors show that the population density of steppe marmots depends on the character and degree of cattle grazing pressure on their habitats (Seredneva, 1978; Bibikov, 1989). However, the reasons for it are insufficiently clear. Any detailed observations on food preference of animals in habitats with different grazing pressure are lacking as well as the detailed study of ground-cover vegetation. It makes difficult the comparison of results obtained in different parts of the wide steppe range occupied by marmots and, consequently, the evaluation of habitat suitability for distribution and re-introduction of animals, optimal population density calculations, etc. The purpose of our work was to study forage preferences and plant characteristics of habitats with different grazing pressure as well as the evaluation of these habitats suitability for steppe marmots.

Material and methods

This study was carried out in 1990–1997 at colony site located in a broad gully system (about 90 km to the north-east of Kharkov). Vegetation of such systems has a transitional nature. It is characterized by communities both of northern meadow-steppe and of "forbs + fescue + feather grass" steppe. Three types of steppe marmot habitats were identified. First type: territories without any cattle grazing and hay-making. Second type: territories with a periodic cattle grazing (middle grazing pressure) or hay-making. Hay-making is performed annual in mid-June and there after this territory is used as a pasture. Vegetation cover has the attributes of pasture degradation of the third-fourth stage. Third type: with active permanent cattle grazing (high grazing pressure) and with the fourth-fifth stage of the degradation.

The vegetation was sampled in 1992–1995 in June (first period) and in August (second period). The phytocenological analysis (0.25 square-meter method) was carried out for each habitat type.

The total number of sampling quadrates is 162. Vegetation was clipped at a ground level. Poaceae, Cyperaceae and Juncaceae were accounted for combined. All others were separated by species. All plants were dried in a thermostat to a constant weight and weighted. Non-uniform multi-diversity vegetation covers were divided into patches (microcenoses) which were separately analyzed. Then the size of each patch was determined and average mass calculations were conducted according to the size values obtained.

In early August 1998 and 1999, some plant species were sampled at the territory without grazing and at the pasture to determine the proportion of young parts relative to the whole mass of this plant. In the young parts of these species (i. e. in the tops of young leaves, shoots and flowers) were determined water, ash, protein, fat, N-free extractive matter and cellulose content.

The observations were carried out in 1992–1996 at the same periods of vegetation sampling. An area of about 6 ha size was separated within each habitat type where all the families available were counted and an assessment of vegetation cover was performed. Members of the family group were identified in the course of long-term observations on the basis of their joint living in the same permanent burrow or in the system of those within a certain period of time. During field observations foraging patches (microcenoses), where marmots usually were feeding and patches not used for feeding, were identified. The green food intake rate was chosen as a main qualitative characteristic of forage resources of marmots` habitats. The green food intake rate was determined in each patch. For this purpose 1 x 1 x 0.5 m grid cage without bottom was moved according of the grazing marmot movements within this cage, or the marmot was feeding held on special dog-lead (in length 2 m). We were registering species eaten and rejected in each trial. The quantity of forage ingested was determined from the difference in the body mass of two adult hand-reared marmots before and after grazing. (Hand-reared animals of the living marmot collection from the Biological Station of Kharkov State University were used in experiments). The marmots were grazed twice per day in dry weather during 20–30 minutes at least five times for each patch. In the cases of defecation and urination the data were not used. On the whole, 132 grazing events were carried out: 67 for the female and 65 for the male. The intake rate was: $S = (m_2 - m_1) / t$, where m_1, m_2 — was the marmots' mass in grams before and after grazing, t — was foraging time in minutes. To average the data obtained in experiments with animals differing in sex and body mass the intake rate was expressed in percents of the maximum one ($s = S \times 100\% / S_{max}$). The maximum intake rate (S_{max}) was determined for each animal while feeding it with a diet of preferred fresh plants in an abundance. The data comparison of intake rate was performed for the same activity season.

In additional to the field experiences, we conducted laboratory feeding trials with cage-kept marmots (1990–1997). The marmots were fed by various mixtures of fresh plants of the same vegetative phase (Ronkin, Tokarsky, 1993). The plant species preferred or rejected by the animals were determined. Ten adult cage-kept animals of the living marmot collection from the Biological Station of Kharkov State University were used in the experiences.

Results

As a result of the investigations on cage-kept animals it was stated that the plant species of steppe marmot habitats might be classified referring to their palatability (or preference) as follows: 1) main forage plants. These species are consumed by animals first of all independently of their vegetation stage; 2) Forage species, which are eaten in the second place; 3) Species, which are consumed only at their earliest vegetation stages plus absolutely rejected by marmots.

All the food species were analyzed as to their ecotopical dependence as well as their foraging attractiveness for the steppe marmot. The analysis showed that the species of the 1st preference group were predominantly meadow or pasture plants and weeds. The second group mainly comprises species of forest-edge and dry steppe community. Among the plants rejected by marmots are those with pungent odor, coarse downy, eriophyllous or prickly ones independent of their ecological dependence. The same refers to *Potentilla anserina* L. and *Lysimachia nummularia* L. (the meadow plants), *Fragaria viridis* Duch. (excluding berries), all Juncaceae and Cyperaceae. Most of Poaceae, Caryophyllaceae, Rosaceae and Rubiaceae are ingested but only at their early vegetative stages.

As a rule, grazing marmot is on the move and looks like crawling. In the field experiences, hand-reared marmots did not spend their foraging time in searching and a long-term foraging at any stationary place was not a characteristic pattern as well. It was noted that marmots were eating only young parts of food plants. A number of experiments on a long-term (about 45 min) foraging of animals in cages without a bottom within an area of 1 m^2 showed, that in spite of the abundance of food the animal ceased foraging 15–20 min after the start. The marmots have consumed up to 50% of

mass of accessible and suitable parts of plants in each trial. More than ones, some plants though large and succulent were remained practically untouched.

The main foraging pattern for grazing hand-reared as well as for free-living marmots was a selective consumption the young parts of the plants dominating in the cover and accessible at the given moment. The grazing marmots move incessantly about and bite off the food time and again. That is, the foraging behavior is characterized by moving but not by search, by choice of plants mostly of the 1st–2nd preference groups, which prevail just in the vegetative cover and by selective consumption of young parts. The time spent by a marmot for each plant is practically equal, be it large juicy chicory (*Cichorium intybus* L., the 1st group), small dandelion (*Taraxacum officinale* Webb ex Wigg., the 1st group) or couch grass (*Agropyron repens* L., the 2nd group), etc. The leaves of some preferred fodder plants were sometimes situated closely to the ground (for example, the rosette leaves of *Taraxacum serotinum* (Waldst. et Kit.) Poir. in open grass canopy). In such cases, the marmots unstuck a few leaves with their forepaws and bit off some parts of these leaves. It is interesting to note that one of the marmots' favorite plants is *Lactuca serriola* Torner sporadically met in the covers but frequently present as a field weed in crops where many of wild-living marmots were feeding according to our field observations.

Taking into account all above mentioned, we carried out a phytocenological analysis of each habitat type which revealed the compositions of main plant species (those the frequency of which and the proportion relative to the total aboveground plant mass exceeds 5 and 0.01% respectively) as it is their combinations that determine foraging suitability of steppe marmot habitats. The general number of the main plant species is more on the territory without grazing, than on the intensive pasture in 1.8. The number of fodder species is almost equal but species not eaten or eaten in very low quantities by marmots are much less presented in the pasture. The sample compositional similarity of habitats was 0.3 (Jaccard' coefficient, $K_j < 1$) for the first-third type, 0.5 for the first-second type and 0.4 for the second-third type.

To compare phytocharacteristics of habitats studied in terms of their foraging resources for the steppe marmot the forage plants mass percentage in the total aboveground plant mass was calculated. The total aboveground plant mass is 2–4 times greater that on the territories without grazing. Thus mass of the food plant is most equal but the litter mass is 7 times higher. The proportion of the fodder plants (the 1st and the 2nd group) relative to the total aboveground plant mass, on the contrary, is 2.7– 3.2 times greater on the. As the marmots eat only young parts of plants, we have made account of the ratio of the young parts mass relative to the whole mass of this plant. Already in June this ratio was on the average 1 : 5 (wet weight, the fodder plants) on the territories without cattle grazing and approximately 1 : 2 in the pastures. That is the proportion of the real forage relative to the total aboveground plant mass is 6.5–8.0 times higher on the pastures than on the territory without grazing. Furthermore, the young parts of species on the pastures contained a little more protein than the same parts on the territory without grazing and unlikely were less juicy.

The green food intake rate greatly varied in the different patches of grassy plants differing as to their composition. The food intake rate and ecological dependence of main grassy patches in the marmot habitats of different type are presented here (tabl. 1). It follows from table 1 that permanent cattle grazing leads to diminishing of the vegetation cover diversity and to disappearing of those patches where the green food intake rate is the least one. Therefore these plant patches are of little forage value for the steppe marmot. The vegetation of the pastures is mostly represented by three elements: meadow community *Poa pratensis* L. + forbs, steppe community *Festica valesiaca* Gaud. + forbs and patches of *Polygonum aviculare* L. + Brassicaceae. In all such patches, the green food intake rate was mostly above 30% of maximal one. The highest intake rate was registered in the patch where *Polygonum aviculare* was abundant, the lowest in *Calamagrostis epigeios* (L.) Roth. It was noted that the intake rate in patch *Poa pratensis* + forbs was much higher on grassland than at other territories (46 ± 6 and 32 ± 8 accordingly).

Table 1. The green food intake rate by the steppe marmot in main grassy patches of different habitats
Таблица 1. Скорость потребления зеленого корма степным сурком в основных растительных группировках различных местообитаний

Habitats	Patches (species that dominate)	Number of mean species	Plant community	Abovegro-und biomass (g/i2, dry weight)	Ratio of food plants relative to above-ground biomass, %	Green food intake rate, % of S_{max}, x ± s. d.
Without grazing and haymaking	*Poa pratensis* L.	10	meadow	271	54	32 ± 8
	Festuca rupicola Heuff.	7	meadow steppe	205	69	34 ± 9
	Calamagrostis epigeios (L.) Roth	8	meadow edge	201	8	11 ± 3
	Hieracium pilosella L.	6	dry steppe	179	35	18 ± 3
	Crinitaria villosa (L.) DC.	10	dry steppe	168	15	14 ± 5
	Fragaria viridis Duch.	6	steppe	417	27	18 ± 9
Grassland	*Poa pratensis*	11	meadow	216	86	46 ± 6
Pastures with middle grazing pressure	*Festuca valesiaca* Gaud.	7	steppe	157	70	26 ± 9
Pastures with high grazing pressure	*Poa pratensis*	7	meadow	124	66	32 ± 8
	Festuca vale-siaca	10	steppe	68	86	39 ± 4
Overgrazing	*Polygonum aviculare* L.	2	ruderal	131	89	47 ± 9

In spite of the fact that the wild-living marmots frequently grazed in flowering bushes, the grazing of hand-reared marmots in the patches of shrubs were difficult therefore they were not considered.

Habitats without grazing and hay-making are characterized by a high diversity of their cover mainly represented by patches of grasses *Calamagrostis epigeios*, *Festuca rupicola* Heuff., *F. valesiaca* Gaud., *Stipa capillata* L. or shrubs *Caragana frutex* (L.) C. Koch, *Chamaecytisus austriacus* (L.) Link, *Genista tinctoria* L. as well as by availability of trees *Pyrus communis* L. The population density constituted 0.3 family groups per ha.

The population density on the territory with a periodic cattle grazing was 0.8 fam/ha. On the territory with permanent grazing — 1.9 fam/ha.

Discussion

Often the preferred species by feeding of cage-kept animals do not correspond to those ingested in natural environment (Abaturov, 1984). So only under experimental conditions during feeding cage-kept animals with freshly clipped plants it is possible to identify plants species consumed first of all and "in the second place", those less consumed and absolutely rejected. The natural result of intensive grazing is damage and trampling down vegetational cover by cattle, i. e. its impoverishment because of the disappearance of some plant species, mainly of the 3rd group. It provides the formation of a vegetation cover with plants of the1st—2nd preference group, which simultaneously are resistant to cattle grazing *Polygonum aviculare*, *Taraxacum officinale, Achillea submillefolium* Klok. et Krytzka, *Artemisia austriaca* Jacq., *Plantago media* L. etc. In spite of the unpretentiousness and simplicity of diet choice mentioned by many authors (Seredneva, 1978; Bibikov, 1989; Mashkin, 1997), steppe marmot nevertheless prefer meadow and pasture species, mainly Asteraceae and Fabaceae. Indeed, it was confirmed in our tests on the cage-kept and hand-reared marmots. The avoidance of plant, as a rule, are well explained by chemical composition of plants or morphological peculiarities making them inconvenient to animals. Rejection or low ingestion of plant species with defensive compounds was confirmed for yellow-bellied marmots (*M. flaviventris* Audubon et Bachman,

1841) (Frase, Armitage, 1989). Also was described the avoidance of plant secondary compounds by alpine marmots (*M. marmota* Linnaeus, 1758) (Ramousse et al., 1993).

Besides, pasture plants are characterized by an abundant regrowth of the grazed parts with an increased protein and water content. It is the regrowth that is necessary to meet energy requirements (Stogov, 1956; Seredneva, 1978; Ronkin, Tokarsky, 1993). Indeed, the young parts of species sampled on the pasture contained a little more protein than same species on the territory without grazing but because of low the sample compositional similarity better much to compare a mixture (according to their abundance) of the species eaten. For example, *Centaurea jacea* L., *Trifolium montanum* L., *T. alpestre* L. were rare in the pasture canopy but *T. repens* L., *T. fragiferum* L. etc. were not present on the territory without grazing. Considering that the ratio of the young parts mass relative to the whole mass of this plant was approximately 1 : 2 on the pasture and 1 : 5 on the territory without grazing, the conclusion concerning relatively greater abundance of regrowth on the pasture is proved. Therefore under such conditions (i. e. the regrowth lack) it is the combinations of plant dominants differing in their phenological qualities (Bibikov, 1989) that may be of a paramount importance for marmots on territories without grazing. Some authors (Shubin et al., 1978) consider that the general number of food species in foraging areas should be great. On the contrary, on pasture the marmots all the active period consume only a limited number of plant species but these have the permanent regrowth. That is, the marmots mostly feed on 10–15 dominant species during the whole activity period. Whether it is important, that the general number of food species in foraging areas of animals is great? Apparently, for the steppe marmot in Ukraine it is an opposite case.

Marmots as a rule have an opportunity to choose certain foraging areas in their home-ranges. For example, yellow-bellied marmots typically fed in areas where only a few plant species predominated (Frase, Armitage, 1989). In our field observations, on the pasture the preference of certain foraging areas over others was not appreciable because of relatively high homogeneity of the pasture cover. On the territory without grazing the marmots distinctly preferred to forage in meadows areas, in patches with flowering shrubs (generally *Caragana frutex*) and at the field-edges. During the activity seasons the changes of several foraging areas and 2–3 main burrows affected by phenology were observed here. Therefore the home range size was 3.6 times greater that on the pasture. The most obvious conclusion is that the use of territory and foraging areas depends both on the food preference and on the vegetation structure. Similar conclusions are received for alpine marmot (Bassano et al., 1996).

As it was shown by many researchers (and the authors of this paper are of the same opinion) the main feature of steppe marmot foraging behavior is the young parts ingestion of food plants while moving unceasingly about. It is important, that such forage should not be covered over unsuitable plants. We assume further that the dead plant mass together with the species rejected by marmots limit the access to forage species. Consequently, the absolute mass of presented available food cannot serve a suitability index for foraging area. On the contrary, the specificity in foraging behavior of steppe marmots is connected with a relative plant accessibility which plays an important part and may be expressed as the proportion of the phytomass of forage species (or vice versa of dead plants and of the species rejected by animals) relative to the total aboveground phytomass. This proportion, probably, determine the green food intake rate for steppe marmot (tabl. 1). It was shown that animals diet was determined by abundance and accessibility of food in natural environment (Abaturov, 1984). The increase of regrowth in forage species and decrease of the unfavorable mass provides not only an abundance of foraging resources but also their readier accessibility for marmots. In this connection the choice of foraging areas was especially necessary for marmots on the territory without grazing, where the proportion of fodder species relative to the total aboveground plant mass was in different patches from 8 to 69% and by far less necessary on the pasture, where this ratio was from 51 to 96%. At the same time for the steppe marmot, as well as for the grey marmot (*M. baibacina* Kastschenko, 1899) landscapes with a mosa-

ic dislocation of steppe and meadow patches are probably optimal (Bibikov, 1989), which can be observed in conditions of split relief.

Community pattern on the territories without grazing is more definite than in the pasture but only in meadow patches of small size the food intake rate was 34% of maximum one (tabl. 1). All other patches were low suitable for foraging of the steppe marmot. On the contrary, grazing pressure of the third-fourth-fifth stage transforms a landscape of northeast Ukraine forming extensive areas for foraging of marmot. Marmots consume here young plants of the 1st preference group in abundance during the whole activity period. The change of burrow and foraging areas is not necessary. The green food intake rate by marmots in available patches was 32–47% of the maximum one (tabl. 1). Meadow patches possess the best foraging qualities (due to a high leguminous content) on the pastures with middle pressure whereas in those with high pressure steppe patches are best for foraging (due to a high percentage *Achillea submillefolium*, *Plantago media* and *Taraxacum officinale*). As was found in our experiments and those of other authors (Seredneva, 1978; Ronkin, Tokarsky, 1993) the daily ingestion of an adult cage-kept steppe marmot constitutes about 108 g in dry weight or 750 to 850 g of green food. With this consumption the animals lose weight. The cage-kept marmots gained weight only when fed with concentrated and mixed foods (Ronkin, Tokarsky, 1993). Calculations showed that the equivalent amount of green food is equal to 1350–1700 g. According to our data on the green food intake rate in natural environment the marmot must spend 3 to 6.5 hours on the pasture, at the same time it takes from 4.5 to 12 hours on territory without grazing to intake such food mass. That is why marmots prefer pastures rather than territories without grazing. The population density in those habitats is the highest one, as a rule, a family group has one permanent burrow.

Apparently, there is a direct connection between the population density of the steppe marmot and the patches size with suitable values for foraging. The investigations performed permit to conclude that the high percentage of dead plants together with species rejected and eaten in low quantities (for similar mass of forage plants) diminishes the accessibility to forage and worsens foraging conditions for marmots. Impoverishing the vegetation cover and providing during the whole activity season a high accessibility to young parts of forage plants for the steppe marmot, cattle grazing improves foraging resources for them and makes suitable for foraging practically the whole pasture cover. Probably this fact, among others, explains a high population density of the steppe marmot on pastures in north-eastern Ukraine. We hope that this conclusion will be not considered as the uselessness of conserving virgin steppe plots.

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