FAECES AS INDICATORS OF MOOSE ACTIVITY AND ROLE IN ECOSYSTEMS

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ABSTRACT: Faeces can serve as a significant index of spatial distribution of moose and provide estimates of moose population composition. Using faeces of moose to gather data for determining forage pressure and level of removal of plants, territorial distribution, population density, traces of activity, and other population indices can be regarded as a simple and reliable method for investigation of moose ecology.

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By consuming plants, excreting faeces and urine into the environment, maintaining metabolic processes of the body, and through diurnal and seasonal displacements, moose are involved in transfer of energy and metabolism of matter in forest ecosystems (Kusnetsov 1976). Faeces can serve as a significant index of spatial distribution (Yurgenson 1961, 1970), the amount of consumed production (Semenov-Tyan-Shansky 1948, Kuznetsov 1975), transfer of energy (Kuznetsov 1976), and other forms of moose involvement in ecosystems.

Estimation of ungulate faeces as a method for the evaluation of the numbers of moose and spatial distribution first originated in the USA as early as the 1950s, and in the USSR this method was first applied in 1957 by P.B.Yurgenson, who proposed an original variant based on the common principles of the MacQuane method adopting an almost constant number of defaecations per day in ungulates (Yurgenson 1970). Subsequently, faeces as an indicator were successfully used to determine the foraging pressure of moose and their winter distribution in various hunting grounds and habitats of European Russia (Pivovarova 1965, Ivanova 1967). Our studies in Valdai based on an annual estimate of moose faeces along a 3 km transect with constant sampling sites (300 m^2 every 50 metres), demonstrated varying pressure of moose on particular habitats. In fact, the amount of faeces, on average, on the sample site over the year reached 147 ± 46 pellets in the pine forest with cowberry, 85 ± 27 pellets in pine forest with green moss, 72 ± 11 in the pine forest with sphagnum, 60 ± 10 in spruce forest with herbs, 59 ± 9 in a mixed sphagnum forest, 49 ± 11 in a spruce forest with green moss, and 5 ± 1.5 in a mixed sphagnum forest (Fig. 1). Over the 20 years of observations (1970–1990), the greatest number of faeces in the pine forest with sphagnum was recorded > 7 times, in the pine forest with cowberry 5 times, in the pine forest with green moss 2 times, and in the spruce forest and other types of forest 1 time, which is indicative of different trophic and topical pressure of moose in these types of forest. Interestingly, in Valdai we recorded dissimilar rates of visitation by moose of particular habitats (Fig. 2); this is true of other regions as well (the Tula Region). Thus, depending on the amount of forage

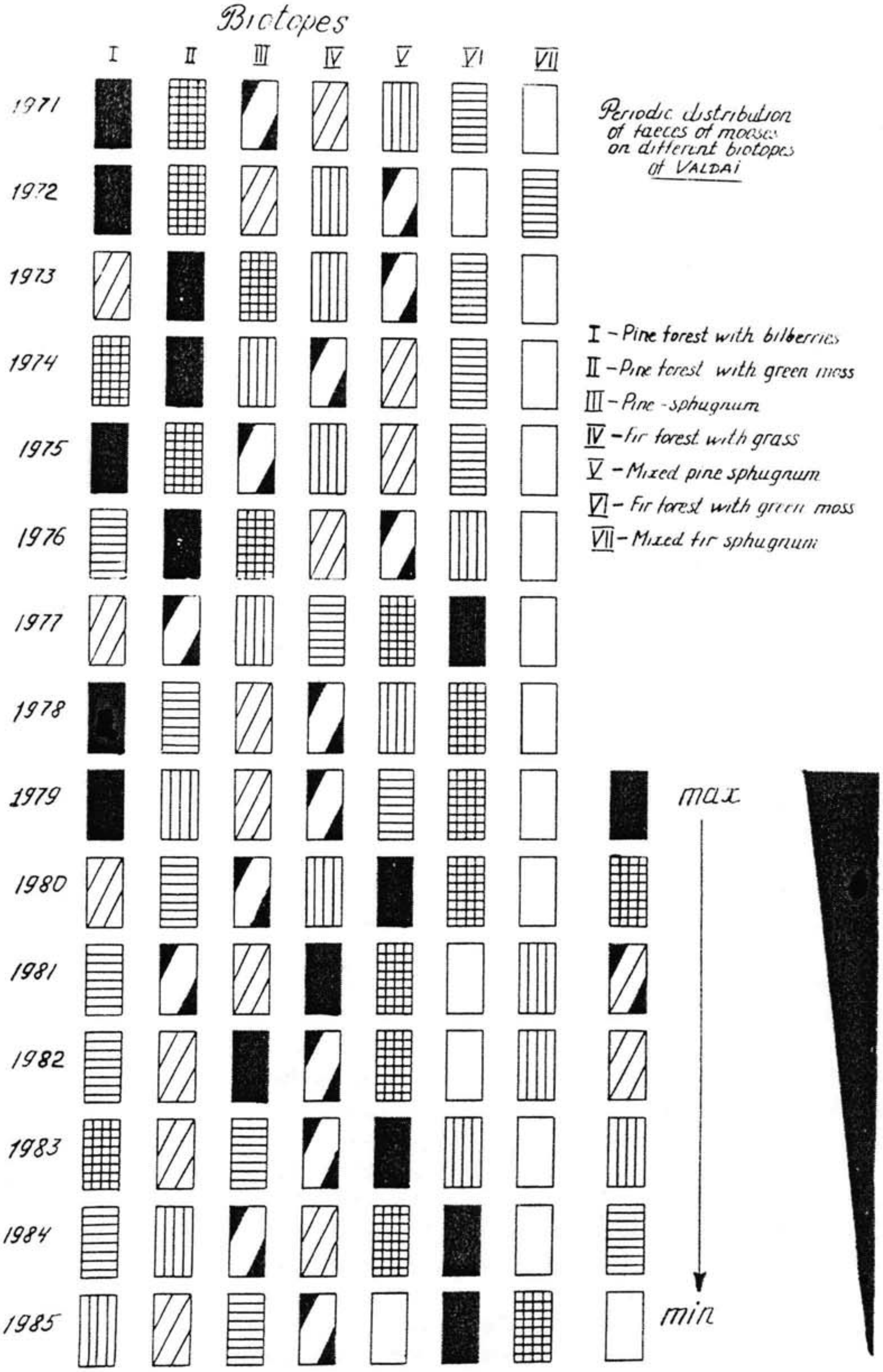

Fig. 1. The amount of moose faeces in different habitats of Valdai (data collected over a 15-year observation period, 1970–1985).

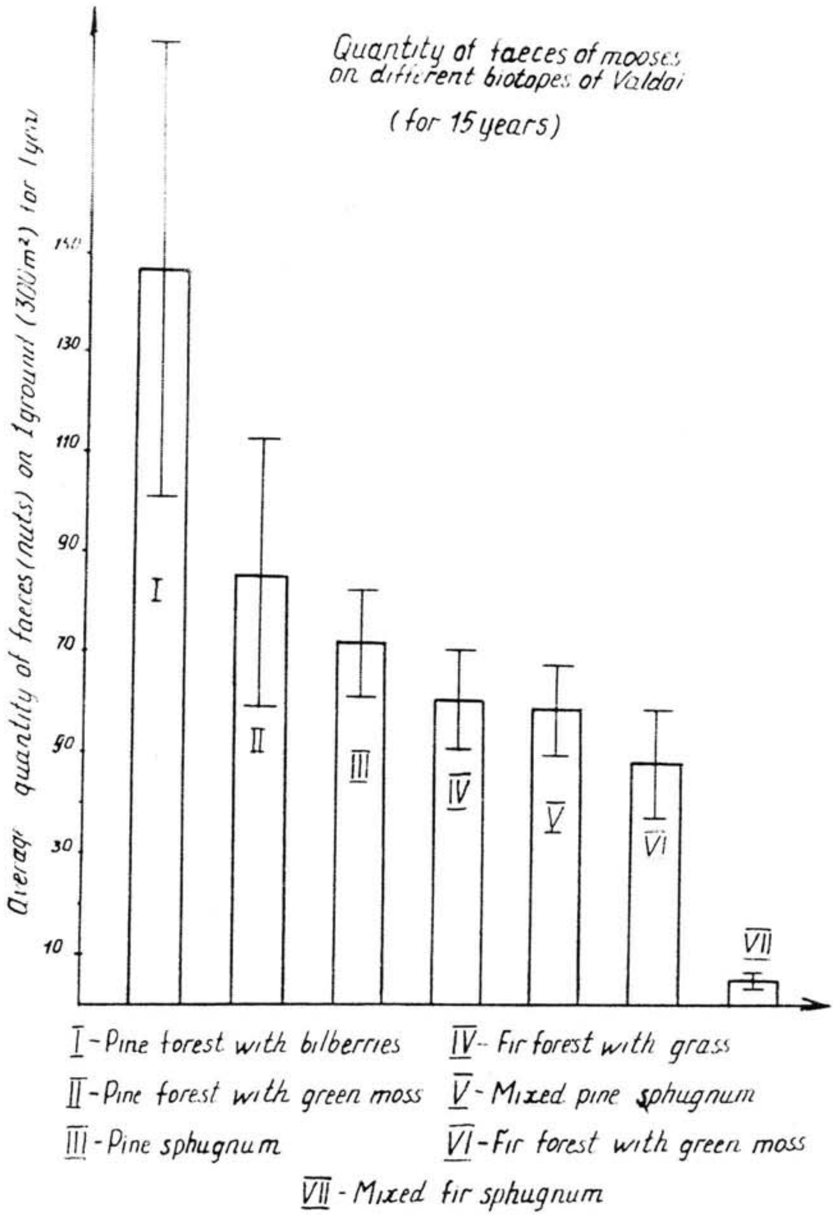

Fig 2. Rate of visitation by moose to different habitats of Valdai as determined from distribution of their faeces throughout habitats in different years.

and the protective functions of the habitat, moose seem to regulate their trophic pressure on particular habitats, and in this way they maintain optimal spatial distribution of their population.

The involvement of moose in transfer of energy is small. For instance, the energy released by moose with faeces in the habitats of Valdai accounts for 12–19 thousand kcal/ha/yr, which constitutes a fraction of the energy in young pine forests (12 million kcal/ha/yr) (Kuznetsov 1976). In other regions (Kaluga and Vladimir Regions) the amount of energy released through faeces by moose also attains the greatest values in pine plantations (91–130 thousand kcal/ha) and the least in old spruce forests (5–8 thousand kcal/ha) (estimated according to

Pivovarova 1965). Such data make it possible to estimate the involvement of moose in transfer of energy in different biocenoses. It is important to take into account the existence on the same ranges of the migrating and sedentary part of moose populations (Knorre 1959, Baskin 1984), which influences the complex biological nature of the role of moose in the ecosystems.

The method for determining the amount of plant mass consumed by moose according to their faeces was first applied by Semenov-Tyan-Shansky (1948). The use of this method in nature necessitates data on the amount of faeces (in dry weight) excreted by moose in a particular area, the period of time over which the moose defaecated, and the coefficient of forage digestibility. On the whole, it can be assumed that the mean annual coefficient of food digestibility in moose is close to 70%. It does not exceed 50–55% in winter and reaches up to 84% in summer (Ivanova and Simakov 1975; Kuznetsov 1975, 1976). Thus, on obtaining data on the amount of faeces excreted by moose (dry weight) over the year and in a definite area (the constant sample sites are preliminarily cleared of old faeces) and knowing the coefficient of forage digestibility, one can easily estimate the amount of forage consumed by moose over the year in a particular territory, using the formula for the digestibility coefficient (Kuznetsov 1975, 1976). Subsequently, Abaturov (1980, 1984) proposed estimating the amount of vegetation consumed according to dry weight of the accumulated faeces and coefficient of forage digestibility by the formula: $C = (F \times 100)/(100 - B)$; where, C = consumed phytomass (dry weight), F = dry weight of the faeces, and B = coefficient of digestibility of the phytomass of the animal species (%); i.e., a mathematically proposed form is deduced for the digestibility coefficient.

In this respect, the method of Milner (1967) is also of interest. Milner estimated the amount of forage consumed by animals from the ratio of the weight of faeces to the forage consumed as established in the laboratory. Subsequently, by estimating the amount of faeces left by animals over a certain period, one can determine the amount of the forage consumed: $C = F/(F/C)$ (Dinesman and Khodashova 1974).

In the field, the amount of forage consumed by moose was determined from their faeces in the population of the Byelorussian Lake Region (Dunin 1989) and Valdai (Kuznetsov 1975, 1976). This method makes it possible to objectively evaluate the removal of forage by moose in a definite territory without estimation of their population. Along with that, a number of authors (Zlotin and Khodashova 1974, Abaturov 1984) indicate that the accuracy of the results can be affected by the activity of microorganisms and coprophagic animals, and also the effect of the physical factors of the environment in particular geographical zones. For instance, in the subarctic, conditions for the rate of decomposition of moose faeces is low. The mass of faeces over 4 years declines by 53% (Malafeev and Kryazhimsky 1990). According to our data, under Valdai conditions, the mass of moose faeces decreases by 64% over 4 years, and by 89% over 6 years.

One can estimate the population density of moose according to the amount of faeces deposited by a moose population over a certain time in a particular territory (Yurgenson 1961, 1970; Kuznetsov 1976). Based on the fact that every adult moose over a year excretes 2 kg of faeces (dry weight) every day (this is in conformity with the data of Knorre and Knorre 1959), we conclude that the population density of moose in Valdai, the amount of faeces excreted by moose in this area over 1 year being 2.9 kg/ha, represents 1 individual per 252 ha; i.e., 4 individuals per 1,000 ha (Kuznetsov 1976).

This is consistent with census data on moose in the study area.

In the field one can determine sex and age of an animal by its faeces (Padaiga 1970). Some good results are provided by sexing moose from the distribution of urine on snow (Ustinov 1964). However, Rukovsky (1984) believes that moose sexing by the form of pellets is unreliable, although the establishment in the winter population of the ratio for adult animals to those of the same year is quite realistic. The latter is supported by our data as well. In fact, judging from the relationship between the size of the piles of faeces to the age of moose (Semenov-Tyan-Shansky 1948), we attempted to reveal the age structure of moose populations in different geographic regions (in Lithuania and in Valdai). The average size piles of faeces in the moose in Lithuania is 44.0 ± 3.26 pellets (n = 60) and in Valdai 95.3 ± 3.89 (n = 119) (Fig. 3); i.e., the population of moose in Lithuania is represented by younger individuals compared with those in Valdai, which is supported by harvest data in Lithuania (I. Tauginas 1982, personal communication) and land censuses in Valdai.

Thus, the use of faeces for determining the forage pressure and level of removal of plants, the territorial distribution, population density, traces of activity, and other population indices can be regarded as a simple and reliable method for investigation of moose ecology.

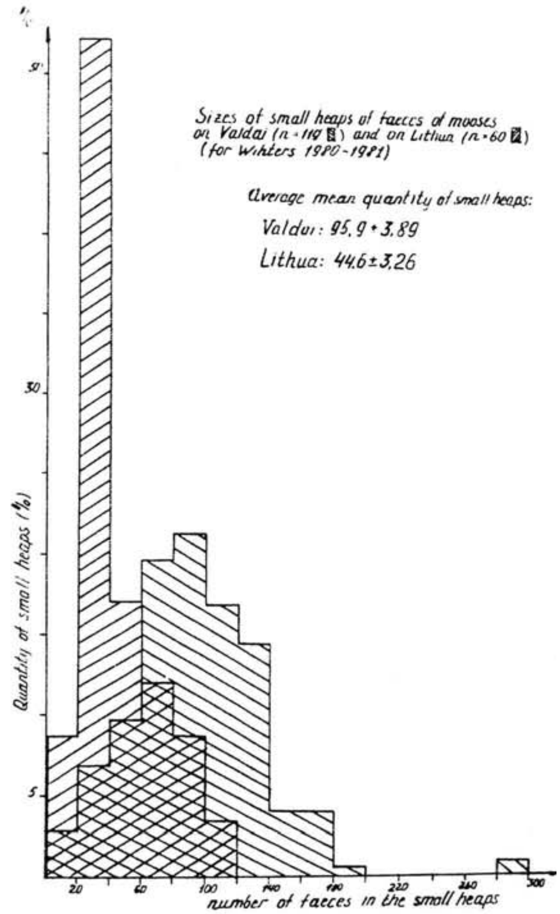

Fig. 3. The number of pellets in a pile of moose faeces in the Valdai and Lithuanian population.

REFERENCES

Abaturov, B. D. 1980. On determining the rate of food consumption and utilization of forage resources by herbivorous mammals. Zoologicheskyi Zhurnal 59:1726–1731. (In Russian).

_______. 1984. Mammals as a component of ecosystems as exemplified by herbivorous mammals in a semidesert. Nauka, Moscow, Russia. (In Russian).

Baskin, L. M. 1984. Moose. Pages 45–72 *in* V. E. Sokolov, editor. The wildlife of the Southern Taiga. Nauka, Moscow, Russia. (In Russian).

Dinesman, L. G., and K. S. Khodashova. 1974. Investigation of vertebrate animals as ecosystem components. Pages 132–145 *in* Programme and method of Biocenological Research. Nauka, Moscow, Russia. (In Russian).

Dunin, V. F. 1989. Daily rations and some features of feeding of moose in the winter. Soviet Journal of Ecology 20: 188-192.

Ivanova, G. I. 1967. Estimate of habitats for the moose during the winter season on the basis of the estimate of faeces.

Pages 281–287 *in* A. G. Bannikov, editor. Biology and harvest of moose. Rosselkhozizdat, Moscow, Russia. (In Russian).

_______, and A. F. Simakov. 1975. Protein metabolism. Pages 63–127 *in* Comparative physiological study of protein and mineral metabolism in ruminants under northern conditions. VINITI, Moscow, Russia. (In Russian).

Knorre, E. P. 1959. Ecology of moose. Proceedings of the Pechoro-Ilych State Reserve 7:5–22. (In Russian).

_______, and E. K. Knorre. 1959. Investigations of some physiological characteristics of moose. Proceedings of the Pechora–Ilych Reserve–Syktyvkar 7: 133–167. (In Russian).

Kuznetsov, G. V. 1975. Estimation of the consumption of plant production by moose from their faeces. Pages 176–177 *in* Ungulates of the USSR Fauna. Nauka, Moscow, Russia. (In Russian).

_______. 1976. The role of moose in energy transfer in forest biogeocenoses. Pages 140–147 *in* Soils and productivity of plant communities. Volume 3. MGU, Moscow, Russia. (In Russian).

Malafeev, Y. M., and F. V. Kryazhimsky. 1990. The rate of decomposition of moose faeces in the subarctic. Page 68 *in* Proceedings of the Third International Moose Symposium. Abstracts. Syktyvkar, Russia. (In Russian).

Milner, R. S. 1967. The estimation of energy flow through populations of large herbivorous mammals. Page 171 *in* Secondary productivity of terrestrial ecosystems. Warzawa-Krakow, Poland.

Padaiga, V. I. 1970. Methods for the regulation of deer population in an intensive forest economy. Kaunas, Lithuania. (In Russian).

Pivovarova, E. P. 1965. On winter distribution of moose in game management units of the Vladimir and Kaluga Regions. Pages 106–112 *in* A. G. Bannikov, editor. Biology and harvest of moose. Volume 2. Rosselkhozizdat, Moscow, Russia. (In Russian).

Rukovsky, N. N. 1984. A path-finder hunter. Fizkultura i Sport, Moscow, Russia. (In Russian).

Semenov-Tyan-Shansky, O. N. 1948. Moose on the Kola Peninsula. Proceedings of the Lapland State Reserve 2:91–162. (In Russian).

Ustinov, S. K. 1964. Some problems of the biology of the moose of the Barguzin Range. Pages 142–153 *in* A. G. Bannikov, editor. Biology and harvest of the moose. Rosselkhozizdat, Moscow, Russia. (In Russian).

Yurgenson, P. B. 1961. Census of moose and estimation of their winter activity in forests of the temperature zone by spring census of the number of defecations. Proceedings of the Priosko-Terrasny Reserve 3:48–71. (In Russian).

_______. 1970. Winter census of game mammals and birds by their faeces. Pages 287-288 *in* Proceedings of the 9th International Congress of Game Biologists. Moscow, Russia. (In Russian).

Zlotin, R. I., and K. S. Khodashova. 1974. The role of animals in biological turnover of forest-steppe ecosystems. Nauka, Moscow, Russia. (In Russian).