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IS SUPPLEMENTARY FEEDING ESSENTIAL FOR RED DEER (*CERVUS ELAPHUS*) IN HUNGARY?

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Summary: Practical deer management requires understandingthe relationship between the quantity and quality of the available food and resource use by deer in the habitat. Although red deer (*Cervus elaphus)* primarily forages on woody plant species from the shrub layer, supplementation by non-browse food is very common among game managers. Provision of extra food in addition to the natural supply has significant costs. Consequently, it is important to know how essential this feeding may be for populations of game like red deer. In our study area we determined the consumption by red deer of two feed types (maize silage and apple pomace which is the residue from pressing apples) commonly offered at feeding plots in Hungary during the winter. Additionally, we assessed the minimum distance for these feeders to have an attractive effect. We used microhistological analysis of faeces and rumen content and macroscopic observation of markers mixed into the food. Based on our analyses, 20 to 90% of the red deer (depending on the date and method of investigation) had eaten the supplemental food. However, the proportion of supplementary food in the red deer droppings collected in the immediate surroundings of the feeding plots was always very low (<10%). The detected range of effect of the feeding plots (the distance from which deer came to the feeder) was typically around 1.7 km, but no more than 3.2 km. All this indicates that only a part of the red deer population visits the feeding plots, and from short distances from the forest. Thus, our data strongly suggests that supplementary food did not necessarily play an important role in the diet of the red deer individuals regularly visiting these sites. Managers considering supplementary feeding should evaluate the quality of the forest area because the natural food supply can greatly influence the use of the feeding plots.
Key words: apple pomace, maize silage, diet composition, feeding plot

Introduction

Practical deer management requires understanding the relationship between the quantity and quality of the available food and resource use by deer in the habitat (Tremblay et al., 2004, Sahlsten et al., 2010). Although red deer *Cervus elaphus* is an intermediate feeder (Hofmann, 1989) which primarily forages on browse (Gebert & Verheyden-Tixier, 2001), supplementation by non-browse food is very common among game managers (Rajský et al., 2008). Supplementary winter feeding by readily-available crops (e.g. corn *Zea mays*, wheat *Triticum aestivum*, oat *Avena sativa*, rye *Secale cereale*) or cheap by-products is also a widespread practice in Central Europe (Csányi & Lehoczki, 2010) as well as in the U.S. (Brown & Cooper, 2006, Timmons et al., 2010).

According to the common opinion of Hungarian game managers (for some details see e.g. Heltay, 2000, Faragó, 2002), grasses, agricultural crops, crops grown in game fields, and supplementary winter feed are all considered important in the diet of red deer in Hungary. It is also a commonly-accepted idea among game managers and nature conservationists that winter feeding greatly contributes to local density increases (Sanchez-Prieto et al., 2004, Luccarini et al., 2006) and overabundance of large game (Putman & Staines, 2004, Geisser & Reyer, 2005, Gortázar et al., 2006).

For a manager, provision of extra food in addition to the natural supply has significant costs (Calenge et al., 2004). However, many supplemental feeding programs in Hungary and elsewhere proceed without such data collection. The supplemental feeding is often not adapted to the addressed management goal, the size of game populations or their requirements and is mainly the result of management habits which are not investigated for cost-efficiency (Page & Underwood, 2006, Biró et al., 2010, Csányi & Lehoczki, 2010).

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In this study our main aim was to determine the importance of supplementary feed in the diet of the red deer in two different areas. We investigated: a) the proportion of the supplementary food compared to that of natural ones in the red deer diet and b) the proportion of the individuals using the feeding plots and consuming supplementary feed.

Material and Methods

The research was carried out at Hajósszentgyörgy (46°24'N, 19°07'E) situated between the Danube and Tisza rivers. The site of 14600 ha is mainly a forested area located in two blocks around Hajósszentgyörgy. The forested areas grow on extremely dry sand dunes where no natural water courses are found. The forests in the surroundings of the town of Hajós were established in the second half of the 20th century in places less suitable for agricultural use. These are mainly black locust *Robinia pseudoacacia* and pine *Pinus sylvestris* and *P. nigra* woodlands. In addition, smaller stands of poplar *Populus* spp. plantations and oak *Quercus* spp. woodlands can be found. The estimated size of the red deer population within the area of the game management unit was 1100 in 2007 (according to the Hungarian National Game Management Database).

Two types of supplementary feed were provided during our study period, apple *Malus domestica* pomace and maize *Zea mays* silage. Apple pomace is the residue of apple juice production; it mainly contains apple peel, ovaries and seeds. Maize silage is made by grinding, compressing and fermenting harvested maize plants.

Supplementary feeding in the area was started in the middle of September 2007, when apple pomace was fed regularly at 17 sites (approx. one site per 200 ha). After the beginning of November, however, apple pomace was supplied at only two game fields (Kukulla and Lugozi, 5 km away from each other). Here, 4 tons (wet weight) were fed at both game fields, five times each (20 tons altogether) until the beginning of February 2008. At two game fields (Kismajor and Tinósi, 2.5 km away from each other) maize silage marked for research was fed. Between November 6, 2007 and January 31, 2008 at both game fields an average of 542 (±42 kg) kg of food was fed, eleven times each. Feed was always put down on the ground and available for all ungulates. At the game fields of Kismajor and Tinósi from January, 10 to 20 kg of rubber scrapings (a filler used at tennis courts using artificial grass) was mixed into the maize silage as marking material (for distinguishing from maize consumed beyond the feeding plots). Before application, rubber scrapings were tested in laboratory conditions and did not loose weight after having been soaked in concentrated hydrochloric acid for 24 hours at 40°C, which means it should not disappear during the extreme conditions of digestion.

On the investigation days (November 22, December 13 and 29, 2007 and January 14, February 12, 2008) we collected faeces samples in the vicinity (to a maximum distance of 100 m) of the feeding sites to determine the proportion of the supplemental food in the diet of individuals visiting that site. In addition to this, we collected faecal samples on the above mentioned days walking a 5 km long straight line transect between Kukulla and Lugozi recording the precise location of the samples by GPS. From these latter samples, based on the presence of supplementary food in them, we determined the distance animals came from to these feeding sites.

During hunting, professional hunters collected samples for us (200 to 300 g) in 40 known locations from red deer rumens from which we also determined the presence of natural (apple seed, only available at the feeding stations) and artificial (rubber) markers proving the consumption of supplemented apple pomace or maize silage, respectively. The length of the faeces sampling line from Kukulla to Lugozi game field (approx. 5 km) has determined the maximum detectable distance of attractive effect of feeders in about 2.5 km. Based on these rumen samples we could determine the range of effect of the game feeders more precisely. Hunters shot the deer individuals from stands within an approx. 5 km x 5 km area around the transect, but never in the close proximity of the feeding plots.

Our laboratory investigation approach was based on two different simultaneously used methods (macro- and microscopic analysis). We used the macroscopic method, a thorough laboratory analysis with a stereo microscope, for the detection of natural (apple seed) and artificial (rubber) markers. In this way we were able to determine the frequency of supplementary food consumption (samples with markers / all samples), but not the proportion of supplementary food in the individual samples (we could separate the categories „consumed to some extent” or „not consumed at all”, depending on the presence/absence of apple seed and rubber markers in the sample).

Before the macroscopic analysis, the collected and frozen deer faeces and rumen samples were defrosted and washed through a tea filter with 0.1 mm diameter pores until the effluent water was clean. Afterwards we spread the samples in Petri dishes and dried them for 24 hours at room temperature, then examined them by stereo microscope to detect the apple seeds and rubber pieces. We analyzed macroscopically 40 red deer rumen samples (n=40 for apple pomace, n=19 for maize with rubber scrapings), as well as 10 faeces samples collected at feeding plots and 53 faeces samples collected in the forest.

Simultaneously, we carried out microhistological analyses (Katona & Altbäcker 2002) using our own reference collection (Mátrai & Katona 2004). With this parallel technique we were able to determine both the frequency (explained previously) and the proportion of supplemented feed in the collected individual droppings and rumen contents. The method is based on the microscopic identification of the residues of undigested plant dermal tissues according to the diagnostic anatomical characters specific to different plant species with a binocular microscope. In Hajósszentgyörgy, only apple pomace but not maize was examined in the microscopic analysis as maize was cultivated in some game fields, consequently only the rubber marker was a useful indicator of consumption of supplied maize food. We microscopically analyzed 30 red deer faeces samples collected around the feeding plots, 20 collected in the forest, and 24 deer rumen contents.

Results and Discussion

In Table 1 we summarize the results from Hajósszentgyörgy. Based on the macroscopic analysis of faeces samples collected in the immediate surroundings (< 100 m) of the Tinósi feeding plot offering maize silage on February 12, 2008, the majority of samples did not contain the marker mixed into the maize silage (20%; n=10 contained rubber).

Microscopic analysis of faeces collected at the Lugozi feeding plot offering apple pomace, on November 22, December 13 and 29, 2007 revealed a greater consumption of supplementary food. There, the frequency of apple pomace consumption in the faeces reached 80 to 90 % ($n_{1,2,3}$=10). However, the proportion of apple pomace in the diet was low; it always stayed under 10 % (Paired t-test: t=95.59, df=29, p<0.0001).

Based on the macroscopic analysis of faeces samples collected along the 5 km long forest line connecting the apple pomace feeders of Lugozi and Kukulla on January 14 and February 12, 2008 the majority of samples did not contain apple pomace or the marker of maize silage (23%; n=53 contained rubber scrapings).

Nevertheless, according to the results of microscopic analysis, 70 % of deer faeces (n=20) collected along the above mentioned line on December 13 and 29, 2007 contained residues of apple pomace.

On the basis of the macroscopic analysis of red deer rumens 20% (n=40) of samples contained apple seed, which indicated the use of apple pomace feeders. However, no rubber scrapings were found in these samples (n=19).

During the microscopic analysis of deer rumens, apple pomace was found in 62.5% (n=24) of samples (64%; n=14 in November and 60%; n=10 in December).

In the vicinity of the feeding plot offering maize silage marked by rubber particles, faeces containing marker were found up to about 1.4 km from the feeding site. Both in January and February, we found marked red deer faeces farther than 1.2 km from the feeder.

Faeces containing apple peel were found at distances of about 2.4 km; while the farthest rumen samples in which apple residues were detectable either microscopically or macroscopically were shot at about 3.2 km far from the feeder. In most cases, however, this distance varied between 0.7 and 1.7 km. The proportion of supplementary feed in the diet did not change by the distance between the feeder and location of a given faecal or rumen sample, i.e. specimens sampled closer to the feeder did not eat more supplementary food (Pearson-correlation: faeces, microscopic analysis: n=20, r= -0,02, p=0,93; rumen, microscopic analysis: n=19, r= -0,095, p=0,7).

Table 1. Summary of the results in Hajósszentgyörgy. Proportion of faecal and rumen samples containing supplementary feed (frequency), proportion of supplementary feed in the diet and the detected range of effect of the feeding plots are detailed according to different investigations.

Date	Collection	Type of analysis	Feeder	Frequency (present/all); proportion (%) of feed intake	Most frequent range of effect (m)	Maximum detected range of effect (m)
Feb12, 2008	Around the feeder	macroscopic from faeces	Tinósi maize silage	2 / 10	--- ---	--- ---
Nov 22, 2007		microscopic from faeces	Lugozi apple pomace	9 / 10; always <10%	---	---
Dec 13, 2007				8 / 10; always <10%	---	---
Dec 29, 2007				9 / 10; always <10%	---	---
Jan 14 and Feb 12, 2008	In the forest	macroscopic from faeces	Tinósi, Kismajor, maize silage	12 / 53	600-1000	1400
Dec 13 and 29, 2007		microscopic from faeces	Lugozi, Kukulla, apple pomace	14 / 20; always <10%	900-1700	2400
2007-2008 autumn - winter	Hunting	macroscopic from rumen	Tinósi, Kismajor, maize silage	0 / 19	---	---
			Lugozi, Kukulla, apple pomace	8 / 40	700-1700	3200
		microscopic from rumen	Lugozi, Kukulla, apple pomace	15 / 24; always <10%	900-1700	3200

Our results indicate that red deer certainly use the feeding plots, as is also verified by the large amount of droppings found there. However, this does not automatically mean that the role of supplementary food would be significant in the diet. Sahlsten et al. (2010) also concluded in moose that the increased faecal pellet density in the vicinity of feeding sites reflected only the usage by a small portion of the population. They also found that many individuals just walked around the provided silage grass without feeding on it.

According to our results, the occurrence of supplementary food in the winter diet of the red deer, based on a large sample size of both rumen content and faeces analysis, is low. From 10 to 80% of the animals (depending on the date and method of investigation) had not eaten the supplementary food. Those specimens that had eaten from the food consumed only a small proportion (less than 10 % of their diet). This indicates that not every individual of the red deer population visits the feeders (regularly or occasionally), or if it does, it eats a very small or undetectable amount of the provided food. The maximum detected range of effect of a feeding plot was about 3.2 km, but usually did not exceed 1.7 km. Therefore, deer living within this range do have a major chance to use the feeder. Ribács et al. (2009) revealed very similar range of effect of feeding plots (maximum 4 km) in another Hungarian area.

It is important to note that we did not find any individual in which the supplementary food dominated the diet. Newey et al. (2009) found similar results for mountain hares *Lepus timidus*. They reported that over the course of one winter only 50% of the target hare population used supplementary feed and there was considerable individual variation in the time spent feeding among those individuals that did feed on it. Our analyses demonstrated that supplementary feed was not the primary diet component of red deer during winter. This is in agreement with a previous study at Hajósszentgyörgy (Mátrai et al. 2002), which reported that the role of the applied food and game field crops was negligible in the forest diet of the red deer, and only the consumption of alfalfa reached 20% in some cases. Thus, in spite of frequent observations of a rapid disappearance of the supplementary food from feeding plots, we should not conclude that this diet component would surely be important for red deer. Its importance in the diet could be rather low compared to the natural food sources (especially woody understory species). According to our biomass estimations carried out in the forests of Hajósszentgyörgy, the natural food supply of the forest understory can offer 2 to 3 tons of woody sprouts and twigs per hectare during the vegetation season and it is still above 500 kg per ha in winter (Katona et al. 2007). In theory, supplementary winter feeding could compete with this quantity but only at a huge expense. However, we suggest that supplemental feeding should provide food containing nutrients or compounds limited or lacking in natural foods in the area.

Our results suggest that supplementary feeding is unlikely to reach and strongly influence all individuals of a population of red deer. Nevertheless, this does not mean that for those specimens who regularly eat the supplied food, it cannot have positive physiological consequences (e.g. balancing the lack of quality food, better survival or better reproduction in the following year). Groot Bruinderink et al. (2000) stated that cessation of supplemental feeding resulted in problems in the mineral status of red deer and wild boar. Schmidt & Hoi (2002) reported that in their first year of life, supplemented red deer are under reduced natural selection pressure. Since measuring the local presence of these effects is not easy for the game manager, our results should be viewed with some caution perhaps. But it is essential to keep in mind that the observation that the supplied food regularly vanishes from the feeder does not necessarily mean that even one red deer has gained significant biological advantage which might be expressed as a later financial profit for the game manager. To put another way, the red deer population can have an obvious effect on supplementary feed; meanwhile that food may have little or no effect on deer individuals.

Conclusion

It is always recommended to think over the exact goal of supplementary feeding in a given area. Thus the feeding program should take into consideration the natural dietary preferences and diet choice of the red deer (Mátrai & Kabai, 1989, Gebert & Verheyden-Tixier, 2001; Szemethy et al., 2003a). In terms of the detected maximum range of effect (3.2 km) of the feeding plots it might be necessary to plan the spatial location of the feeders. Based on earlier (Szemethy et al., 2003b) and present results, there should be an appropriate game field or feeding site available in a distance adequate to the diameter of the daily activity range of each specimen (approx. 1 km in our area; see Türke et al., 2004), but maximum the diameter of the winter seasonal activity range (approx. 3.5 km, Szemethy et al., 2001). We propose that the largest distance between game fields and feeders should be about 3 km. Of course, by decreasing the distances we can give a chance to the specimens to choose and we can possibly reduce the concentration of animals at a game field or feeder.

And lastly, but in the practice first of all, it would be very important to evaluate the status of the entire forest area mainly based on the availability and quality of food supply in the understory layer. We have to emphasize that the use of feeding plots is only partly determined by the supplementary food itself, as the natural food supply offered to red deer by other patches of the habitat should be much more important.

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References

1. Biró, Zs., Bleier, N., Szemethy, L., 2010, A kiegészítő takarmányozás jelentősége a nagyvadgazdálkodásban. (In Hungarian with an English summary: The importance of supplementary feeding in big game management.), Vadbiológia, 14: 55-64.

2. Brown, R.D., Cooper, S.M., 2006, The nutritional, ecological, and ethical arguments against baiting and feeding white-tailed deer, Wildlife Society Bulletin, 34: 519-524.

3. Calenge, C., Maillard, D., Fournier, P., Fouque, C., 2004, Efficiency of spreading maize in the garrigues to reduce wild boar (*Sus scrofa*) damage to Mediterranean vineyards, European Journal of Wildlife Research, 50: 112-120.

4. Csányi, S. and Lehoczki, R.: Ungulates and their management in Hungary, in: European Ungulates and their Management in the 21st Century. 2010, Eds. M., Apollonio, R., Andersen, R., Putman, Cambridge University Press, Cambridge, pp. 291-318.
5. Faragó, S.: Vadászati állattan. 2002. Mezőgazda Kiadó, Budapest, 496 pp. (in Hungarian).

6. Gebert, C., Verheyden-Tixier, H., 2001, Variations of diet composition of red deer (*Cervus elaphus* L.) in Europe, Mammal Review, 31: 189-201.

7. Geisser, H., Reyer, H.U., 2005, The influence of food and temperature on population density of wild boar *Sus scrofa* in the Thurgau (Switzerland), Journal of Zoology, 267: 89-96.

8. Gortázar, C., Acevedo, P., Ruiz-Fons, F., Vicente, J., 2006, Disease risks and overabundance of game species, European Journal of Wildlife Research, 52: 81-87.

9. Groot Bruinderink, G.W.T.A., Lammertsma, D.R., Hazebrook, E., 2000, Effects of cessation of supplemental feeding on mineral status of red deer *Cervus elaphus* and wild boar *Sus scrofa* in the Netherlands, Acta Theriologica, 45: 71-85.

10. Heltay, I.: Vadásziskola. 2000. Hubertus Kft,, Budapest, 366 pp. (in Hungarian).

11. Hofmann, R.R., 1989, Evolutionary steps of ecophysiological adaptation and diversification of ruminants: a comparative view of their digestive system, Oecologia, 78: 443-457.

12. Katona, K., Altbäcker, V., 2002, Diet estimation by faeces analysis: sampling optimisation for the European hare, Folia Zoologica, 51: 11-15.

13. Katona, K., Szemethy, L., Nyeste, M., Fodor, Á., Székely, J., Bleier, N., Kovács, V., Olajos, T., Terhes, A., Demes, T., 2007, A hazai erdők cserjeszintjének szerepe a nagyvad-erdő kapcsolatok alakulásában. (In Hungarian with an English summary: The role of understory in the ungulate-forest relationship.), Természetvédelmi Közlemények, 13: 119-126.

14. Luccarini, S., Mauri, L., Ciuti, S., Lamberti, P., Apollonio, M., 2006, Red deer (*Cervus elaphus*) spatial use in the Italian Alps: home range patterns, seasonal migrations, and effects of snow and winter feeding, Ethology Ecology & Evolution, 18: 127-145.
15. Mátrai, K., Kabai, P., 1989, Winter plant selection by red and roe deer in a forest habitat in Hungary, Acta Theriologica, 34: 227-234.

16. Mátrai, K., Katona, K., Szemethy, L., Orosz, Sz., 2002, A szarvas táplálékának mennyiségi és minőségi jellemzői a vegetációs időszak alatt egy alföldi erdőben. (In Hungarian with an English summary: Quantitative and qualitative characteristics of red deer diet during vegetation period in a lowland forest, Hungary.), Vadbiológia, 9: 1-10.

17. Mátrai, K., Katona, K., 2004, Mikroszövettani határozókulcs növényevők táplálékvizsgálatához / Digital key for microhistological analysis of herbivore diet, Hungarian – English bilingual CD content, ISBN 963 219 865 4.

18. Newey, S., Allison, P., Thirgood, S.J., Smith, A.A., Graham, I.M., 2009, Using PIT-tag technology to target supplementary feeding studies, Wildlife Biology, 15: 405-411.

19. Page, B.D., Underwood, H.B., 2006, Comparing protein and energy status of winter-fed white-tailed deer, Wildlife Society Bulletin, 34, 3: 716-724.

20. Putman, R.J., Staines, B.W., 2004, Supplementary winter feeding of wild red deer *Cervus elaphu*s in Europe and North America: justifications, feeding practice and effectiveness, Mammal Review, 34, 4: 285-306.

21. Rajský, M., Vodňanský, M., Hell, P., Slamečka, J., Kropil, R., Rajský, D., 2008, Influence supplementary feeding on bark browsing by red deer (*Cervus elaphus*) under experimental conditions, European Journal of Wildlife Research, 54: 701-708.

22. Ribács, A., Náhlik, A., Tari, T., Kocsis, M., 2009, A gímszarvas (*Cervus elaphus*) mesterséges etetőhely-használatának vizsgálata a Sopron-Fertődi kistérségben. (In Hungarian with an English summary: Use of artificial feeding places by the red deer (*Cervus elaphus*) in the Sopron-Fertőd region (Győr-Moson-Sopron County, Hungary.), Állattenyésztés és Takarmányozás, 58, 6: 585-595.

23. Sahlsten, J., Bunnefeld, N., Månsson, J., Ericsson, G., Bergström, R., Dettki, H., 2010, Can supplementary feeding be used to redistribute moose *Alces alces*?, Wildlife Biology, 16: 85-92.

24. Sanchez-Prieto, C.B., Carranza, J., Pulido, F.J., 2004, Reproductive behavior in female Iberian red deer: Effects of aggregation and dispersion of food, Journal of Mammalogy, 85: 761-767.

25. Schmidt, K.T., Hoi, H., 2002, Supplemental feeding reduces natural selection in juvenile red deer, Ecography, 25: 265-272.

26. Szemethy, L., Biró, Zs., Katona, K., Tóth, P., 2001, Szezonális területváltás a gímszarvasnál: területhasználati stratégiák összehasonlítása. (In Hungarian with an English summary: Seasonal home range shift in red deer: comparison of different strategies.), Vadbiológia, 8: 1-8.

27. Szemethy, L., Mátrai, K., Katona, K., Orosz, Sz., 2003a, Seasonal home range shift of red deer hinds *Cervus elaphus*: are there feeding reasons?, Folia Zoologica, 52: 249-258.

28. Szemethy, L., Mátrai, K., Biró, Zs., Katona, K., 2003b, Seasonal home range shift of red deer in a forest-agriculture area in southern Hungary, Acta Theriologica, 48: 547-556.

29. Timmons, G.R., Hewitt, D.G., DeYoung, C.A., Fulbright, T.E., Draeger, D.A., 2010, Does supplemental feed increase selective foraging in a browsing ungulate?, Journal of Wildlife Management, 74: 995-1002.

30. Tremblay, J.-P., Hester, A., McLeod, J., Huot, J., 2004, Choice and development of decision support tools for the sustainable management of deer-forest systems, Forest Ecology and Management, 191: 1-16.

31. Türke, I.J., Katona, K., Bleier, N., Szemethy, L., 2004, Gímszarvas napi mozgáskörzetének vizsgálata két különböző élőhelyen. (In Hungarian with an English summary: Daily home range of female red deer in two different areas.), Vadbiológia, 11: 1-10.