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SHORT COMMUNICATION

Alpine Mountain Hare *Lepus timidus varronis* Defecation Rate: A First Step Toward Faecal Pellet Count Monitoring

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Abstract
Lepus timidus varronis, is the alpine sub-species of *Lepus timidus* and an endemic glacial relict of the Alps. Despite the great conservational and biological relevance of the species, the number of studies concerning it's biology and ecology are limited. An essential parameter for species management is to correctly estimate population density. To date there are no standardized nor validated survey techniques for surveying *L. t. varronis*. The faecal pellet count is considered a suitable census method but its use is limited due to the absence of data concerning the daily mean defecation rate of the species. The aim of this work is therefore to estimate the daily mean defecation rate of *L. t. varronis* in a controlled environment in order to allow the implementation of subsequent studies on population density and dynamics. A mean defecation rate of 411.7 ± 41.3 pellets/day per hare was estimated on the 14 breeding Alpine hares that were included in the study.

Introduction

The first step toward the conservation of a species, is to know its population density and demographic trend [1]. When cryptic species have to be monitored indirect estimate methods are the best choice [2]. Among these, the faecal pellet count (FPC) is a highly feasible census method that estimates density on the basis of the number of faecal pellets present in a sample area [3]. FPC has been used to estimate population density of mountain hare *Lepus timidus*, but also to monitor population trends and to compare different presence areas [4].

This method seems to be particularly appropriate for mountain hare *Lepus timidus* (Linnaeus 1758) in the Alps, where a suitable monitoring method has not yet been standardized. The *L. timidus* population is present in the Alps as an endemic sub–species (*L. t. varronis*; Miller 1901) [5].

L. t. varronis is a species of great biological value because of its endemic distribution within the high-altitude Alpine environment and its importance in the local trophic

chain [6]. To the best of our knowledge, only few scientific studies attempted to investigate the biology of this species [5-8]. Further effort is needed to improve management and conservation plans of *L. t. varronis* especially because in some areas of the Italian Alps its population seems to be declining [6]. Despite, this potential decreasing trend, presently this species is classified as a game species.

Scandinavian and Scottish authors used different methods for estimation of abundance of other *L. timidus* subspecies such as capture – mark – recapture [9], direct counts [10], snow tracks [11] and game bags [12] but a suitable monitoring method for *L. t. varronis* has not yet been standardized.

In order to correctly use FPC, it is a prerequisite to know i) decay rate and ii) defecation rate [13] of the studied species. Data about decay rate are available for closely related species such as *L. americanus*. The reliability of such data is limited since decay rate is highly influenced by local conditions (weather, land use, etc).

FPC implemented with Bennet's formula or with the more recent distance sampling approach has been successfully used to estimate density from pellets density [14, 15]. Clearing the sample area of all faeces before starting the survey allows to bypass the use of decay rate (Clearance count – [13]).

Nevertheless no data about *L. t. varronis* defecation rate is available; and the only existing datum (250 pellet/day – [16]) refers to *L. timidus scoticus* (sub-species phenotipically different from *L. t. varronis*). The lack of such information makes impossible the estimation of *L. t. varronis* density through FPC method.

The aim of this work is to determine the *L. t. varronis* daily defecation rate, in order to obtain an instrument to monitor mountain hare population, based on the FPC method.

Methods

The study was carried out in the Asiago plateau (45° 52' 34'' N, 11° 30' 32'' E; Vicenza's province, Northeastern Italy), at 1,000 m a.s.l., where breeding captive mountain hares (eight females and six males) were maintained in grilled metallic cages (Table 1). The animals were not maintained in captivity for this study, but they were detained as ornamental animals in accordance with the Italian Law (National Law no. 157/92). During the essays there was no need to manipulate the animals, because pellets were collected outside the grilled cage.

Animals were fed *ad libitum* with a variety of hayed Alpine meadow grasses, common laburnum *Laburnum anagyroides* branches and rabbits industrial fodder (proteins 16%, lipids 3%, fiber 17.5%, ashes 10%); water was administered *ad libitum*. Moreover, in order to recreate natural conditions, no food was given the first day after a snowfall.

On April 2008 faeces were collected removing the litter from the cages at 24 hour intervals; the number of pellets was counted. Each cage was controlled during three consecutive days. Data were processed and statistically analysed to establish the mean defecation rate value.

The essays were not made with isolated animals, in order to avoid stress factors, associated with the separation of breeders already used to be together in the same

cage. There was also no usefulness in the estimation of defecation rates between sexes, because in field trials using faecal pellet counts, it is not possible to separate scats according to the sex,

A non-parametric Mann-Whitney test was used to compare defecation rate values with regard to a different food intake.

Results

The number of pellets collected is reported in table 1. Daily defecation mean rate was 372.5 ± 69.6 SD pellets/day with a coefficient of variation of 18.7%.

Table 1: Number of hares/cage and number of collected pellets for each day: in "Day 1" animals were not fed (fast day implication on defecation rate are observed in "Day 2").

Group	N° hares	Day 1 (mean)	Day 2 (mean)	Day 3 (mean)
A	4	1916 (479)	1047 (261.7)	1712 (428)
B	2	789 (394.5)	520 (260)	800 (400)
C	3	1298 (432.6)	988 (329.3)	1007 (335.6)
D	5	1918 (396.2)	1627 (325.2)	2137 (427.4)

As for food consumption, the first collection day was characterized by a heavy snowfall. During snowfalls, the animals significantly reduce food consumption so we considered separately the daily defecation rate of "normal" and "snow" days. The mean defecation rate value for snow days was 294.1 ± 38.4 SD, and it was statistically different from the samples recorded during the "normal feeding days" (411.7 ± 41.3 SD; $W = 32$; $p < 0.01$) implying that a day without access to food can reduce the defecation rate by 28.6%.

On the basis of these observations and in order to obtain a standardized daily defecation rate, we decided to exclude the snow day defecation rate.

The standardized mean defecation rate (SMDR) was 411.7 ± 41.3 SD, ranging between 336 and 479 pellets/day, with higher frequency values between 380 and 440 pellets/day. The coefficient of variation was 10%.

Discussion

This is the first report concerning *L. t. varronis* daily defecation rate. Despite the fact that these essays were done with captive animals and so in environmental conditions that differ from the natural ones, this datum is very important for species management as it will allow a more accurate monitoring of *L. t. varronis* population status and trend using faecal pellet count (FPC) methodologies.

The actual lack of reference data is explained by difficulties in finding *L. t. varronis* in controlled environment, when compared to other species such as cervids [13]. In fact, breeding individuals are the only ones available for which it is possible to record defecation rates under constant monitoring and full pellet's detection [2, 16].

The mean defecation rate estimated in our study (411.7 ± 41.3 SD pellets/day) is higher (about 39%) than the one reported for *L. t. scoticus* (250 pellets/day – [16]) but very similar to the one of *L. europaeus* (430 pellets/day – [16]). This result shows that the application of Flux's *L. t. scoticus* defecation rate to *L. t. varronis*, will consequently produce a large overestimation of the population.

Population density estimation can be affected by several environmental variables that influence the defecation rate; among these factors we can consider the higher or lower food consumption and the sex and age of the population [17].

Our work highlights that during one "snow" day, when hares generally stay under cover [18], lead to a defecation rate reduction of 28.6%. As previously reported, a statistically significant difference between defecation rate in "snow" and normal days was obtained, resulting in the exclusion of "snow" day samples from the calculation of SMDR value. This allowed to increase the precision of our data and to reduce the coefficient of variation.

The composition of the diet (above all its fiber content) is another factor that could influence the defecation rate [17], especially for captive herbivore species. Even if it could be a source of bias, at the same time it is a common problem in all defecation rate studies because the study of this parameter is only possible with captive individuals [2, 16].

The value of SMRD obtained in our study was similar to a personal observation made in another study area (Introd's Parc Animalier 45° 41' 34'' N, 7° 10' 55'' E in Aosta's Valley, 869 m a.s.l). In this breeding site, only one male and one female *L. t. varronis* were present and the observed defecation rate value was 403.71 ± 65.92 SD in "normal feeding days" and 272.29 ± 69.39 SD in "snow" days (unpublished data).

We therefore believe that the adoption of our results to FPC can contribute to establish the basis for starting an appropriate system of *L. t. varronis* management-monitoring.

F urther studies are needed to improve the evaluation of the defecation rate specially in what concerns the need to increase the number of sampled animals and extent of the sampling period.

In the same way it will be necessary to evaluate the faecal decay rate with the use of decay station in different environmental and climatic condition.

References

Five "key references", selected by the authors, are marked below (Three recommended (●) and two highly recommended (●●) papers).

1. Sutherland, W. J. (1996). Ecological census techniques, a handbook. Cambridge University Press, 336 pp.
2. Dinerstein, E., Dublin, H. T. (1982). Daily defecation rate of captive Axis Deer. Journal of Wildlife Management, 46(3): 833-835. http://dx.doi.org/10.2307/3808586
3. ●● Newey, S., Bell, M., Enthoven, S., Thirgood, S. (2003). Can distance sampling and dung plots be used to assess the density of mountain hares *Lepus timidus*?. Wildlife Biology, 9(3): 185-192.
4. Preatoni, D. G., Tattoni, C., Bisi, F., Masseroni, E., D'Acunto, D., Lunardi, S., Grimod, I.,

Martinoli, A., Tosi, G. (2012). Open Source evaluation of kilometric indexes of abundance. Ecological Informatics, 7(1): 35-40.
http://dx.doi.org/10.1016/j.ecoinf.2011.07.002

5. Couturier, M. A. J. (1964). Le gibier des montagnes françaises. [French mountains game]. Grenoble (Isère): Arthaud, 463 pp.

6. Bisi, F., Nodari, M., Dos Santos Oliveira, N. M., Ossi, F., Masseroni, E., Preatoni, D. G., Wauters, L. A., Martinoli, A. (2011). Space use patterns of mountain hare (*Lepus timidus*) on the Alps. European Journal of Wildlife Research, 57(2): 305-312.
http://dx.doi.org/10.1007/s10344-010-0429-2

7. ●● Bisi F., Nodari, M., Dos Santos Oliveira, N. M., Ossi, F., Masseroni, E., Preatoni, D. G., Wauters, L. A., Martinoli, A. (2013). Habitat selection and activity patterns in Alpine mountain hare (*Lepus timidus varronis*). Mammalian Biology. Vol. 78: 28-33.
http://dx.doi.org/10.1016/j.mambio.2012.05.004

8. Bouche, M. (1989). Le lièvre variable dans le massif des Écrins. [The mouintain hare in Écrins massif]. Documents scientifiques du Parc National des Écrins, 111 pp.

9. Hewson, R. (1965). Population change in mountain hare *Lepus timidus scoticus*. Journal of Animal Ecology, 34: 587-600.
http://dx.doi.org/10.2307/2452

10. Hakkinen I., Jokinen, M. (1981). Population dynamics of the mountain hare on an island in the Outer Archipelago. Proc. 1st Lagomorphs World Conf. Guelph Ontario, 469-477.

11. Kauhala, K., Helle, P., Helle, E., Korhonen, J. (1999). Impact of predator removal on predator and mountain hare populations in Finland. Annales Zoologici Fennici 36: 139–148.

12. Stoddart, D. M. (1984). Mountain hare *Lepus timidus* – bags and moor management. Journal Zoology London, 204: 563-590.
http://dx.doi.org/10.1111/j.1469-7998.1984.tb02388.x

13. ● Mayle, B. A., Peace, A. J., Gill, R. M. A. (1999). How many deer? A field guide to estimating deer population size. Forestry Commission, Edinburgh, 96 pp.

14. ● Bennet, L. J., English P. F., McCaine, R. (1940). Study of deer population by use of pellet group count. Journal of Wildlife Management, 4: 398-403.
http://dx.doi.org/10.2307/3796010

15. Thomas, L., Buckland, S. T., Rexstad, E. A., Laake, J. L., Strindberg, S., Hedley, S. L., Burnham, K. P. (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology, 47(1): 5-14.
http://dx.doi.org/10.1111/j.1365-2664.2009.01737.x

16. ● Flux, J. E. C. (1970). The life history of mountain hare (*Lepus timidus scoticus*) in north-east Scotland. Journal of Zoology, 161: 75-123.
http://dx.doi.org/10.1111/j.1469-7998.1970.tb02171.x

17. Neff, D. J. (1968). The pellet group count technique for big game trend, census and distribution: a review. Journal of Wildlife Management, 32(3): 597-614.
http://dx.doi.org/10.2307/3798941

18. Hewson, R., Hinge, M. D. C. (1990). Characteristics of the Home Range of Mountain Hares *Lepus timidus*. Journal of Applied Ecology, Vol. 27, No. 2 (Aug., 1990), 651-666.
http://dx.doi.org/10.2307/2404309