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Spring density and daytime distribution of the European hare in relation to habitat in an open field agrosystem

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Abstract

Studied the spring abundance and the daytime distribution of hares in a simplified agrosystem. The assessments were made by using a global census method on an area covering 6.5 km^2, during the 1975–78 period; and the preference value for resting places was tested by using the Jacob's index. The hare density varied from year to year, between 22.6 and 34.9 animals per square kilometer. The distribution of resting places differs significantly from a random distribution, with preference for the ploughed and winter-wheat fields to the harrowed fields and pastures. Because of modifications in safety conditions and attraction of woods during the day, all fields very close to a forest were underselected.

Introduction

Pielowski (1966), Jezierski (1968, 1972, 1973), Bresinski (1976) and Bresinski and Chlewski (1976) pointed out that differences in spring density and spatial distribution of the European hare (*Lepus europaeus* Pallas) are correlated with ecological conditions. All these studies used strip censuses, referred to as "belt assessment" by Pielowski (1969). Limiting in that, this census method can not register possible variations in local density or in daytime resting place habitat selection on a small scale. The aim of the present study is to test this possibility on an experimental area covering 6.5 km^2 located in a simplified agrosystem near Soissons (Bassin-Parisien – France) using a global census technique.

Material and methods

Study area

The study was carried out in a region of flat open fields, with a very limited variation in agricultural production systems. Soils were of silt (two thirds of the area) and of clay (one third). Three contiguous farming areas were considered: (A) Vaubéron Nord (199 ha); (B) Vaubéron Sud (224 ha) and (C) Le Murger (227 ha). The last two areas are bordered by the Retz forest (Fig. 1).

With the exception of the small permanent pastures (2.9 % of the total area), all the other fields

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range from 3.5 to 40.8 ha. The mean area is about 20 ha for the Vaubéron Nord area and 15.5 ha for the Vaubéron Sud and Le Murger areas.

During the 1975–78 period, a slow but progressive increase of winter-wheat crops occured: during

Distribution of crops and of hares in spring in the 3 farming areas during 1975–78

I = winter-wheat crops; II = ploughed fields; III: harrowed fields. No hares in any year were observed in pastures (19 ha), so this kind of field is not included in the table

Year	Field habitats	Vaubéron Nord (A)		Vaubéron Sud (B)		Le Murger (C)	
		Area (ha)	Hare counts (n)	Area (ha)	Hare counts (n)	Area (ha)	Hare counts (n)
1975	I	85	24	50	18	108	24
	II	114	45	156	46	100	22
	III	/	/	18	1	/	/
1976	I	92	50	99	26	64	17
	II	22	15	66	11	31	17
	III	85	6	59	1	113	4
1977	I	96	47	121	41	62	43
	II	74	49	77	30	41	11
	III	29	1	26	0	105	5
1978	I	91	31	97	24	96	45
	II	87	41	127	28	112	38
	III	21	2	/	/	/	/

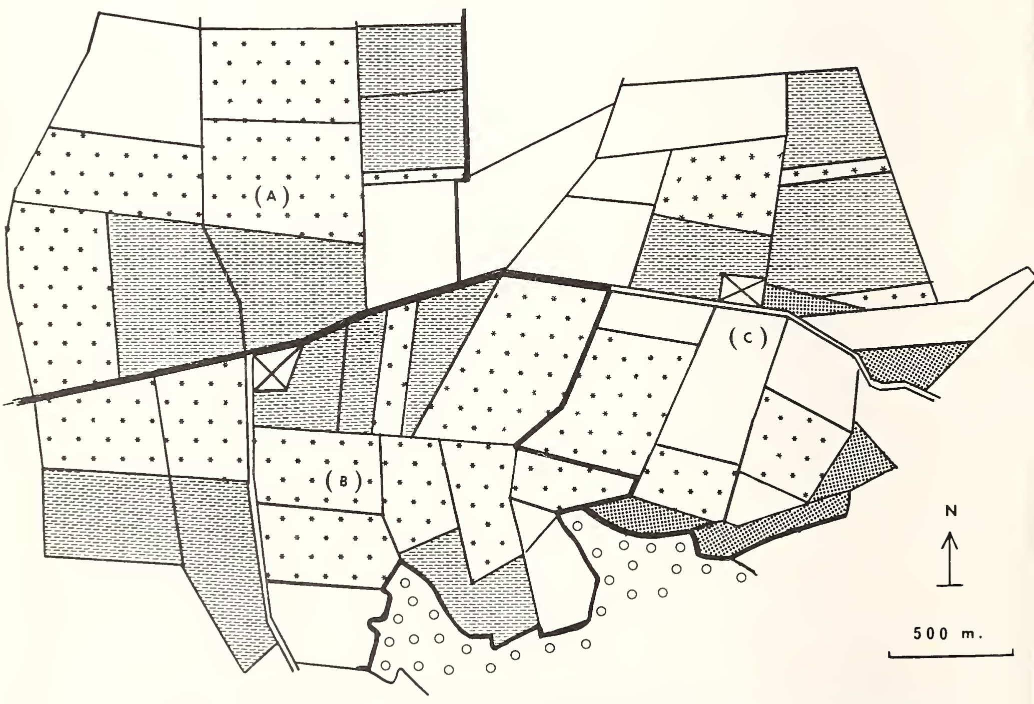

Fig. 1. Distribution of fields in the study area for the spring 1977. (A) = Vaubéron Nord area; (B) = Vaubéron Sud area; (C) Le Murger area. [*] winter-wheat crops; [ploughed symbol] ploughed fields; [ ] harrowed fields; [pasture symbol] pastures; [O O] Retz forest

the first year, it represented 243 ha (37.4 % of the total area) while 284 ha (43.8 %) three years later (Table). Other fields were ploughed or harrowed fields which largely change in proportion from one year to another (Table).

Field observations

Each spring in the 1975–78 period, a global census of the hares was conducted on the totality of the experimental area. This method, described in details by PÉPIN (1974), consists of counts through the area. Beating took place between 09.00 and 17.00 hours, when animals are almost static in their resting place. The beaters, spread out along a line, flushed all animals in front of and between them. To avoid double counts, they drove the hares in the direction of an already counted area or outside the census area. The paths and the new resting places of animals that did not run in the intended direction were mapped. The detail of the drive varied with topography, field size, crop, direction and velocity of the wind. In the large beats, stationary observers placed around the beat area counted animals that went out while the beaters were getting into place. The mean distance between the beaters was about 20 m for ploughed and winter-wheat fields and 50 m for harrowed fields.

From 1975 to 1977, the hare counts were taken over 3 days (in the period 4–9 April) with an average of 6 beaters. In 1978, there were a total of 18 beaters and stationary observers, and the counts were taken on 30–31 March.

Estimation of habitat selection for daytime resting place

The observed daytime resting place distribution of hares every year can be compared to a theoretical random distribution over the total area under study by using the chi square test.

Using the index of JACOBS (1974), the preference value of hares for habitat i is:

$$Pi = \frac{\frac{Hi}{Ht} - \frac{Ai}{At}}{\frac{Hi}{Ht} + \frac{Ai}{At}}$$

where, Hi is the number of hares sighted in habitat i, Ht is the total number of hares sighted, Ai is the area of habitat i, and At is the total area under study. Values of P from 0 to 1 indicate positive selection, and values from 0 to −1 indicate negative selection. This index is used to compare habitat selection between different areas and between different years. The statistical analyses follow SIEGEL (1956) and SNEDECOR and COCHRAN (1980).

Results

Mean hare density

During the study period, the total number of hares counted varied annually from 147 to 227 animals (Table). A decrease of 33 (18.3 %) hares between 1975–76 is followed by an increase of 80 (54.4 %) from 1976 to 1977. The corresponding range of mean hare density for the total area is 22.6 to 34.9 hares per square kilometer.

During the 4 spring seasons, no hares were observed in the pastures, and low density was found in harrowed fields. On the other hand, each year, similar high mean hare density was observed in winter-wheat and ploughed fields (Fig. 2). Nevertheless, in both kinds of fields, the mean hare density varied from year to year: the extreme values occured in 1975 (27 hares km^{-2}) and in 1977 (47 hares km^{-2}) while the values for 1976 and 1978 were intermediate and similar (Fig. 2).

Daytime resting place distribution

Each spring, the daytime resting place distribution of hares differed significantly from a random distribution. The difference was more significant in 1976 and in 1977 ($\chi^2 = 72.7$ and 71.4; $\underline{P} < 0.001$) than in 1975 and 1978 ($\chi^2 = 9.2$ and 10.5; $\underline{P} < 0.05$), due perhaps to the smaller proportion of harrowed fields during these two last years (Table).

Considering the complete study period, the relative area of winter-wheat crops was practically identical in each farming area but the relative number of hares does not follow

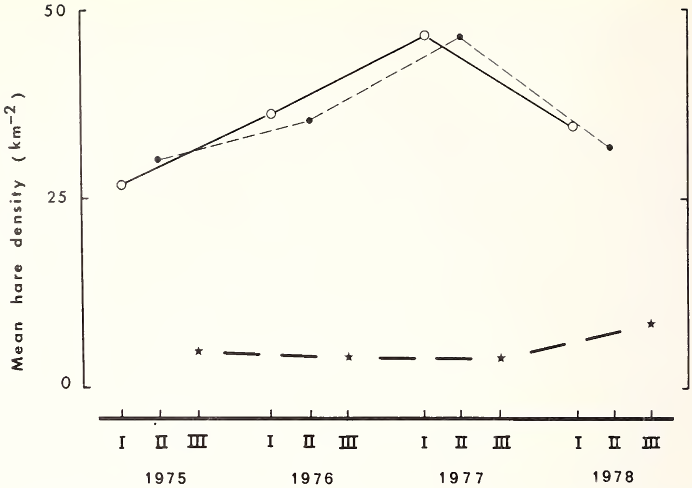

Fig. 2. Mean density of hares counted in spring in each type of fields in the whole area during 1975–78. I = ○ = winter-wheat crops; II = ● = ploughed fields; III = ★ = harrowed fields

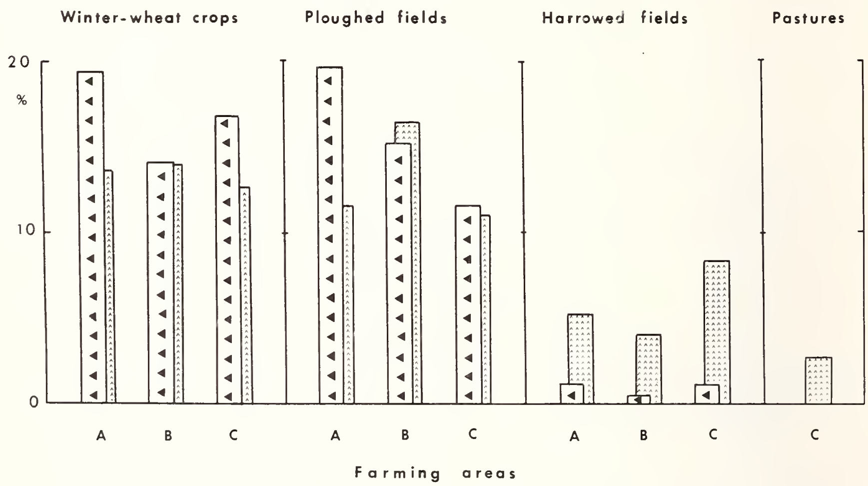

Fig. 3. Percentage distribution of hares in various habitats during spring in the whole area during 1975–78. Observations of different years concerning the same habitat and the same farming area (A, B or C) are pooled. The distribution of habitats in each farming area is given as a percentage of the total sampling area. [◄] = Hares; [^^^] = Habitats; A = Vaubéron Nord area; B = Vaubéron Sud area; C = Le Murger area

the same trend (Fig. 3). Even so, more hares were found in ploughed fields in the Vaubéron Nord area than in the Vaubéron Sud area although this kind of crop was less represented in the first farming area (Fig. 3). Consequently, it seems that the distribution of hares in a given type of field may change with its geographical location or perhaps with the spring annual density of animals.

In order to test these hypotheses for each year, datum from each farming area was considered separately and the Jacobs (1974)-index was used. Two preference values categories appear to be unambiguous (Fig. 4). The first category, of positive or near zero values, corresponds to the winter-wheat and ploughed fields and the second category, of

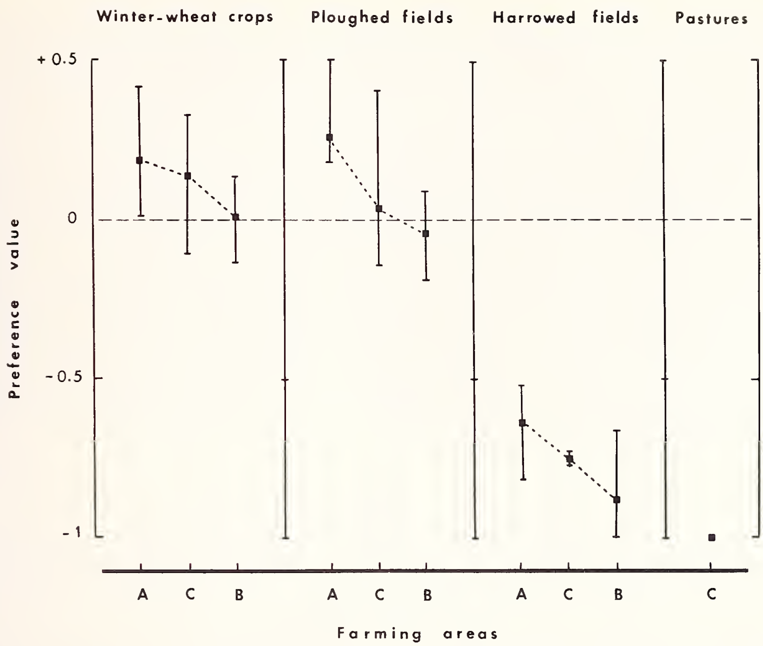

Fig. 4. Habitat selection of hares (given as mean and range figures) in the whole area during 1975–78. Sampling plots are the same as in Fig. 3. Habitat selection was calculated according to JACOBS (1974) – index. Values from 0 to 1 indicate positive selection; values from 0 to −1 indicate negative selection. A = Vaubéron Nord area; B = Vaubéron Sud area; C = Le Murger area

values below −0.5, corresponds to harrowed fields and pastures (−1). Moreover, as illustrated by Fig. 4, the fields of Vaubéron Nord seem as a whole more selected than the other two areas. However this difference in attraction is observed in all years, only in the case of ploughed fields (Mann Whitney $\underline{U}$ – test; $\underline{U}$ = 3; $\underline{P}$ = 0.014).

Forest influence

As indicated above, Vaubéron Sud and Le Murger are bordered by the Retz forest and, if the fields closest to this forest are considered, hare density is reduced by approximately one third for winter-wheat and ploughed fields and by one half for harrowed fields. The annual JACOBS-index reflects this difference. For winter-wheat crops, it is in the range −0.71–+0.17 (mean −0.06) near the woods and in the range 0 – +0.28 (mean + 0.14) at a distance from the forest (Mann Whitney $\underline{U}$ - test; $\underline{U}$ = 3; $\underline{P}$ = 0.1). For ploughed fields, the annual JACOBS-index is in the range −0.13 – +0.14 (−0.10) near forest and in the range +0.03 – +0.24 (+0.11) at a distance from the forest ($\underline{U}$ = 2; $\underline{P}$ = 0.057). For harrowed fields, the corresponding indexes are – 1 to −0.67 (−0.86) and −0.54 to −0.78 (−0.71). Consequently, the hares avoided to establish their forms in all field types located near the Retz forest.

Discussion

Choice of census method

The use of the strip census method to study spring density, spatial distribution and habitat selection for hares has some major disadvantages. Firstly, using net-catching as a reference, PIELOWSKI (1969) found that strip census overestimated the hare density by 20 %. This overestimation results from double counts, flocking of hares or subjective widening of strips (Rajska 1968). Using global census methods as the reference, Pépin and Birkan (1981) found that strip census also overestimated the hare density in the same proportion. Therefore, there is some evidence that the accuracy of global census is nearly identical to that of net-catching.

Secondly, to study the spatial distribution of hare population using strip census, previous studies divided the assessment belt into sections of 200 m (Jezierski 1972; Rajska 1968) or of between 100 to 400 m (Pielowski 1966). They are then required to register the position of each flushed hare in the belt, which is not always possible under field conditions.

Thirdly, when the distribution of fields within the total area is not mapped, Jezierski (1968, 1973) suggests directly converting the time spent by the observers during the strip census in each type of crops into an area. But, as demonstrated by Pépin and Birkan (1981), the walking speed of observers changes with the type of crops. Therefore, the estimation of the distribution of fields may be incorrect and so therefore would be the evaluation of habitat selection by hares.

Variation of spring hare density

The annual variations of several parameters have a major influence on the spring abundance of hares in a given area. Among these, the relation of hunting pressure on the animal increase of the concerned populations appears to be the most important (Andrzejewski and Jezierski 1966; Pielowski 1968). In order to maintain a stable population level an estimate of the total number of hares present at the opening of each hunting season was made based on the analysis of hunting gabs, to preserve about 200 animals as reproductive stock (Pépin 1981). In spite of this attempt at adjustment, it is obvious that the spring hare global density does not conserve at a stable level. It may be that the evaluation of hare density at the start of the hunting season was not always valid or that the winter mortality rate of animals changes from year to year. Moreover, as illustrated by the Table, the relative abundance of various field habitats changes every spring. This yearly variation in rotation cropping produces inevitable adjustments in the spatial repartition of hare population, including unquestionable movements on both sides of the study area boundaries towards the most attractive fields.

Variation of habitat selection for resting places

As a result of harvest and hunting pressure, the distribution of hares in autumn is completely disorderly. However, after this unstable period, a re-establishment of resting places takes place which, according to Pielowski (1966), maintain a remarkable stability from December to April.

In spring, the forms of hares generally consist of a depression in the soil or vegetation essentially offering some protection from the weather, and a place to rest. De Vos and Dean (1965) indicate that a permanent form showed definite evidence of construction, with the posterior portion of the form excavated, and the earth scraped in front of the form. In our study, the ploughed and winter-wheat fields were probably preferred because they are the most suitable habitats for this kind of construction. In the Vaubéron Nord area, where the hare density was consistently higher than the other two areas, the ploughed fields were selected more than the winter-wheat crops. The same result was also noted by Jezierski (1973) when the hare density was over of 40 animals km^{-2}. This fact clearly indicates that the habitat selection for forms is not dictated by food accessibility, but that it can be modified by the relative abundance of hares in the concerned area. As demonstrated by Jezierski (1973), the flushing distance of hares in front of beaters is directly dependant on the population density. Therefore, the chances of survival are probably greater when the distribution of hare population is aggregated than when the distribution pattern is random.

In contrast to the positive selection of ploughed fields and winter-wheat crops, there is a systematic avoidance of pastures for resting places during day-time. In the studies of Frylestam (1976) and of Barnes et. al (1983), an inverse correlation was found between livestock and European hare densities on pasture during night-time. Here, the negative selection of pastures without relation with presence or absence of livestock may be related to the proximity of the Retz forest, since all the other directly adjoining fields are also appreciably underselected. Avoidance of fields near forest could be due to frequent visits of foxes and avian predators (Bresinski and Chlewski 1976; Bresinski 1983) and by other modifications of the safety conditions. For example, air temperature and wind velocity have a direct effect on the hare activity (Jezierski 1973), and these meteorological factors may be considerably modified in the fields near woods. It may also be that the hares rest in the woods during the day and come out at night to feed in the fields. Pielowski (1966) indicated that such movements of hares from areas near woods to small forests are particularly more frequently observed when meteorological (and food) conditions become very difficult.

In conclusion, this study demonstrates that while the daytime distribution of the European hare follows certain general rules, some adjustements are always possible on a very small scale in relation to optimum safety conditions or strong attraction of aparticular element in the agrosystem.

Acknowledgments

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Zusammenfassung

Populationsdichte im Frühjahr und Verteilung der Hasen am Tage in Habitaten eines offenen Agrosystems

Häufigkeit und Verteilung am Tage von Hasen im Frühjahr wurden in ziemlich einheitlich gegliedertem Kulturland im Pariser Becken auf einer Fläche von 6,5 km^2 in den Jahren 1975–1978 bestimmt. Bei systematischen Treiben wurden die Hasen hierzu gezählt. Außerdem wurde die Verteilung der Lager (Sassen) auf die verschiedenen Habitate ermittelt.

Die Hasendichte schwankte in den vier Jahren zwischen 22,6 und 34,9 km^2. Die Sassen fanden sich bevorzugt in Winterweizen und auf Sturzäckern, unterdurchschnittlich auf geeggten Feldern und Wiesen. Die Dichte der Lager war auf waldnahen Flächen geringer als auf waldfernen.

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Der Einfluß des Vomeronasalorgans auf das olfaktorisch geleitete Verhalten nestjunger Mäuse

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Abstract

The influence of the vomeronasal organ on olfactory guided behaviour in suckling mice

Studied was the effect, removal of the VNO exerts on odour preference in young mice (strain ICR). The animals were vomeronasal ectomized (VNX) at the 6th day of life; during the following 7 days the preferential choice to the odour of nesting material was tested.

The VNX-mice showed a marked deficit in the rate of growth; their olfactory guided behaviour to nesting material however did not differ considerably from the behaviour of sham-operated and normal control animals. In all groups the nesting material was significantly preferred already at the 7th day of life (one day after the surgery); the VNX-mice spent only slightly less time in the familiar odourous environment as the controls.

Einleitung

Die ontogenetische Entwicklung wird bei Nagetieren in entscheidendem Maße von olfaktorischen Reizen beeinflußt (Alberts 1976; Cowley 1980). Vor allem die Lokalisation der Zitzen scheint von geruchlichen Faktoren bestimmt zu werden, so daß man annehmen muß, daß das Riechsystem von Geburt an funktionsfähig ist.

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