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INTEGRATION OF INTRODUCED MOUFLONS WITH THE LOCAL POPULATION IN THE SUDETY MOUNTAINS

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Summary: The research was carried out in the Sowie Mountains that are located in central part of the Sudety Mountains (South-western Poland). In 1902, 5 mouflons *Ovis aries musimon* were brought from Slovakia into this region. Over years there was an increase in population size until it reached 778 animals in 1995. Changes in improper proper development of horns have been noticed for a long time. The older the males were the more curved horns they had, which eventually started to stab into the animal's neck. This process eliminated older animals and it was suggested that inbreeding is the main reason. In order to increase genetic variability it was decided to introduce more mouflons from Slovakia and Czech Republic. Between 2002 and 2004, 76 mouflons were bought and placed to reproduce in three enclosures located in the Bielawa (Forest District Świdnica, n=1) and the Jemna (Forest District Bardo Śląskie, n=2). In June 2006 mouflons from both enclosures (n= 177) were released. All released animals were given ear tags and 10 females and 10 males got radio collars produced by Televilt. In the following years location of animals was registered through telemetry receivers. The results suggest that released mouflons colonized the area of 850 ha near the Bielawa enclosure and 690 ha near the Jemna enclosure. The animals were located max. 1.0 km - 3.1 km from the enclosures apart from one male that was found 9.1 km away from the original enclosure. The average home range of males was 287.5 ha whereas for females it was 175.0 ha. After 4 years 19 out of 20 animals were still alive. Forest area in the Sowie Mountains inhabited by local population of mouflons comprise surface of 26600 ha. The degree of integration of released animals with the local mouflons was low as they occupied only 5.8% of range distribution of local population. Eight years after the introduction no essential improvements were seen in the horns of the harvested rams, probably because of high population density which amounted to 68.8 animals/1000 ha..

Key words: mouflon, southwestern Poland, introduction, home range, dispersal, radio tracking

Introduction

The population of mouflons currently living in the Sudety Mountains within the Sowie Mountains originated from five individuals brought in 1902 from Slovakia (Szczepkowski 1951). Immediately prior to the outbreak of World War II, the population size was estimated at ca. 250 individuals (Nowak 1968). Official records from 1948 gave the number of only 62 individuals in

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the Sowie Mountains. In subsequent years, however, there has been increase the numbers of mouflons. The data obtained from foresters and hunters indicate that between 2000 and 2007 a mouflon population ranged from 500 to 800 animals (Pleśniarski et al. 2007). In the 1980s, it was found that the developing horns of mouflon rams were abnormally coiled, and their sharp tips were ingrowing causing wounds and the subsequent deaths of rams aged 4 – 5 years. It was suggested that these negative developments were a result of inbreeding because multiple crossbreeding between closely related individuals enhances the likelihood of two recessive alleles appearing in the same gene (Selwa-Żurawska 1968). It is known that adult heterozygotic rams of bighorn sheep are characterised by larger horns compared with individuals with a higher level of heterozygosity (Fitzsimmons et al. 1995). It was decided to augment the local population of mouflons with animals from Slovakia and the Czech Republic. In order to implement this measure, an adaptation enclosure was set up in the Świdnica Forest District near the Bielawa town, and two such enclosures in the Bardo Śląskie Forest District in the Jemna village. Between 2002 and 2004, 94 mouflons were introduced to these breeding enclosures. In June 2006, 177 mouflons were released from the enclosures (Table 1). Each was provided with an earring, and, additionally, 20 of them were given collars with radio transmitters manufactured by TELEVILT.

The objective of this paper is to analyse the dispersion of introduced mouflons based on telemetric study. Another objective is the verification of game estimates pertaining to population numbers in the study area.

Material and Methods

The study area included compact forests in the Sowie Mountains, administered by the Bardo Śląskie, the Jugów, and the Świdnica Forest Districts. The Sowie Mountains are a mountain range within the Central Sudety chain of mountains with highest peak Wielka Sowa Mountain (1.015 m). The duration of the vegetation season varies, and lasts 190 days on average (Starkel 1999). In the area concerned, spruce (*Picea abies*) and beech (*Fagus silvatica*) predominate, with respective 59% and 13% shares of the forested area (Lenart et al 2007). The mouflon population inhabits 26,600 hectares of forest.

In June 2006, ten mouflons released from the Jemna enclosure, and ten mouflons released from the Bielawa enclosure were given collars with radio transmitters. Half of the animals released were adult males and females. Four sessions of telemetric measurements were completed in August and November 2006, and in June and September 2007. Each measurement session lasted three days, and mouflons were located at six-hour intervals. The location of animals was detected by using a triangulation method where each individual was located from three different points. The measurements were done by using hand-held directional aerials and radio receivers. Home ranges were calculated with the use of minimum convex polygon software (Frąckowiak et al 2007). The locations of mouflons were next followed by observations through binoculars which permitted the assessment of the degree of introduced mouflons with the local population.

Population census of mouflons was carried out in March 2008. Number of animals was estimated by using 9 large sampling plots i.e. by the block count technique (Maruyama and Furubayashi 1989, Bobek et al 2013), covering 4500 ha. Using time space analysis the multiple observations of the same animals were eliminated.

Results

Dispersion of introduced animals

During telemetry done near the end of August 2006, mouflons were located near the enclosures from which they were released. The maximum straight-line distance from the Jemna enclosure in the Bardo Śląskie Forest District was 1.2 km, and only 600 m from the Bielawa enclosure in the

Świdnica forest division. The telemetric data completed in November 2006 showed that mouflons were at greater distances from both enclosures than in August, and occurred in higher parts of the mountains. The maximum straight-line distance of mouflons located was 1.6 km from the Jemna enclosures, and 2.6 km from the Bielawa enclosure. The June 2007 data is shown the tendency of increasing the distance between the mouflons and enclosures from which they were released. Among the individuals released from the Jemna enclosure, signals from as far away as neighbouring valleys were received, and the maximum straight-line distance was 2.2 km. No individuals were located in the immediate vicinity of the enclosure. The group of mouflons released from the Bielawa enclosure also wandered further from the place of release, with a maximum distance of 2.9 km recorded by one of the rams.

During location exercises in October 2007, the further dispersion of animals was recorded for animals from both released groups. Among the mouflons released from the Jemna enclosure, one of the rams was located at a straight-line distance of ca. 3.5 km from the enclosure, whereas another male moved near the Bielawa enclosure, i.e. 9.1 km from the original enclosure.

Four sessions of measurements for locating mouflons bearing collars with radio transmitters did not confirm any deaths among these animals in the following 18 months. None of the animals with collars or earrings migrated into the neighbouring Jugów Forest District. In October 2007, the average maximum distance from the enclosure reached by released individuals was 3.58 km for males, and 1.98 km for females.

Integration with local population

The mean annual size of the home range in sedentary males ($n=8$) was larger than in sedentary females ($n=8$) [287.6 ± 209.9 ($\bar{x} \pm \text{SD}$) vs. 175.0 ± 132.7 ($\bar{x} \pm \text{SD}$) hectares]. According to telemetric measurements, during 18 months, the released mouflons colonised only 8.5% of the forested area in both Forest Districts studied, and a mere 5.8% of the area of three Forest Districts. Within these areas, covering some 1540 hectares, groups of mouflons were observed composed of local individuals along with mouflons with collars and earrings coming from both enclosures. The observations of 12 social groups (herds) of mouflons, ranging from 7 to 14 animals, showed that in five social groups there were animals with collars or earrings living together with individuals from the local population. The total number of mouflons in these groups was 68 individuals, of which 9 individuals or 13.2% were introduced.

Table 1. Number of released mouflons from 3 enclosures in the Bardo Śląskie Forest District and the Świdnica Forest District during June 2006

Forest District	Size of enclosures (ha)	Males	Females	Young	Total
Bardo Śląskie	30 ($n=2$)	26	36	38	100
Świdnica	40 ($n=1$)	15	31	31	77
Total	70 ($n=3$)	41	67	69	177

Population number estimate

In March 2008, a population estimate of mouflons was carried out on 9 large sampling plots in the areas of their occurrence within the Bardo Śląskie, the Jugów, and the Świdnica Forest Districts, covering a total of 26.600 ha of forest. In these sampling plots, a total of 308 mouflons were recorded which corresponded to an average population density of 69.3 individuals / 1000 hectares of forest. The population densities varied between the studied forest districts and ranged from 37.8

to 84.8 individuals / 1000 hectares of forest and the mean density amounted to 68.8 animals/1000 ha (Table 2). According to the data obtained from large sampling plots, the population size in the three studied forest districts amounted to 1830 mouflons.

Table 2. Population census of mouflons in the Sowie Mountains (southeastern Poland) during March 2008

Forest District	Number of observers	Number of sampling plots	Area sampling plots (ha)	Number of mouflons	Population density N/1000 ha
Bardo Śląskie	102	3	1591	135	84.8
Jugów	128	3	1400	53	37.8
Świdnica	110	3	1487	120	80.7
Total/mean	496	9	4478	308	68.8*

*weighted mean

Discussion

The relatively low rate of colonization of forested areas by introduced mouflons was perhaps associated with their feeding habits using easily available fodder from nearby feeding stations. The fact that some of the mouflons had been born in adaptation enclosures certainly had an effect. A similar phenomenon of animals staying for a longer period of time near the adaptation enclosures was observed in fallow deer (Dolev et al 2002). The longer migration distances were noted among individuals from the Bielawa enclosure (the Świdnica Forest District) as it was situated far away from busy roads. The breaking up original social groups of introduced mouflons, and the migration of rams for several kilometers, was probably a result of the rutting season which lasts from November till December.

Calculations made for the purpose of improving the genetic structure of the local population was based on the assumption that the number of mouflons in the area was ca. 550 individuals, thus the introduction of 177 animals from Slovakia and the Czech Republic should have eliminated the adverse effect of inbreeding (Nowakowski 2002). However, 8 years after the introduction, no essential improvements were seen in the horns of the harvested rams. If the hypothesis of the high degree of homozygosity in the local population is true, the effect of the introduction was severely limited because in 2006 the population number of mouflons in the study area was actually ca. 1400 animals, thus 2.5 times higher than that given in the hunters' estimates. Therefore, the introduced animals did not constitute 32% of the local population size but only 12.6%.

The genetic hypothesis concerning the effect of inbreeding on the shape of rams horns is scientifically extraordinarily attractive and should be taken as a topic for professional research. Nevertheless, the second, competing hypothesis should also be taken into account i.e. that the reason for the abnormal coiling of their horns is the excessive density of the mouflon population co-habiting the same area with a population of red deer, whose density in 2007 amounted to 54.1 individuals / 1000 hectares of forest. Between 2007 and 2013, in the study area, increases were noted in the density of mouflons and red deer which certainly degraded the quality of the potential food of these animals. The winter diet of mouflons in the Sowie Mountains is composed predominantly of grasses, sedges, and browse, i.e. by fodders of low nutritional value.

Conclusion

The mouflons in the Sowie Mountains represent an interesting topic for studies in ecology and population genetics, as well as for hunting practice. However, apart from laboratory studies of the genetic structure of population, feeding trials should also be conducted on the effect of food quality on the development and shape of horns in rams. It is also necessary to obtain reliable knowledge on the population size which is not provided by game statistics based on arbitrary estimates by hunters and foresters.

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