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REPRODUCTIVE POTENTIAL OF ROE DEER IN SLOVENIA

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Summary: European roe deer (*Capreolus capreolus* L.) is the most important game species in majority of European countries, including Slovenia. Therefore, it is crucial to perform an effective management of this species, which should be based on the knowledge of its population dynamics. Systematic research on reproductive potential (e.g. fertility and potential litter sizes) of roe deer in Slovenia began in 2013. Reproductive organs (uteri with ovaries) of culled roe deer females, i.e. adult does (n = 392) and yearlings (n = 82), were sampled in 45 hunting grounds all around Slovenia during the hunting season, from 1 September to 31 December 2013. Fertility was determined by the presence of corpora lutea in ovaries, and potential litter size by counting their numbers.Results confirmed high fertility of roe deer females in Slovenia. Corpora lutea were present in ovaries of all except two adult does, and only 15.9% of yearlings was infertile, all of them in poor body condition (undressed body mass <11 kg, i.e. without abdominal content, but with head and legs retained). Potential litter size (number of corpora lutea in ovaries) was primarily influenced by doe body mass and age. Mean number of corpora lutea was 1.84 in adult does, and 1.20 in yearlings, respectively. Body mass has a strong positive impact on the potential litter size in both age classes. However, yearlings (primiparous does) perform much higher variability in reproductive potential (i.e. all individuals <10 kg were without any corpus luteum, and all individual >16 kg had 2 corpora lutea). This has to be taken into account when making management decisions. Indeed, particularly selective culling of yearlings in poor condition, i.e. with low body mass, and preserving of heavier individuals, can have a significant impact on fawn production, and hence also on the reproduction of roe deer in the following year(s).

Key words: Roe deer, reproductive potential, doe fertility, corpus luteum

Introduction

European roe deer (*Capreolus capreolus* L.) is one of the key species of European terrestrial ecosystems and consequently, it has a great impact on forest and agricultural ecosystems. It also represents the most important game-management species not only in Slovenia but also in the vast majority of European countries (Andersen et al., 1998; Apollonio et al., 2010). It is estimated that there are more than 200,000 roe deer living in Slovenia (Jerina et al., 2013), and in the period between 2001 and 2010, more than 428,000 roe deer were taken from hunting grounds (total recorded mortality), which is between 41,150 and 44,736 animals per year (Statistični…, 2012a; 2012b). For balanced development of terrestrial ecosystems and sustainable use of their potential, including the potential of roe deer as a natural resource, it is crucial that the management of this species is effective and in accordance with the ecosystem, economic and socio-political carrying capacity of the environment (Pokorny, 2008; 2009).

In Slovenia, game management is relatively well organized (i.e. systematic, well planned and controlled) and it is based on sustainable use of game as a renewable natural resource (Hlad and Skoberne, 2001; Pokorny, 2009). Collection of several high-quality data and the existence of

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integrated and on-line available databases rank Slovenia as one of the most developed countries considering management of free-ranging ungulates (Putman, 2008). However, for effective game management information on the basic population parameters that shape the population dynamics of different game species, including roe deer, is still lacking. In contrast to many other European countries (reviewed in Andersen et al., 1998; Appolonio et al., 2010; Putman et al., 2011), there has been almost no systematic research on roe deer in Slovenia despite the existence of complex and extensive databases on every single animal culled (Virjent and Jerina, 2004; Stergar et al., 2012). Consequently, for roe deer there are no relevant data on the biological parameters that influence its population dynamics, i.e. reproductive potential or fertility rate and yield (e.g. Vincent et al., 1995; Hewison, 1997) and/or early fawn mortality (Jarnemo, 2004; Panzacchi et al., 2009).

Reproductive potential or potential litter size (the number of fertilized ova) can be determined by the identification and counting of the corpora lutea in roe deer ovaries. Litter size is determined by embryo counts and later by counting newborn fawns. Factors affecting the reproductive potential of roe deer include different individual (particularly maternal phenotype, i.e. body size, body mass, physical condition) (Kjellander et al., 2004; Hamel et al., 2009), population (e.g. population density, demographic structure, social stress, genetics) (Andersen and Linnell, 2000; Nilsen et al., 2009) and environmental characteristics (habitat quality, weather conditions, interspecific interactions, etc.) (Nilsen et al., 2004; Toïgo et al., 2006). The final output of reproductive potential is the sum of all influencing factors and several combinations between them and therefore varies among different populations and environments.

Because of the outstanding landscape and ecological variability of Slovenia, it is very important to determine the impacts of individual, population and environmental factors on roe deer yield, i.e. on fertility rate, number of embryos and number of fawns per reproductive doe, among the whole gradient of ecological factors. However, in this paper we are focusing merely on the fertility rate of does, and on the influence of individual factors (age and body mass) on reproductive potential of roe deer females in Slovenia.

Material and Methods

Reproductive organs (uteri with ovaries) of culled roe deer females were sampled in 45 hunting grounds all around Slovenia during the hunting season, from 1 September to 31 December 2013. Some samples were also obtained during the later period, i.e. in winter and early spring 2014 (road-kill). Sampling of specimen was held in cooperation with hunters. In total 474 reproductive organs were collected, from which 392 samples were from adult does and 82 samples belonged to yearlings. Reproductive organs were placed into plastic bags and frozen. For each specimen, hunters recorded sampling date, locality, eviscerated carcass mass (total body mass less viscera but with head and feet on) and approximate age. We also collected lower mandibles for age determination, and the age of harvested animals was assessed by macroscopic inspection of tooth development and tooth-wear. Due to the fact that it is impossible to determine the age of adult roe deer with one-year accuracy (Pokorny et al., 2012), we grouped animals into the following age categories: yearlings (15–19 months old), young adults (2–4 years), middle-aged adults (5–7 years), old adults (8–10 years) and senescent adults (10+ years), respectively. However, for the purposes of this paper, we used two age categories only – yearlings and adult females (older than 2 years). Based on the undressed body mass, we classified animals into six categories (<10.0 kg, 10.0–11.9 kg, 12.0–13.9 kg, 14.0–15.9 kg, 16.0–17.9 kg, and >18 kg).

Prior to the laboratory analysis, the frozen reproductive organs were defrosted. Each uteri was then examined and on the basis of the presence of caruncles (maternal side of the placenta) retrospective information on reproduction in previous year was gained. After the parturition, necrosis of the caruncular tissue occurs, but the signs of caruncles are still visible. Fertility of the recent year was determined by the presence of corpora lutea in ovaries. All incomplete samples, where one or both ovaries were missing, were excluded from further analysis. Ovaries were dissected to count the number of corpora lutea present, reflecting the number of ova released and fertilized. We used the number of corpora lutea as a measure of potential litter size of every single individual.

Results

The specimens were collected during the hunting season, which in roe deer coincides with the period of embryonic diapause. Roe deer undergo obligate embryonic diapause between early August and late December. Therefore, it was not possible to determine which animals were pregnant as during the embryonic diapause the corpora lutea remain active regardless of whether the doe is pregnant or not. The corpora lutea regression in non-pregnant does coincides with blastocyst reactivation in pregnant does. Nevertheless, with this inspection we gained an important information on doe's fertility. Results confirmed high fertility of roe deer females in Slovenia. Corpora lutea were present in ovaries of all except two adult does. Among yearlings, only 15.9% was infertile, as their ovaries were without corpora lutea.

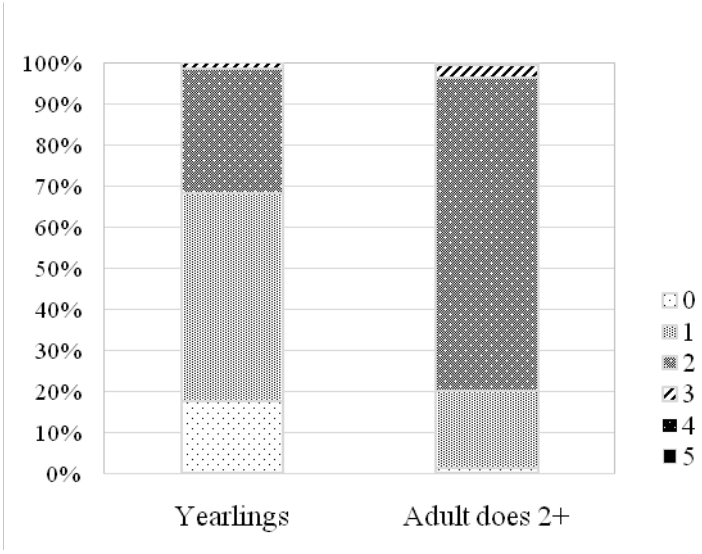

Figure 1: Potential litter size (numbers of corpora lutea) in ovaries of yearlings and adult does.

Potential litter size (number of corpora lutea in ovaries) differed between two age classes (Figure 1). Among yearlings, 50.7% of specimens carried only one corpus luteum and 30.4% of them carried two. We found three corpora lutea in ovaries of only one yearling. Among adult does, those with two corpora lutea dominated (76.5%) and 18.8% of specimens had one corpus luteum. There were also some individuals that carried three (8 does), four (one doe) and even five corpora lutea (one doe) in their ovaries. Mean number of corpora lutea was significantly higher (Mann-Whitney U test for independent samples: n_1=59; n_{2+}=199; z=5.65; p<0.0001) in adult does (1.85) as in yearlings (1.20).

Table 1: Potential litter sizes of roe deer in different European countries.

Country	Average number of CL in adult does (2+)	References
Slovenia	**1,85**	In this study.
Croatia	2,00	Nikolandić, 1970, cit. in Nikolandić and Degmečić, 2007
Switzerland	2,12	Wandeler, 1975, cit. in Nikolandić and Degmečić, 2007
Denmark	1,98	Strandgaard, 1972, cit. in Nikolandić and Degmečić, 2007
Belgium	1,92 ± 0,61	Wauters et al., 1995
Italy	1,44 ± 0,10	Focardi et al., 2002
Englandand Wales	1,73	Macdonald and Johnson, 2008

Litter sizes in roe deer differ between different areas. Roe deer populations from northern environments (especially Scandinavia) are known to have larger litters than populations from southern areas (Andersen et al., 1998). We compared the potential litter size from Slovenia with the results from some other European countries (Table 1).However, it should be stressed that by counting corpora lutea only potential litter size is determined. Indeed, actual litter size depends on the success of blastocyst implantation, and due to implantation failure it can significantly differ from potential litter size (number of fertilized ova).
Ungulate females with good phenotypic quality typically ovulate in greater numbers than younger, lighter or poorer condition females (Gaillard et.al., 1992; Andersen and Linnell, 2000; Hewison and Gaillard, 2001). This was also confirmed by our results, as potential litter size was in both age classes strongly influenced by body mass. However, yearlings (primiparous does) perform much higher variability in reproductive potential, which significantly increases with increasing body mass of this age category (Kruskal-Wallis ANOVA: $H_{(4,59)}$=27.5397; p<0.0001). All yearlings in poorer condition, with body mass lower than 10 kg, were not able to reproduce, as there were no corpora lutea present in their ovaries In the body mass category of 12–14 kg, individuals with one corpus luteum prevailed, while in categories 14–16 kg and 16–18 kg the proportionof individuals with two corpora lutea became much higher, and all individuals that weighted more than16 kg had 2 corpora lutea (Figure 2).

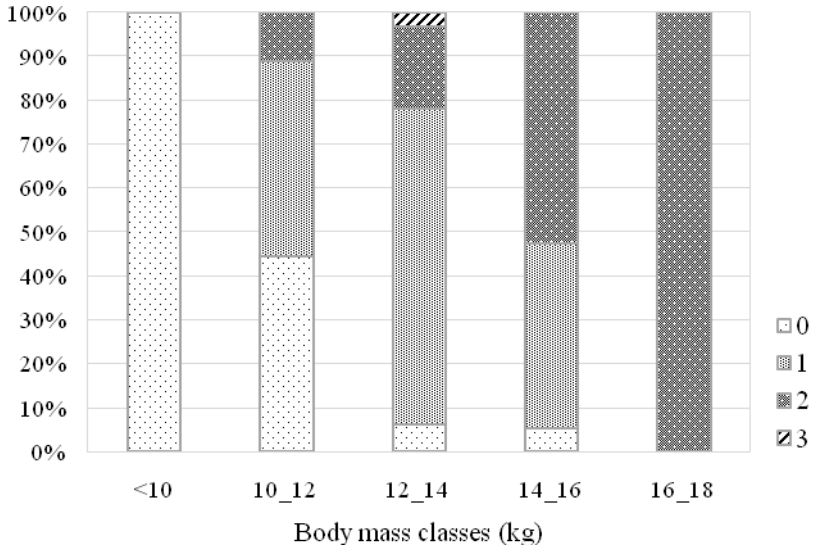

Figure 2: Effect of body mass on number of corpora lutea in yearlings.

In adult does, body mass is also an important factor influencing the potential litter size. Among adult does there were only two individuals without corpora lutea and were therefore not able to reproduce in the ongoing year. Both individuals had low body mass (10–12 kg). It is very evident from our results that does in poor condition (body mass <10 kg) are not able to produce more than one fawn. With the increase in body mass, numbers of corpora lutea increases, and all does with body mass >18 kg had two or even more corpora lutea. However, although the proportion of does that produce two or even more fawns becomes larger with the higher body mass (Figure 3), differences in mean number of corpora lutea per doe are not significant among weight classes (Kruskal-Wallis ANOVA: $H_{(4,180)}$=5.0529; p=0.28).

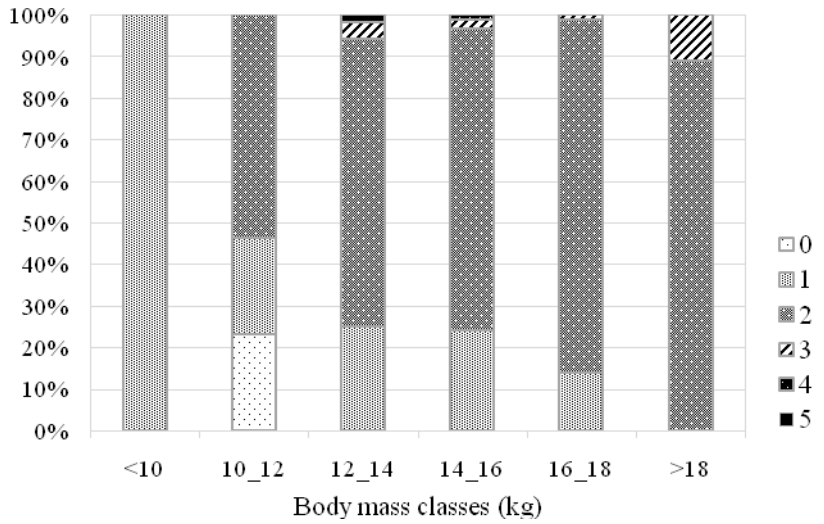

Figure3: Effect of body mass on number of corpora lutea in ovaries of adult does.

Conclusion

Roe deer reproductive potential is primarily influenced by the age (differences between yearlings and adult does) and body mass. The number of corpora lutea increases markedly with the increasing body mass of both yearlings and adult does; however, the variability in reproductive potential is higher among yearlings. Consequently, this age category can have the greatest impact on the reproduction of roe deer and the number of offspring in the following year(s), which has to be taken into account when making management decisions. Roe deer yield (number of newborn fawns) in the following year can be markedly influenced and increased by selective culling of yearlings in poor condition with low body mass and by preserving of heavier yearlings. Culling of weaker individuals (with body mass lower than 10 kg) does not have any impact on roe deer yield as such individuals are not able to reproduce. Furthermore, their long-term reproductive potential would also be relatively low due to expected lower body mass in the following years. On the contrary, excessive culling of heavier yearlings would have negative impact on management success. Yearlings in good condition are able to perform equal reproductive potential in the ongoing year as adult does.

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