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## Effect of shooting on the structure of population of golden jackal (*Canis aureus* L.) in Sarnena Sredna Gora mountain

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**Abstract.** Being a protected species in the middle of the last century with rather limited distribution in our country, the jackal has become a widely spread species. The aim of the study was to investigate the effect of shooting on the jackal population and to reveal how its demographic structure changes, specimens from which age groups are taken out and how the gender ratio changes with age. The study material comprises 210 jackal skulls shot during 4 autumn-winter hunting seasons from 2006 to 2010 in the area of Sarnena Sredna gora mountain. To determine the animals' age year rings in the dentine have been observed by a stereoscope measuring the level of tearing upper incisors and observing the closing of basal skull synchondroses. The simultaneous use of the three methods facilitates the more precise determination of age and assigning samples to 4 age groups. Of all animals shot during the four hunting seasons 67,5 % are young ones, aged up to 1 year. The gender ratio in these groups is 2,28/1 in favour of male animals. The ratio in the two-year-old jackal population is 1,25/1 in favour of the female ones, i.e. restoration of the normal gender ratio is observed typical of most carnivorous mammals in sexual maturity. As a result of the hunting pressure only 1/3 of the animals in each age group survive by the following hunting season. The demographic structure of the jackal population in Sarnena Sredna Gora mountain is strongly influenced by hunting, turnover is increased, but the effect of shooting is not enough to reduce the overall number. Jackal population is restored each year by compensation mechanisms such as migration, immigration, enhanced reproduction.

**Keywords:** gender ratio, age structure, jackal population, predator management

### Introduction

Golden jackal is a widely spread representative of the Canidae family. Its habitat comprises areas of Central, East and South Europe, North Africa and part of Asia. Small, scattered but stable population exists within the Balkan peninsula. The highest is its density in Bulgaria (Krystufek et al., 1997).

Being a protected species in the middle of last century (Atanasov 1955), with rather limited distribution in our country, the jackal has become a widely spread species getting over the Stara planina mountain range along the Black Sea coast and entering from Strandzha and Sakar mountains in North Bulgaria (Spasov, 1989). It is known that it only avoids habitats of high altitude. Its expansion, started by increase in the number in the 1960s, accelerated in the 1980s. Nowadays it's spread in Hungary, Serbia, Slovakia and Austria and recently reported in Italy (Arnold et al., 2011). In our country it is considered harmful for forestry and livestock breeding and bonuses are paid for shooting it (Genov and Vasilev, 1991).

Sarnena Sredna Gora is an area in which shooting of jackal has never stopped since the beginning of its expansion. One can assume that a population of that species has been permanently established. Its long eradication has not been effective for reducing the number, or it has been rather small. According to data submitted by the State Forestry in Stara Zagora, annually from 1000 to 2000 specimens are shot in the area. When people make use of hunted mammals, the knowledge and record on the age structure are extremely important. In species with great annual addition to the population, a significant part thereof can be taken over. Having in mind that the speed of reproduction affects the age structure (Ricklefs, 1979), having good knowledge of it, we can forecast the number of the species for several generations ahead (Chernova and Bylova, 1981).

In order to make it clearer what the effect of shooting on the jackal population is, it is necessary to study how its demographic structure changes, specimens from which age groups are taken out and how the gender ratio changes with age. So far it is not clear what is the price paid by the species as a result of the "hunt pressure". Then we could answer the question why we are not able to reduce the number of jackals by shooting only.

### Material and methods

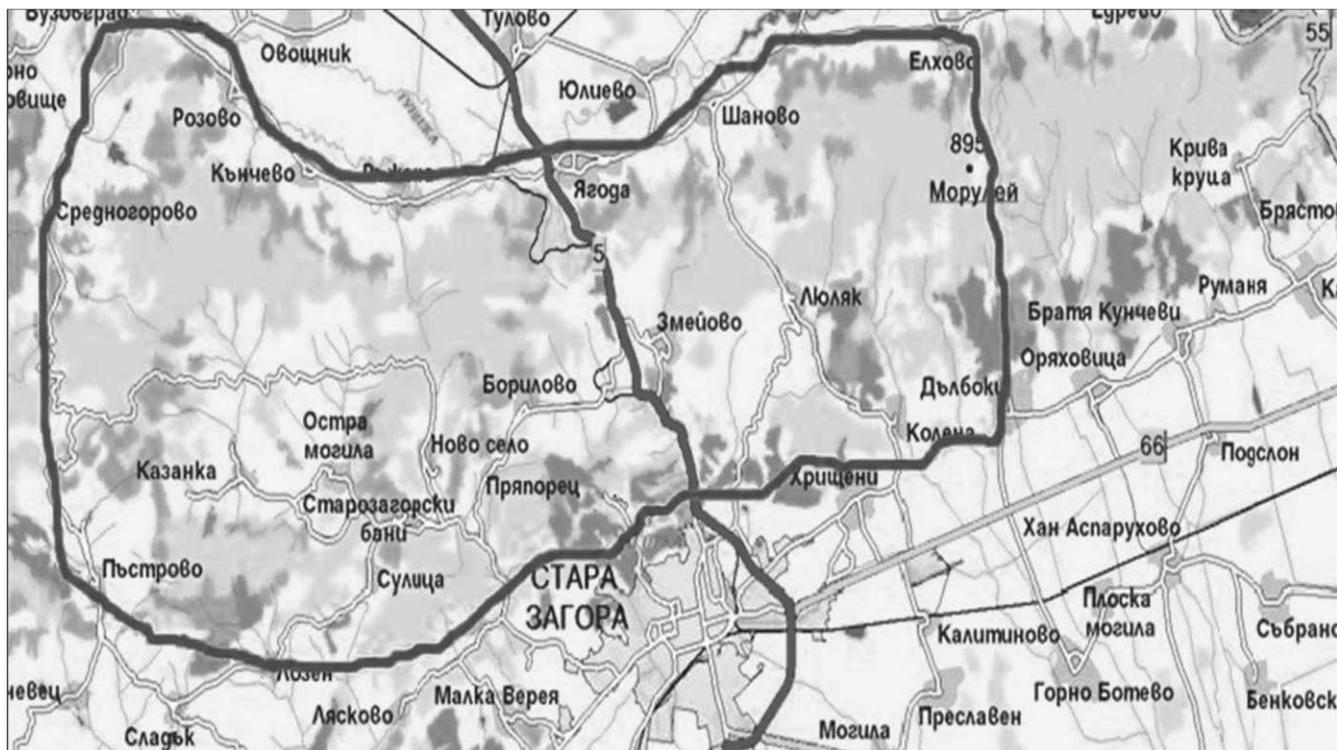
The study material comprises 210 jackal skulls shot during 4 autumn-winter hunting seasons from 2006 to 2010 in the area of Sarnena Sredna Gora mountain (Figure 1). Various hunting methods have been used which protects our excerpt from selectiveness. To collect samples hunters from the Hunting and Anglers Society in Stara Zagora and employees at the State Forestry have assisted. The carcasses have been autopsied in the taxidermy laboratory at Trakia University. The skulls have been boiled and bleached by the routine methods of preparing hunting trophies. To determine the animals' age a set of methods has been used:

1. Through cutting and polishing a canine tooth in the area of radix dentis (Klevezal and Kleinenberg, 1967). Year rings in the dentine have been observed by a stereoscope.

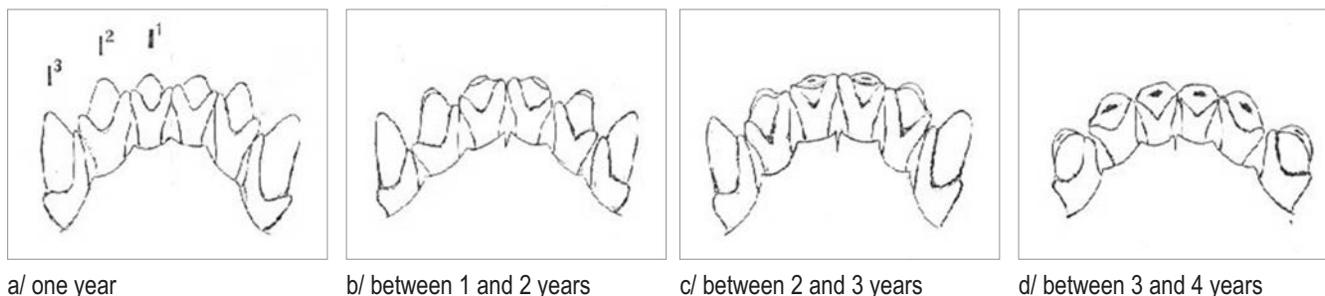
2. By observing the closing of basal skull synchondroses with age – a widely used method for determining the early age of wild canines (Dolgov and Rossolimo, 1966).

3. By observing the level of tearing upper incisors (Harris, 1978; Lombaard, 1971; Gurskii, 1973). All three methods have been adapted by Raychev (2002) to the jackal, and for tearing the incisors the following scheme (Figure 2) has been used:

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**Figure 1.** Map of the study area



**Figure 2.** Tearing of upper incisors

The simultaneous use of the three methods facilitates the more precise determination of age and assigning samples to 4 age groups:

- Up to 1 year – comprises specimens aged 7 to 11 months (young ones).
- Between 1 and 2 years – animals in the second year of their lives aged 1 year 7 months to 1 year 11 months.
- Between 2 and 3 years of age
- Over 3 years of age. A small number of animals aged 3, 4 and 5 years have been assigned to that group

## Results and discussion

Of all animals shot during the four hunting seasons 67,5 % are young ones, aged up to 1 year. They comprise the offspring, the new generation resulting from the last reproduction cycle. The gender

ratio in these groups is 2,28/1 in favour of male animals (Table 1). Regardless of the gender ratio when the young ones are born, about which we have no data, of the animals that have survived by the autumn, the male ones predominate. The ratio in the two-year-old jackal population is 1,25/1 in favour of the female ones, i.e. restoration of the normal gender ratio is observed typical of most carnivorous mammals in sexual maturity. It is known that natural selection tends to maintain animal populations in 1:1 ratio (Monahov and Bakeev 1981; Mayr, 1968). This ratio facilitates carnivorous mammals in achieving their reproductive potential to the fullest and with the least energy lost. Jackals over 2 years of age have almost the same gender ratio 1.09/1 (Table 1). Jackals in our excerpt show change in the gender ratio in the course of age. Very similar results to ours are obtained by Tariannikov (1975) who studies jackal in the valley of the Syrdarya river. Among the shot jackals young ones predominate - 77% and in that age group males are twice more than females. In adults the gender ratio is normal. The causes for that phenomenon could be two:

1. In shooting and road accidents more young male animals are killed since they are more active looking for individual areas compared to the females, moreover, they are the more active ones during the reproduction period.

2. It is possible for young male animals to be more subject to adverse natural factors: diseases, restricted food niche, lower social status, etc.

In foxes it is proved that mainly young males become victims of road traffic and hunting (anthropogenic factors) (Macdonald, 1978). Probably with the jackal this is the risk group of the generation. Animals enter new territories with poorly known shelters and therefore their risky behavior results in their more successful shooting.

Studying the shooting of age groups in greater detail by months regardless of gender (Figure 3), it becomes clear that the greatest number of young animals are shot in December – 49.8%, the one-year-old ones in January – 42.2%, the 2-year-old ones – also in January, and the 3-year-old ones – in February. Adult jackals – over 2 and 3 years of age are extremely precautious. They know their individual territories and the shelter dens very well. What's more, in November they comprise rather small percentage of the entire population. Therefore, at the beginning of the hunting season mostly 1- and 2-year-old specimens are shot. In December hunting efficiency increases abruptly due to improvement of visibility in the forest. The number of the populations starts decreasing rapidly at

the expense of young specimens. That results in change in the age group ratio. In January and February, though difficult, more jackals are shot aged between 2 and 3 and over 3. Another reason about that could be the reproductive season under way when all adults increase their activity. Very few specimens live up to the age over 3. The domination of 1- and 2-year-old animals within the total sample proves intensive turnover in the population influenced mostly by the hunting press. The ration between age groups shows that  $\frac{1}{3}$  (141/45) of youngsters live up to the second year,  $\frac{1}{3}$  (45/15) of those who have lived up to the second year survive into the third, etc. (Table 1).

One of the specific characteristics of age structure is its greater instability compared to gender structure (Timofeev–Resovski et al., 1973; Schwarz, 1965). Our observations on the condition of killed animals revealed that only 2 of all 210 are in bad condition. The remaining 208 animals have abundant fat depositions, some of them even to the end of February. The bad condition of 1 jackal was due to apparent abnormality in the jaw structure. In the second specimen the so-called “yellow fat” was found probably as a result of a disease. We can make a conclusion that death rate among jackals in the studied area is not due to insufficient food (Koleva and Georgiev, 2005). On the contrary, its abundance in the area favours the development of the jackal (Raychev, 2002).

A main reason for decrease of the number in autumn and winter is the hunting control. It largely displaces natural mortality. The relative risk for affecting various age groups changes throughout the

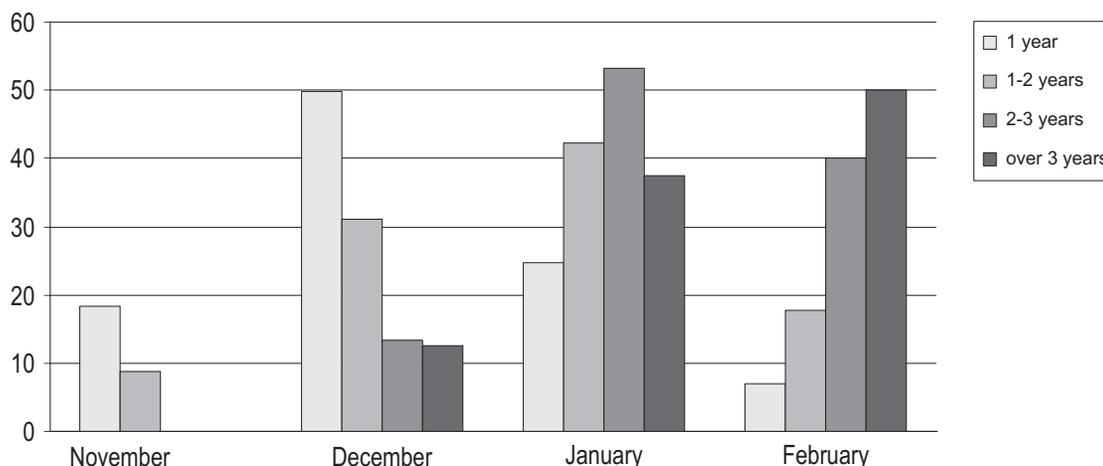


Figure 3. Shooting of age groups by months in %

Table 1. Shooting of different age groups by hunting seasons

	1 year		1-2 years		2-3 years		Over 3 years		Overall
	♂	♀	♂	♀	♂	♀	♂	♀	
Season 2009-2010	11	2	7	4	2	-	2	1	29
Season 2008-2009	72	28	8	11	2	2	-	4	127
Season 2007-2008	8	10	3	8	-	3	-	-	33
Season 2006-2007	7	3	2	2	4	2	1	-	21
Overall	98	43	20	25	8	7	3	6	

year. Hunting pressure is the main determining factor for demographic changes in predators. According to Karelov et al. (1989) industrial hunt affects selectively various gender and age groups by enhancing or weakening reproduction processes. The selective use of a given animal species has the potential of increasing the genetic response of the target population. In turn, the effect on demographic structure results in changes in the size of population (Coltman, 2008). The response to that effect is a tendency for quick restoration of the normal age ratio (Monahov and Bakeev, 1981). The effect of restoring the number is achieved through movements of animals as well. On the vacated territories new specimens arrive from adjacent areas with greater density and weak shooting. Adams and Coll (2008) give evidence that the wolf population compensates exploitation by man by not less than 29% mainly through local dispersion and immigration. The same effect could be expected in jackal as well. In foxes mostly strangers have been trapped in winter with live traps – 52 % (Baker and Coll, 2001).

Our observations show that regardless of the enhanced shooting and payment of bonuses in recent years, the number of jackals in Sarnena Sredna Gora mountain does not decrease. That is difficult to be established through taxation but through shooting data obtained from the State Forestry in Stara Zagora in 2005 - 1346, in 2006 - 810, in 2007 - 1538, in 2008 - 1457, in 2009 - 1607 and in 2010 - 1177. In our opinion shooting temporarily reduces the density of population which in its turn responds through enhanced reproduction. To preserve the number, the high survival rate of youngsters till the following winter season and immigration in winter time from areas of higher density contribute a lot. A similar effect has been found with the fox in Scotland. Every effort to reduce the fox population through long years of extermination in rabies control requires expansion of efforts and use of more levels of control (Kolb and Hewson 1980). In recent years the opinion that extermination is not desirable as a method of influencing the number of wild predators has become prevalent (Baker et al., 2008). The need of humane attitude to animals starts influencing management strategies worldwide. Various innovative programs propose non-lethal methods for management of predator mammals (Reynolds and Tapper, 1996).

## Conclusion

Gender ratio in young jackals aged 8-11 months is 2:1 to the benefit of males, in adults it is 1:1. Intensive shooting in autumn and winter months is mostly at the expense of offspring. As a result of the hunting pressure only  $\frac{1}{3}$  of the animals in each age group survive by the following hunting season.

The demographic structure of the jackal population in Sarnena Sredna Gora mountain is strongly influenced by hunting, turnover is increased, but the effect of shooting is not enough to reduce the overall number. Jackal population is restored each year by compensation mechanisms such as migration, immigration, enhanced reproduction.

## Recommendations

It is necessary winter hunt to be supported by extra mechanisms of influencing the jackal number by including non-lethal methods in the control strategy that comply with modern tendencies of predator management.

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**Book chapter or conference proceedings:** Author(s) surname and initials, year. Title. In: Title of the book or of the proceedings followed by the editor(s), volume, pages. Name of publisher, place of publication. Example:

**Mauff G, Pulverer G, Operkuch W, Hummel K and Hidden C**, 1995. C3-variants and diverse phenotypes of unconverted and converted C3. In: *Provides of the Biological Fluids* (ed. H. Peters), vol. 22, 143-165, Pergamon Press. Oxford, UK.

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### **Thesis:**

**Penkov D**, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscovy duck (*Carina moschata*, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

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