

## SEASONAL AND MONTHLY DISTRIBUTION OF DEATHS OF CYPRUS MOUFLON OVIS GMELINI OPHION

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**ABSTRACT.**— One hundred five (54M, 37F, 13L, 1 adult of unknown sex) recently dead Cyprus mouflon were collected from November 1985 to January 1998 from Pafos forest in Cyprus. Most carcasses (37.2%) were recovered in the fall (18M, 20F, 1L) followed by winter (31.4%; 24M, 8F, 0L), Spring (22.9%; 10M, 3F, 11L), and finally Summer (8.6%; 2M, 6F, 1L). The highest mortality of rams (13 rams) occurred in January, followed by December (10 rams), November (8) (during the rutting season), and September (6). Seventeen (45.9%) females were found dead in late fall, 6 (16.2%) in early winter, 6 (16.2%) in summer, 3 (8.1%) in spring and 3 (8.1%) in early fall. During the long dry summer of Cyprus, forage is reduced in quality and quantity. The high energy requirements of the rut, poor nutrition and health problems, in combination with the first winter cold, likely leads to the increased mortality observed in late fall and early winter.

**RÉSUMÉ.**— Nous avons collecté entre novembre 1985 et janvier 1998 en forêt de Pafos (Chypre) cent cinq cadavres (54M, 37F, 13L, 1 adulte de sexe indéterminé) récents du Mouflon de Chypre. La plupart des cadavres (soit 37,2%) a été recueilli en automne (18M, 20F, 1L), puis en hiver (31,4 % ; 24M, 8F, 0L), au printemps (22,9% ; 10M, 3F, 11L) et en été (8,6% ; 2M, 6F, 1L). La plus haute mortalité de béliers a eu lieu (13 béliers) en janvier, suivi de décembre (10 béliers), novembre (8) (durant la période de rut) et septembre (6). Plus concrètement, 17 femelles (soit 45,9%) sont mortes en fin d'automne, 6 (16,2%) en début de printemps, 6 (16,2%) en été, 3 (8,1%) au printemps et finalement 3 (8,1%) en début d'automne. Au long du sec été de Chypre, la production de fourrage est très réduite tant en qualité qu'en quantité. Sans doute la grande nécessité d'énergie durant le rut, la mauvaise nutrition et les problèmes de santé, associés aux premiers froids de l'hiver, provoquent une augmentation de la mortalité à la fin de l'automne et au début de l'hiver.

**RESUMEN.**— Ciento cinco muflones de Chipre (54 machos, 37 hembras, 13 crías y un adulto de sexo desconocido) fueron recogidos recién muertos desde noviembre de 1985 a enero de 1998 en el bosque de Pafos (Chipre). La mayoría de los cadáveres (37,2%) fueron recogidos en el otoño (18M, 20H, 1C), seguido del invierno

no (31,4%, 24M, 8H, 0C), primavera (22,9%, 10M, 3H, 11C), y verano (8,6%, 2M, 6H, 1C). La mayor mortalidad de carneros (13) se dio en enero, seguida de diciembre (10) y noviembre (8) (durante el periodo de celo), y septiembre (6). Setenta hembras (45,9%) murieron a finales de otoño, 6 (16,2%) a principios de invierno, 6 (16,2%) en verano, 3 (8,1%) en primavera y 3 (8,1%) a principios de otoño. El forraje se reduce en cantidad y calidad durante el largo y seco verano de Chipre. Los altos requerimientos energéticos del celo, una mala nutrición y los problemas sanitarios, en combinación con los primeros fríos del invierno, probablemente explique el incremento de mortalidad observada a finales de otoño y principios de invierno.

**Key-words:** Cyprus mouflon, Cyprus, *Ovis gmelini ophion*, mortality factors.

## 1. Introduction

The only wild caprin on the island is the endemic Cyprus mouflon (*Ovis gmelini ophion*) inhabiting the Pafos State Forest, a mountainous forested area of 620 km<sup>2</sup> (HADJISTERKOTIS, 1993; 1995; 1996a; 1996b; 2001a; HADJISTERKOTIS & BIDER, 1997). This wild sheep is listed as Endangered (A1a) in the 1996 IUCN Red List of Threatened Animals (IUCN, 1996), and its status has not changed since (HILTON-TAYLOR, 2000). Cyprus, which is located in the eastern part of the Mediterranean basin, has a Mediterranean climate with mild rainy winters (December, January and February) and long dry summers (June, July and August). During the last 15-20 years Cyprus experienced long dry autumns, which occasionally continued until mid winter (HADJISTERKOTIS, 2001b). For all Holarctic ruminants so far studied, the deaths of adults are concentrated in late winter and are associated with lack of food and loss of body weight (GEIST, 1971; BOYD & JEWELL, 1974). Because the mild rainy winters of Cyprus favor grass growth, it is expected that the high post-rut mortality and the winter losses observed in other Holarctic ruminants should not take place in Cyprus mouflon.

The purpose of this study was to examine the dates of death for males, females and the lambs and to compare the seasonal mortality of the Cyprus mouflon. The high winter mortality and the post-rut mortality, which is observed in other temperate climates was examined to determine whether it occurs in Cyprus.

## 2. Methods and materials

Carcasses of dead animals were collected in Pafos Forest. From November 1985 to December 1988 and from April 1990 to September 1991, an extensive

search for carcasses was carried out in individual valleys of Pafos Forest on foot and by car at least once a week. Foresters and people working in the forest also found some carcasses. From January 1989 to March 1990, and from October 1991 to January 1998, I collected dead animals during occasional visits to the forest. Occasionally, game wardens, police or forest officers collected carcasses. Foresters patrol the forest daily, particularly in the summer, for fire prevention. During the years 1995 and 1996 two game wardens searched for carcasses almost daily. The study was based on fresh carcasses for which the date of death could be identified. All carcasses were collected, regardless of the cause of death. To familiarize myself with the time of death and the postmortem condition of the carcasses, the organs of healthy animals were examined at various times after death in different months and seasons, since the changes in appearance resulting from decomposition can be radical (COWAN & KARSTAD, 1971).

The sex of each animal was recorded based on the primary and secondary sex characteristics, which included black throat ruff, darker colors, white saddle patch in fall and winter and horns for the males. The females are hornless and lack a saddle patch in winter, and are lighter in color. If the head was taken away by predators and most of the skin was removed, the sex was determined based on the suspensory tuberosities on the pelvis for the attachment of the ligaments of the penis (HADJISTERKOTIS, 1993; TABER, 1956). In the absence of the above criteria the sex was considered unknown. The sex was not determined in lambs because are all hornless, of the same color, and because their bones were not calcified, most of the carcass was eaten by foxes.

### 3. Results

Two hundred and fifty-one mouflon carcasses were collected. One hundred and five (54 M, 37F, 13L, 1 adult of unknown sex) mouflon were identified as freshly dead (Table 1). November was the month with the highest mortality rate (8M, 11F, 0L), while July (0M, 1F, 0L), and June (2F) were the lowest. April was the month with most dead lambs. Nine out of the 13 lambs were newborns or few days old, since parturition began at the end of March and ended at the beginning of May (HADJISTERKOTIS & BIDER, 1993). Fall (September, October and November) was the season with the highest mortality rate with 39 (37.1%) dead animals. It was followed by 33 (31.4%) in winter (December, January and February), spring (March, April, May) with 24 (22.8%) animals and summer with nine (8.6%) mouflons (Table 2).

January was the month with the highest ram mortality (13), followed by 10 rams in December. Of the 13 rams collected in January, 10 were found the first 10 days of the month. Most of the females died in late fall and early winter (Table 1). Mortality was highest in November (18.0%) and the lowest in July (0.9%) and June (1.9%).

Table 1. Number of mouflon found dead in Pafos forest from December 1985 to December 1997.

Month	Male	Female	Lambs	N. D.* Adults	Total
January	13	0	0	1	14
February	1	2	0	0	3
March	5	3	0	0	8
April	0	0	9	0	9
May	5	0	2	0	7
June	0	2	0	0	2
July	0	1	0	0	1
August	2	3	1	0	6
September	6	3	0	0	9
October	4	6	1	0	11
November	8	11	0	0	19
December	10	6	0	0	16
	54	37	13	1	105

\* N. D. = Sex not determined

Table 2. Seasonal mortality of the Cyprus mouflon in Pafos Forest, Cyprus.

Season	Male	Female	Lambs	Sex not Determined	Total
Winter	24	8	0	1	33
Spring	10	3	11	0	24
Summer	2	6	1	0	9
Fall	18	20	1	0	39
Total	54	37	13	1	105

#### 4. Discussion

The most important mortality factors of Cyprus mouflon are road kills, poaching, falling from cliffs, and predation from stray dogs. Most of the adult mouflon are suffering from parasitic pneumonia and intestinal parasites (TOUMAZOS & HADJISTERKOTIS, 1996). Adult males are suffering from spondylosis of the thoracic vertebra and the females from arthritis of the lumbar vertebra (HADJISTERKOTIS, 1995). There are however, some factors that might predispose the animals to the above problems and diseases, such as starvation, lack of nutrients and the cold weather.

According to BOYD & JEWELL (1974), in searching for potential controlling factors for the population, it is obvious that the months from December to March are of prime importance and small changes in food value, or random fluctuation in weather or other environmental parameters then, will have a disproportionate effect on population size. Low levels of important nutrients and digestible energy will result in death or abortion of fetuses, the death of ewes and rams from starvation, death of lambs as a consequence of ewe deaths, and the subsequent death of lambs due to low milk supply in the lactating ewe. In December, January and February the animals, particularly pregnant ewes, require the use of body reserves of fat and protein to maintain homeothermy. During January there must be considerable mobilization of reserves to maintain the animal. Excess of metabolizable energy in temperate climates usually exists during March, when new plant growth occurs. During this time ewes and rams eat enough to survive.

Since lambing in Cyprus take place between the end of March and the beginning of May (HADJISTERKOTIS & BIDER, 1993), the energy and protein requirements for pregnancy should start to rise in late January. In Cyprus at this time, in contrast to other temperate areas, there is an abundance of grass and forbs particularly at the edge of the forest (HADJISTERKOTIS, 1993). Thus, the nutritional crisis experienced by wild sheep in temperate areas does not occur in winter for Cyprus mouflon, and as a consequence the late winter losses are low, particularly for females (Table 1).

The high mortality observed during the spring is because of the large number of juveniles present in the population, vulnerable to accidents, poachers and occasionally predators, such as red fox (*Vulpes vulpes*). The small number of dead females found in the beginning of Spring in March, was due to the fact that this month pregnant ewes are prone to predation by stray dogs, and accidents due to falling from steep cliffs, where they go for lambing (HADJISTERKOTIS & BIDER, 1993). Contrary to the females, rams forage in open fields which are rich in grass, and perhaps it is easier to locate dead rams than females. This might be the reason for the larger number of rams collected in my sample.

The long dry Mediterranean climate summers of Cyprus are hot and dry. Usually by June all grasses are dead, and forage is reduced in quantity and quality. As pasture forage matures, the protein content declines, fiber increases, and both forage intake and digestibility decline (NRC, 1985). Most of the trees and shrubs inside Pafos Forest contain anti-herbivore substances, such as volatile oils, essential oils, tannic and gallic acids (HADJISTERKOTIS, 1993, 2001b). These oils inhibit activities in the rumen flora (NAGY & TENGHERDY, 1967; LONGHURTS *et al.*, 1968; NAGY & TENGHERDY, 1968; NAGY & REGELIN, 1977). Ninety-five percent of the diet of the Cyprus mouflon are grasses and forbs which are free of toxins (HADJISTERKOTIS, 1996b, 2001b). A seasonal chemical analysis of the

major mouflon forage species from Pafos Forest indicated that during late Summer and early Fall, grass, which is the main item in the diet of mouflon, was below the minimum requirements for maintenance required by sheep (HADJISTERKOTIS, 1993), which is 7% (NRC, 1985). Although at the end of the summer the animals face a shortage in forage, there are some factors that harmfully affect the population, increasing the loss of energy. Woodpigeon (*Columba palumbus*) hunting is permitted in august at the periphery of the forest and the hunting area overlaps the range of mouflon (HADJISTERKOTIS & HAAFTEN, 1997: map 1; HADJISTERKOTIS, 1999). During this period, thousands of hunters gather around the forest forcing the animals to retreat inside the forest, in areas with less forage and less water (HADJISTERKOTIS, 2001a). In addition to the stress, which the hunters impose on the population, a number of animals are illegally shot by poachers. The animals are further stressed at the end of October with the beginning of the rutting season, which lasts for about one month. In temperate climates in addition to loss of condition, there is a high post-rut mortality (CLUTTON-BROCK *et al.*, 1982; GRUBB, 1974). Male ruminants such as sheep and many deer species have their highest energy cost during the rut. Many lose body weight during the rut, because the time that would be spent grazing is taken up with activities such as following estrous females and fighting rival males (GEIST, 1971). The low quality food in combination with high loss of energy during the rut, the drop in temperature which increases the need for higher energy, and possibly a combination of diseases and parasites leads to a loss of condition and eventually death in both male and female. Therefore, the highest mortality for Cyprus mouflon is during the rut and the period immediately following, for one or two months. Depending on the rains, fresh grass might not appear, particularly inside the forest until one and sometimes two months after the rut. Due to the rutting season and due to the poor nutrition of the late summer and autumn, the rams have no chance to recover and they die.

Shortly after the rains the vegetation begins to grow, providing young, easily digestible material rich in protein and nutrients, especially forbs and grasses, which help the animals to recover. In addition, the winter temperatures are milder than those in temperate climates, snowfall being light and infrequent and as I observed in the Pafos Forest since 1985, rarely lying for more than a day or two. Thus the nutritional crisis experienced by other wild sheep in late winter does not occur for Cyprus mouflon.

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