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POPULATION EVOLUTION OF CANTABRIAN CHAMOIS (*RUPICAPRA PYRENAICA PARVA*) WITH SARCOPTIC MANGE (*SARCOPTES SCABIEI*) IN CENTRE-EASTERN ASTURIAS (NORTHWEST SPAIN)

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ABSTRACT.– We analyze the evolution of a Cantabrian chamois population affected by sarcoptic mange over a twelve-year period, from 1991 to 2002. This population is spread out over 83,000 ha and has reached an average density of 12.3 chamois/100 ha. The epidemic appeared an 1993, however the population continued to increase until 1995, after which it began to decrease reaching its minimum in 2001. Currently there are 35.9% of the specimens that were in evidence in 1995. The annual variation of population in sectors affected by sarcoptic mange was considerable, with maximum losses between 30-48%. The heaviest losses occurred between the first and the third year after the epidemic entered the area. Five or six years after the beginning of the epidemic, the population stablilized at a density level of 4.1-6.4 specimens/100 ha.

RÉSUMÉ.– Durant une période de 12 ans, entre 1991 et 2002, nous avons analysé l'évolution d'une population d'isard cantabrique qui a été affectée par une épidémie de gale. La population s'étend sur 83 000 ha, la densité étant de 12,3 isards/100 ha. Malgré le fait que l'épidémie soit apparue en 1993, la population a continué à augmenter jusqu'à 1995, puis a baissé jusqu'à un minimum en 2001. Actuellement, la population représente 35,9% de celle de 1995. La variation annuelle de la population dans les secteurs affectés par la gale était considérable, avec des pertes maximales entre 30 et 48%. Ainsi la plus forte perte a eu lieu entre la première et la troisième année après l'arrivée de la maladie. Puis, cinq ou six ans après l'initiation de l'épidémie, la population s'est stabilisée à un niveau de densité de 4,1-6,4 individus/100 ha.

RESUMEN.– Se analizó la evolución de una población de rebeco cantábrico afectada por sarna sarcóptica entre 1991 y 2002. Esta población abarca 83.000 ha y

ha alcanzado una densidad media de 12,3 rebecos/100 ha. La epidemia comenzó en 1993, aunque la población continuó aumentando hasta 1995, tras lo que empezó a decrecer, alcanzando su mínimo en 2001. Actualmente la población representa el 35,9% de la existente en 1995. La variación poblacional anual en zonas afectadas por la sarna sarcóptica fue considerable, con pérdidas máximas entre 30-48%. Las mayores mortalidades ocurrieron entre el primer y el tercer año tras la aparición de la epidemia en la zona. Cinco o seis años antes de la epidemia, la población se había estabilizado en una densidad de 4,1-6,4 individuos/100 ha.

Key-words: Cantabrian chamois, sarcoptic mange, Cantabrian mountain range, population dynamics.

1. Introduction

Sarcoptic mange *Sarcoptes scabiei* affects a high number of species in the world (ARLIAN *et al.*, 1989), and some species of Spanish mountain ungulates, such as the Western Iberian wild goat *Capra pyrenaica hispanica* (PÉREZ *et al.*, 1997) or the Cantabrian chamois. In northern Spain the chamois is the main species affected, although on a few occasions transmission to red deer *Cervus elaphus* and roe deer *Capreolus capreolus* (FERNÁNDEZ MORÁN *et al.*, 1997) has been recorded, a phenomenon that has also been observed in other areas (KUTZER, 1966; KUTZER *et al.*, 1990; ONDERSCHEKA, 1982; LEÓN-VIZCAÍNO, 1990; LEÓN-VIZCAÍNO *et al.*, 1994).

The chamois population we analyze in this study is refered to the subspecie *Rupicapra pyrenaica parva*, which is the smallest chamois in the world. This subspecie only lives in the north-west of Spain. Before the disease began, the total population numbered some 16000 specimens. Currently, sarcoptic mange has affected approximately half of the population, however in the next few years it will probably affect most of the remaining animals (currently over 2000 chamois are isolated from the main nuclei of the infected area).

The sarcoptic mange epidemic began in two different nuclei located about 20 km away from one another. In the first of these the epidemic was detected in 1993, and in the other in 1994. As a consequence of the spread of the disease, the two areas merged in 1998 (see Table 1). Since then, the epidemic has moved eastwards, as in other directions the lack of a continuous distribution of the species has prevented the disease's advance.

The highest percentage of deaths caused by sarcoptic mange occurs between February and May, as *Sarcoptes scabiei* reaches it's maximum level of egg-production in Autumn (ROSSI *et al.*, 1995), and at the end of Winter and the beginning of Spring, chamois are at their lowest point physically. (BARBERÍA, 1994).

Table 1. Number of chamois observed in the manual census. (The data of 1992 and 1994 have been obtained from the average values of the previous and following years).

	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
In zones with mange	0	0	179	929	1930	2355	3132	2727	3026	2691	2208	2468
In zones without mange	5457	5642	5647	5121	4343	2994	1377	1372	198	100	44	0
In the study area	5457	5642	5826	6050	6273	5349	4509	4099	3224	2791	2252	2468

2. Materials and methods

Every year from 1991 to 2002 (except 1992 and 1994), between the end of June and mid-July, 80 census itineraries were carried out to estimate the total population of the studied area (GONZÁLEZ-QUIRÓS *et al.*, 2002). The estimates for the years 1992 and 1994 has been obtained from the average values of the previous and following year.

Every year in December we made a map of the areas affected by sarcoptic mange, using the method of the maximum convex polygon, starting from the data obtained thanks to the locations of specimens observed that year which were affected by the sarcoptic mange.

We have separated four zones (S-95; S-96, S-97 and S-98), according to the year the epidemy spread out in each of them, and we have analyzed their respective changes in population. These four areas cover 82% of the total surface of the area as a whole. As a consequence of there having been initially two separate outbreaks located 20 km away from each other (which lated merged), in some zones the disease appeared on two different fronts at different times. These zones have been excluded from this study.

3. Study area

The studied area is formed by four Game Reservations (Aller, Caso, Piloña y Ponga) in Central-Eastern Asturias which cover a surface of 82,760 ha. Chamois are spread over about 80% of the territory, forming an area of continuous distribution linked to the main range of the Cantabrian Mountains.

In the study area the chamois live at altitudes ranging from 400 to 2000 meters, although they occupy mainly those areas which are over 800 meters. The average temperature is between 10 and 13 °C and the annual rainfall ranges from 1300 to 1600 mm.

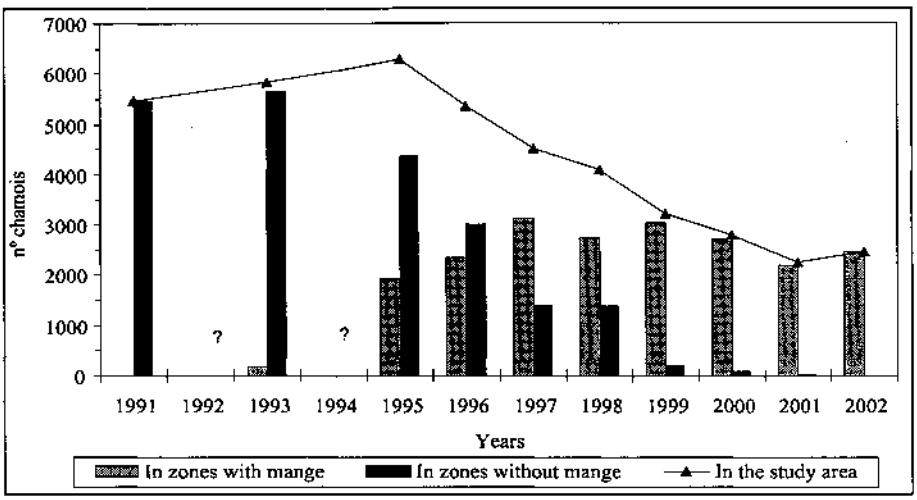

Figure 1. Evolution of the number of chamois (values of table 1) (1991-2002) in the area with mange in Northwest Spain (Asturias).

4. Results

Table 1 and Figure 1 show the results obtained in the annual censuses. Sarcoptic mange appeared in 1993 and since then, the number of chamois located in areas non affected by the epidemic has fallen as the disease has advanced. Until 1995, the total number of specimens increased, reaching in the studied areas that year, a total number of 6273 individuals. Since 1995, when more than 40% of the chamois observed were located in infected areas, the total population began to decrease until it fell to less than 2500 chamois in 2002.

The maximum fall in each zone –calculated as the percentage rate between the maximum and the minimum population levels- varies between –56.5% and –76.1%. In the total area it drops by –64.1% (See Table 2, Figure 2). However, the decrease comparing the year the epidemic arrived in each sector and the minimum population rate, varies between –55.1% and –73.0%, and –61.3% for the area as a whole.

Table 2. Number of chamois in each sector, according to the year the epidemy started in each of them.

sector	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
S-95	2021	2015	2009	1985	1961	1377	1069	880	899	1050	961	1040
S-96	1144	1124,5	1105	1114	1123	1120	582	472	454	475	392	423
S-97	1171	1366	1561	1669	1777	1679	1572	1537	861	532	424	546
S-98	719	789,5	860	879,5	899	871	870	851	716	513	286	278
total area	5457	5642	5826	6050	6273	5349	4509	4099	3224	2791	2252	2468

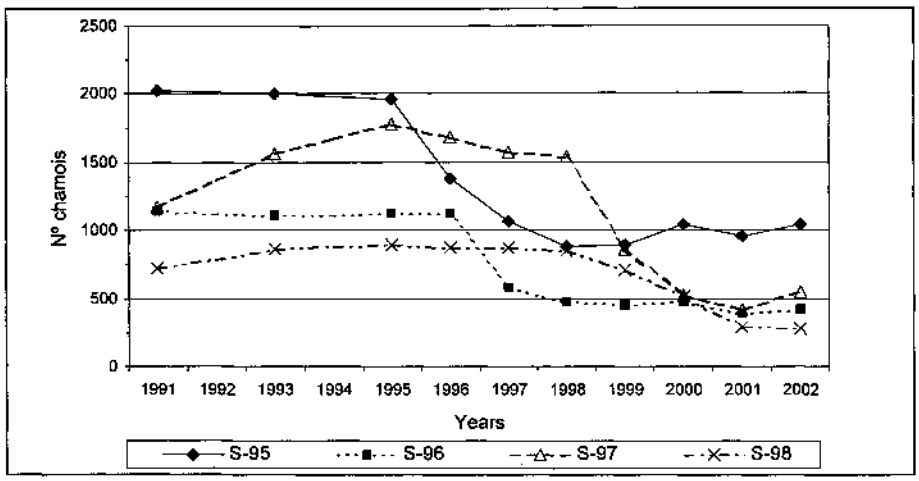

Figure 2. Evolution of the number of chamois (values of table 2) in each sector, according to the year the epidemy started in each of them.

The difference in population total from one year to the next varies in sectors affected by the sarcoptic mange, but falls of 30-48% have been recorded.

In the zones analyzed, taking into consideration the dates on which the disease began, the population evolution has followed the same pattern: population increase or stability until the entry of the disease in the area, and then decreases for the following four or six years. After 12 years study, the time between the maximum and the minimum population observed in all the zones, is 7-8 years.

Density, taken to mean the number of chamois per 100 ha, is high if we compare it with other populations (CATUSSE *et al.*, 1991). The maximum for a given zone varied between 9.5-18.6 chamois/100 ha and in the whole area reached 12.3 chamois/100 ha in 1995 (Table 3, Figure 3). After the population was reduced because of the sarcoptic mange outbreak, density dropped down to 3.3-6.7 chamois/100 ha, and for the whole area 4.4 chamois/100 ha in 2001.

Table 3. Density evolution in each sector (chamois/100 ha.), according to the year the epidemy started in the area with mange in Northwest Spain (Asturias).

sector	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	2002
S-95	9.5	9.4	9.4	9.3	9.2	6.4	5.0	4.1	4.2	4.9	4.5	4.9
S-96	18.6	18.3	18.0	18.1	18.3	18.2	9.5	7.7	7.4	7.7	6.4	6.9
S-97	9.1	10.7	12.2	13.0	13.9	13.1	12.3	12.0	6.7	4.2	3.3	4.3
S-98	13.7	15.0	16.4	16.7	17.1	16.6	16.6	16.2	13.6	9.8	5.4	5.3
total area	10.7	11.1	11.4	11.9	12.3	10.5	8.9	8.0	6.3	5.5	4.4	4.8

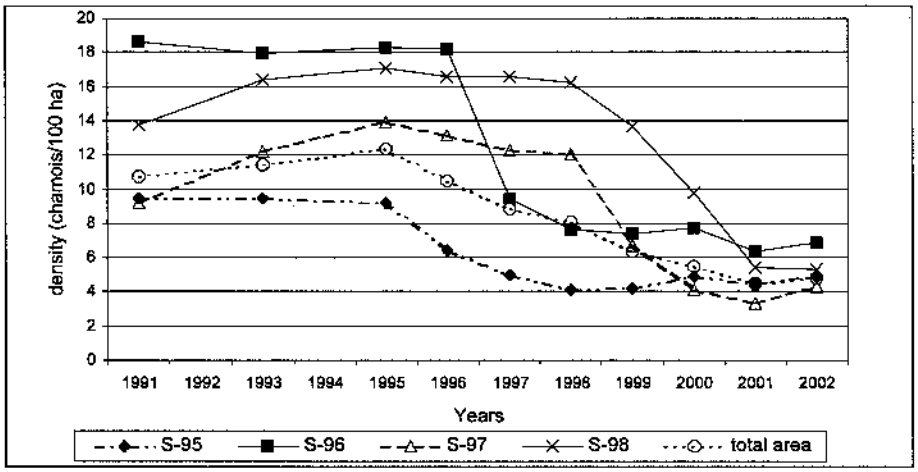

Figure 3. Evolution of the population density according to the year the epidemy started in the area with mange in Northwest Spain (Asturias).

Densities obtained before and after the disease, match with the results obtained in different areas of the Pyrenees. Densities reached in the French Pyrenees in 1990 are variable, in some protected areas these fluctuate between 4.9-16.3 chamois/100 ha, and in some game areas between 0.3-4.0 chamois/100 ha (CATUSSE *et al.*, 1991). In the same year in the National Park of Ordesa (Spanish Pyrenees) an average density of 21 chamois/100 ha was recorded (GARCÍA-GONZÁLEZ *et al.*, 1992).

5. Discussion

Although all the zones have suffered a population decrease, the rate of this decrease in each zone has been different. In zones S-95 and S-96, the most significant fall occurred one year after the arrival of the disease in the area, however in sector S-97 it occurred after two years, and in zone S-98 after three. This difference can possibly be explained by considering whether the disease initially entered a given zone in an area of sparse or dense population. In the former case the disease would take longer to affect the main population while in the latter, its effects would be more immediate. So in zone S-95 the disease was detected in 1993 but for two years it only affected a very small area (4 km^2 in 1993, 54 km^2 in 1994 of a total surface area of 213.5 km^2). We also believe that in some cases the disease was not immediately

detected upon first arrival. In zone S-97 for example, which has a total of 128 km^2, the population level slightly decreased one year before the sarcoptic mange was detected, although it was two years after when a large decrease occurred. In all probability, as is the case over the total area (See Figure 1), a large portion of the area needs to be affected in order for a sharp descent of the population to be recorded.

At the moment it is too soon to be able to understand the population demographic behaviour after the disease. In those areas where the disease has been present for more than five years, population has stabilized at low levels or even shows a light increase after having descended to low levels.

In Europe in other intense parasite processes which have lasted for 6-15 years, and in which inactivity periods are common, the percentage of deaths is higher during the initial outbreak than in later ones (KUTZER & ONDERSCHEKA, 1966; MILLER, 1985; ROSSI *et al.*, 1995).

There is no evidence of a pattern which links the population descent with the initial density of the area. Areas with low density and those with high density suffered similar decreases. Although the possibilities of contagion could be increased by the gregarious relations in the chamois group. The density of an area is usually in direct relation with the group size or with dispersive movements of the specimens (CRAMPE, 1997; JULLIEN *et al.*, 1997). We can not be sure that population stabilizes when it drops to a point of density in which the effects of the disease are reduced or even eliminated.

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