THE DYNAMICS OF SARCOPTIC MANGE IN THE IBEX POPULATION OF SIERRA NEVADA IN SPAIN - INFLUENCE OF CLIMATIC FACTORS

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Abstract: Sarcoptic mange has been affecting the Sierra Nevada ibex population since 1992, if not longer. As local inf nation on the dynamics of scabies is needed if we try to prevent and central the disease, a monitoring program was started in August 1992. Data obtained revealed that females were significantly more infested thaft males. Monthly prevalence showed a marked seasonal pattern and it was related to temperature and rainfall of previous months. On the other hand, contrary to the expected evolution of mange, a decrease in prevalence in later years or the study was observed. Moreover, the scabies-induced-mortality did not reach high levels and the ibex population density is still increasing.

Key words: *Capra* pyrenuica, climate management, parasite, *Sorceptes* senbiei. Spanish ibex.

J. Wild. Res. 2(1): 86-89, 1997

INTRODUCTION

Sarcoptes scabiei (De Geer 1778) is an astigmatic mite with a world-wide distribution producing a contagious disease, know as mange or scabies, in mammals (both domestic and wild) including man. This was the first human disease with a known aetiology (Falk 1982, Arlian 1989) and there are several effective medicaments against it. Nevertheless, to date it has been impossible to eradicate it. The history of scabies epidemiology in human and wild animal populations reveals a common pattern consisting of periodic fluctuations (outbreaks) with cycles ranging from 10 to 30 years, influenced by a variety of host, parasite, and external factors (Orkin 1975, Arlian 1989, Rossi et at. 1995). Several epizootic patterns involving wild ungulates, such a Cervus *elaphus* Linnaeus, 1758 (red deer), *Capreolus Capreolus* Linnaeus, 1758 (roe deer), and *Capra ibex* Linnaeus. 1758 (ibex) (Vyrypaev 1985), or *Rupicapra rupicapra* Linnaeus, 1758 (Alpine chamois)(Kutzer 1966, Miller 1985, Tataruch et al. 1985, Rossi et al. 1995) have been reported, both in wild populations and in those maintained in zoological gardens (Yeruham et al. 1996).

An extremely severe outbreak of sarcoptidosis recently (187-1991) produced a mortality of over 95% in the Capra *pyrenaica* Schinz, 1838 (Spanish ibex) population from the Cazorla, Segura, and Las Villas Natural Park, very near to our study area (Fandos 1991). In 1989, the epizootic reached the ibexes of the nearby Sierra Magina range mountains (Palomares and Ruiz 1993) with similar consequences. However, lack of detailed data on climate, host density and health status of the host population, dynamics of the parasite population, vectors and reservoirs involved in the disease transmission, among other factors, make comparative analysis needed to predict the spread of scabies within a given population difficult. Such information is needed to develop prevention and control programmes.

Within the context of a global management program for wild animal populations, diseases are one of the basis factors to be considered (Gilbert and Dodds 1992). In this context, certain efforts to control sarcoptic mange in wild populations have been carried out, such as that during an epidemic affecting several Swedish carnivore species, including *Vulpes vulpes* (red fox) and *Alopex* lagopus (Arctic fox), involving capture and treatment of mangy animals which gave excellent results (Morner 1992).

In this paper, the results of a four year surveillance program of the scabies outbreak affecting an ibex population from southern Spain are given. The influence of climatological factors, e.g. temperature and rainfall, on the disease epidemiology are analyzed.

Authors wish to thank to Mrs. M.C. Perez and Mr. J. Navarro for their help in field work and laboratory diagnosis, and, especially, to the gamekeepers of the Sierra Nevada Natural Park. This study has been supported by the Consejeria de Medio

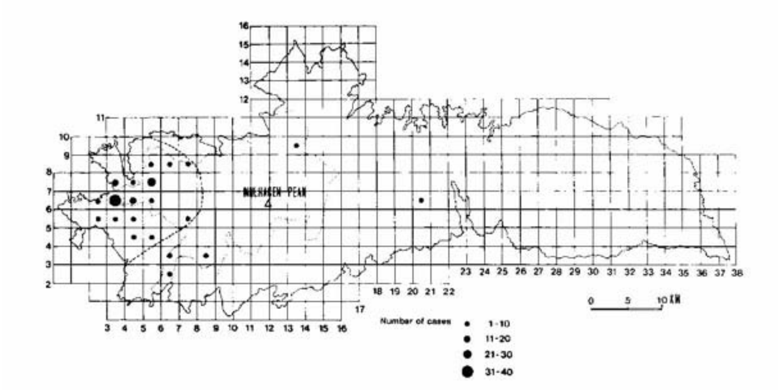

Fig. 1. The spatial occurrence of scabies cases (*Sarcoptes scabiei*) in the Sierra Nevada Natural Park, Spain, during 1992-1996. Dotted line indicates borders of the National Game Reserves, brocken line delimitates the area named as Focus I.

Ambiente (Junta de Anadalucia) and by the Fundacion Caja de Madrid (during the period 1993-1994). The climatic data were kindly supplied by the Instituto National de Meteorologia (Malaga, Spain).

MATERIAL AND METHODS

The study was conducted from August 1992 to April 1996 in the Sierra Nevada Natural Park (2°34'-3°40' N, 36°55'-37"10' E). This area includes of about 1,690 km², and comprising the highest peak of the Iberian Peninsula, the Mulhacen (1,481 mast) together with 11 other peaks higher than 3.000 m. Attitudinal gradients of temperature and rainfall, and all the bioclimatic stages described for the Mediterranean climate being present. Nowadays the natural vegetation is severely altered by different human activities, although about 2,000 endemic plant species still can be found (Valle 1985). The National Game Reserve (NGR), measuring 354 km², is located in the western zone of this natural park (Fig.l).

The prevalence of sarcoptic mange, as the percentage of animals infested from a sample (Margolis et at. 1982), was monitorized, predominantly, within the NGR. Animals were live-trapped by using corral-traps (Perez et al., in press), as well as shot during the official hunt periods, and selectively hunted, both for management purposes and when scabies symptoms were detected. The western zone of the NGR comprises the basins of three rivers: Monachil, Dflar y Dtircal. These, together with the areas between them and adjacent areas were designated "Focus I", because within them the first cases of mange, and most of the positive cases were detected (Fig. 1). The host population size was obtained for the whole natural park by line tran sect surveys carried out in 1993 (Perez et al. 1994), and 1995 (Fandos et al., unpubl. data).

A total of 554 animals were surveyed: 320 males and 234 females. Positive diagnosis of scabies was made only if mites were removed and identified. Differences in prevalence hetween host sexes and between different years (1993, 1994, and 1995) were analyzed by means of a chi-square tests.

Meteorogical data were obtained from the nearest field station, located at 37°00'N-3°33'E, and at 8901n above sea level. To determine the relationships between prevalence of sarcoptic mange (both from the whole natural park and from the "Focus I" area), and climatic variables, e.g. monthly mean temperature (°C) and rainfall (mm), a non-parametric correlation analysis (Spearman) was carried out (Siegel 1956). The influence of climatic variables from previous months on monthly prevalence

Table 1. Annual evolution of sarroptic mange prevalence (in percentage) in the ibex population from the whole Sierra Nevada Natural Park and from Focus I area.

Year	Whole Natural Park		Focus 1	
	a	Prevalence (%)	n	Prevalence (%)
1992	26	'7.7	9	22.2
1993	163	35.6	118	49.2
1994	211	18.5	60	51.7
1995	127	20.5	68	382
1996	27	14.8	13	23.1
Total/Mean	554	33.3	268	44.8

in the same way was also tested.

RESULTS

The overall mean prevalence of scabies cases obtained for the 1992-1996 period was over 23% (n=554) and reached almost 45% (n=268) within the Focus I area (Table 1). During this four-year period, the prevalence observed was significantly higher in females than in males (31.1% and 16.3%, respectively) ($_{Z}$Z=159.9; df=1; p<0.001). Mange symptoms were detected, and *Sarcoples seeable(* specimens were removed from 69.8% of dead ibexes (n=53). all of them found within the area named Focus I. The spatial spread of sarcoptic mange within the study area is shown in Fig. 1, being the widest distribution of positive cases observed during 1994.

Significant differences were observed in monthly prevalence of scabies cases for animals within the whole park among different years *(x'=72.9; df=22;* p<0.001). However, within the Focus I area, interannual differences in monthly prevalence proved to be not significant (x' =32.3, *df=22;* p>0.05). Within this area, the prevalence showed a seasonal pattern, reaching the highest values within the period comprising winter and spring months (Fig. 2B). A clear increase in prevalence was also noted in September. Prevalence in the whole park and Focus I area showed a significant correlation: (r,=0.892; p<0.01; n=39), although they did not fluctuate in similar ways with climatic factors studied.

The mean monthly temperatures and rainfall for the period August 1992-April 1996 are included in Table 2. A significant correlation between the monthly prevalence for the whole park (P_{eep}) and the mean rainfall for the 3 previous month-period (Rs,): (r=-0.371; p<0.05; n=39) was detected. These P_{wp} values were also significantly negatively correlated with temperature (T) for the previous month: (r,=0.395, p<0,05; n=40). These variables could be described by the equation: Pw,,r=115.43 — 2.528*T 1.32*R. No significant correlation was obtained between monthly prevalence from the Focus I area and climatological variables.

Table 2. Mean monthly temperature (°C) and rainfall (mm) in the Focus I area, for the period from August 1991 to April 1996.

Months	Temperature		Rainfall	
	Mean-18D	Range	Mean±SD	Range
January	9.582.4	7.7-13.0	26.6±18.1	8.5-44.7
February	10.581.5	8.5-12.0	30.08221	4.9-58.8
March	11.631.0	10.5-13.0	22.2±10.8	7.2-32.5
April	13.2-812	11.6-14.5	28.0±14.4	7.9-41.3
May	17.7-80.7	17.0-18.6	14.6±10.0	0.5-23.0
June	20.830.4	20.2-212	12.3±17.4	0.0-36.9
July	24.2±2.1	21.2-26.0	—	
August	25.331.2	24.0-27.3	1.381.9	0.0-4.0
September	19.930.5	193-20.5	7.585.8	1.0-13.5
October	16.5±0.7	15.5-17.4	52.0±324	4.3-87.7
Novansher	12.831.4	10.5-14.0	37.1±15.5	20.5-57.9
December	9.180.6	8.5-9.8	35.2349.0	t-4-119.6

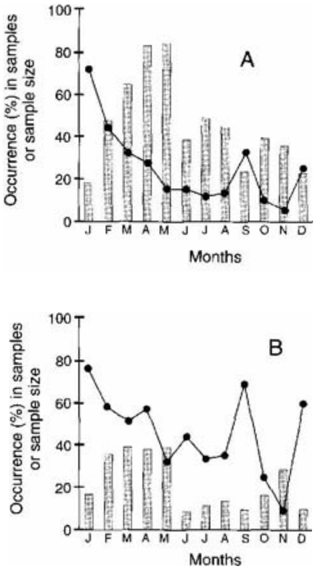

Fig. 2. Seasonal fluctuations of the sarcoptic mange (Sarcoptes *scabies)* in the Sierra Nevada Natural Park (A) and in the Focus I area (B). Bars indicate monthly sample size. Data were collected during 1992-1996.

An increase of the overall host population density was observed: from 7.7 ibexes/km' in 1993 (Perez et al. 1994) to 8.7 ibexes/km' in 1995 (Fandos et al. unpubl. data). The sex-ratio was near 1:1 throughout the whole study period: 0.8:1.0 to 1.2:1.0 for the 1993 and 1995, respectively. The number of kids/adult female increased from 0.39 in 1993 to 0.46 in 1995.

DISCUSSION

When a sarcoptic mange outbreak arises within an animal population, two possible sources can be considered: a) the disease has an external origin and is transmitted by infested animals belonging to the same, or different, host species; orb) the epizootic has an origin within the host population, being produced because mutation of a present and established mite strain leads to more pathogenic parasites, and/or the host population becomes more susceptible to the disease (Kutzer 1966, Samuel 1981, Morner 1981, 1992, Pence et al. 1983). In this case, the transmission of scabies from domestic sheep and goats has been suggested, although no evidence exists to support this hypothesis.

Once the sarcoptic mange affects a wild population, we would expect it to become endemic and it's practically impossible to eradicate it (Arlian 1989, Wobeser 1994). Chronic infestations by *Sarcoptes scabiei* eventually can produce host death, but the mechanism of mortality (in which certain inner host tissues can be effected by amyloidosis) still remains unclear (Pence et at. 1983, Tataruch et al. 1985, Arlian et al. 1990). Moreover, after the first contact with the parasite, high rates of mange-induced mortality can occur. This seemed to be the case for the ibex population from the Sierras de Cazorla, Segura y Las Villas Natural Park, which declined dramatically in a four-year period (Fandos 1991). In later stages, successive epizootic waves can be expected, with lower levels of mortality (Rossi et al. 1995). This was our first impression when attempting to describe the scabies outbreak dynamics in SiercaNevada, but lack of previous data made it impossible to confirm this hypothesis. However, the prevalence of scabies cases may be underestimated because of the difficulty in finding mites during the early stages of the disease.

Apart from immunological and physiological factors involving both the parasite strain and host population, there are other factors involved in the dynamics of the disease, such as host density and climatic factors. It is know that temperature and relative humidity (RH) directly affect the viability *of* mites, especially when they leave the host. Periods with low temperatures and high RH levels are favourable for the parasites (Fain 1978, Arlian et al. 1984, Ibrahim and Ahu-Samra 1987, Arlian et al. 1989). To date, the recent extremely dry years (especially the period 1992-1994) could explain the relatively slow spread of the disease and the low prevalence and mortality observed in the Sierra Nevada ibex population. Our results indicate that the effects of climate on the epidemiology are not noted immediately, but during the following months. The importance of rainfall has been previously reported by Vyrypaev *(1985).* It is also know that the severity of the skin lesions caused by the mites increases at high RH (Ibrahim and Abu-Samra 1987).

On the other hand, summer months would he those most unfavourable for the parasite. This period therefore seems to be the most appropriate to intensify control measures for scabies, in order to achieve greatest efficacy (Hawthorne 1980).

In the near future an increase in the disease prevalence and induced mortality is possible, because host density is still increasing. A spread of scabies to the east part of the massiff mountains can also be expected. In our opinion, the dynamics of the disease throughout wild ungulate populations from adjacent locations, together with the health status of domestic livestock which exploit the high mountain summer pastures in the Sierra Nevada, need special attention. Strict veterinary control of livestock, together with an appropriate management of ibex density, may effective measures for the prevention and control of scabies in the area.

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