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SARCOPTIC MANGE IN SPANISH IBEX FROM SPAIN

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ABSTRACT: The Spanish ibex (*Capra pyrenaica hispanica*) population of the "Sierras de Cazorla, Segura y Las Villas" Nature Park (Spain) was isolated as the result of a severe epidemic of sarcoptic mange. In this context, the dynamic characteristics of the disease were analyzed in a wild group consisting of 35 animals from the beginning of the epizootic (when the mating period started) to the extinction of the population due to mange. Monthly tracking permitted the sequential characterization of the pathology in each animal. The duration of the disease was 2 to 3 mo, evolving to severe disease and terminating in death. Incidence and prevalence rates in terms of morbidity and severity, and mortality and lethality were calculated. At the end of the mating season, 81% of the population were affected. There were no statistically significant differences in severity of the disease across sex or age categories of the animals. Most of the carcasses were found in caves used as refuge and/or near rivers or streams. Additionally, 46 of the 63 (73%) ibex captured in different areas of the nature park were naturally infected with the *Sarcoptes scabiei.* Infected ibex were examined for number of mites during the initial stage of the disease ($n = 3$), in the development stage ($n = 12$), in the consolidation stage ($n = 17$), and in the chronic stage ($n = 14$). The prevalence of mites in different anatomical regions was determined in each of these phases of the infection. A histological study of the skin lesions was conducted in 22 animals. Both the clinical and the pathological (macroscopic and microscopic) aspects of the sarcoptic mange in Spanish ibex corresponded to the classic description of sarcoptic mange in other wild and domestic small ruminants.

Key words: Capra pyrenaica, epidemiology, mange, pathology, *Sarcoptes scabiei,* Spanish ibex, symptomatology.

INTRODUCTION

The Spanish ibex (*Capra pyrenaica*) is an ungulate found only in Spain. Of the three extant subspecies, *C. pyrenaica pyrenaica, C. pyrenaica victoriae* and *C. pyrenaica hispanica,* the natural populations of the *C. pyrenaica hispanica* are found in a large part of the massifs of southern and eastern Spain (Fandos, 1991). The "Sierras de Cazorla, Segura y Las Villas" Nature Park (Cazorla NP) is a mountainous area of 2,140 km^2 located in the eastern side of the Betic Mountains (Spain). In 1987 this habitat had the largest population of Spanish ibex (about 9,500 animals) recorded at that time in Spain (Escos, 1988) and there also was a high census of other wild ruminants (red deer, fallow deer, and wild sheep). Also, various herds of domestic small ruminants, both indigenous and foreign, grazed both within and outside the boundaries of the nature park.

Wild animals have been severely affected by sarcoptic mange (Acari: *Sarcoptes scabiei*) worldwide. In fact, mange is not a rare parasitic condition among free-roaming ungulates in Europe. Kutzer (1966) and Kutzer and Onderscheka (1966) reported a mange epizootic affecting chamois (*Rupicapra rupicapra*), red deer (*Cervus elaphus*), and roe deer (*Capreolus capreolus*) in the Austrian Alps. Mange epizootics in chamois are described in Yugoslavia (Varicak, 1985), Germany (Miller, 1985), and Spain (Fernández-Morán et al., 1997). On the Italian side of the Alps, Rossi et al. (1995) reported the disease both in chamois and ibex (*Capra ibex*). Of special interest, due to the phylogenic

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proximity of the affected species (*Capra ibex sibirica* and *Capra pyrenaica*), is the mange epizootic studied by Vyrypaev (1985) in the Asian Republic of Kirgizia. The mortality rate was high in all of these epizootics.

As in other countries, sarcoptic mange is present in domestic animals in Spain (Alonso and Miro, 1977), but there were no previous reported cases of the disease in wild animals (Sánchez and Cuellar, 1983). In late 1987, an epizootic of sarcoptic mange occurred in the Cazorla Nature Park, and it still persists. At first, it affected only the Spanish ibex population (León-Vizcaíno et al., 1989), but later it was found both in other wild ruminants in the National Park (León-Vizcaíno et al., 1992). A few years later, sarcoptic mange is reported in other populations of Spanish ibex in southern Spain (Pérez et al. 1992; Palomares and Ruiz-Martínez, 1993; Pérez et al., 1997).

The information available on sarcoptic mange in the Spanish ibex is limited. Most of the reported studies refer to geographical descriptions of the disease. The aim of this study was to provide a detailed description of the demographic dynamics of a small population of Spanish ibex affected by an epizootic of sarcoptic mange. Also, we describe both the symptomatology and the skin lesions found in *C. pyrenaica hispanica* naturally infected with *S. scabiei*.

MATERIALS AND METHODS

Epizootiology

The study was conducted on a population of wild Spanish ibex which were localized in an area called "Los Rasos" (WG029913; 37°50′03″N, 2°54′39″W). This population was selected because (1) we were familiar with its demographic structure, and (2) the source of the epizootic was known to be two adult males which became established within the group of apparently healthy females and juveniles (mid-November 1988). These events allowed us to establish quite accurately the onset of the mange epizootic in this population.

The "Los Rasos" population of Spanish ibex was found throughout a 9 km^2 area which was well delimited by geographical features. It consists of a plain and a sharp slope with a rocky wall ending in natural terraces. Half way up this wall are three caves used by the animals as a refuge. At lower elevations the land is covered with grass and sparse Mediterranean woods, but above the flat area the vegetative understory becomes thicker. Approximately 40% of the area in which the ibex live can be observed quite well (visibility 60%) from two ridges at the eastern and southern extremes of the area.

The population of Spanish ibex studied consisted of 11 adult females, 15 juveniles (7 animals between 1- and 2-yr-old, and 8 yearlings), and 9 males (5 sub-adults, 3 adults, and 1 old adult) joined the group in November, at the beginning of the mating season. The males were easily identified by both the individual pattern of the spots on their bodies and the number of growth rings and the morphology of their horns (Fandos, 1991). Females differed from the juveniles in the degree of body and horn development. The use by each family group of a different geographical area favored the identification of individuals. An identification sheet was compiled for each animal, including photographs.

Our observation period lasted for 6 mo, while the mange epizootic in the population studied persisted for a much longer period. It consisted of two consecutive periods of (1) the mating period from the incorporation of males into the female and juvenile group (mid-November 1988) to the end of January 1988 and (2) the post-mating period from when the males left the group until the disappearance of the "Los Rasos" group due to mange mortality (April 1989).

The evolution of sarcoptic mange in this population was monitored by means of daily telescopic observations during the last week of each month. Moreover, in the last 2 days of each week the area was studied, including caves, and was carefully explored to locate carcasses. Throughout the study period, forest wardens looked for dead animals even outside the described geographical area. Each corpse was identified according to the identity sheets. The topographical site where it was found, individual characteristics, and the spread and intensity of sarcoptic lesions were recorded. Also, skin scrapings were analyzed to verify the presence of *S. scabiei*.

Sarcoptic mange cases were characterized according to the stages described by Jackson et al. (1983) and Sheikh-Omar et al. (1984) for domestic goats. Using telescopic observations it was impossible to distinguish healthy animals from those in the initial stage. But it was easy to catalog them in the subsequent developmental (pruritus), consolidation (intense pruritus,

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poor appearance of the skin and bald areas) and chronic stages (emaciation, abnormal movements, long periods lying on the ground, and crusty skin only sparsely covered in hair).

The monthly evolution of the disease was expressed by means of both morbidity and mortality prevalence rates (clinical and mortal mange cases related to the monthly census of the animal group respectively) and severity and lethality prevalence rates (chronic and mortal mange cases related to the clinical cases observed monthly). The total number of mange cases described over a concrete period (total deaths plus affected survivors at the end of the period) was referred to as the disease rate. The monthly disease flow was calculated using the monthly incidence rate (new mange cases described during one month compared to the number of healthy animals at the beginning of that month) and the monthly accumulated incidence rate (new mange cases described in a month plus previous cases related to the initial census of animals) (Thrusfield, 1990). See Table 1 for a definition of epizootiological terms used herein.

A monthly evaluation of the pathogenic stage (healthy, developmental, consolidation, chronic, or death) of each animal studied, individually and in sex and age groups (males, females; juveniles, adults) was conducted in order to describe the clinical evolution of the disease. At the end of the mating period the relative frequency of each pathogenic stage was calculated for each of these three groups, except at the end of the study, when the population studied had become extinct.

Pathology

During the first epizootic of mange in the Cazorla NP (from 1987 to 1995), its population of Spanish ibex was cataloged as a legally protected species. For this reason no experimental infections were performed in order to study the pathology of scabies in *C. pyrenaica.*

The management of the Cazorla Nature Park started a capture and mange treatment plan to establish a healthy population from among those wild animals affected by the mange epidemic. The efficiency of this plan of action is not the subject of the present study. To capture the animals, four pens were constructed using a thick fence made with plant ropes and a curtain door operated manually from a distance. The animals were attracted to the pen with salt and alfalfa. For better transportation and clinical inspection, the animals captured were anaesthetized with a combination of 10 μg/kg body weight of Ketamine (Imalgene®, Rhône Mérieux, Lyon, France) and 200 μg/kg body weight of Xylacine (Rompum®, Bayer, Leverkunsen, Germany).

Sixty-three animals were carefully analyzed as they were captured. These records were used to develop a clinical study of the disease. To characterize the disease in these animals, the four pathologic stages described by Jackson et al. (1983) and Sheikh-Omar et al. (1984) for mange in the domestic goat were the (1) initial period with skin apparently normal, but *S. scabiei* observed in scrapings; (2) developmental period with skin inflamed and with pruritus especially on the face, and on bony projections; (3) consolidation period with intense pruritus, alopecia, hyperkeratosis and self-excoriation; and (4) chronic period in which there was emaciation, skin sparsely covered in hair, numerous scabs, and deep dermal fissures. Clinical observations were always associated with finding mites in derm biopsies.

Parasitology

Both captured and infected animals as well as carcasses were carefully examined to determine the presence of mites. For this purpose deep scrapings were made of the epithelium with a scalpel blade, until causing haemorrhage. The microscopic study of skin scrapings involved the analyses of three 4 cm^2 biopsies taken from 18 external regions on both sides of the body including the face, retro-articular region, neck, shoulder, costal area, elbow, carpus, chest, axilla, back, flank, lumbar-sacral region, coxal tuber region, knee, tarsus, abdomen, groin, and scrotum. Samples were treated with a 10% KOH solution and incubated at 37 C for 8 hr. They were centrifuged at 800 × *g* for 5 min and the resultant supernatant was discarded. Tubes were filled with a saturated glucose solution and after 10 min the top layer was removed to observe the mites under a steroscopic microscope with 4× and 10× lenses. Specific identification of the parasite was performed following the descriptions given by Pence (1984) and Mehlhorn et al. (1992). The relative frequency (RF) of external regions of the body parasited by *S. scabiei* was calculated (average of external regions/number of diseased animals) for each of the different pathologic stages of sarcoptic mange in the captured infected animals.

Histopathology

A histological analysis of skin lesions was conducted in 22 individuals suffering from severe mange to a few hours after death in several geographic areas of the Cazorla Nature Park (including the "Los Rasos" area). Diseased animals in the pre-mortem stage were

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euthanized in the field with a lethal injection of sodium barbital solution (Tiobarbital®, Palex S. A., Jaén, Spain). Pieces of skin with mange lesions due to *S. scabiei* were taken from these animals and from carcasses. Tissues were fixed in a pH 7.2 buffer solution with 10% formol, embedded in paraffin, cut into 5 μm-thick sections and stained with haematoxyline-eosin and van Giensson methods (Nezelof et al., 1972).

Statistical analyses

The differences in the monthly rates of mange infection were compared using a *t*-test. Chi square and Fishers exact analyses of 2×2 contingency tables was used (1) to evaluate differences between mite intensity on the two sides of the body, and (2) to compare the prevalence data of affected Spanish ibex across age and sex classes during the mating season. To determine if the mange distribution on the body corresponded to a profile, the relative frequency of the affected corporal areas of animals grouped in each of the four pathologic stages were analysed with ANOVA (Tukey's method). Statistical analyses were accomplished using the EpiInfo 6 integrated epidemiological statistic package (Dean et al., 1994) and SPSS software (Ferrán, 1996).

RESULTS

Epizootiology

The epizootic of sarcoptic mange in the "Los Rasos" Spanish ibex population started at the beginning of the mating season (mid-November 1988), when two adult males with mange (consolidation stage) arrived. The disease was specifically confirmed by means of parasite isolation and the study of macroscopical and histological skin lesions in three mortalities recorded in December. Mange escalated to the epizootic level, the whole population being affected in 5 mo (Fig. 1).

Duration of infection in most of the 35 animals (Fig. 1) lasted for 2 mo (19 cases, relative frequency [RF] = 0.54) or 3 mo (13 cases, RF = 0.37), with extreme values of 1 mo (1 case, RF = 0.03) to 4 mo (2 cases, RF = 0.06).

The presence of *S. scabiei* was measured by the incidence (new cases) of pathogenesis in terms of morbidity and mortality. The evolution of the disease always increased in a highly contagious way; the accumulated incidence increased from 6% to 100% in 4 mo: 6% in November, 37% in December, 82% in January, 97% in February and, 100% in March 1989 (Table 1). Statistically significant differences ($P < 0.0001$) occurred after the first 3 mo. In addition, the number of new cases increased monthly with regard to the healthy monthly population (disease rate).

The monthly prevalence of morbidity increased until the end of the mating season (maximum $P_{morbidity} = 59\%$). The rate then maintained a slightly lower level, which was constant until the population disappeared. The monthly prevalence of mortality increased gradually during the mating period and sharply increased during the following 3 mo until it reached 100%. The analysis of both rates as a whole showed the rapid increase of the monthly prevalence of illness during the mating season, which then decreased until all the animals were affected. The kinetics of the prevalence of illness were similar to the incidence rates, especially to the accumulated incidence rate.

Sarcoptic mange evolved as a very severe disease. The prevalence of disease severity reached 40% in the second month of the epizootic; from that moment on it maintained high levels, ranging from 40 to 66%. Alternatively, as far as the duration of the disease (2–3 mo) was concerned, the prevalence of lethality increased noticeably 3 mo after the beginning of the epizootic.

During the mating period, males showed a more severe evolution of the disease ($P_{severity}$, $P_{mortality}$, and $P_{lethality}$), but it was less frequent ($P_{morbidity}$) than in females and young individuals (Table 2). In this stage, all the adult males fell ill in <2 mo (Fig. 1). Males developed the disease in a more severe form than juveniles, progressing from healthy to illness in the developmental (1/4) or in consolidation stage (1/4) and dying, if they were initially in the consolidation stage (2/4). Alternatively, most of the juvenile population (4/5) took longer (until the end of the mating period)

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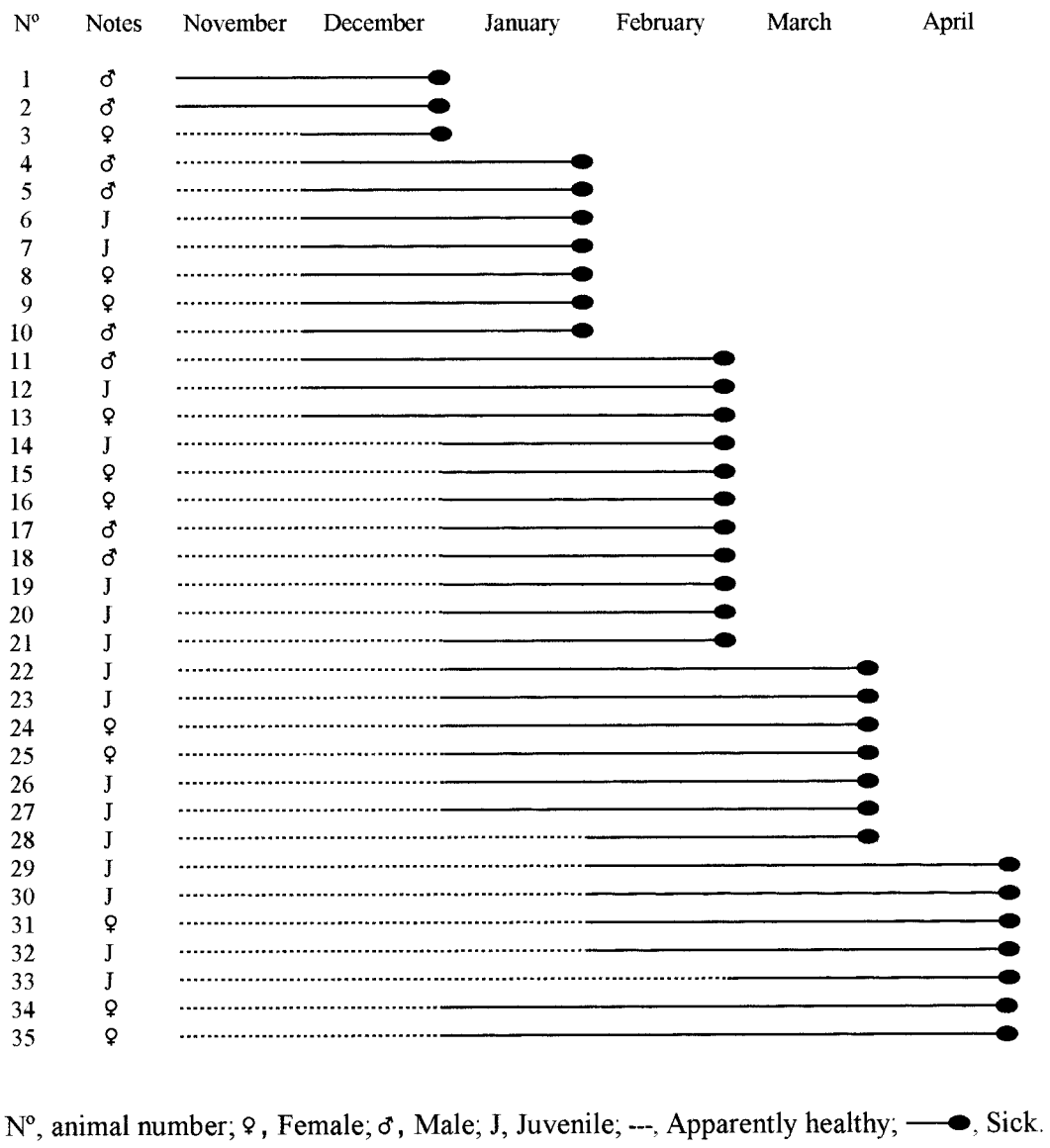


FIGURE 1. Individual evolution of sarcoptic mange in the Los Rasos population of Spanish ibex (Cazorla, Segura y Las Villas Nature Park).

to progress to the chronic stage (3/5) or to die (1/5).

All the animals progressed steadily toward the consolidation and chronic stages, and finally died from the mange (Fig. 2). The animals' movement became increasingly difficult and their extraordinary climbing ability was altered to the point where many even fell to their deaths. They lost their flight reflexes, developed cachexia and finally died. Carcasses were found in typical sites such as inside or near the caves normally used by the Spanish ibex as a refuge (n = 11, RF = 0.31), on the routes to the nearest water courses (n = 20, RF = 0.57), and in the rest of their territory (n = 4, RF = 0.11). We counted as many carcasses as there were registered animals comprising the "Los Rasos" population. Some individuals were found to

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TABLE 1. Monthly kinetics[a] of a sarcoptic mange epizootic in "Los Rasos" population of Spanish ibex (prevalence and incidence rates) in Spain.

Parameters	Month					
	Nov	Dec	Jan	Feb	Mar	Apr
Diseased animals[b] (A)	2	10	19	13	6	0
Critical diseased animals[b,c] (B)	0	4	8	6	4	0
New cases (C)	2	11	16	5	1	0
Deaths (D)	0	3	7	11	8	6
Total cases[d] (A+D)	2	13	26	24	14	6
Initial census (E)	35	35	32	25	14	6
Initially healthy population (F)	33	33	22	6	1	0
Prevalence of morbidity[b] (A/E)	0.06	0.29	0.59	0.52	0.43	0
Prevalence of mortality (D/E)	—	0.09	0.22	0.44	0.50	1.0
Prevalence of disease[d] (A+D/E)	0.06	0.37	0.81	0.96	1.0	1.0
Prevalence of severity[b] (B/A)	—	0.40	0.42	0.46	0.66	0
Prevalence of lethality (D/A+D)	—	0.23	0.27	0.46	0.57	1.0
Incidence of disease[d] (C/F)	0.06	0.33	0.73	0.83	1.0	0
Accumulated incidence (Ci+ . . . Cn/Ei[e])	0.06	0.37	0.83	0.97	1.0	—

[a] Epidemiological terms defined in Thrusfield (1990).
[b] Calculated during the last week of each month.
[c] Animals in chronic stage.
[d] Ill and dead animals.
[e] Calculated as the total of new cases plus those recorded since the first month studied in reference to the initial census of animals.

have fallen below the entrances to the caves. After the mating period (in February), two sub-adult males (17 and 22, Fig. 1) were found dead 3.5 km from the "Los Rasos" territory.

TABLE 2. Clinical evolution and prevalence rates of sarcoptic mange during the mating season according to age and sex of animals.

Category	Males (n = 9)	Females (n = 11)	Juveniles (n = 15)
Pathogenic Phases			
Healthy	0[a] (0.0)[b]	1 (0.09)	5 (0.33)
Development	0 (0.0)	1 (0.09)	2 (0.13)
Consolidation	1 (0.11)	4 (0.36)	3 (0.20)
Chronic	3 (0.33)	2 (0.18)	3 (0.20)
Death	5 (0.56)	3 (0.27)	2 (0.13)
Affected	9 (1.0)	10 (0.91)	10 (0.67)
Prevalence Rates			
Morbidity	0.44	0.63	0.53
Mortality	0.55	0.27	0.13
Disease	1.0	0.91	0.67
Severity	0.75	0.28	0.37
Lethality	0.55	0.30	0.20

[a] Absolute frequency = number of cases (see Thrusfield, 1990).
[b] Relative frequency = number of cases/number examined (see Thrusfield, 1990).

The entire skin of the carcasses appeared markedly scabby, keratinized, dry and cracked. The lesions around the mouth, which made it difficult or even impossible to bite and masticate food, and eyes were especially intense. Likewise, the fragility and sparseness of the hair were noticeable.

Histopathology

Between March 1989 and June 1989, 63 Spanish ibex were captured. Seventeen (27%) were registered as mite-free. Subsequently, 46 (73%) were found infected with *S. scabiei.* In each case, the affected Spanish ibex had been classified in one of the four pathogenic stages of mange: initial (n = 3, RF = 0.07), developmental (n = 12, RF = 0.26), consolidation (n = 17, RF = 0.37) and chronic (n = 14, RF = 0.30).

Statistical (chi-square) analyses showed no significant differences between mite occurrence on the two different sides of the body. Alternatively, Tukey's test (Fig. 3) indicated that the disease tended to start (initial stage) on the face, shoulders, carpus and tarsus. In the developmental

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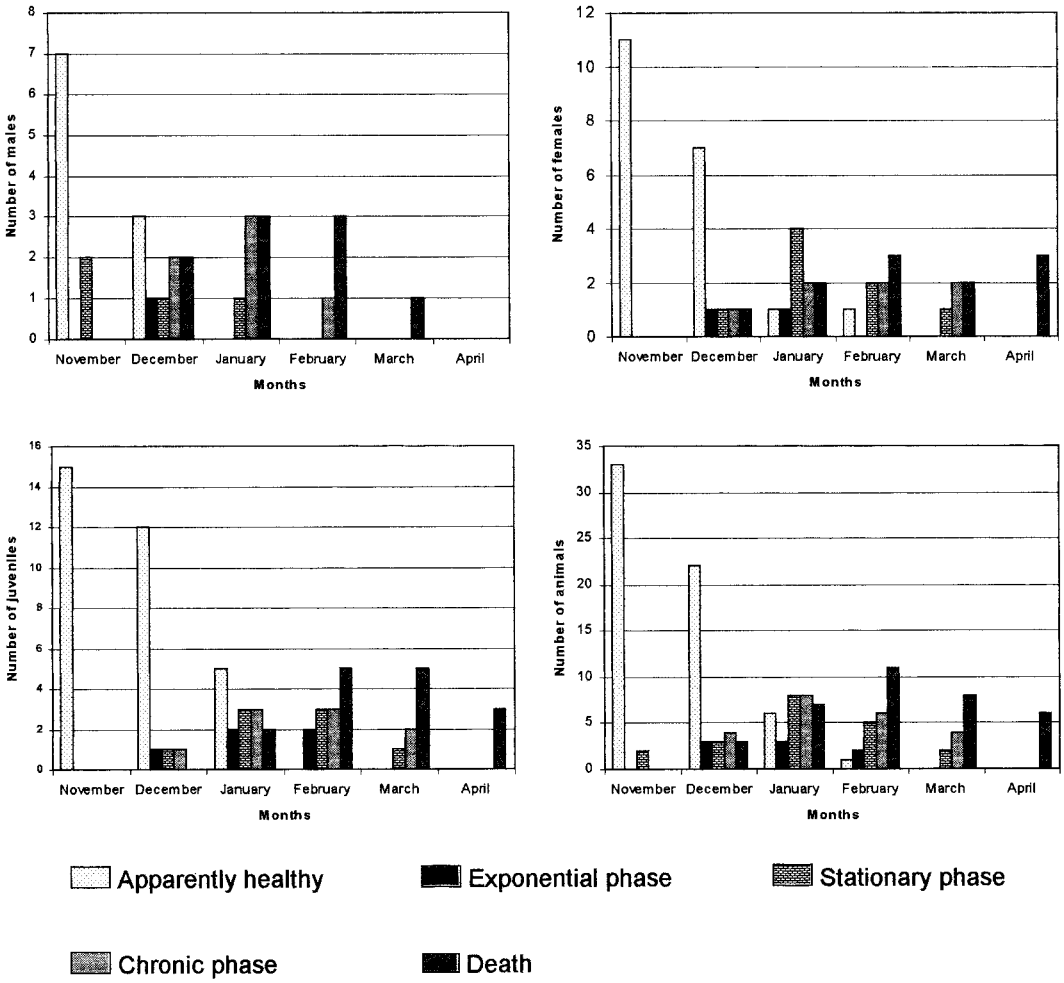


FIGURE 2. Chronologycal evolution of healthy Spanish ibex and those at different pathogenic stages of the disease, grouped according to sex and age.

stage, *S. scabiei* spread to the neck, elbow, ear, and knee; it showed higher prevalence rates in the costal, lumbar-sacral, and groin areas than in others. In the consolidation period the mite could be isolated from all the corporal areas, but it was less frequent in back, axilla, and flanks. Finally, in the chronic stage of the mange the parasite was detected in all areas of the body.

The three sick animals we examined in initial stage showed mild pruritus on the head, neck, and back. Their skin appeared generally normal, but hosted mites especially in the head, neck, shoulders and extremities, and (to a lesser extent) in the chest and pelvis (Table 3).

In the development stage, the animals' appearance was largely normal, but they showed generalized pruritus. Underneath the apparently normal hair covering, the skin was seen to be red. In most cases *S. scabiei* was detected in the head, neck, shoulders, and extremities, to a lesser extent in the back, abdomen and flanks, and to a moderate degree in other external areas (Table 3).

Mange in the consolidation stage was detectable with the naked eye because of the continuous pruritus and the skin lesions (lusterless skin and numerous bald patches). They were more frequent in the head, neck, shoulders, and extremities, but

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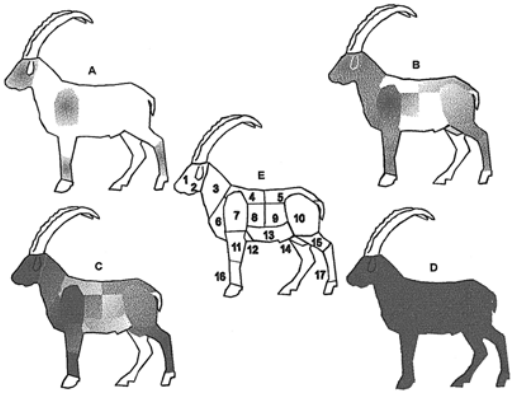


FIGURE 3. Profile of the spread of *Sarcoptes scabiei* in the areas of the body of Spanish ibex studied at different pathogenic stages of mange. A. Initial stage when the mite was isolated on the face,[1] shoulder,[7] carpus,[16] and tarsus.[17] B. Developmental stage when the mite increased its presence in neck,[3] elbow,[11] ear,[2] and knee,[15] and could be detected in pelvis,[10] costal area,[8] chest,[6] groin,[14] and lumbar-sacra[15] area. C. Consolidation stage when mites spread to the back,[4] axilla,[12] abdomen,[13] and flanks.[9] D. Chronic stage when all external areas were infected with mites.

careful observation revealed the presence of mange lesions in most of the body. The skin had lost its elasticity and became scabby and cracked, the hair was fragile and sparse, and there were abundant bald patches. Numerous excoriation skin flakes and severe exudation also were noted. *Sarcoptes scabiei* was detected in all the described external regions, but the back, axilla, flank, and scrotum were less frequently infected. (Table 3). Finally, animals in the chronic stage of infection showed all the external areas of the body severely to be affected, with worse degrees of hyperkeratosis and alopecia than those recorded in the consolidation stage of the disease. All external areas were infected with mites (Table 3).

Histologically, mite segments were located mainly in the stratum corneum and also in the stratum granulosum. They were surrounded by a series of concentric layers of keratin. The skin surface had foci of epidermal edema and necrosis consisting of cellular debris and cellular infiltration (lymphocytes, eosinophils, macrophages, and a few neutrophils).

In parasite-free areas, the epidermis was slightly hyperkeratotic. The highly infected areas revealed histopathological changes consisting of chronic inflamation of the epidermis with acanthosis, hyperkeratosis and parakeratosis, mild to moderate follicular hyperkeratosis and vascular dilatation (Fig. 4).

Beneath the dermis, there was fibroplasia with condensations of dermal connective tissue accompanied by an inflamatory infiltrate of macrophages, basophils, eosinophils, and neutrophils, lymphocytes, plasma cells, mastcells, and fibroblasts (Fig. 4). The deepest layers showed proliferation of fibroblasts and the skin was thickened and packed with collagen. The most extensively involved areas showed elongation of the dermal papillae, and there were often abscesses in the interpapillary spaces.

On the annexal portions of the skin there appeared degenerative processes, especially in the sudoriparous glands. Their epithelial cells showed an intensely basophilic cytoplasm and pycnotic nuclei, and some were seen to be separate from others by a basophilic amorphous substance. Also, there were alterations in the hair follicles, especially in the medular portion of the hair. The lesions were occasionally accompanied by microabscesses.

DISCUSSION

There is good evidence that the mange epizootic which destroyed the population of Spanish ibex in the Cazorla NP (León-Vizcaíno et al., 1992) and which still persists, had its origin in the introduction of infected domestic goats. This adaptation of *S. scabiei* to a new highly susceptible and receptive host was one of the hypotheses proposed by Arlian et al. (1989) as the cause of sarcoptic mange epizootics in previously mange-free populations.

Original epizootics, such as the one which occurred in the Cazorla NP, usually bring fatal consequences to the population in a short time (Miller, 1985; Rossi et al.,

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TABLE 3. Absolute frequency of corporal regions and relative frequencies of the average of symmetric corporal areas with *Sarcoptes scabiei* in Spanish ibex at different pathologic stages of the disease.

	Initial stage (n = 3)					Developmental stage (n = 12)					Consolidation stage (n = 17)					Chronic stage (n = 14)				
	Side			Cases		Side			Cases		Side			Cases		Side			Cases	
	[a]L	[b]R	[c]RF	[d]AF	RF	L	R	RF	AF	RF	L	R	RF	AF	RF	L	R	RF	AF	RF
Face	2	2	0.66	2	0.66	10	10	0.83	11	0.91	16	15	0.94	16	0.94	14	14	1.0	14	1.0
Ear	2	1	0.50	2	0.66	9	8	0.70	10	0.83	14	14	0.82	14	0.82	14	14	1.0	14	1.0
Neck	0	2	0.33	2	0.66	6	8	0.70	10	0.83	15	13	0.82	15	0.88	14	14	1.0	14	1.0
Chest	1	0	0.16	1	0.33	5	4	0.37	6	0.50	10	12	0.64	13	0.76	14	14	1.0	14	1.0
Shoulder	1	2	0.50	2	0.66	8	8	0.66	9	0.75	16	13	0.85	16	0.94	14	14	1.0	14	1.0
Elbow	1	0	0.16	1	0.33	8	10	0.79	11	0.91	11	12	0.67	14	0.82	14	14	1.0	14	1.0
Carpus	1	2	0.50	2	0.66	7	10	0.70	10	0.83	15	17	0.94	17	1.0	14	14	1.0	14	1.0
Back	0	0	0.0	0	0.0	2	2	0.16	3	0.25	6	5	5.32	8	0.47	14	14	1.0	14	1.0
Costal	0	0	0.0	0	0.0	6	3	0.37	7	0.58	11	14	0.73	14	0.82	14	14	1.0	14	1.0
Axilla	0	0	0.0	0	0.0	3	4	0.29	5	0.41	7	7	0.41	8	0.47	14	14	1.0	14	1.0
Lumbarsacral	0	0	0.0	0	0.0	3	4	0.29	5	0.41	9	11	0.58	12	0.76	14	14	1.0	14	1.0
Flank	0	0	0.0	0	0.0	4	3	0.29	4	0.33	7	7	0.41	9	0.52	13	14	1.96	14	1.0
Abdomen	0	0	0.0	0	0.0	2	2	0.16	3	0.25	10	12	0.64	13	0.76	13	14	0.96	14	1.0
Pelvis	1	1	0.33	1	0.33	7	8	0.62	8	0.66	13	14	0.79	15	0.88	14	14	1.0	14	1.0
Groin	0	0	0.0	0	0.0	6	3	0.37	6	0.50	13	10	0.67	14	0.82	14	14	1.0	14	1.0
Knee	0	2	0.33	2	0.66	7	8	0.62	9	0.75	11	16	0.79	16	0.94	14	14	1.0	14	1.0
Tarsus	1	1	0.33	2	0.66	10	9	0.79	10	0.83	17	14	0.91	17	1.0	14	14	1.0	14	1.0
Scrotum	0/1		0.0	0	0.0	3/7		0.42	3	0.42	5/8		0.62	5	0.62	7/8		0.87	7	0.87

[a] L = left
[b] R = right
[c] RF = relative frequency (Thrusfield, 1990).
[d] AF = absolute frequency (Thrusfield, 1990).

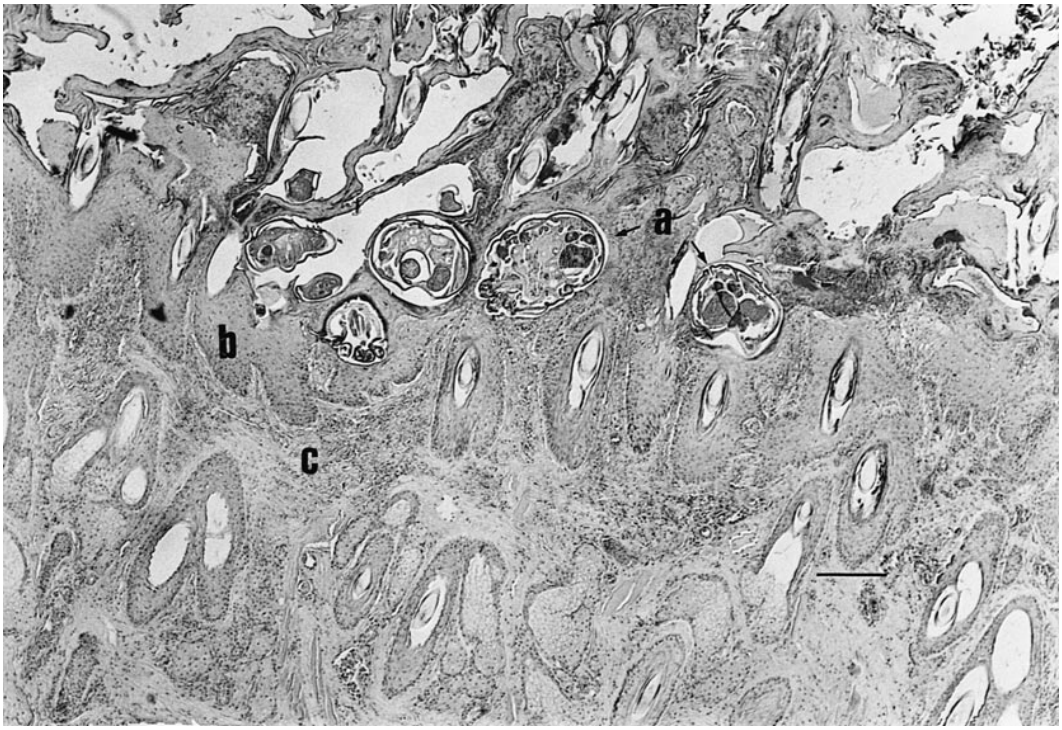


FIGURE 4. Low magnification of epithelium containing mites (a) covered with hyperkeratotic epithelium, acanthosis and infiltration with inflammatory cells (b), and showing intradermal proliferation of connective tissue (c). H&E. Bar = 200 μm.

1995). Four years after the epizootic started (León-Vizcaíno et al., 1989), Fandos (1991) described a reduction of 95% in this population of Spanish ibex. All the rates of frequency, dynamics, and severity of the sarcoptic mange studied (prevalence and incidence of morbidity, mortality and lethality) showed that the first epizootic of the disease was highly contagious and lethal.

The evolution of the mange epizootic was fatal for both the population of Spanish ibex of the Cazorla NP, and the subpopulation of "Los Rasos". This fact contrasted with the medium (23%) and high (45%) prevalences recorded in the nearest populations of Spanish ibex, in Sierra Nevada Nature Park, and in Sector I of the same park respectively (Pérez et al., 1997). The epizootiological differences between these two populations could be related to a hypothetical weakness of the Spanish ibex population of the Cazorla NP. Escós (1988) suggested this since, prior to the epizootic, he had observed that size, trophies, and fertility rate were lower and the general mortality rate was higher than the standard values for this species from other areas. Alternatively, the former epizootiological differences could be attributed to the high density (0.31 individuals/ha) of the whole wild ruminant population of the Park (deer, fallow deer, bighorn sheep, and Spanish ibex) and of Spanish ibex in particular (0.11 individuals/ha) (Escós and Alados, 1988). To this effect, Rossi et al. (1995) observed that the high density of the chamois population was a predisposing factor, increasing both the prevalence rate and the severity of mange.

The way the Spanish ibex uses its territory is very different from that of the chamois or ibex in alpine areas. This could be the origin of the differences in the population dynamics in sarcoptic mange cases. Chamois have been considered as "dis-

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tance animals" (Rossi et al., 1995), while the Spanish ibex are "gregarious", especially during the mating season. This characteristic favors the infection to an unusual degree. The social structure of these animals implies that males and females keep apart, except during the mating period (from mid-November to mid-January) (Alados, 1985). It seems that animals in the nest facilitated the advance of the epidemic to "Los Rasos" by means of the movement from distant areas of infected males. In addition, the characteristic coldness and humidity of this season favor the survival of mites (Arlian et al., 1989; Pérez et al., 1997). The disease usually reaches higher levels during the winter, coinciding with poorer physical conditions of the animals, decreased availability of food, the ethological characteristics of this species, and the biology of the parasite itself (Onderscheka, 1982; Arlian, 1989). For all these reasons, the accumulated incidence of mange in the "Los Rasos" population of Spanish ibex reached 82%.

Across multi-year periods, the prevalence rate of sarcoptic mange was significantly higher in males than in females (Pérez et al., 1997). In the present study, records obtained during the mating period showed that the disease is slightly more prevalent in males (100% versus 91%), although the difference is not statistically significant. This agrees with Rossi et al. (1995). They revealed that in first infections, as occurred in "Los Rasos", both sexes are equally vulnerable. The mating season of the Spanish ibex takes place in winter. This coincidence favors male weakness and increases their susceptibility to the mange. Rossi et al. (1995) indicated that, in winter, juvenile chamois were infected as often as adults, but with a lower prevalence of lethality because of the absence of mating stress. In the same way, juvenile males of the "Los Rasos" population tended to show clinical signs and die later than adult males.

Clinically, the appearance of an intense pruritus, reddening of the skin, and hair loss are the characteristic lesions in Spanish ibex. Subsequently, the skin appears cracked and scabby, and the animal may become emaciated and die.

There are no exhaustive and systematic descriptions of the spread of the mange to the different areas of the body in wild or domestic animals at the four stages of the disease. Kutzer (1966) studied sarcoptic mange in deer, chamois and roe deer, and agreed with Vyrypaev (1985) who studied the central Asiatic mountain ibex (*Capra sibirica*) and Scott (1988) and Kambarage (1992) with the domestic goat that the disease started in the head and neck, spread to the extremities, and the abdomen. More detailed data presented in this study showed the same profile in the Spanish ibex. Lesions began on the head and neck, although they ended up affecting all parts of the body, with skin lesions visible from a distance, especially on the head, neck, back, and extremities.

The description of the disease as it occurred in the Spanish ibex is very similar to what would correspond to an epizootic of sarcoptic mange in small domestic ruminants, both goats (Jackson et al., 1983; Ibrahim and Abu-Samra, 1985) and sheep, although sarcoptic mange is not very common in the latter (Soulsby, 1987; Scott, 1988). However, the extent and intensity of the lesions together with the severity of the clinical features and progression are far more notable in the cases of mange in the Spanish ibex, at least during this first epizootic, than those normally seen among domestic ruminants (Scott, 1988; Soulsby, 1987; Yager and Scott, 1985).

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